North American Tungsten Corporation Ltd.

ISSUED FOR USE

MACTUNG MINE PROJECT PROPOSAL
YESAB – EXECUTIVE COMMITTEE SUBMISSION

W23101110

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EXECUTIVE SUMMARY

North American Tungsten Corporation Ltd (NATC) is the proponent for the proposed Mactung mine development project (Mactung). NATC is the largest producer of tungsten concentrate in the western world and has its head office in Vancouver, British Columbia. The company also maintains an office in Whitehorse, Yukon, for the local coordination of mining and exploration activities at the existing Cantung mine and the Mactung property.

The Mactung property is in eastern-central Yukon, approximately eight km northwest of Macmillan Pass. It has been subject to mineral exploration activities by various parties since the 1960s. In the last few years, NATC has conducted mineral exploration of the property under a mining land use approval (LQ00138). NATC recently submitted an application to the YESAB Watson Lake Designated Office requesting an evaluation for renewal of this approval for further exploration activities.

The Mactung site contains a scheelite skarn deposit with an indicated current mineral resource of 33 million tons at a grade of 0.88% WO_3. Based on the size of the deposit as well as the average grade, NATC has estimated that the development of an underground tungsten mine could produce tungsten concentrate over an 11-year mine life. The purpose of the proposed Mactung project is the design, construction, operation, decommissioning, and closure of a tungsten mine and concentrating plant. The principal activities include:

- Extract tungsten-bearing ore from Mt. Allan by underground Long-Hole Blasting (LHB) stoping and cut-and-fill mining.
- Concentrate the tungsten mineral at a milling rate of 2,000 tonnes-per-day (tpd) using a scheelite gravity and flotation process.
- Transport the tungsten concentrate to market by way of Edmonton, AB, and Vancouver, BC.

The proposed project includes the mine site and accessory activities described in Section 5; including a new 35 km access road, upgrade of an existing 10 km service road on NATC's mineral claims, and an expansion of the Macmillan Pass Aerodrome.

FIRST NATIONS/COMMUNITY CONSULTATION

Based on the location of the project, the route to be taken by project-related traffic and the foreseeable environmental, economic and social effects of the project, NATC identified the following communities as being directly affected by the Mactung project.

- The Community of Ross River
- The Municipality of the Town of Faro (Town of Faro)

NATC also identified that the Mactung project is located within the traditional territories of the following three First Nations, and therefore needed to consult with each First Nation regarding the project:

- Ross River Dena Council
- Liard First Nation
- First Nation of Nacho Nyak Dun

Section 2 provides additional information on the form and dates of consultation conducted, information provided, a summary of views presented, how some of these views were similar or differing, and how these views have been fully and fairly considered.

No significant uncertainties, concerns, or issues were identified by First Nations, communities, and individuals. Their views were consistent in terms of appreciating the opportunities for economic development, employment, training, and First Nations capacity building; while ensuring that the project is conducted in a manner that is respectful of the economic, social, and environmental values of the area.

PROJECT LOCATION

The Mactung property is located on the Yukon side of the Yukon-Northwest Territories border in the Selwyn Mountain Range. The site is approximately eight kilometres northwest of Macmillan Pass in the Mt. Allan area. The nearest settlement accessible by road is the unincorporated community of Ross River, approximately 250 km southwest along the North Canol Road. The Mactung project area is located within the Yukon River watershed next to the continental drainage divide.

Legal land tenure for the proposed project can be identified as Yukon Government crown land. The proposed mine site, including the service road, will remain crown land for the duration of the project, with an authorization for Quartz Mining. The project occurs within the Mayo Mining District of the Yukon. NATC is the full owner of 151 quartz mining claims which form the area proposed for the Mactung mine site.

The Mactung project is proposed to occur in the Traditional Territories of three Yukon First Nations; including: the Ross River Dena Council, the Liard First Nation (both non-settled First Nations) and the First Nation of Nacho Nyak Dun (a settled First Nation). The project site, as currently designed, does not cross settlement land or land set aside by the non-settled First Nations, otherwise known as interim protected land.

Two land/resource plans were identified as relevant for fish and wildlife-related considerations of this project: *"Community-Based Fish and Wildlife Management Plan: Nacho Nyak Dun Traditional Territory"* and the *"Integrated Wildlife Management Plan: Ross River Traditional Territory"*.

DESCRIPTION OF EXISTING CONDITIONS

Environmental Conditions

NATC has commissioned extensive environmental baseline studies of the area in 2006, 2007 and 2008; including soils and surficial geology, wildlife, fisheries and aquatic resources, water quality, hydrology, hydrogeology, geochemistry, meteorology, vegetation, and archaeology. The following provides brief information of the environmental setting and unique features. The specific details are provided in Section 4, and in more detail in appended reports.

General Physiography, Surficial Geology and Vegetation

The Mactung mine is entirely located within the Selwyn Mountain Ecoregion of the Taiga Cordillera Ecozone of Canada. Distinguishing characteristics of the region include the Itsi Range and Keele Peak in the Hess Mountains, which are outside of the project area. Most of the project production area is located in unforested high alpine terrain, and forest stands occur only at lower elevations below about 1550 m a.s.l.

The Selwyn Mountains are characterized by sharp peaks, steep side slopes and narrow rounded valleys. Mean annual temperatures for the region are between -5ºC and -8ºC, with daily temperature averages that range between -20ºC in January to 8ºC in July. The project area lies in the discontinuous permafrost zone of the Yukon. The Selwyn Mountains have the second highest annual precipitation levels (600-700 mm) in Yukon next to the Coast Mountains (Smith et al. 2004).

Soils in the project area originate from glacial, colluvial and minor fluvial processes. The higher areas of the mountains have little or no soil development. The lower slopes and valley floors are covered with thin deposits of residual soils, overlying colluvium and glacial tills. Major rock types present are quartz monzonite, argillite, shale, hornfels, chert and limestone. The deposit occurs in skarn developed at the contact between a Cretaceous quartz monzonite stock and Lower Paleozoic calcareous sedimentary rocks.

The ecology of the proposed access road into the Mactung Mine from the North Canol Road is characterized by largely forested valleys surrounded by steep rugged mountains typical of the Selwyn Mountains. The alpine zone above 1700 m asl is mainly talus slopes below steep bedrock. The alpine gives way to thick willow dominated subalpine slopes between 1650 m asl and 1550 m asl. The boreal highland forested areas are a mix of subalpine fir with a lichen and moss understory on the majority of the slopes and subalpine fir-willow in drainage areas and avalanche chutes. Below 1400 m asl forests are a mix of white spruce and subalpine fir with a lichen and moss understory typical of the boreal lowland. Dry benches give rise to fescue grasslands and birch-lichen communities. A river system runs through the valleys with numerous feeder streams. The valley bottoms are a mix of willow-riparian communities and fast-flowing streams with deep cuts banks. In flatter areas, flow energy dissipates to form wetlands such as sedge meadow fen systems.

Wildlife

Abundance and distribution of wildlife in the Mactung area was found to be representative of boreal high, subalpine and alpine habitats. Caribou from the Redstone herd frequent the project area from spring to fall, as do grizzly bear. Moose, wolf, wolverine, fox and other small mammals are present in the area year-round. Sheep were not found to occupy the project area, with the exception of some infrequent incidental observations. Both terrestrial and wetland habitats were found to be used by migratory birds during the spring and summer seasons. Generally, habitat abundance was found to be high, with no limiting habitats in the areas studied.

Water Resources

Observations made during 2008 in the region surrounding the Mactung property indicate that natural acid rock drainage is present in the project area. The bedrock exposures in the area of the mine site are variable in sulphidic content and neutralization potential (NP), and contain both potentially acid generating (PAG) and non-acid generating (NAG) materials. Metal leaching analysis indicates that there should not be significant metal leaching associated with the Mactung ore and waste rock used for site development purposes.

Background metal concentrations in water for aluminum, cadmium, copper, iron, nickel, selenium and zinc were consistently found to be above the Canadian Council of Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life. The pH in the Tributary A upstream of potential minesite influences was found to be below the CCME guideline criterion. These deviations appear to be a natural phenomenon based on the limited level of development within the watersheds and the mineralized nature of the project area.

The project area is bordered by groundwater flow divides to the north, east, and south. The general groundwater flow direction generally mimics surface topography. Deep groundwater flows from the highest areas of Mt. Allan southwards, turning south-westerly or westerly in the valley of Tributary C (see Figure 4.1.10-14). Shallow groundwater flow within the overburden is characterized by local, small-scale flow cells, with its flow direction closely following local topography. Groundwater recharge typically occurs at higher elevations with groundwater ultimately discharging to surface water bodies at lower elevations in valleys. The presence of permafrost in the upland areas tends to reduce infiltration to groundwater. At lower elevations where permafrost is absent groundwater recharge occurs at the lower valley slopes in areas where a hydraulic connection exists between the shallow overburden and deep bedrock aquifers.

The surface waters in the Mactung are generally unproductive, with a low abundance of aquatic resources and fish. Natural factors such as elevation and undesirable natural water quality parameters (metals, acidic conditions) appear to limit the potential of these systems. Some low order tributaries with suitable water conditions were found to support resident populations of Dolly Varden, while the larger Hess River Tributary supports slimy sculpin year round, as well as Arctic grayling, Dolly Varden, and round whitefish on a seasonal basis.

Archaeology

Archaeological studies of the Mine site and adjacent facilities on the upper slopes of Mt. Allen and the valley floor were conducted in 2006 and 2007. No archaeological sites were discovered in the vicinity of the mine site or associated development facilities. The 2008 investigations focused on the proposed access road alignment from Macmillan Pass to the mine site; the proposed water pumping station on a southern tributary of the Hess River and connecting road/pipeline alignment to the mine site access road; and a proposed extension to the northeast end of the Macmillan Pass Aerodrome. One small archaeological site, KgTg-3 is located on a knoll in the Macmillan Pass. This site is considered unlikely to yield additional information that would significantly add to the understanding of the prehistory of the area.

Socio-economic Conditions

The socio-economic section indicates that human activity in the area is described as low due to its remote location and high elevation. Traditional subsistence hunting by individuals in the project area is low, while the area is used by trappers. The overall Yukon economy and structure is summarized, along with the socio-economic conditions in Ross River, Faro, Watson Lake, and Mayo.

Ross River is the closest community to the Mactung property and all road traffic to and from Mactung must pass through the community. The community as a whole has wide-ranging socio-economic interests in the project. Ross River is the home community of the Ross River Dena Council (RRDC), a Kaska First Nation. The First Nation delivers a variety of services to its citizens in the community. There is no other form of local government in the community. Ross River's relatively high levels of unemployment and underemployment, coupled with the high proportion of residents experienced in the trades and transportation occupations, indicates that the Mactung project may be able to draw a proportion of its labour force from the community.

Faro, like Ross River, is located relatively close to the project and the community has socio-economic interests in the development of the Mactung mine, especially if some of the mine's new employees choose to make their home in the community. Faro has been an incorporated municipality since 1970 and the Town collects property taxes, delivers a variety of municipal services, and has the authority to pass bylaws in the municipality. Faro has a high proportion of its work force either working in mining or having the skills and experience necessary to work in the industry. The Mactung project may therefore be able to draw on the community for a small proportion of its workforce. One of the overriding goals of the community is to attract additional permanent residents (especially families with children) to ensure a population is high enough to support, maintain and build on its existing infrastructure and services.

Watson Lake is situated in the south-eastern corner of the Yukon. Neighbouring villages are the home community of Liard First Nation (LFN). Because Mactung is located in the Kaska traditional territory, Liard First Nation has an identified interest in the project. Watson Lake itself has been an incorporated municipality since 1984. The Liard First Nation acts as the only form of local government in neighbouring villages. The high level of unemployment in the Liard First Nation villages, coupled with the high levels of residents with trades certificates and apprenticeships points to the likelihood that Mactung could readily draw a portion of its workforce from the community.

Mayo is located in central Yukon approximately 410 km north of Whitehorse. The community is the home of the First Nation of Nacho Nyak Dun. Because Mactung is located on an overlap between Nacho Nyak Dun and Kaska traditional territory, the Nacho Nyak Dun First Nation has an identified interest in the project. However, Mayo is more than 700 km away from the Mactung site by road and is therefore unlikely to see significant socio-economic effects from the project.

PROJECT DESCRIPTION

NATC is proposing to design, construct, operate, maintain, decommission, and abandon a tungsten extraction and concentrating mine in east-central Yukon. The principal objectives of the project follow.

- Extract tungsten-bearing ore from Mt. Allan by underground Long-Hole Blasting (LHB) stoping and cut-and-fill mining.
- Concentrate the tungsten mineral at a milling rate of 2,000 tonnes-per-day (tpd) using the scheelite gravity and flotation process.
- Transport the tungsten concentrate to market by way of Edmonton, AB, and Vancouver, BC.

Accessory activities include:

- A 35 km access road, with access gate, from the North Canol Road (Highway #6) to the project's pipeline and water supply road;
- A 13 km access road and water pipeline from the Hess Tributary to the mine site;
- Macmillan Pass Aerodrome upgrades to accommodate 19-passenger Beachcraft-sized aircraft, or equivalent;
- Freshwater intake facility and associated infrastructure on the Hess Tributary River;
- Water treatment and distribution system, including fire protection;
- Tungsten Processing Mill;
- Ammonium nitrate (ANFO) storage facility and emulsion plant, producing 1,300 kg/day of ANFO explosives;
- Workforce accommodation complex and first-aid station;
- Equipment maintenance facility;
- Warehouse, workshop and laboratory facilities;
- Administration office and communication system;
- Wastewater treatment facility;
- Solid waste facility (storage and incinerator);
- Powerhouse containing 5 x 2.5 MW diesel generators and power distribution system;
- Waste oil burner for building heating;
- Diesel Fuel Storage Facility for storage of 3.3 million litres of diesel;
- Storage facilities for other hazardous materials (e.g., propane, waste oil, engine oil, lubricants etc.);
- Dry-stacked tailings facility for storage of filtered tailings on surface;
- Underground backfill storage of filtered tailings;

- Site haul roads;
- Water diversion structures;
- Water retention dam and reservoir;
- Underground portal, ventilation, conveyor and ramps; and
- Underground crusher and grizzly feeder.

NATC is also planning to conduct the following additional accessory activities:

- Ground transportation of tungsten concentrate from the mine to market via Edmonton, AB, and Vancouver, BC, using the North Canol Road, Robert Campbell Highway, Alaska Highway.
- Air and ground transportation of supplies, including fuel, food, equipment, etc., from Vancouver, BC, and Whitehorse, YT, to the mine, using the Macmillan Pass aerodrome and North Canol Road.
- Air and ground transportation of personnel from surrounding Yukon communities to the mine, using the Macmillan Pass aerodrome and North Canol Road.

The project description also includes the alternatives considered to the proposed project and technologies being proposed.

Spatial Bounding of the Project

The spatial bounding of the project includes the principal and accessory activities as described in Section 5 of this project proposal, and is further described in Figures 5.4.1-1 to 5.4.3-9, which are included in Section 5.

Temporal Bounding of the Project

The temporal bounding for the project will be 20 years; from construction planned to begin in the spring of 2010 upon receipt of the applicable regulatory approvals, to the end of closure and monitoring activities in 2029.

Construction of the access road and aerodrome upgrades will be completed first during the summer/fall of 2010. At the same time, the camp and site development construction will begin, and it will continue until summer 2012. Construction of the process plant will commence immediately after the site pad and foundation is prepared, which will be approximately fall 2010. Plant construction is expected to take 27 months, lasting until fall of 2012. The power plant and power line infrastructure construction will commence in spring 2011 and will take approximately 15 months to complete.

The dry-stacked tailings facility and water retention dam construction will begin in the spring 2011 and is expected to take approximately 18 months to complete. Mine pre-development will commence at the beginning of 2011 and will continue for approximately 21 months ending in time for the site commissioning to take place in the fall of 2012. This correlates with the commencement of mining activities in early 2013.

The underground production phase will commence at the beginning of 2013 and is expected to continue for 11 years. Underground mining activities are projected to end in 2024. Closure activities will follow the underground mining phase. Closure activities starting immediately after underground mining ceases will take approximately two years and be completed by the end of 2026. Post-closure monitoring will occur until 2029, or as described by regulatory agencies.

Construction Phase

The construction phase of the Mactung project will commence in the Spring of 2010 and be completed and commissioned by the end of 2012. The construction phase can be summarized in the following components.

- Construction of access routes and infrastructure facilities, including staging areas, temporary construction camp, borrow sites, upgrade of Macmillan Pass Aerodrome, upgrade of existing tote and service roads, access road, and water intake infrastructure.
- Construction of mine site facilities, including infrastructure pads and site roads, accommodations complex, storage facilities (fuel, hazardous materials, wastes, explosives), process plant, powerhouse, maintenance shop, and administration buildings, the Ravine Dam, the dry-stacked tailings facility foundation, and surface water management infrastructure.
- Development of underground mine structures and components, including underground access (1895 and 1845 portals, drifts, ramps, conveyor decline, underground crusher and conveyor, and underground access to the ore body.

Section 5.4.2 includes the detailed information on the activities of the construction phase.

Operation Phase

The operation phase of the project will commence in early 2013 and be completed by the end of 2024, at which time the reclamation phase will begin. The operation phase of the project will include the following on-going activities:

- Erosion Control and Sediment Management;
- Camp and Ancillary Infrastructure;
- Access and Haul Roads;
- Explosives Storage Facilities;
- Processing Plant and Ancillary Infrastructure;
- Underground Access;
- Tailings Storage Facility;
- Ravine Dam;
- Diversion Channel;
- Borrow Areas;
- Hess River Tributary Pumping Station;
- Contaminated Soils;
- Infrastructure Pads; and
- Post-Closure Monitoring Programs.

A detailed Emergency Response Plan to address accidents and malfunctions, including spills, is included as Appendix M2.

Decommissioning and Closure

The goal of decommissioning and closure activities for the site is to eliminate any long term potential negative effects from the project. Progressive reclamation will be conducted on areas that are no longer operationally required during the production phase. Reclamation research into revegetation techniques will be included in the progressive reclamation program for the site. Areas have been grouped into reclamation units in order to allow for the development of decommissioning plans and associated costing. Conceptual decommissioning plans have been developed based on mining industry standards and accepted engineering practice and principles. Identification of post closure monitoring and inspection programs for the property are also included in the decommissioning and closure planning.

The following reclamation units are included in this Plan:

- Erosion Control and Sediment Management;
- Camp and Ancillary Infrastructure;
- Access and Haul Roads;
- Explosives Storage Facilities;
- Processing Plant and Ancillary Infrastructure;
- Underground Access;
- Tailings Storage Facility;
- Ravine Dam;
- Diversion Channel;
- Borrow Areas;
- Hess River South Tributary Pumping Station;
- Infrastructure Pads;
- Contaminated Soils; and
- Post-Closure Monitoring Programs.

The costing component for this plan is based on past experience and professional judgment. Earthworks sensitivity analyses have been conducted to allow for determination of the best combination of equipment for conducting the required works. A detailed Decommissioning and Closure Plan is provided in Appendix M1. This Plan also includes the estimated decommissioning and closure costs based on the conceptual decommissioning plans.

Climate Change Considerations

This section includes some examples of how NATC has incorporated climate change considerations into its project planning.

Project activities will result in the emission of carbon dioxide (CO_2) and other greenhouse gases (GHGs); however, the degree to which the proposed project activities may affect the climate is not measurable. NATC is committed to employing mitigation measures to minimize the project's contribution to emissions by:

- investigating the potential of using alternative energy sources, such as wind energy, at the site;
- using state-of-the-art power generators that are designed to produce fewer emissions; and
- having collective transportation of its workforce during shift-changes.

NATC has also considered, as alternatives to the project, whether some operational and waste management facilities could be located off-site in places such as Ross River or Whitehorse rather than on-site. It found that they could not be moved off-site as the nearest community is too far away to make it feasible due to excessive transport costs and increased emissions of greenhouse gases. Considerations for permafrost were also made during the mine ventilation design. Fresh air pumped underground during operations will not be heated in the winter to prevent thawing around all the underground openings. It also eliminates the need for hydrocarbon consumption to heat the underground air.

ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS ASSESSMENT

Methods

Environmental Effects Assessment

The methods used to assess the environmental effects of the project were developed in accordance with the Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions (referred to herein as "the guidelines"; YESAB, 2005) as well as other assessment literature and resource documents. The environmental effects assessment includes the following:

- Identification of Valued Components;
- Baseline Information Summary;
- Temporal and Spatial Boundaries Identification;
- Effects Characterization and Mitigation; and
- Significance Determination

The above factors were used to conduct environmental effects assessments of the following:

- Natural Landscape, Soil Stability and Terrain Hazards;
- Acid Rock Drainage/ Metal Leaching;
- Climate;
- Air Quality;
- Noise Levels;
- Wildlife;
- Water Resources, including:
  - Hydrology;
  - Water Quality;
  - Hydrogeology; and
  - Aquatic Ecosystems and Fisheries Resources; and
- Archaeology.

The topics "effects of the environment on the project" and the "effects of accidents and malfunctions" were considered, where relevant, as part of the effects assessment for each of the above noted topics.

Socio-economic Effects Assessment

The methods used to assess the Socio-economic effects of the project were developed in accordance with the *Guide to Socio-economic Effects Assessments* (YESAB 2006) as well as other assessment literature and resource documents. The socio-economic effects assessment includes the following:

- Identification of Valued Components;
- Baseline Information;
- Effects Assessment and Mitigation/ Enhancement; and
- Significance Determination.

The above factors were used to conduct socio-economic effects assessment of the following topics:

- Sustainable Livelihood;
- Community Vitality; and
- Health and Socio-cultural Well-Being.

Summary of Effects, Mitigation, Residual Effects, and Significance

In keeping with its commitment to the environment and to foster social and community well-being, NATC completed the effects assessment for its proposed Mactung Mine. This section provides a summary of the key potential environmental and socio-economic effects of the project, the proposed mitigation, potential residual effects, residual effects; and an analysis of significance of these effects.

Table 6.5-1, below, provide summaries of the anticipated residual effects and the significance determination for the main environmental effects that are identified in Section 6.4.1. Other topics, such as noise, were determined to have no residual effects and therefore low significance; and no further significance analysis was required. Such topics have not been included in the table below.

TABLE 6.4-1: SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

Key Environmental Effects	Proposed Mitigation Measures
Natural Landscape	
Reduced aesthetic value	• Minimum road widths and infrastructure footprint to be used • Cleared slopes to be revegetated. • Aesthetics will be considered for borrow pit site selection. • Minimum size borrow pits will be used
Loss of habitat	• Adopt an adaptive management approach, e.g., re-vegetate as required • Salvage of organic and mineral top soils for future reapplication during reclamation and revegetation

TABLE 6.4-1: SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	
Key Environmental Effects	Proposed Mitigation Measures
	• Prohibit the use of all-terrain vehicles, and limit the use of motorized vehicles and equipment to established roads • Educate employees regarding the removal of any local plants or plant parts for consumption • Educate employees regarding the sensitive nature of alpine vegetation. • Application of dust suppressants (water), if required, during summer operation of roads and the dry-stacked tailings facility • Restrict the placement of snow and sand piles to areas that are less sensitive to mineralization • Ensure any re-contouring, scarification, and reclamation of disturbed areas is conducted with appropriate and approved native seed mixes • Ensure revegetation measures are applied in a timely manner • Monitor potential accumulation of trace elements at established monitoring stations
Soil Stability	• Revegetate disturbed areas with native vegetation • Seeding, armouring or other mitigative techniques. • Relevant cut slope ratios will be used • Conscientious drainage management • Engineered cut and fill slopes • A slope stability assessment will be conducted. • A geotechnical evaluation will be conducted as part of the detailed road design • Specific design parameters will be applied to sections identified with permafrost • Adequately-sized culverts to be used and additional culverts placed where necessary • Sections of road with inadequate culvert frequency will be identified and additional ditches and culverts will be added as required. • Armoured outlets of culverts where no natural stream channel exists.
Human Safety	• Reporting system in place for potential rockfalls and actual fallen rocks • Development of an avalanche management and safety training program
Fish & Wildlife	
Increased Pressure on Key Wildlife Species	• Post speed limits and traffic signs in sensitive wildlife areas • Enforce that wildlife has the right of way • Prohibit the use of ATVs and snowmobiles at Mactung • Removal of infrastructure at decommissioning will return site to pre-development conditions • Roads and bridges to be decommissioned at the end of the project • Limit extent of clearing required for all infrastructure • Minimize clearing and construction activities during late winter (low energy reserves and high snow depth) • Reclamation through revegetation • Limit snow bank height at known travel corridors • A strictly enforced no hunting policy for all employees and contactors at Mactung • Installation of a gate on the new portion of the access road

TABLE 6.4-1: SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	
Key Environmental Effects	Proposed Mitigation Measures
	• Keep worksite clean • Manage garbage to avoid attracting bears and other wildlife • An environmental management plan will addresses the protocol for dealing with bear issues • Restrict vegetation clearing to outside of the bird breeding season • Develop and implement a Wildlife Monitoring Program in consultation with appropriate Yukon Government agencies and communities.
Biodiversity	• Avoid or minimize alteration of natural drainage patterns, topography and avalanches to maintain natural physical process • Proper camp management to avoid wildlife conflicts • Avoid introduction of invasive and alien species or deleterious substances • Minimize footprint
Effects on Aquatic and Fisheries Resources	• DFO permitting via Fisheries Act Authorization or Letter of Advice. • Screen all pump intakes to prevent fish fatalities • Instream works conducted in isolation from active channel. • Development of, and adherence to an environmental management plan (EMP) and emergency response plan, and monitoring for construction, site control, site stabilization, and instream works. • Protection of riparian areas and limited clearing. • Instream works in fish-bearing watercourse conducted at low flow periods. • No fords to be used as stream crossings • Minimize cleared areas and revegetation of disturbed areas • Application of best management practices within riparian zones • Preparation of compensation plan • Integration of DFO requirements for fish-bearing watercourse crossings • Education of employees regarding aquatic resources at Mactung • Acceptable release protocols for process water to be developed with federal agencies and territorial Water Board • Process water to be held during low flows if necessary • Toxicity testing of decant water to be conducted on an ongoing basis • Supplement winter flows if necessary to maintain minimums • Supplement early summer flows in Tributary C, if necessary, to mimic those during freshet • Fish passage conditions at closure will meet baseline conditions • DFO Letter of advice to be sought for removal of crossings • Restriction of access to Hess River Tributary following closure
Water Resources	
Effects on Water Quality	• Use of silt fences • Ditch filters and settling ponds/sumps at culvert inlets • Scheduled inspections of access roads and diversion channel to allow for timely removal of snow • Geochemical characterization to understand long-term acid rock drainage and metal

TABLE 6.4-1: SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	
Key Environmental Effects	Proposed Mitigation Measures
	leaching behaviour of tailings in order to minimize any acid generation • Underground disposal of potentially acid generating (PAG) material within frozen bedrock zone • Construction design to minimize drill and blast (avoidance) • Encapsulation of PAG materials • Encapsulation and isolation of PAG tailings • Isolation of underground materials from water and oxygen • Install Sewage Treatment system with qualified operations and maintenance personnel • Water withdrawals from all streams to kept to less than 10% of total flow • Instream work and earthworks best management practices and scheduling to be used. • Spill Contingency Plan available (Appendix M2) • Sediment management practices to be used for construction • Site water tank sized to provide some freshwater for processing • Development of site specific water quality objectives based on natural baseline information • Treat discharge water from the ravine dam, if required • Compliance with territorial Water Licence criteria • All discharges report to the reservoir • Best practice design and construction methods used for all access roads. • Erosion control and sediment management best practices to be used • Ravine dam operations manual to include section on the potential introduction of deleterious substances • Annual engineering inspections • Ability to stop discharges during periods of potential non-compliance with Water Licence • Main mine infrastructure is within the reservoir catchment • No water discharge to environment unless it meets Water Licence criteria • Decommission tailings facility prior to ravine dam • Monitoring of water quality in reservoir. • Collect seepage from the ravine dam, if required, using a series of groundwater extraction wells downgradient of the ravine dam and discharge back into the reservoir
Effects on Groundwater	• Dewatering of mine (from year five) and discharge of mine inflow into the reservoir • Backfilling and sealing of underground workings to reduce exposure to oxygen, thereby limiting oxidation in mine workings and generation of acidic rock drainage. • Keep PAG waste rock on surface less than five years. Monitor and accelerate disposal period of waste rock underground if acidification is observed
Effects on Surface Water Flow	• Erosion control and sediment management practices during construction. • Discharges around the work area to maintain flow • Use of Hess River Tributary to supplement un-diverted inflows • Construction sequencing to minimize flow interruptions • Maximum water withdrawal rates to be set for streams (no more than 10% of available flow)

TABLE 6.4-1: SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	
Key Environmental Effects	Proposed Mitigation Measures
	• Withdrawals from the Hess River Tributary are less than 6% for all but two months of the year • Additional fresh water storage in site water tank • Ravine dam discharge volumes will be managed in accordance with Water Licence • Discharges from the tailings and underground workings will collect in the reservoir • Decommissioning methods to be developed to minimize flow interruptions • Ravine dam discharges will be regulated • Decommissioning of infrastructure at the end of the project • Impermeable cover to isolate tailings at decommissioning

Table 6.5-2, below, provides a summary of the significance determination for the main socio-economic effects that are identified in Section 6.4.1. Significance is described as either positive effect, no significant adverse effect ("not significant"), or significant adverse effect.

TABLE 6.5-1: SUMMARY OF SOCIO-ECONOMIC EFECTS AND SIGNIFICANCE	
Main Socio-economic Effects	Significance
Sustainable Livelihood	
Traditional Economic Activities	Not significant
Employment and Employability	Positive effect
Infrastructure	Not significant
Economic Growth/ Healthy Business Sector	Not significant to positive effect
Community Vitality	
Community Population	Faro – Positive effect Ross River – Not significant
Social Cohesion and Quality of Life	Not significant to positive effect
Health and Socio-cultural Well-being	
Best Possible Health	Not significant
Reducing Alcohol and Drug Abuse	Not significant
Public health and safety	Not significant
Workplace health and safety	Not significant
Cultural Continuity	Not significant

Statement of Significance

Under YESAA, proponents are required to conduct an analysis of significance as part of their environmental and socio-economic assessment documentation.

For the Mactung project, the methods used for analysing and determining the significance of effects for the valued environmental and socio-economic components are described in Sections 6.1.1 and 6.1.2, respectively.

With respect to environmental effects, the significance ranking was determined as either "low", "moderate", or "high". With the application of mitigation measures, the assessment of each of the valued environmental components has found the significance of effects to be "low" for all environmental components, except for the following:

- The project may have moderate effects on the aesthetic value of the natural landscape after mitigation and until final decommissioning. Some visual effects will remain from clearing, stripping and excavating the road corridor, mine footprint, borrow pit and quarry sites. These effects will decrease with time.
- Clearing of alpine riparian and wetland ecosystems may result in some moderate effects in terms of loss of habitat.

No environmental effects with "high" significance were found as a result of applying mitigation measures.

With respect to socio-economic effects, the significance ranking is described as "positive effect", "not significant", or "significant adverse effect". With the application of mitigation measures, the assessment of each of the valued socio-economic components has found the significance of effects to be "not significant" for all categories, except for the following:

- A positive effect was determined for the categories "Employment" and "Employability".
- A combination of "not significant to positive effect" was determined for "Community Population", "Social Cohesion and Quality of Life", and "Economic Growth/Healthy Business Sector".

No "significant adverse socio-economic effects" were found.

With the overall low significance of the environmental effects, and the combination of "not significant to positive effect" significance determination for socio-economic effects, the overall significance of the effects of the Mactung project is considered to be low.

CUMULATIVE EFFECTS ASSESSMENT

NATC has reviewed the activities that exist in the area of the proposed project as well as any projects for which there is a known proposal.

The project area is remote and at high elevation. There is limited activity occurring in the region; with no agriculture or timber harvesting, or oil or gas exploration currently underway. The

Macmillan Pass area has been subject to considerable mineral exploration since the 1960s, but there are no operating mines in the region. Traditional subsistence hunting has been identified to occur in the project area and its effects to wildlife and wildlife habitat are considered within Section 6 of this proposal. Recreational hunting has also been considered and has been found to be limited. The project area is used by some trappers, and the Mactung project area falls within one Yukon outfitting.

NATC is not aware of any industrial or other activity in the area that would result in residual effects that could be assessed with any residual effects from the Mactung proposal.

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APPENDICES

1.0 INTRODUCTION

1.1 THE ORGANIZATION AND LAYOUT OF THE PROJECT PROPOSAL

The Mactung project proposal is in a report format and organized according to the order of topics set out in YESAB's *"Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions"*. All of the tables, figures and photographs are placed within the body of the text and are listed within the table of contents. Some incidental photographs are also included within the body of the text. Each main section of the proposal has a dedicated Appendix which is referenced within each section, e.g., Community Consultation – Appendix A. Where necessary, each Appendix is subdivided into sub-appendices, e.g., A1, A2, A3 etc. All appendices are contained on a single compact disc included at the back of the project proposal.

1.2 PROPONENT INFORMATION

North American Tungsten Corporation Ltd (NATC) is the proponent for the proposed Mactung Mine Development Project. The company is a publicly listed Tier 1 Junior Resource Company engaged primarily in the operation, development, and acquisition of tungsten mineral properties in Canada. NATC has been identified as the largest producer of tungsten concentrate in the western world. The company is managed by its Executives and Board of Directors in the head office located in Vancouver, British Columbia. The company also maintains an office in Whitehorse, Yukon for the local coordination of mining and exploration activities at the Cantung and Mactung properties (See Figure 1.2-1).

North American Tungsten Corporation Ltd. - Assessment Representative

Mr. S. Wade Stogran R.P.Bio, Vice-President of Environmental and Corporate Affairs is the company representative for the assessment and permitting of the Mactung Project. Mr. Stogran has 30 years' experience in the field of mining and the environment. His work has been spread throughout both North American and South America providing a variety of experience in the mining industry. Mr. Stogran has worked both for mining companies and as a consultant during his time with the industry. As the Vice President of Environmental and Corporate Affairs, Mr Stogran has taken on the responsibility of permitting for both the Mactung and Cantung properties and is also charged with ensuring compliance in environmental and socio-economic matters.

Mr. S. Wade Stogran,
VP, Environmental and Corporate Affairs
North American Tungsten Corporation Ltd.
#1640 - 1188 West Georgia Street
Vancouver, British Columbia, V6E 4A2
p. 604.684.5300
e. wstogran@natungsten.com

Figure 1.2-1: General location of NATC's Cantung and Mactung properties

Primary Contact

Mr. Glenn Rudman of EBA Engineering Consultants Ltd (EBA) is the primary contact for the proposed Mactung Project during the assessment by the Yukon Environmental and Socio-economic Assessment Board (YESAB). Mr Rudman works as a Project Manager in EBA's Whitehorse Environmental Group, focusing on the management of projects requiring environmental baseline studies, environmental and socio-economic assessments, consultation, contaminated sites remediation and other environmental science related works. Mr Rudman has more than 13 years' experience in the environmental field and a Master of Science in Environmental Management.

Glenn Rudman, M.Sc.
Project Manager
EBA Engineering Consultants Ltd.
Calcite Business Centre
Unit 6 – 151 Industrial Road
Whitehorse, Yukon, Y1A 2V3
p 867.668.2071 x236
e. grudman@eba.ca

EBA's project sponsors are Mr. Rick Hoos, M.Sc., R.P.Bio., and Mr. Bengt Pettersson, B.Sc., M.A. Mr. Hoos is a Principal Consultant with EBA; with more than 35 years' professional experience in managing large development projects in the mining, oil and gas, and pipeline industries. Mr. Pettersson is the Project Director for EBA's Whitehorse Environment Group with 26 years' professional experience, of which 19 years were with the Yukon's environmental regulatory regime. Mr. Pettersson will be the alternate contact to Mr. Rudman if Mr. Rudman is not available at EBA's office.

1.2.1 Corporate Policies

NATC's Corporate environmental, health and safety policy is provided below.

OBJECTIVE

The objective of this Environmental, Health and Safety Policy (the "Policy') is to ensure that **NORTH AMERICAN TUNGSTEN CORPORATION LTD**. (the "Company", "our" or "we") are:

Committed to the protection of health and environment for present and future;

Strive to be leaders in environmental, health and safety management.

ENVIRONMENTAL, HEALTH AND SAFETY POLICY

Our Board of Directors has established an Environmental, Health and Safety policy. The Board of Directors and/or Management are responsible for overseeing our environmental, health and safety practices. The Board of Directors and/or Management's responsibilities in relation to the Policy include:

1. Design, construct, operate and reclaim our facilities to meet or surpass applicable regulations and law;
2. Promote active commitment to this policy and provide our employees with the necessary resources to support their capabilities in its implementation;
3. Provide a workplace where open communication between our employees and management on health, safety, environmental and mining practices is encouraged.
4. Ensure that effective, realistic systems are in place to minimize risk to health, safety and the environment;
5. Communicate openly with the public and government on our plans, programs and performance;
6. Work cooperatively with government agencies, local communities, supplier and trade associations to ensure the safe handling, use and disposal of all our materials and products;
7. Acquire scientific knowledge and technologies to continuously improve the safe, efficient use of our processes, materials and emergency response systems. Apply

best management practices to advance environmental protection and to minimize environmental risk; and

8. Maintain an active, continuing, self-monitoring program to ensure compliance with government and Company standards.

1.3 PROJECT BACKGROUND

The tungsten deposit at the proposed Mactung property was discovered by James Allan in 1962. It is assumed that the discovery by Allan, a geologist of Amax Northwest Mining Co. Ltd. (Amax), was related to the original regional stream sediment survey carried out as part of the Ogilvy Reconnaissance Project.

Amax completed a number of surveys between 1963 and 1967 including geological mapping, rock geochemical sampling, magnetometer surveying, and grid geochemical soil sampling. In 1968, surface diamond drilling was completed followed by the 1970 development of an 11 km access road from the North Canol Road to the property. Further investigations were completed in 1971 and 1972 with the surface drilling of 69 holes. In 1973, development at the property was furthered with the construction of an adit and 726 m of lateral advancement and 27 m of raising within the Lower Zone, known as the "2B" horizon. During these works a 295 tonne bulk sample was obtained and sent for metallurgical testing. From the adit, underground holes were drilled in order to define the mineralization of the Lower Zone. Further surface diamond drilling and underground development was completed by Amax in 1979 and 1980. Environmental and feasibility studies continued at the site until 1985, when tungsten prices fell and work on the project ceased.

The Mactung and Cantung properties were sold to Canada Tungsten Mining Corporation (CTMC) in 1986. CTMC went through a number of mergers and acquisition between 1986 and 1997 at which time both properties were purchased by North American Tungsten Corporation Ltd. (NATC).

In 2000, the markets began to show an improvement in tungsten prices, allowing NATC to reopen the Cantung Mine in December 2001. Underground production and milling resumed until December 2003 when the mine was closed. Preparatory work for reopening the mine began in July 2005, and operation at the Cantung Mine resumed in late September 2005 and continues to this date.

During 2005, NATC began surface diamond drilling at the Mactung property to define the west end of the deposit and upgrade the resource classification of some mineral resource blocks.

Since the surface drilling in 2005 NATC has undertaken a vast array of environmental baseline studies, geotechnical investigations, socio-economic research and consultation activities in order to advance the Mactung project to the assessment and permitting stages for mine development within the Yukon.

In December of 2008, NATC submitted an application to the Watson Lake Designated Office requesting a Designated Office Evaluation for renewal of a Class III mining land use permit (#LQ00138) for further exploration activities. This assessment is centered on the need to removal a bulk sample intended to further the company's understanding of the resource.

Essential to the further advancement of the Executive Committee project proposal for mine development has been the ongoing communication between NATC and affected First Nations and communities, regulators and assessors. A summary and analysis of the consultation activities is contained in Section 2.0 of this proposal.

Discussions with regulators and assessors have been on-going. Both NATC and EBA representatives have been working with these parties to ensure all information required for the successful permitting of the project have been acquired and presented within the Project Proposal. Formal meetings between the parties have been summarized in the Table 1.4-1 below.

TABLE 1.4-1 MEETINGS WITH REGULATORS AND ASSESSORS REGARDING THE PROPOSED MACTUNG DEVELOPMENT

Date	Parties Present	Subject of Meeting
November 26, 2007	NATC; EBA;	Presentation provided to assessors and regulators to give an overview of the project, planning, and objectives.
January 9& 10 2008	NATC; EBA;	Introduction of Wade Stogran of NATC to Regulators for the purpose of introducing the project and the companies objectives for assessment and permitting
September 24, 2008	NATC; EBA; YG (Project Coordinator, EMR, ECO, Env) Environment Canada	Presentation and discussion of project design, baseline studies and mitigation objectives and planning.

1.4 PROJECT PURPOSE

The purpose of the proposed Mactung Mine Development Project is the design, construction, operation, decommissioning, and abandonment of a tungsten extraction and concentrating mine in eastern-central Yukon. NATC's objectives for the project are:

- The extraction of tungsten ore from Mt. Allan utilizing underground Long-Hole Blasting (LHB) stoping and cut-and-fill mining;
- Concentration of the tungsten mineral through the scheelite gravity flotation and separation process;
- Production at a 2000 tonnes per day (tpd) milling rate for eleven years, commencing in 2013; and,

- Transportation of tungsten concentrate to market via the North Canol Road and Robert Campbell Highway.

Tungsten (or Wolfram) is a unique metal as it has the lowest coefficient of expansion and lowest vapour pressure of any metal. It has the highest melting point and is corrosion resistant and environmentally benign. The metal is extremely hard and very dense. These characteristics put tungsten in great demand in the global market. The metal is used predominantly in hard metal production but is now being used in a growing number of applications. For instance tungsten may be used as a replacement for lead, radiation shielding, electronics and ballistics. The metal has few substitutes, making it valuable for industrial applications.

The Mactung site contains a scheelite skarn deposit with an indicated current mineral resource of 33 million tons at a grade of 0.88% WO_3. Based on the size of the deposit as well as the average grade, NATC has estimated that the development of a tungsten mine could produce tungsten concentrate over an 11-year mine life.

The Mactung site hosts the largest known, high grade, undeveloped tungsten skarn in the world. The quality and size of the deposit combined with the site location in a politically, economically and environmentally stable territory makes the proposed Mactung Project a strategic and viable asset.

To further the project's success NATC will be able to use its experience of operating the Cantung mine located south of the Mactung site in the NWT close to the Yukon and NWT border. This experience will allow NATC to ensure the economic success and environmental integrity of the Mactung project.

1.5 REQUIRED AUTHORIZATIONS AND REGULATORY APPROVALS

1.5.1 YESAA Requirements

This project is subject to assessment in accordance with Section 47(2)(c) of YESAA. The "circumstances" for this requirement are identified below in sections 1.5.2 and 1.5.3.

1.5.2 YESAA Project Regulations

The proposed Mactung Project has been identified as being assessable under YESAA through Schedule 3 Item 3(a) of the *Assessable Activities. Exceptions and Executive Committee Project Regulations*, which states:

> *"Construction, decommissioning or abandonment of (a) a metal mine, other than a gold mine, with an ore production capacity of 1500 t/day or more."(Canada, 2005)*

Further to these criteria, the project meets the requirements for an assessment through the requirement of authorizations from a variety of federal and territorial agencies. All the major authorizations required for the development of the Mactung mine are outlined below.

It should be noted that a final and comprehensive list of required authorizations can only be identified at the time of permitting.

1.5.3 Applicable Legislation

Quartz Mining Licence

The Quartz Mining Licence, *Quartz Mining Act*, may be issued in two phases, the first will include authorization to proceed with construction activities which do not require licensing through the *Waters Act* (Yukon). The second phase will form the final component of the major licensing requirements for the proponent and will provide authority to finalize construction activities and proceed with the proposed mining program.

Type A Water Licence

Water licensing is conducted by the Yukon Water Board under the authority of the *Waters Act* (Yukon). The Mactung project will require a Type A Water Licence for its operation activities.

Applicable legislation, regulations, and approvals for this project are identified in Table 1.5-1 below.

TABLE 1.5-1 APPLICABLE LEGISLATION REGULATIONS AND APPROVALS

Legislation	Regulations	Approvals
Canada		
Aeronautics Act	Canadian Aviation Regulations	Memorandum of Understanding for the expansion of an aerodrome
Canada Wildlife Act		
Canadian Environmental Protection Act		
Explosives Act	Blasting Regulations Ammonium Nitrate and Fuel Oil Order	Blasting Permit Explosives Factory Licence Explosives Magazine Licence Non-Mechanical ANFO Certificate Blasting Explosives Purchase and Possession Permit Permit to Transport Explosives
Fisheries Act	Metal Mining Effluent Regulations	Metal Mining Effluent Authorization Authorization for Works or Undertakings Affecting Fish Habitats
Migratory Birds Convention Act		
Navigable Waters Protection Act		Approval under Navigable Water Protection Act
Species at Risk Act		

TABLE 1.5-1 APPLICABLE LEGISLATION REGULATIONS AND APPROVALS

Legislation	Regulations	Approvals
Transportation of Dangerous Goods Act	Transportation of Dangerous Goods Regulation	Waste Manifest
Health Canada	Guidelines for Canadian Drinking Water Quality	
Yukon		
Building Standards Act		Building Permit
Dangerous Goods Transportation Act	Dangerous Goods Transportation Regulation	
Electrical Protection Act		Electrical permit
Environment Act	Storage Tanks Regulation Air Emissions Regulations Solid Waste Regulations Special Waste Regulations Contaminated Sites Regulation Spills Regulation	Storage Tank Permit Air Emissions Permit Solid Waste Permit Special Waste Permit Relocation Permit, LTF Permit
Gas Burning Devices Act		
Highways Act	Highways Regulations Bulk Commodity Haul Regulations	Over dimensional Weight permit Access permit Permit to work within the Highways right-of-way
Historic Resources Act	Archaeological Sites Regulation	Archaeological Sites Permit
Lands Act	Lands Regulation	
Occupational Health & Safety Act	Occupational Health and Safety Regulations (applicable Parts, including mine safety)	
Public Health and Safety Act	Eating and Drinking Places Regulations Sewage Disposal Systems Regulations Drinking Water Regulation	Sewage Disposal System Permit
Quartz Mining Act		Quartz Mining Licence
Territorial Lands (Yukon) Act	Territorial Lands Regulation Land Use Regulation Timber Regulation Territorial Quarrying Regulation Forest Protection Regulation	Land Use Permit Timber Permit Quarry Permit Land Lease
Waters Act	Waters Regulation	Type A Water Licence Type B Water Licence
Wildlife Act	Wildlife Regulations	

TABLE 1.5-1 APPLICABLE LEGISLATION REGULATIONS AND APPROVALS		
Legislation	Regulations	Approvals
Codes and Guidelines		
Canadian Council of Ministers of the Environment (CCME)	Canadian Environmental Quality Guidelines Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products Canada-wide Standards for Petroleum Hydrocarbons in Soil	
Canadian Dam Association Dam Safety Guidelines		
National Building Code		
National Fire Code		

2.0 FIRST NATIONS/COMMUNITY CONSULTATION

2.1 INTRODUCTION

With regards to First Nation and community consultation, section 50(3) of the Yukon Environmental and Socio-Economic Assessment Act (YESAA) states:

"Before submitting a proposal to the Executive Committee, the proponent of a project shall consult any first nation in whose territory, or the residents of any community in which, the project will be located or might have significant environmental or social economic effects."

This section describes how NATC, notified, engaged with, and consulted affected communities and First Nations regarding the proposed Mactung project. It also describes how any views or information provided to NATC about the Mactung project by the consulted parties were fully and fairly considered in the preparation of this project proposal.

2.2 IDENTIFICATION OF PARTIES TO BE CONSULTED

Based on the location of the project, the route to be taken by project-related traffic and the foreseeable environmental, economic and social effects of the project, NATC identified the following communities as being directly affected by the Mactung project.

- The community of Ross River
- The Municipality of the Town of Faro (Town of Faro)

Also, NATC identified that the Mactung project is located within the traditional territories of the following three First Nations, and therefore needed to consult with each First Nation regarding the project:

- Ross River Dena Council
- Liard First Nation
- First Nation of Nacho Nyak Dun

Table 2.2-1 provides a summary contact list of those communities and First Nations who were contacted and given notice of the proposed Mactung project.

The form and detail of the contact information including copies of letters, flyers, emails, presentations and project information handouts are appended to this proposal. The appended information is grouped by community as follows:

- Appendix A1: Ross River
- Appendix A2: Town of Faro
- Appendix A3: Liard First Nation
- Appendix A4: First Nation of Nacho Nyak Dun

TABLE 2.2-1 SUMMARY CONTACT LIST OF PARTIES NOTIFIED OF THE MACTUNG PROJECT

Contact information	Method of contact
Chief Gordon Peter Ross River Dena Council General Delivery Ross River, Y.T., YOB 1SO	Letters, telephone calls, meetings. Please see Table 2.3-2 for further details.
Community of Ross River	Flyers sent to each household and posters distributed in Ross River advertising public meetings/open houses. (Approximately 173 occupied houses and businesses). Meetings and open houses. See Table 2.3-2 for further details.
Mayor and Council Municipality of the Town of Faro P.O. Box 580 Faro, Y.T., Y0B 1K0	Letters, telephone calls and meetings. Please see Table 2.3-3 for further details.
The Municipality of the Town of Faro (Town of Faro)	Flyers sent to each household and posters distributed in Faro advertising public meetings/open houses (Approximately 310 occupied houses and businesses). Meetings and open houses. Please see Table 2.3-3 for further details.
Chief Liard McMillan Liard First Nation Box 328 Watson Lake, YT Y0A 1C0	Letters, telephone calls, email, meetings. See Table 2.3-4 for further details.
Chief Simon Mervyn First Nation of Nacho Nyak Dun Box 220 Mayo, YT Y0B 1M0	Letters, telephone calls, email, meetings. See Table 2.3-5 for further details.

2.3 FORM OF CONSULTATION

Various formats of consultation were used during consultation with potentially affected communities and First Nations. Table 2.3-1 provides a summary of each format of consultation and where it was used.

TABLE 2.3-1 SUMMARY OF CONSULTATION FORMATS AND LOCATIONS

Method	Ross River Community	Faro Community	First Nation of Nacho Nyak Dun	Liard First Nation	Ross River Dena First Nation
Public meeting(s)	**Y**	**Y**	**N**	**N**	**Y**
Information Open House	**Y**	**Y**	**Y**	**N**	**Y**
Information handouts	**Y**	**Y**	**Y**	**Y**	**Y**
Meetings with Mayor and Council	**N/A**	**Y**	**N/A**	**N/A**	**N/A**
Meetings with Chief and Council	**Y**	**N/A**	**Y**	**Y**	**Y**
Information booth at General Assembly	**Y**	**N/A**	**Y** (Mayo)	**Y*** (Watson Lake)	**Y** (Watson Lake)

*NATC also had an information booth at the South East Yukon and Northern BC Mining Forum held in Watson Lake on October 21 to 23, 2008.

The dates, methods, format and content of contact with First Nations and communities are provided in more detail the following four tables along with the time provided for recipients to consider the information. The location of supporting documentation is also provided in the tables. See Table 2.3-2 (Ross River), 2.3-3 (Faro), 2.3-4 (Liard First Nation), and 2.3-5 (First Nation of Nacho Nyak Dun). The information regarding contact with Ross River Dena Council and the community of Ross River has been provided in the same table (Table 2.3-2).

TABLE 2.3-2 METHODS, FORMAT AND CONTENT OF CONTACT WITH ROSS RIVER				
Date notice was provided	Method of Contact	Format / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
January 18, 2008.	Letter from NATC to Chief Gordon Peter	Request for meeting regarding the Mactung project. Arrangements made for meeting on February 19.	N/A	Appendix A1
February 11, 2008.	Flyers sent to each household and business via Post Master (Canada Post data: 172 residences and businesses). Posters sent to Sharon Ladue, RRDC, for distribution.	Flyers and posters advertised the community meeting for February 19, 2008	N/A	Appendix A1
February 19, 2008	Meeting with Chief and Council in Economic Development. Office, 10.00am	Mactung project presentation and discussion	Verbal timeline provided of June, 2008 for the YESAB submission.	Appendix A1: presentation. Table 2.6-1: Recorded views and questions
February 19, 2008	Community meeting. Community Hall. 6.00pm. Supper provided.	Supper provided to attendees followed by Mactung project presentation and questions.	Verbal timeline provided of June, 2008 for the YESAB submission.	Appendix A1 - presentation. Table 2.6-1: Recorded views and questions
April 25, 2008. Flyers and posters sent to Ross River from Whitehorse	Flyers sent to each household and business via Post Master (Canada Post data: 172 residences and businesses). Posters sent to Sharon Ladue, RRDC, for distribution	Flyers and posters advertised community open house, 3pm – 8.30pm. Tuesday May 6, 2008	N/A	Appendix A1

TABLE 2.3-2 METHODS, FORMAT AND CONTENT OF CONTACT WITH ROSS RIVER				
Date notice was provided	Method of Contact	Format / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
May 6, 2008	Open House in Community Hall. 3.00pm – 8.30pm	Presentations offered but not given due to low attendance. Plans of the project available and information handout available (dated May 2008).	No end date specified	Appendix A1 – Information handout. Table 2.6-1: Recorded views and questions
May 7, 2008	Meeting with Chief and Council, Boardroom, RRDC	Discussion regarding project and future working relationship. Maps, 3D model and Information handout available (dated May, 2008).	No end date specified	Appendix A1: Information handout. Table 2.6-1: Recorded views and questions
August 12-14, 2008	NATC's Attendance at the Kaska General Assembly, Watson Lake	NATC information booth at General Assembly. Information handouts available (dated June 2008).	September 1, 2008 given as a deadline for comments prior to project proposal submission to YESAA	Appendix A1: Information handout. Table 2.6-1: Recorded views and questions
October 3, 2008. Flyers and posters sent to Ross River from Whitehorse	Flyers sent to each household and business via Post Master (Canada Post data: 172 residences and businesses). Posters sent to Sharon Ladue, RRDC, for distribution	Flyers and posters advertised Open House on October 15, 2008	N/A	Appendix A1:
October 15, 2008	Meeting with Chief and Council.	Presentation available but not shown at the request of Chief and Council. Discussion mostly covered SEPA arrangements. Information handout provided (dated October 2008)	November 7, 2008 given as a deadline for comments prior to project proposal submission to YESAA	Appendix A1: Information handout and presentation. Table 2.6-1: Recorded views and questions

TABLE 2.3-2 METHODS, FORMAT AND CONTENT OF CONTACT WITH ROSS RIVER

Date notice was provided	Method of Contact	Format / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
October 15, 2008	Open House. Community Hall. 3.00pm – 9.30pm	Presentation available for anyone who wanted to see it (partial presentations were given coverving specific aspects). Maps, 3D model and information handout available (dated October 2008). Refreshments available.	November 7, 2008 given as deadline for comments prior to project proposal submission to YESAA	Appendix A1: Information handout and presentation. Table 2.6-1: Recorded views and questions

TABLE 2.3-3 METHODS, FORMAT AND CONTENT OF CONTACT WITH FARO

Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
January 18, 2008	Letter from NATC to Mayor and Council	Request for meeting regarding Mactung project proposal	No deadline provided	Appendix A2
February 14, 2008.	Posters emailed to Faro Town Council.	Poster advertised community meeting (with supper) for Wednesday, February 27 2008, 6.15pm. Posters distributed to each occupied residence and business through the Town Council	No deadline provided	Appendix A2
February 27, 2008	Meeting at Council offices	Presentation followed by questions and comments	Verbal timeline provided of June, 2008 for the YESAB submission.	Appendix A2: presentation. Table 2.6-2: Recorded views and questions
February 27, 2008	Community meeting / presentation	Community meeting with Mactung project presentation. Refreshments provided.	Verbal timeline provided of June, 2008 for the YESAB submission.	Appendix A2: Presentation. Table 2.6-2: Recorded views and questions

TABLE 2.3-3 METHODS, FORMAT AND CONTENT OF CONTACT WITH FARO

Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
April 25, 2008	Posters emailed to Faro Town Council.	Poster advertised community open house 4pm – to 9pm. Faro Recreation Centre, Wednesday May 7, 2008. Posters distributed to each occupied residence and business through the Town Council	N/A	Appendix A2
May 7, 2008	Open House with presentation	Open House. 4pm – 9.00pm. Faro Recreation Centre. Presentation given. 3D model, maps, Information handouts (dated May, 2008).	No deadline provided	Appendix A2: Presentation, information handouts. Table 2.6-2: Recorded views and questions
May, 2008 (date unknown)	Email to Faro Town Council	Digital version of information handout (dated May 2008) for Town website.	No deadline provided	Appendix A2: Information handout.
June 15, 2008	Email to Faro Town Council	Digital version of information handout (dated June 2008) for Faro	September 1, 2008	Appendix A2: Email and information handout
October 8, 2008	Meeting with Mayor and Council.	Town Council offices. 9.30 am – 11.00 am. Discussion regarding the project. 3D model and maps and Information handout available (dated October 2008). Updated presentation not required by Mayor and Council.	November 7, 2008	Appendix A2: Information handout. Table 2.6-2: Recorded views and questions
October 10, 2008	Email to Faro Town Council.	Digital version of Information handout (dated October 2008) for Town website.	November 7, 2008.	Appendix A2: Information handout.

TABLE: 2.3-4 METHODS, FORMAT AND CONTENT OF CONTACT WITH LIARD FIRST NATION				
Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
January 18, 2008	Letter from NATC.	Request for meeting re project proposal.	N/A	Appendix A3: Letter
January 29, 2008	Meeting between LFN representatives and NATC representatives regarding Mactung, Vancouver.	Minutes of meeting which state some high level objectives by both NATC and LFN.	No deadline provided	Appendix A3:
February 18, 2008	Meeting in Whitehorse (LFNDC offices) with Chief Liard McMillan, Councillor Wolftail and advisors.	Mactung presentation given. Discussion and questions regarding the project.	No deadline provided	Appendix A3: Presentation Table 2.6-3: Recorded views and questions
May 28, 2008	Email to Mr. Alex Morrison of LFNDC from NATC.	Suggestion regarding setting up consultation meetings in Watson Lake.	N/A	Appendix A3: Email
June 9, 2008	Email to Mr. Alex Morrison from EBA on behalf of NATC.	Request for advice regarding community meetings in Watson Lake regarding the Mactung project.	N/A	Appendix A3: Email
July 2, 2008	Email to Mr. Alex Morrison of LFNDC.	Mactung information handout (dated June 2008) attached to email.	September 1, 2008	Appendix A3: Email and Information handout
July 8, 2008	Letter to Chief Liard McMillan.	Covering letter and hard copies of Mactung information handout (dated June, 2008).	September 1, 2008	Appendix A3: Letter and Information handout

TABLE: 2.3-4 METHODS, FORMAT AND CONTENT OF CONTACT WITH LIARD FIRST NATION

Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
July 8, 2008	Delivery to LFNDC office, Whitehorse.	Mactung information handouts (dated June 2008) delivered to LFNDC office, Whitehorse (hand delivered).	September 1, 2008	Appendix A3: Information handout
July 11, 2008	Email correspondence between Mr. Alex Morrison (LFNDC) and Mr. Wade Stogran (NATC).	Email correspondence speaks of an opportunity to meet with LFN Chief and Council at the Yukon Handgames, Watson Lake, July 18-July 20, 2008.	N/A	Appendix A3: Email
July 15, 2008	Email from Ms. Laurie Allen (LFN) to Mr. Wade Stogran (NATC)	Email states that Chief Liard McMillan would not like to have any community meetings in the near future. Mr. Stogran's response is included.	N/A	Appendix A3: Email
July 18-July 20, 2008	NATC's presence at the Yukon Handgames, Watson Lake.	NATC information booth set up on July 19 with project maps and 3D model. NATC engaged with LFN members about the Mactung and Cantung projects. Information handouts available about the project (dated June, 2008).	September 1, 2008	Appendix A3: Information handout.
July 25, 2008	Email from Mr. Wade Stogran (NATC) to Ms. Agnes Ball (Kaska Tribal Council).	Email outlines arrangements for NATC to attend the Kaska General Assembly in Watson Lake.	N/A	Appendix A3: Email

TABLE: 2.3-4 METHODS, FORMAT AND CONTENT OF CONTACT WITH LIARD FIRST NATION				
Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
August 12-14, 2008	NATC presence and information booth at Kaska General Assembly, Watson Lake.	NATC booth at General Assembly. Information handouts available (dated June, 2008), maps and 3D model.	September 1, 2008	Appendix A3: Information handout.
August 31, 2008	Letter from Mr. A. Morrison (LFNDC) to Mr W. Stogran (NATC).	Letter requests Mr. Stogran's views on an agenda for a mining forum to be held in Watson Lake in October, 2008 and a financial contribution for the conference.	N/A	Appendix A3: Letter dated August 31, 2008
October 16 2008	Mactung information handout (dated October, 2008).	Information handout (dated October, 2008) taken to LFNDC office, Whitehorse (hand delivered)	November 7, 2008	Appendix A3: Information handout
October 21-23, 2008	NATC's attendance at mining forum, Watson Lake organised by LFN and LFNDC.	NATC information booth at Mining Forum. Information handout (dated October, 2008), maps, 3D model available. Mr. Stogran gave presentation about the proposed Mactung project.	November 7, 2008	Appendix A3: Information handout
October 27, 2008	Email from Mr. Wade Stogran (NATC) to Chief Liard McMillan (LFN).	Email of thanks to Chief Liard McMillan for the opportunity for NATC to attend the mining forum and offers regret that a proposed meeting between NATC and LFN Chief and Council did not take place during the Mining Forum.	N/A	Appendix A3: Email

TABLE: 2.3-4 METHODS, FORMAT AND CONTENT OF CONTACT WITH LIARD FIRST NATION				
Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
November 6, 2008	Email from Mr. Alex Morrison to Chief Liard McMillan.	Attempt to set up a meeting with LFN Chief and Council.	N/A	Appendix A3: Email
November 11, 2008	Email from Mr. Wade Stogran (NATC) to Mr. Alex Morrison (LFNDC)	Potential arrangements for a meeting in Watson Lake with Chief and Council on November 20 (subsequently changed to November 21).	N/A	Appendix A3: Email
November 21, 2008	Meeting at LFNDC office, Whitehorse, Chief and Council and Wade Stogran (NATC)	Meeting discussed the Mactung project, Cantung, funding, business opportunities, SEPAs and arrangements with RRDC. Information handouts provided (dated October 2008).	N/A	Appendix A3: Draft Minutes of meeting and information handouts.

TABLE: 2.3-5 METHODS, FORMAT AND CONTENT OF CONTACT WITH FIRST NATION OF NACHO NYAK DUN				
Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
January 18 2008	Letter from NATC.	Request for meeting re project proposal	N/A	Appendix A4: Letter
February. 26, 2008	Meeting with Chief and Council and advisors	Mactung presentation given. Discussion and questions regarding the project.	No deadline provided	Table 2.6-4: Recorded views and questions

TABLE: 2.3-5 METHODS, FORMAT AND CONTENT OF CONTACT WITH FIRST NATION OF NACHO NYAK DUN				
Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
March 27, 2008	Letter from Chief Simon Mervyn (FNNND) to Mr. Wade Stogran (NATC).	Letter provides general support for the Mactung project and requests further talks regarding future opportunities that may be beneficial	N/A	Appendix A4: Letter
May 14, 2008	Letter from Mr. Wade Stogran (NATC) to Chief Simon Mervyn (NND)	NATC requested to have an information booth at FNNND's General Assembly in June 2008.	N/A	Appendix A4: Letter
June 27-29, 2008	NATC information booth at FNNND General Assembly	Booth at General Assembly. Informal presentation given by Mr. Stogran. Information handouts (dated June, 2008) provided. Maps and 3D model available.	September 1, 2008	Appendix: A4: Information handouts. Table 2.6-4: Recorded views and questions
July 8, 2008	Letter to Chief Simon Mervyn (FNNND) from Mr. Wade Stogran (NATC).	Thank you letter sent for General Assembly hospitality. Copies of environmental baseline study reports sent to NND (on CD) and additional handout information (dated June 2008).	September 1, 2008	Appendix A4: Letter, information handout
September 18, 2008	Letter from Ms. Joella Hogan, Heritage and Culture Manager, FNNND to Mr. Wade Stogran (NATC)	Letter outlining NND's consideration of Traditional Knowledge relating to the Mactung Property.	N/A	Appendix A4: Letter

TABLE: 2.3-5 METHODS, FORMAT AND CONTENT OF CONTACT WITH FIRST NATION OF NACHO NYAK DUN				
Date notice was provided	Method(s) of Contact	Notes on format / method / content of contact	Time provided to the recipient(s) to consider the information received	Location of documentation / comments
October 16, 2008	Email to Steven Buyck, Lands Manager, FNNND.	Updated Mactung information handout (dated October 2008). Hard copies sent in the mail the same day.	November 7, 2008	Appendix A4: Email, information handout
October 24, 2008	Email from Mr. Steven Buyck (FNNND) to Mr. Glenn Rudman (EBA)	Request for information regarding the project	N/A	Appendix A4: Email. Table 2.6-4: Recorded views and questions
November 5, 2008	Email to Mr. Steven Buyck (FNNND) from Mr. Rudman (EBA Engineering)	Response to Mr. Buyck's email of October 24, 2008.	N/A	Appendix A4: Email. Table 2.6-4: Recorded views and questions.

Further information is provided below on the format of consultation meetings.

Public Meetings with Presentation

Public meetings with presentations were advertised to communities to allow people to come together at a community venue to:

- Learn about the proposed Mactung project,
- Ask questions about the project, and
- Provide views or suggestions.

A light supper was served or refreshments were available before the presentations started. A Powerpoint presentation was delivered by Mr. Wade Stogran, Vice-President of Environmental and Corporate Affairs, NATC. The presentation provided an overview of tungsten as an important world commodity, and included details about the Mactung project. More information about the presentation is provided in Section 2.4.

Views and questions were also invited from attendees and were documented for full consideration. The public meetings also provided an opportunity for NATC to obtain information about the communities' valued socio-economic and environmental components (VESECS). NATC asked those present at the meetings about their experiences of previous mines in the area. By asking people what was good and bad about former mines in the area attendees provided NATC with a good understanding of the preferences people had for working at mines and with mining companies, e.g., preferred shift patterns for working at mines, the need for cross-cultural awareness training, and different approaches to environmental protection. Additional VESECS were also established through some of the questions and comments provided by attendees at the meetings. The socio-economic and environmental components derived from the meetings were supplemented by previously published material that was made available to NATC, e.g., *The snow that eats the snow, A mining strategy for Ross River, Yukon Territory* (RRDC 2004); *Faro Forward: Integrated Community Sustainability Plan (ICSP)* (Town of Faro 2007).

Open Houses

'Open houses' were organized as a less formal and more flexible alternative to public meetings. Anyone interested in the project could visit the venue of the open house during advertised times and obtain the same level of information as at a public meeting. Open houses generally took place between 3.00 pm and 8.30 pm to allow people the opportunity to attend.

The open house format provided individuals with the opportunity to speak with a representative from NATC on a one-to-one basis. Comments and questions were also invited from attendees and were documented for full consideration. If attendees did not wish to pass on their comments verbally, there was also the opportunity to write down comments relating to specific headings, e.g., social issues, economic issues, environmental issues. Maps, photographs, 3D model and information handouts were also available at the open houses. Refreshments were provided at all the open houses and presentations about the proposed project were also offered at pre-set times.

There was opportunity at the consultation meetings for people to comment on the project in writing as well as verbally

Meetings with Chief and Council and Mayor and Council

Meetings with Chief and Council of the three First Nations that have territories in which the project is located, along with meetings with Mayor and Council in Faro, were organized to:

- Provide information about the proposed Mactung project,
- Provide feedback to council on any related public meetings and open houses,
- Respond to views and questions about the project, and
- Where relevant, discuss matters relating to the project such as the collection of Traditional Knowledge and Socio-Economic Participation Agreements (SEPAs).

The views and questions provided at the meetings were documented for full consideration by NATC.

North American Tungsten information booth at the First Nation of Nacho Nyak Dun General Assembly, June 27, 2008

North American Tungsten information booth at the Yukon Hand Games hosted by Liard First Nation in Watson Lake, July 19, 2008

2.4 INFORMATION PROVIDED DURING CONSULTATION

Copies of information provided to those consulted are appended to this project proposal. The appendices are divided up as follows:

Appendix A1: Ross River

Appendix A2: Town of Faro

Appendix A3: Liard First Nation

Appendix A4: First Nation of Nacho Nyak Dun

A summary of the information used as part of the consultation process is provided below.

Powerpoint Presentations

The presentations were used to introduce people to NATC and the proposed Mactung project. In general, the presentations covered the following topics:

- Tungsten – the product
- North American Tungsten Corporation – location of offices, projects
- The Cantung Mine
- The Mactung deposit and overview of proposed operations
- Benefits to the community
- The mine and the environment
- Mactung environmental baseline studies
- Mine reclamation and closure (including an example from Quebec).
- Contacts

The presentation was updated over time as more information was obtained and decisions about the mine were made by NATC. Copies of the relevant versions of the presentation are provided in the relevant appendix for each community or First Nation.

Information Handouts

From May 2008 onwards copies of information relating to the Mactung project were made available at the public meetings, open houses and meetings with Chief and Council, and Mayor and Council. The Town of Faro also posted the information on its website. As more information became available for the proposed project the information handout was updated and either sent to or made available to the relevant communities and First Nations. The versions of the information handout are dated:

- May, 2008
- June, 2008
- October, 2008

Copies of the different versions of information handouts are appended to this proposal within the relevant appendix for each community or First Nation.

In general, the information handouts contained the following information.

- North American Tungsten Corporation – office location, projects
- Mactung location, history and ownership
- Tungsten markets
- The mine and the environment
- Employment, training and the local economy
- Mine reclamation and closure
- Traditional use of the Mactung area
- The consultation process
- Contacts

Detailed Maps and Three-Dimensional Model

From May 2008, detailed maps (34" x 22") showing the proposed footprint of the mine site were provided at all meetings and open houses. The map at a 1:40,000 scale gave an overview of the proposed mine infrastructure location, access roads and the Macmillan Pass Aerodrome. The 1:5,000 scale map provided a more detailed layout of the mine including the location of buildings, the pumphouse, dry-stack tailings facility, ravine dam and reservoir. The maps provided visual two-dimensional information that could be discussed with people at the meetings.

A three-dimensional model at a scale of approximately 1:40,000 was also available at all meetings and open houses from June 2008. The model showed the boundary between the Yukon and the NWT, the mill and accommodation block, reservoir and ravine dam, dry-stack tailings facility and the pumphouse location. The model also showed the location of the proposed road to the mine in relation to the North Canol Road and the location of the Macmillan Pass Aerodrome adjacent to the North Canol Road. The model provided a three-dimensional visual setting of the mine and the proposed access road that NATC representatives could discuss with people at meetings.

Three dimensional model used to help people gain an understanding of the Mactung setting

2.5 OPPORTUNITY TO PRESENT VIEWS

From the time of the initial meetings and telephone conversations with the affected communities and First Nations, NATC representatives indicated that they could be contacted to discuss any aspect of the Mactung project. NATC representatives could be contacted by letter, email, telephone or in person. Contact information was provided to individuals by way of email addresses, letters, business cards and the information handouts.

During the various meetings, responses to views, questions and comments were provided to the best of NATC's knowledge. The views, comments and questions were also documented for full and fair consideration within this project proposal (see Section 2.6).

For project meetings and information that took place before June 2008, no specific deadline was provided for people to provide views and comments. This is mainly due to that fact that some key decisions about the mine and the related infrastructure were being made at this time and there was some uncertainty about the precise timing of the project proposal submission. However, a clear message was given that NATC intended to submit a project proposal to YESAB in 2008. From June onwards, specific deadlines were set for views and comments to be received about the project. The deadlines set are given below.

- For information provided in June and July – The deadline for responses was September 1, 2008; and,
- For information provided in October – The deadline for responses was November 7, 2008.

2.6 SUMMARY OF VIEWS PRESENTED

The views and questions received from individuals about the proposed project were placed under one of five broad categories. These categories are:

- Mine scope (construction, infrastructure operations, decommissioning, closure)
- Social
- Economic
- Environment
- Consultation

The views and questions received during the consultation process were recorded in tables to allow the views to be compared across the communities and First Nations. The tables are numbered as follows:

Table 2.6-1. Ross River
Table 2.6-2. Town of Faro
Table 2.6-3. Liard First Nation
Table 2.6-4. First Nation of Nacho Nyak Dun

NATC has been able to identify the main issues presented by individuals or groups from different communities and First Nations, and understand the main similarities and differences between the views. These have been summarized in the sections below.

2.6.1 Similarity of Views

The main views and questions that were raised more than once during the consultation process, either within a community or First Nation or between communities and First Nations, are listed below under the relevant category. Full consideration of each view or question by NATC is provided within Tables 2.6-1 through to Table 2.6-4.

Mine Scope

- Transportation routes for the concentrate and mine supplies
- The mine life
- The power source for the mine
- The upgrading and maintenance of the North Canol Road including crossing of the Pelly River

Social

- Shift schedule

Economy

- Number of workers at the mine
- Early training for mine jobs
- Types of positions available and availability of jobs

Environment

- Traditional use of the Mactung property area
- Downstream water quality and flow direction

Consultation

- Coordination of meetings with other mining projects to reduce consultation "burn out" in communities

2.6.2 Differences of Views

There were no views presented where communities offered opposing views on any particular topic. However, several people within the Faro community suggested that an alternative haul road route could be considered which would allow mine related vehicles to use the existing bridge across the Pelly River, near Faro. This would negate the need to build a new bridge over the Pelly River or upgrade the barge on the Pelly River in Ross River. In addition, Faro residents suggested that Faro has the space available for infrastructure to provide a staging area for mine traffic as well as the housing and the amenities for mine staff. These comments are discussed further in section 2.7.

2.7 CONSIDERATION OF VIEWS PRESENTED

The questions and views received during the consultation process have allowed NATC to identify the main issues presented by individuals or groups, and demonstrate a full and fair consideration of each of the questions and views received by each community or First Nation. Tables 2.6-1 through to Table 2.6-4 provide consideration of each view and question. The views and questions have been presented this way to ensure no view or question was overlooked. This sometimes means that there is repetition of views and the consideration of the views in the tables.

Where a view or question was identified as a possible project design component or mitigation it has been incorporated in the Project Description section (Section 5) or within the effects assessment section (Section 6). However, many of the views and questions received did not raise specific concerns or offer specific suggestions, but rather mostly required clarification or further detail about the proposed mine phases.

TABLE 2.6-1: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM ROSS RIVER										
Theme	**Question / View**	**NATC's Consideration of Questions and Views**	**RRDC Chief and Council. February 19, 2008**	**Ross River Community Meeting. February 19, 2008**	**Ross River Open House. May 6, 2008**	**RRDC Chief and Council. May 7, 2008**	**Handgames Watson Lake. July 18-20, 2008**	**Kaska General Assembly. August 12-14, 2008**	**Ross River Chief and Council. October 15, 2008**	**Ross River Open House. October 15, 2008**
Mine (project scope)	Where will the concentrate be shipped to? On which route will the ore from Mactung be trucked?	The concentrate will be trucked from Mactung to both Edmonton and to Vancouver. From Edmonton, the concentrate will travel by freight to eastern Canada for Eurpoean markets. From Vancouver the concentrate will be shipped to Asian markets.	1							
	How will you get to the mine? Where does the road go?	The mine staff will fly to the Macmillan Pass Airstrip and then travel by bus into the mine site. Supply trucks will travel up the North Canol Road to approximately 5 km west of the Macmillan Pass Aerodrome and then travel north along a valley route to the mine site. Maps and figures were provided at meetings showing the proposed road route to the mine. Figures showing the mine and road layout can be found in Section 3 and Section 4 of this proposal.								1
	What is the potential mine life?	The proposal is for 11.2 years of underground mining with a potential for an additional 15 years of open pit mining. Only the underground mining is being submitted for the environmental and socio-economic assessment.	1							
	Where exactly is the ore body?	The ore body is in Mt. Allen with 90% of the ore body being in the Yukon. NATC will only be mining in the Yukon.	1							
	Will there be tailings? What kind and how will they be dealt with?	Approximately 50% of the tailings will be put back underground (backfilled) and approximately 50% will be dry-stacked and compacted on the surface.	1							
	Will there be lots of equipment mobilized for the project up the North Canol for summer 2008?	The amount of equipment mobilized up the North Canol Road during 2008 was comparable to 2006 and 2007. Some additional fieldwork took place in 2008 which is now complete.	1							
	How much traffic can be expected? How many trucks?	It is planned to have four trucks per day leave the mine site and four arrive at the mine site. For the trucks arriving at the mine site there will be one truck of fuel and three trucks of food and other supplies. For the trucks leaving the mine site, one will contain tungsten concentrate and three will either be empty or will be transporting items that need to be removed from the mine site, e.g. empty propane containers, equipment that needs repairing. NATC will draw up a traffic plan to minimize traffic problems in Ross River in consultation with the community. Such a plan may include scheduling all trucks to avoid entering town while children and adults are walking to or from school, and ensuring that they do not tie up the ferry for long stretches.	1							
	Has reclamation security been set or any paid yet?	The reclamation security has not been set. Reclamation security is usually set during the permitting process which follows the YESAA process.	1							
	There are some very bad, steep switchbacks near the mine including Moose Hill and Blue Hill. This will be problematic for truck access.	The North Canol Road is a public highway and the responsibility of the Government of Yukon. It is NATC's understanding that the the road will be upgraded by the Government of Yukon to a standard that is adequate for NATC's use.		1						
	Which airstrip will be used?	The Macmillan Pass Airstrip will be used to fly mine staff to and from the project area. Some supplies will also be flown in. The airstrip will be upgraded from 1500 feet long to 4000 feet long, and from 50 feet wide to 100 feet wide. The airstrip will be leased from the Government of Yukon for the life of the mine and then returned to the Government of the Yukon when the mine is closed.	1							
	Is there enough space available to expand the Macmillan Pass Airstrip?	Yes, at the south eastern end.								1
	How will you deal with medivacs? How does the Cantung mine do medivacs?	Cantung has contract with Alkan Air to provide air medivacs on-call. Also have paramedics and an ambulance on site. NATC anticipates a similar arrangement at Mactung.		1						
	How will you power the mine? Can you tap into the Faro hydro grid? Operating 7-8 MW generators will need a lot of diesel trucked in.	NATC will have paramedics and an ambulance on site and will have a contract with Alkan Air for medivacs.		1						

TABLE 2.6-1: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM ROSS RIVER

Theme	Question / View	NATC's Consideration of Questions and Views	RRDC Chief and Council. February 19, 2008	Ross River Community Meeting. February 19, 2008	Ross River Open House. May 6, 2008	RRDC Chief and Council. May 7, 2008	Handgames Watson Lake. July 18-20, 2008	Kaska General Assembly. August 12-14, 2008	Ross River Chief and Council. October 15, 2008	Ross River Open House. October 15, 2008
Mine (project scope)	If the North Canol is upgraded, it will have to be maintained as well which will be expensive because of problem areas.	NATC is discussing the maintenance of the North Canol Road with the Yukon government. NATC also has current experience with a similar need for maintenance of the Nahanni Range Road, leading to Cantung.	1	1						
	How will you cross the Pelly River? Use the ferry and ice bridge? What about the shoulder seasons that can be up to 7-8 weeks in spring and fall?	The Government of Yukon will be responsible for making arrangements to cross the Pelly River. This could be done by building a bridge or by having an appropriately sized ferry. The Minto mine has shown that it is possible to operate using a ferry and ice bridge while storing enough supplies and stockpiling product during the shoulder seasons.	1							
	Are you getting support from the community to improve the North Canol and build a bridge over the Pelly?	There has been support from Ross River to improve the condition of the North Canol Road. NATC has not received specific comments about a potential bridge over the Pelly River.		1						
	RRDC generally supports an upgrade to the North Canol Road but the incorporation of Traditional Knowledge is important.	Traditional Knowledge is an important issue and RRDC should discuss this with the Government of Yukon who will be leading the upgrade of the North Canol Road.							1	
	Do you absolutely need a bridge to make this project work?	A bridge or a ferry would allow the project to proceed.		1						
	How will workers get to the mine?	Mine workers will be flown to the Macmillan Pass Airstrip and then be taken by bus to the mine site.					1			
	When will mine construction start?	The planned construction is due to start in the second quarter of 2010 and last about 27 months.								
	RRDC would like to have a schedule on the mine development, e.g. permitting, construction etc.	A detailed schedule (Gantt chart) of the proposed mine YESAA and permitting process, construction, production and mine closure phases was provided to Ross River Dena Council on October 15, 2008							1	
Social	RRDC would like some support from NATC regarding the Resource Planning that is needed to upgrade the North Canol Road.	NATC is happy to support RRDC in its requests for support regarding resource planning. Draft letters can be sent to Mr. Wade Stogran for review.							1	
	A socio-economic partnership agreement with RRDC will likely take one year.	NATC is working closely with RRDC to develop a Socio-Economic Partnership Agreement.				1				
	RRDC would like to have some financial assistance for a healing centre.	NATC can currently offer support in kind but not direct financial support. This may change as NATC approaches the production phase of the mine.				1			1	
	How will Traditional Knowledge be incorporated into the Mactung project? It may be beneficial for RRDC to take the lead on Traditional Knowledge rather than the Dena Kayeh Institute. Budgets, protocols and workplans can be drawn up very quickly. Face to face meetings are preferred.	To date, RRDC and the community have provided some limited Traditional Knowledge which has been considered as part of the project proposal. NATC is happy to continue to work with RRDC on this issue and is prepared to receive any Traditional Knowledge related to the Mactung project that RRDC wishes to pass on.							1	
Economic	Training for mine jobs has to start now to get people ready. Life skills are also important, not just technical skills.	NATC is working closely with the Yukon Mine Training Association (YMTA) to provide training for underground mine workers. It is in NATC's best business interests to help train people as skilled trades are generally in short supply in mining.	1						1	
	Transferable skills are important.	NATC will support appreticeships and training for transferable skills such as millwrights, electricians, pipefitters and heavy equipment operators.	1							
	Want to see a benefits package negotiated between RRDC and NATC.	NATC will negotiate a SEPA with RRDC.	1							

TABLE 2.6-1: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM ROSS RIVER

Theme	Question / View	NATC's Consideration of Questions and Views	RRDC Chief and Council. February 19, 2008	Ross River Community Meeting. February 19, 2008	Ross River Open House. May 6, 2008	RRDC Chief and Council. May 7, 2008	Handgames Watson Lake. July 18-20, 2008	Kaska General Assembly. August 12-14, 2008	Ross River Chief and Council. October 15, 2008	Ross River Open House. October 15, 2008
Economic	Jobs are not the only or even necessarily the primary benefit. Construction and production phases potentially provide economic benefit but disruption to the land starts at the beginning of exploration. Benefits need to be negotiated for access to the land and for any disruption caused.	NATC's exploration phase is 99% complete but any benefits will be negotiated as part of the SEPA.	1							
	How could the RRDC take a direct ownership stake in NATC?	RRDC would need to purchase stock on the open market or make a direct payment to NATC for new shares.	1							
	Other mines have not followed up on the promises they made about training local people. What will be done to make sure that promises are kept.	NATC is already involved with the YMTA to train underground miners and will support future training initiatives because training local people makes economic sense and fosters good relations between the company and local communities. Mines tend to have high employee turnover rates and training and hiring local people helps to lower turnover rates.		1						
	Does Cantung have scholarships or help to get employees to tech school? Apprenticeships?	Mactung will have apprentices for millwrights, electricians, pipefitters and heavy equipment mechanics and scholarships could be negotiated as part of a SEPA.		1						
	The RRDC will be looking to negotiate a SEPA that includes education and training aspects.	NATC will happy to negotiate a SEPA with RRDC. The negotiations should include discussions about education and training among other topics.	1							
	Mining companies like Hud Bay used to offer university scholarships to students from mining towns like Flin Flon in mining-related fields like mining engineering.	NATC will offer scholarships to students for mine related training once mine production has been agreed and the regulatory and assessment processes have been completed successfully.		1						
	Any scholarships should be available for both First Nation and non-First Nation students.	If NATC does provide scholarships then they will be available to both First Nations and non-First Nations people.		1						
	Will there be jobs and training at Mactung?	NATC is planning to employ between 250 and 300 people during the construction phase of Mactung and about 250 people during the operation phase of the mine. Training will be provided both on and off site.					6	5		2
	Having a Social Economic Partnership Agreement (SEPA) in place between RRDC and NATC before the project moves to development will be necessary.	NATC will work closely with RRDC to develop a SEPA before the project moves to the construction phase of the project.				1				
	Is it possible to purchase shares in NATC?	NATC shares can be purchased through a stockbroker. NATC shares are listed on the Toronto Stock Exchange Venture Exchange (TSX-V) under the abbreviation NTC.					1			
	I have a trapline that runs along the proposed access road off the North Canol Road. NATC will need to talk to me before that route is used. Also, once the route is in place I would be interested in any maintenance contracts for the road.	NATC will be happy to to discuss arrangements for the trapline and potential contracts for the maintenance of the road.								1
	Will there be contracting opportunities, e.g., trucking etc.?	There will be a number of contracting opportunities during all phases of the mine.							1	

TABLE 2.6-1: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM ROSS RIVER

Theme	Question / View	NATC's Consideration of Questions and Views	RRDC Chief and Council. February 19, 2008	Ross River Community Meeting. February 19, 2008	Ross River Open House. May 6, 2008	RRDC Chief and Council. May 7, 2008	Handgames Watson Lake. July 18-20, 2008	Kaska General Assembly. August 12-14, 2008	Ross River Chief and Council. October 15, 2008	Ross River Open House. October 15, 2008
Environment	Request lots of photos of the site before further development.	Many photographs of the Mactung property have been taken. Some of these are in existing reports provided to RRDC, NND and LFN. Others are stored digitally by NATC and its consultants.	1							
	Request for all environmental baseline (including archeology) study reports completed.	NATC has provided copies of all the environmental baseline reports from 2006 and 2007 to RRDC, LFN and NND. Reports from 2008 will be provided when they are available.	1	1						
	Will the existing proposal to expand Nahanni Park affect Mactung.	The proposed new boundary of the park is more than 100km south of Mactung. Mactung will not be affected by the proposal.	1							
	It's possible that new parks will be proposed in the region or there will be an extension of the North Canol Heritage Trail into Kaska territory	To date, the proposed extention to the Nahanni Park boundary is approximately 100 km south of Mactung. No formal extensions to the North Canol Heritage Trail have been proposed by the Government of Yukon.	1							
	RRDC would like to be involved from the beginning in environmental monitoring.	When on-going environmental monitoring for the mine is planned with the regulators then contracts will be issued to qualified consultants for the work. Any monitoring work given to RRDC will be subject to discussions between RRDC and NATC.	1							
	In summer 2007 there was a youth environmental training program that used the Mactung site. RRDC is applying for Yukon Mine Training fund support to repeat the program and would like continued support from NATC.	NATC did provide some funding plus workshop expertise in 2007 and will be happy to provide similar support in the future.	1							
	Runoff from the mountain [mine site] will flow into the Hess River drainage; contaminants are a concern.	NATC, in agreement with Government of Yukon and federal regulators, will set up monitoring stations at key locations to ensure that all discharges to the natural environment meet the relevant standards and regulations.		1						
	How good has the archeological work been?	Archaeological studies were completed in 2006, 2007 and 2008. In 2007 and 2008 the fieldwork included digging shallow pits by hand. There were no significant findings. Copies of the archaeological 2006 and 2007 reports have been provided to First Nations. The 2008 report will be provided when it is available.	1							
	The MacPass area is well used by the Dena people for hunting and gathering, e.g., hoary marmots. The mine will affect people's ability to use the area for hunting and gathering.	NATC will enforce a no hunting policy for the immediate mine area and along that part of the road that is controlled by the company. NATC respects that hunting in the mine area will be affected by the mine but only for the life of the mine.				1	1		1	
	The Red Stone caribou herd may be affected by the MacTung project.	A small subset of the Redstone caribou herd does use the proposed mine and road areas as part of its summer range. The herd's winter range does not overlap the project area. The mine footprint is a very small portion of the total range area of the Redstone herd. NATC is confident that the Mactung project will not have any significant effects on the Redstone herd in the short or long term. Furthermore, NATC will put in place measures to keep any effects to a minimum such as a no hunting policy for all mine employees, access control on the proposed road to prevent an increase in hunting pressure in the area, and traffic management systems such as speed controls to keep wildlife fatalities to an absolute minimum.				1				

TABLE 2.6-1: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM ROSS RIVER

Theme	Question / View	NATC's Consideration of Questions and Views	RRDC Chief and Council. February 19, 2008	Ross River Community Meeting. February 19, 2008	Ross River Open House. May 6, 2008	RRDC Chief and Council. May 7, 2008	Handgames Watson Lake. July 18-20, 2008	Kaska General Assembly. August 12-14, 2008	Ross River Chief and Council. October 15, 2008	Ross River Open House. October 15, 2008
Environment	There is too much development happening in the Kaska traditional territory.	Although there are several large development proposals within the Kaska area, NATC believes that not all the proposals will come to fruition at the same time, thereby keeping any cumulative negative effects of development to a minimum. The staggered development of projects within the Kaska area could be beneficial to the long-term economic health of the region and the whole of the Yukon Territory.					1			
	Where does the water that is released from the dam, or diverted around the dam, drain to and will water downstream from the mine be affected?	The water released from the ravine dam heads down the valley (in water courses known as Tributaries C and A in this project proposal) and into a tributary of the Hess River, then into the Hess River. It then flows into the Stewart River and ultimately into the Yukon River. Discharged water will be monitored regularly according to Ministry of Mines Effluent Regulation standards and through an Environmental Effects Monitoring (EEM) program agreed betwen the Federal Government and NATC. NATC will comply with all laws and regulations governing water quality.					1			
	Who have you approached about traditional land use around the Mactung property?	Under the requirements of YESAA, NATC was required to speak with LFN, RRDC and NND about traditional land use and Traditional Knowledge at the Mactung property.	1							
	RRDC has a generic Traditional Knowledge protocol, that would be the place to start but has to be directly between the RRDC and North American Tungsten, not through a third party, e.g., a consultant.	NATC is happy to work directly with RRDC to develop protocols for the collection of any available Traditional Knowledge related to the Mactung project.	1	1						
	How does NATC plan to address RRDC aboriginal rights under Section 35 of the constitution? These have been addressed through SEPAs in other cases.	NATC is happy to work with RRDC to develop a Social Economic Partnership Agreement (SEPA) and will fulfil any obligations it has under section 35 of the Canadian Constitution.	1							
	What is NATC's relationship with the Liard First Nation? Does NATC have a SEPA with the LFN?	NATC is required under the rules of YESAA to communicate and consult with LFN, RRDC and the FNNND, as well as consult with any communities that may be significantly affected by the Mactung project. Therefore, NATC has been talking with the aforementioned First Nations and the communities of Ross River and Faro. NATC is currently developing SEPAs with LFN, RRDC and FNNND.	1							
	The Chu Ta Dena/Mountain Slavey people in RRDC are the traditional land stewards of the Mactung area and they should be directly involved in any archaeological work.	Kaska field assistants were employed as part of the 2006, 2007 and 2008 archeological studies on the recommendation of the RRDC Economic Development office.	1							
Consultation	Two weeks' notice for meetings would be good.	For meetings organized after February 2008, NATC made efforts to extend the notice period for community meetings to two weeks. This was not always possible and a balance has to be achieved between providing too much and too little notice.		1						
	Was your meeting with RRDC Chief and Council positive? Were they supportive of the project/	NATC found meetings with RRDC's Chief and Council to be positive and Council support the project. Further discussions with RRDC will take place regarding MOUs and SEPAs.		1						

TABLE 2.6-2: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM FARO						
Theme	**Question / Comment**	**NATC's Consideration of Question / View**	**Mayor & Council February, 27, 2008**	**Community Meeting February 27, 2008**	**Open House May 7, 2008**	**Mayor and Council, staff October 9, 2008**
Mine (Project Scope)	Where will the concentrate be shipped to? On which route will the ore from Mactung be trucked?	The concentrate will be trucked from Mactung to Ross River, then the Robert Campbell Highway to Watson Lake, then to both Edmonton and to Vancouver. From Edmonton, the concentrate will travel by freight to eastern Canada for Eurpoean markets. From Vancouver the concentrate will be shipped to Asian markets.	1			
	What is the potential mine life?	The proposal is for 11.2 years of underground mining proposal with a potential for an additional 15 years of open pit mining. At this time, only the underground mining is being submitted for the environmental and socio-economic assessment.			1	1
	How will you power the mine? Can you tap into the Faro hydro grid? Operating 7-8 MW generators will need a lot of diesel trucked in.	It would be too expensive for NATC to tap into the grid at Faro. NATC is currently investigating wind and geothermal power generation at or near the site. Hydro power was considered but is not feasible due the elevation of the mine site and lack of suitable water sources. Diesel fuel will provide most of the power at the mine site.	1	1		1
	If the North Canol is upgraded, it will have to be maintained as well which will be expensive because of problem areas.	NATC is discussing the maintenance of the North Canol Road with the Yukon government. NATC also has current experience with a similar need for maintenance of the Nahanni Range Road, leading to Cantung.	1			
	How will you cross the Pelly River? Use the ferry and ice bridge? What about the shoulder seasons that can be up to 7-8 weeks in spring and fall?	The Government of Yukon will be responsible for making arrangements to cross the Pelly River. This could be done by building a bridge or by having an appropriately sized ferry. The Minto mine has shown that it is possible to operate using a ferry and ice bridge while storing enough supplies and stockpiling product during the shoulder seasons.	1			
	Do you absolutely need a bridge to make this project work?	A bridge or a ferry would allow the project to proceed.	1			
	Why has the price of tungsten risen so high so fast?	Higher demand for tungsten coupled with no new tungsten mines has forced the price of tungsten up. China also has tungsten mines and has controlled the release of tungsten to world markets. This has also forced up the price of tungsten.	1			
	Faro would like to see consideration of a new road route that uses the bridge over the Pelly at Faro.	NATC has considered this option but concluded that a new road to Faro would be too expensive to install. The Government of Yukon has also stated that it will upgrade the North Canol Road to a standard more suited to for the trucks travelling to and from Mactung.	1	1	1	

TABLE 2.6-2: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM FARO

Theme	Question / Comment	NATC's Consideration of Question / View	Mayor & Council February, 27, 2008	Community Meeting February 27, 2008	Open House May 7, 2008	Mayor and Council, staff October 9, 2008
Mine (Project Scope)	What will the production be at Mactung compared to Cantung?	Cantung processes approximately 1100 tons of ore per day. Mactung will process approximately 2000 tons of ore per day.		1		
	How will workers get to the mine?	Mine workers will be flown to the Macmillan Pass Aerodrome and then be taken by bus to the mine site.	1			
	When will mine construction start?	The planned construction is due to start in the second quarter of 2010 and last about 27 months.				1
	Will there be an overlap between the operation of Cantung and the start-up of Mactung?	NATC hopes there will be an overlap in production times between Cantung and Mactung although, currently, there are only two years of reserves remaining at Cantung. Further potential tungsten reserves at Cantung are being investigated. Production at Mactung is due to start in 2013.		1		1
Social	What's the shift schedule?	The planned rotation schedule for Mactung is three weeks on/three weeks off. Underground shifts will be 10 hours and surface shifts 12 hours.			1	
	We want people, and especially families with children, to move to Faro. Faro already has much of the infrastructure required to build on the existing community. NATC should consider making use of that infrastructure and encourage mine workers to move to Faro by offering incentives and information about Faro to potential employees.	NATC would like to have a large percentage of its workforce live in the Yukon as it makes economic sense for both the mine and the local community. NATC has offered Faro's Mayor and Council to promote Faro to potential mine workers.	1		1	
	We are tired of boom and bust cycles.	NATC does not have any control over the overall world markets or the Canadian economy. However, NATC is well placed within the mining industry to move forward with the Mactung project. The initial 11 years of underground mining that is proposed will provide some economic stability for the Mactung workforce and the communities affected by the mine. If the open pit mine can also proceed then this will further the economic stability of the area, although the open pit mine is not part of this project proposal.	1			

TABLE 2.6-2: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM FARO

Theme	Question / Comment	NATC's Consideration of Question / View	Mayor & Council February, 27, 2008	Community Meeting February 27, 2008	Open House May 7, 2008	Mayor and Council, staff October 9, 2008
Social	Will NATC have an assistance program for employees dealing with alcohol and drug problems?	NATC already has drug and alcohol policies for Cantung and similar policies will be developed for Mactung. NATC supports the idea of a drug and alcohol treatment centre to help people in Yukon communities. However, that exact nature of the support will have to be discussed as part of a Social Economic Partnership Agreement and can only happen as the mine moves into production, for economic reasons.	1			
	NATC should consider offering relocation incentives to encourage employees to move to the Yukon rather than flying them in and out of the Yukon for their shifts, e.g., housing assistance, relocation packages.	NATC will consider relocation incentives for potential employees at Mactung. Although NATC can't force people to move to the Yukon, having a significant workforce based in the Yukon would be advantageous to NATC and the Yukon as a whole. The precise nature of the incentives can only be considerered once mine production has been agreed and the regulatory and assessment processes have been completed successfully.		1		
	Having more money around the town can lead to more alcohol and drug abuse.	NATC understands this issue and will support treatment programs for people with drug and alcohol abuse problems.			1	
	Community volunteer fire and ambulance crews would greatly benefit from specialist training to respond to emergencies.	NATC will support initiatives to provide specialist emergency service training as it relates to the Mactung project.		1		
Economic	Training for mine jobs has to start now to get people ready. Life skills are also important, not just technical skills.	NATC is working closely with the Yukon Mine Training Association (YMTA) to provide training for underground mine workers. It is in NATC's best business interests to help train people as skilled trades are generally in short supply in mining. NATC also recognizes the importance of life skills and will work with individual communities where required to develop programs that propmote life skills to the potential and actual workforce.			1	
	Will you only have on-site training?	NATC will be providing training for staff on and off site. Cantung will also be used as a training venue in partnership with the Yukon Mine Training Association.	1			
	Will there be jobs and training at Mactung?	NATC is planning to employ between 250 and 300 people during the construction phase of Mactung and about 250 people during the operation phase of the mine.			1	
Economic	Do you have trouble keeping staff at the Cantung mine?	NATC has some challenges keeping staff at Cantung given the general shortage of mine workers, especially skilled trades and underground miners.	1	1		

TABLE 2.6-2: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM FARO

Theme	Question / Comment	NATC's Consideration of Question / View	Mayor & Council February, 27, 2008	Community Meeting February 27, 2008	Open House May 7, 2008	Mayor and Council, staff October 9, 2008
	Given the general shortage of skilled mine labour everywhere (including the Yukon) where are you going to find the project workforce?	NATC would like to have a large percentage of its workforce live in the Yukon as it makes economic sense for both the mine and the local communities. NATC has offered to help Faro's Mayor and Council promote Faro to potential mine workers. Further discussions will take place between NATC and Faro's elected representatives to progress this topic.	1			
	Faro is an ideal location for a trucking base to serve mines in the area.	NATC will use the Robert Cambell Highway (south) to Watson Lake as its main transportation corridor and there will be four round trips per day are anticipated.	1			
	Town of Faro has employees fully qualified to inspect and maintain potable water and sewage disposal systems. May be interested in a inspection/maintenance contract.	The Town of Faro will be given the opportunitiy to bid on water and sewage system related contracts.	1			
	Town of Faro would like to sell the Atco trailer camp on the upper bench.	NATC will examine the trailer camp to see if it meets its needs.	1			
	Would NATC consider incentives to encourage mine employees to locate to Faro where there are existing housing and community facilities.	NATC will consider options for incentives for mine workers to locate closer to the mine if it makes economic sense.		1		
	How many people will be employed at the mine?	During construction the Mactung mine will employ between 250 to 300 people. During production about 150 employees will be at the at the mine at any one time and about 250 staff will be employed in total.				1
	How should the town of Faro promote itself to mining companies	NATC believes that a balance of lifestyle and practical day to day living needs to be promoted, e.g., leisure time activities, health care, schools, purchasing groceries. Faro representatives should attend mine related trade shows and conferences and have flyers available. NATC will help Faro representatives organize a presentation to Cantung staff in preparation for the transfer of staff to Mactung.				1
Economic	Will there be contracting opportunities, e.g., trucking etc.?	There will be a number of contracting opportunities during all phases of the mine.		1		
Environment	Is the project in a watershed that affects Faro?	The Mactung project is in the the Hess River/Stewart River/South Macmillan River watershed which does not affect Faro.	1			

TABLE 2.6-2: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM FARO						
Theme	**Question / Comment**	**NATC's Consideration of Question / View**	**Mayor & Council February, 27, 2008**	**Community Meeting February 27, 2008**	**Open House May 7, 2008**	**Mayor and Council, staff October 9, 2008**
	Is the deposit sulphide and subject to acid drainage?	Sulphide minerals do exist within the deposit and there is potential for acid rock drainage. NATC will be characterizing the ore that is mined and calculating volumes of potentially acid generating material. This will help in the mangement of the material. The dry-stack tailings are assumed to be potentially acid generating and so will be encapsulated at the end of the project. The material placed back underground will be sealed off to prevent moisture from causing acid generation. There will also be on-going monitoring of water quality during construction, production, decommissioning and post closure to ensure there are no negative environmental effects.	1			
	What are the bonding requirements and will they be enforced?	Bonding will be required but the amounts are not known at the moment. Enforcement will lie with the Government of Yukon.	1			
	Concern over risks associated with the amount of fuel being trucked to the site, especially the risk of fuel spill in the Pelly River.	NATC will take all reasonable precautions with all loads to prevent a spill from occurring at any point along the haul route, e.g., ensuring that all loads are secured properly, speed restrictions for trucks. NATC will also have available a trained spill response team		1		
Consultation	If possible please coordinate future public consultation sessions with other proponents of projects in the region. A good option would be an open house, trade-fair style session.	NATC attempted to coordinate community meetings with other mining companies and the Government of Yukon (for the Anvil Range mine), but this was not easy to do due to the schedules of all involved. However, the attendance of several mining representatives at the NND General Assembly was successful.		1		

TABLE 2.6-3: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM LIARD FIRST NATION

Theme	Question / View	NATC's Consideration of Question / View	LFN Chief and Council. January 29, 2008	LFN Chief, Councillor Wolftail and Advisors. February 18, 2008	Handgames Watson Lake LFN. July 18-20, 2008	Kaska General Assembly. August 12-14, 2008
Mine (Project Scope)	Why is NATC share price so low?	Overall market is generally low, Cantung is an old mine, unattractive to investors looking for chance at large and fast return. However, Mactung is very attractive to investors and has a large, high quality resource.		1		
	Where will the concentrate be shipped to? On which route will the ore from Mactung be trucked?	The concentrate will be trucked from Mactung to both Edmonton and to Vancouver. From Edmonton, the concentrate will travel by freight to eastern Canada for Eurpoean markets. From Vancouver the concentrate will be shipped to Asian markets.		1		
	When will a production decision be made?	NATC will make a production decision by late fall 2009. NATC has to consider all the factors involved in the project including the YESAA and permitting process, commodity prices and project investment.		1		
	How will workers get to the mine?	Mine workers will be flown to the MacMillan Pass Aerodrome and then be taken by bus to the mine site.			1	
Social	What's the shift schedule?	The planned rotation schedule for Mactung is three weeks on/three weeks off. Underground shifts will be 10 hours and surface shifts 12 hours.		1		
Economic	LFN has an estimated 60% unemployment rate and pays out approximately $250,000 in social assistance each month.	NATC and YMTA training programs along with employment at the mine will help improve the situation for LFN citizens. NATC is very happy to offer training for potential mine workers and employ LFN citizens who have the relevant qualifications but NATC can not force people to work at the mine. It is important to recognize that although mining can offer competitive salaries, good working conditions and contribute to the local economy, working at a mine is not for everyone. There are also many support services provided to mines either directly or indirectly which offer alternative options for employment.		1		
	How many LFN citizens currently employed at the Cantung mine?	As of November 30, 2008, 19 LFN citizens were working at the Cantung mine. A total of 34 employees out of a workforce of 221 considered themselves to be First Nation.		1		

TABLE 2.6-3: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM LIARD FIRST NATION

Theme	Question / View	NATC's Consideration of Question / View	LFN Chief and Council. January 29, 2008	LFN Chief, Councillor Wolftail and Advisors. February 18, 2008	Handgames Watson Lake LFN. July 18-20, 2008	Kaska General Assembly. August 12-14, 2008
Economic	Now is the time to take advantage of the Yukon Mine Training program.	NATC is actively working with YMTA to provide training programs, particularly for underground mining.		1		
	When business and contracting opportunities arise please notify LFN Development Corporation to allow us to bid for work.	NATC will notify LFNDC of any contracting and business opportunities that arise for Mactung or Cantung.		1		
	Will there be jobs and training at Mactung?	NATC is planning to employ between 250 and 300 people during the construction phase of Mactung and about 250 people during the operation phase of the mine.			6	5
	Is it possible to purchase shares in NATC?	NATC shares can be purchased through a stockbroker. NATC shares are listed on the Toronto Stock Exchange - Venture Exchange (TSX-V) under the abbreviation NTC.			1	
	The Macmillan Pass area is well used by the Dena people for hunting and gathering, e.g., hoary marmots. The mine will affect people's ability to use the area for hunting and gathering.	NATC will enforce a no hunting policy for the immediate mine area and along that part of the road that is controlled by the company. NATC respects that hunting in the mine area will be affected by the mine but only for the life of the mine. For reasons of safety, NATC would also need to restrict the use of the area for gathering, such as for herbs and berries. Again, this would only be for the lifetime of the mine.			1	
	There is too much development happening in the Kaska traditional territory.	Although there are several large development proposals within the Kaska area, NATC believes that not all the proposals will come to fruition at the same time, thereby keeping any cumulative negative effects of development to a minimum. The staggered development of projects within the Kaska area could be positively beneficial to the long-term economic health of the region and the whole of the Yukon Territory.			1	

TABLE 2.6-3: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM LIARD FIRST NATION

Theme	Question / View	NATC's Consideration of Question / View	LFN Chief and Council. January 29, 2008	LFN Chief, Councillor Wolftail and Advisors. February 18, 2008	Handgames Watson Lake LFN. July 18-20, 2008	Kaska General Assembly. August 12-14, 2008
Economic	Where does the water that is released from the dam, or diverted around the dam, drain to and will water downstream from the mine be affected?	The water released from the ravine dam heads down the valley (in water courses known as Tributaries C and A in this project proposal) and into a tributary of the Hess River, then into the Hess River. It then flows into the Stewart River and ultimately into the Yukon River. Discharged water will be monitored regularly according to Ministry of Mines Effluent Regulation standards and through an Environmental Effects Monitoring (EEM) program agreed betwen the Federal Government and NATC. NATC will comply with all laws and regulations governing water quality.			1	
Consultation	LFN expects the company to hold public meetings in Watson Lake as part of the consultation process and LFN will provide further direction on community consultation process.	NATC has made efforts on several occasions since January 2008 to organize meetings with LFN to specifically discuss the Mactung project. As a result of these efforts two meetings took place and information was provided at other gatherings such as the Kaska General Assembly and Yukon Handgames.		2		

TABLE 2.6-4: NATC'S CONSIDERATION OF QUESTIONS AND VIEWS FROM THE FIRST NATION OF NACHO NYAK DUN

Theme	Question / View	NATC's Consideration of Questions and Views	FNNND Chief and Council. February 26, 2008	NNDFN Generel Assembly, Mayo. June 27-29, 2008
Mine (Project Scope)	How will you get to the mine? Where does the road go?	The mine staff will fly to the MacMillan Pass Aerodrome and then travel by bus into the mine site. Supply trucks will travel up the North Canol Road to approximately 5 km west of the MacMillan Pass Aerodrome and then travel north along a valley route to the mine site. Maps and figures were provided at meetings showing the proposed road route to the mine.		1
	What is the potential mine life?	The proposal is for 11.2 years of underground mining with a potential for an additional 15 years of open pit mining. Only the underground mining is being submitted for the environmental and socio-economic assessment.		1
	How much actual tungsten will you mine at Mactung?	NATC will mine about 14 million pounds (Ibs) of tungsten each year for the life of the mine. This will be achieved by processing ore on site at 2,000 tonnes per day.		1
Social	Will NATC have an assistance program for employees dealing with alcohol and drug problems?	NATC already has drug and alcohol employment conditions for Cantung and full policies will be developed for the Mactung mine.		1
	Will there be a town at Mactung like there is at Cantung?	There will be a camp for mine workers with individual rooms and recreational facilities, but there will not be a town site like the one at Cantung that originally included a store and and school (now closed).		1
	Keep the mine and mine site safe.	NATC will have safety program to minimize work accidents and will comply with all work and safety regulations.		1
Economic	Will there be jobs and training at Mactung?	NATC is planning to employ between 250 and 300 people during the construction phase of Mactung and about 250 people during the operation phase of the mine.		8
Environment	Mactung is a good project as long as it doesn't hurt the plants and the animals.	NATC will comply with any regulations and environmental laws that apply to the Mactung project. A number of mitigations have been included in the Mactung project proposal to minimize any environmental effects. NATC does not anticipate any long-term environmental effects.		2
	What chemicals are used in the milling process to achieve tungsten concentrate?	A number of chemicals are used in the production of tungsten concentrate and a list of chemicals can be found within the project description section of this proposal (Section 5) and Section 5 of the Spill Contingenecy Plan (see Appendix M3).		1
	Will the mine have any environmental effects in the NWT?	Mactung is a Yukon only project that is located on the Yukon side of a natural watershed. No significant environmental effects are anticipated for the NWT.		1
	Keep the land clean and help youth set up recycling programs and training.	Excellent environmental stewardship is a corporate priority for NATC and the company will comply with all relevant standards and laws. NATC will be happy to discuss support for youth programs when a decision has been made regarding the overall mine project.		1
	Where does the water that is released from the dam, or diverted around the dam, drain to and will water downstream from the mine be affected?	The water released from the ravine dam heads down the valley (in water courses known as Tributaries C and A in this project proposal) and into a tributary of the Hess River, then into the Hess River. It then flows into the Stewart River and ultimately into the Yukon River. Discharged water will be monitored regularly according to Ministry of Mines Effluent Regulation standards and through an Environmental Effects Monitoring (EEM) program agreed betwen the Federal Government and NATC. NATC will comply with all laws and regulations governing water quality.		1
Consultation	This initial meeting between NATC and NND Chief, Council and staff is informal.	NATC understands that the meeting between NATC and NND Chief and Council did not constitute official consultation. However, subsequent correspondence from NND indicated that NND would like information from NATC about the project and that NND would comment on the project either directly to NATC or through the YESAA process.	1	
	NND is a self-governing first nation under the UFA while RRDC and LFN are not. NND not yet sure how the process between NATC, the different First Nations and other levels of government will work.	Under the YESAA requirements NATC was required to consult FNs who have traditional territories in which the project is located. The FNs could pass on their comments to NATC at anytime or to YESAB after the propsal is submitted.	1	
	NND is drafting protocols and agreements for how the first nation will consult and work with mining companies proposing projects in the traditional territory.	NATC is happy to work closely with NND on agreements and protocols relating to the Mactung project.	1	
	The NND government has a very strong mandate from its citizens to care for the land and water. Therefore NND will want to know all details of project.	Excellent environmental stewardship is a corporate priority for NATC. NATC will provide information to NND. The exact nature of the information and reports will need to be discussed with NND	1	
	NND stated that there will be a need for further meetings, including wider community meetings (e.g., open houses in Mayo).	NATC attended the NND General Assembly in June 2008 and received comments from NND members. NND asked for project information updates as they became available but further meetings in Mayo prior to the project proposal submission to YESAB would not be required.	1	
Consultation	If possible please coordinate future public consultation sessions with other proponents of projects in the region. A good option would be an open house, trade-fair style session.	NATC attempted to coordinate community meetings with other mining companies and the Government of Yukon (for the Anvil Range mine), but this was not easy to do due to the schedules of all involved. However, the attendance of several mining representatives at the NND General Assembly was successful.	1	

3.0 PROJECT LOCATION

3.1 GEOGRAPHICAL LOCATION

The Mactung property is located in the Yukon in the Selwyn Mountain Range. The site is approximately eight kilometres northwest of Macmillan Pass on the edge of Mt. Allan. The nearest settlement accessible by road is the unincorporated community of Ross River, approximately 250 km southwest along the North Canol Road. It takes approximately six hours to travel between Ross River and the Mactung property. The site is directly accessible by helicopter and is approximately 185 km from Ross River. The Macmillan Pass Aerodrome, about 8 km south of the Mactung property is accessible by rotary and fixed-wing aircraft and is about 175 km from Ross River. The Mactung property is not accessible by water. The general location of the Mactung property is provided in Figure 3.1-1.

Figure 3.1-1: General location of the Mactung property

The Mactung project area is located within the Yukon River watershed next to the continental drainage divide. The project site is located within a valley drained by a west-flowing tributary of the Hess River. Tributary C originates in Yukon close to the Yukon/NWT border within the Mactung property and has a catchment of 24.2 km². Tributary C flows into Tributary A, which flows northwest into the south tributary of the Hess River, and eventually into the Stewart River, then the Yukon River. Figure 3.1-2 shows the general layout of the proposed Mactung project including the proposed access road.

Maps depicting the location of the proposed project boundaries, features and routes and the data relating to environmental baseline studies are presented in digital format. For a complete listing of the available map files and their location please refer to Appendix B1.

3.2 LAND TENURE

Legal land tenure for the proposed project can be identified as Yukon Government crown land. The proposed mine site, including the service road, will remain crown land for the duration of the project, with an authorization for Quartz Mining. This authorization will include the right to the sub-surface mining of tungsten as well as surface activities which form part of mine operations.

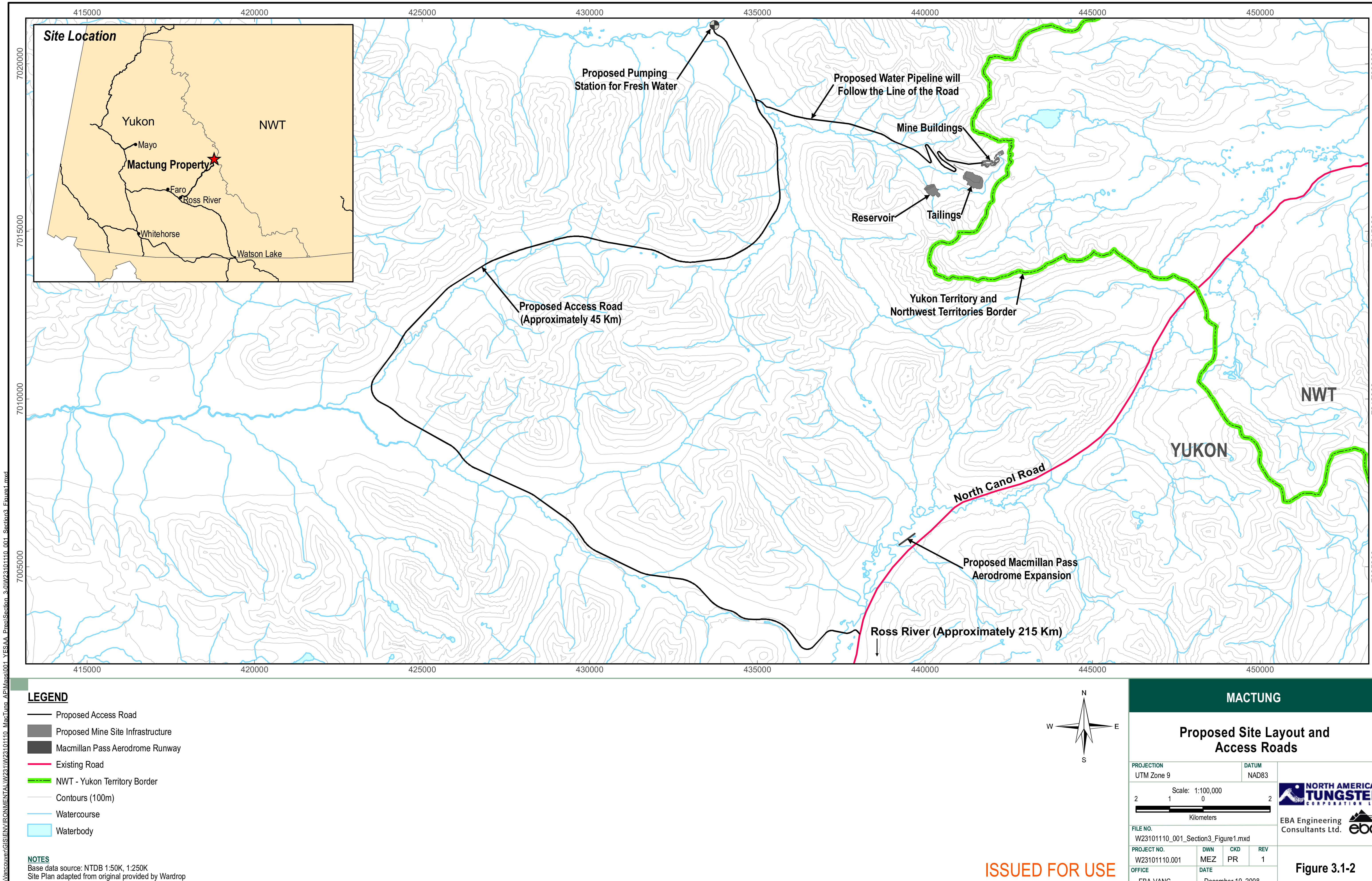
Sections of the proposed mine access road on NATC's claims are currently undergoing a Designated Office Evaluation as part of a Class III exploration application. One section of road on NATC's claims will require an upgrade to be suitable for the operation phase.

The proposed aerodrome expansion and upgrade will not alter the status of the aerodrome which is currently public. Instead, a Memorandum of Understanding is proposed between NATC and the Government of Yukon (Department of Highways and Public Works), allowing the company to upgrade the facility to a level of mutual accord. NATC will conduct the upgrade and utilize the facility under the jurisdiction of Yukon government for the duration of the project.

The North Canol Road is required for the duration of the project as a haul road for the transport of goods and materials as well as the hauling of tungsten concentrate. Over the past year NATC has been in discussion with the Yukon government regarding NATC's proposed use of the North Canol Road and the Pelly River Ferry. It is understood that the road is currently seasonal and its maintenance is the responsibility of Government of Yukon. A Government of Yukon letter (dated November 14, 2008) outlining the government's responsibilities with regard to the North Canol Road is appended to this project proposal (Appendix B2).

Quartz Mineral Claims

The project occurs within the Mayo Mining District of the Yukon. NATC is the full owner of 151 quart mining claims which form the area proposed for the Mactung mine site. A complete list of the quartz mining claims for the proposed project is provided in Appendix B3. Figure 3.2-1 shows the Mactung mining claims.



Site Location
Yukon
NWT
Mayo
Mactung Property
Faro
Ross River
Whitehorse
Watson Lake
Proposed Pumping
Station for Fresh Water
Proposed Water Pipeline will
Follow the Line of the Road
Mine Buildings
Reservoir
Tailings
Yukon Territory and
Northwest Territories Border
Proposed Access Road
(Approximately 45 Km)
NWT
YUKON
North Canol Road
Proposed Macmillan Pass
Aerodrome Expansion
Ross River (Approximately 215 Km)
415000
420000
425000
430000
435000
440000
445000
450000
7020000
7015000
7010000
7005000
LEGEND
Proposed Access Road
Proposed Mine Site Infrastructure
Macmillan Pass Aerodrome Runway
Existing Road
NWT - Yukon Territory Border
Contours (100m)
Watercourse
Waterbody
NOTES
Base data source: NTDB 1:50K, 1:250K
Site Plan adapted from original provided by Wardrop
N
W
E
S
ISSUED FOR USE
MACTUNG
Proposed Site Layout and
Access Roads
PROJECTION
UTM Zone 9
DATUM
NAD83
Scale: 1:100,000
2 1 0 2
Kilometers
FILE NO.
W23101110_001_Section3_Figure1.mxd
PROJECT NO.
W23101110.001
DWN
MEZ
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PR
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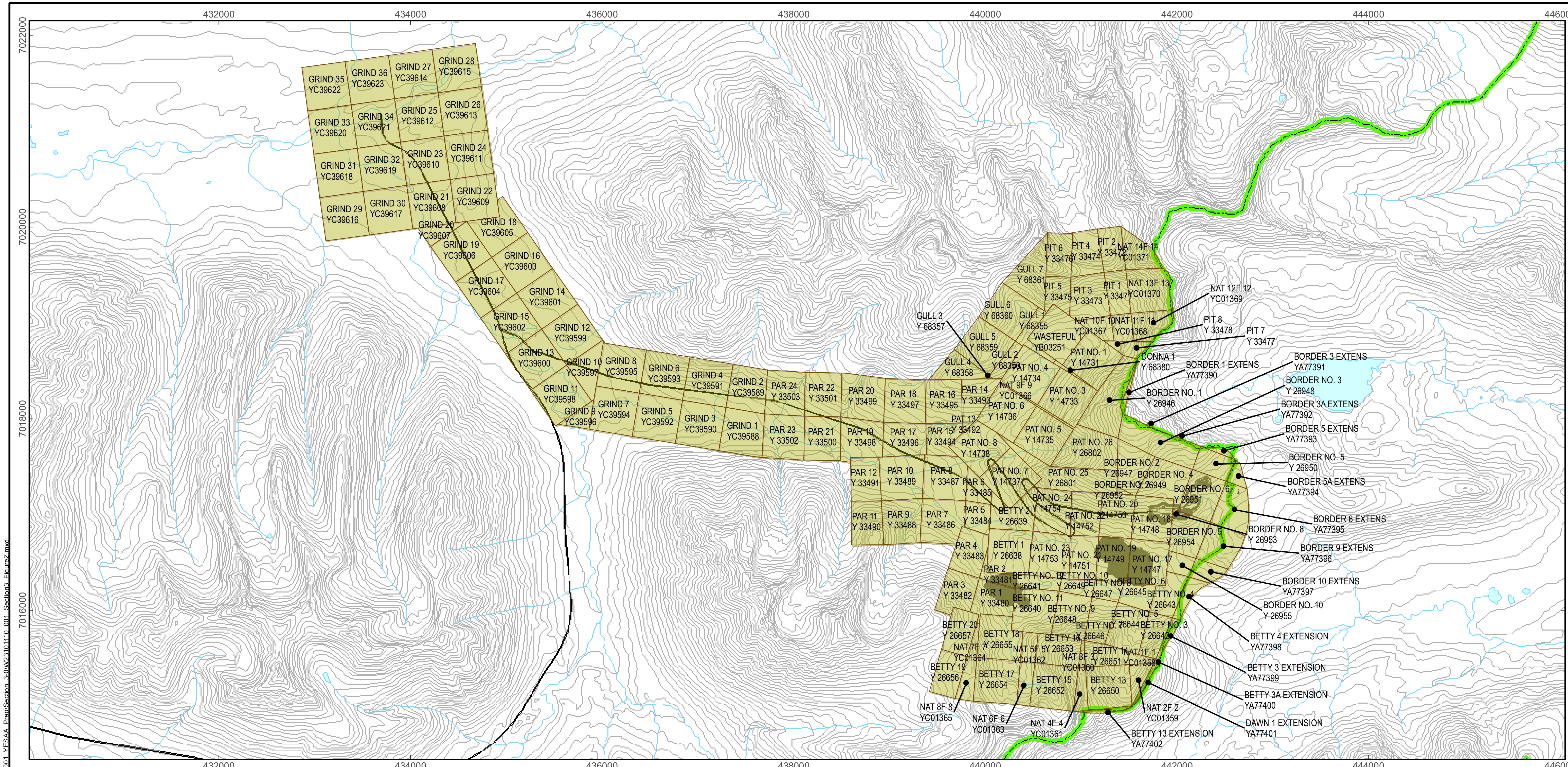
OFFICE
EBA-VANC
DATE
December 10, 2008
NORTH AMERICAN TUNGSTEN CORPORATION LTD
EBA Engineering Consultants Ltd.
Figure 3.1-2



LEGEND

- NATC Mineral Claims
- NWT - Yukon Territory Border
- Proposed Access Road
- Proposed Mine Site Infrastrucutre
- Contours (20m)
- Contours (100m)
- Watercourse
- Waterbody

NOTES
Base data source: NTDB 1:50K, 1:250K, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

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MACTUNG

NATC Mineral Claims - Mactung

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:40,000
0.8 0.4 0 0.8
Kilometers

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FILE NO.
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OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 3.2-1

There are a number of claims which have been staked by other parties in the vicinity of the mine site, access road and aerodrome. These quartz claims are listed under the ownership of various groups including the Hudson Bay Exploration and Development Company Limited, Hudbay Minerals Inc., Cominco Mining Worldwide Holdings Ltd., James Skailes, and others. Figure 3.2-2 shows the location of quartz mining claims in the general vicinity of Mactung that are not owned by NATC. Figure 3.2-2 also shows the position of First Nation Interim Protected Lands in the project area.

Outfitting Concession

Outfitting concessions have legal boundaries within which the owner has the right to outfit hunting to non-residents exclusively. Twenty outfitting concessions are held within the Yukon and Outfitting Concession 9 has been identified to overlap with the proposed project.

Trapping Concessions

The Yukon Territory contains 360 registered trapping concessions and 13 group trapping concessions. These concessions are formed through legal boundaries which provide the holder with exclusives rights to the trapping of furbearing animals. The proposed project including the mine site, access road, service road and aerodrome expansion is located within the defined boundaries of Trapping Concessions 111 and 112. The use of the North Canol Road for the duration of the project will overlap with Trapping Concession 405. This concession is a large group concession which is held by Ross River Dena Council and is used by community members.

Interim Protected Lands

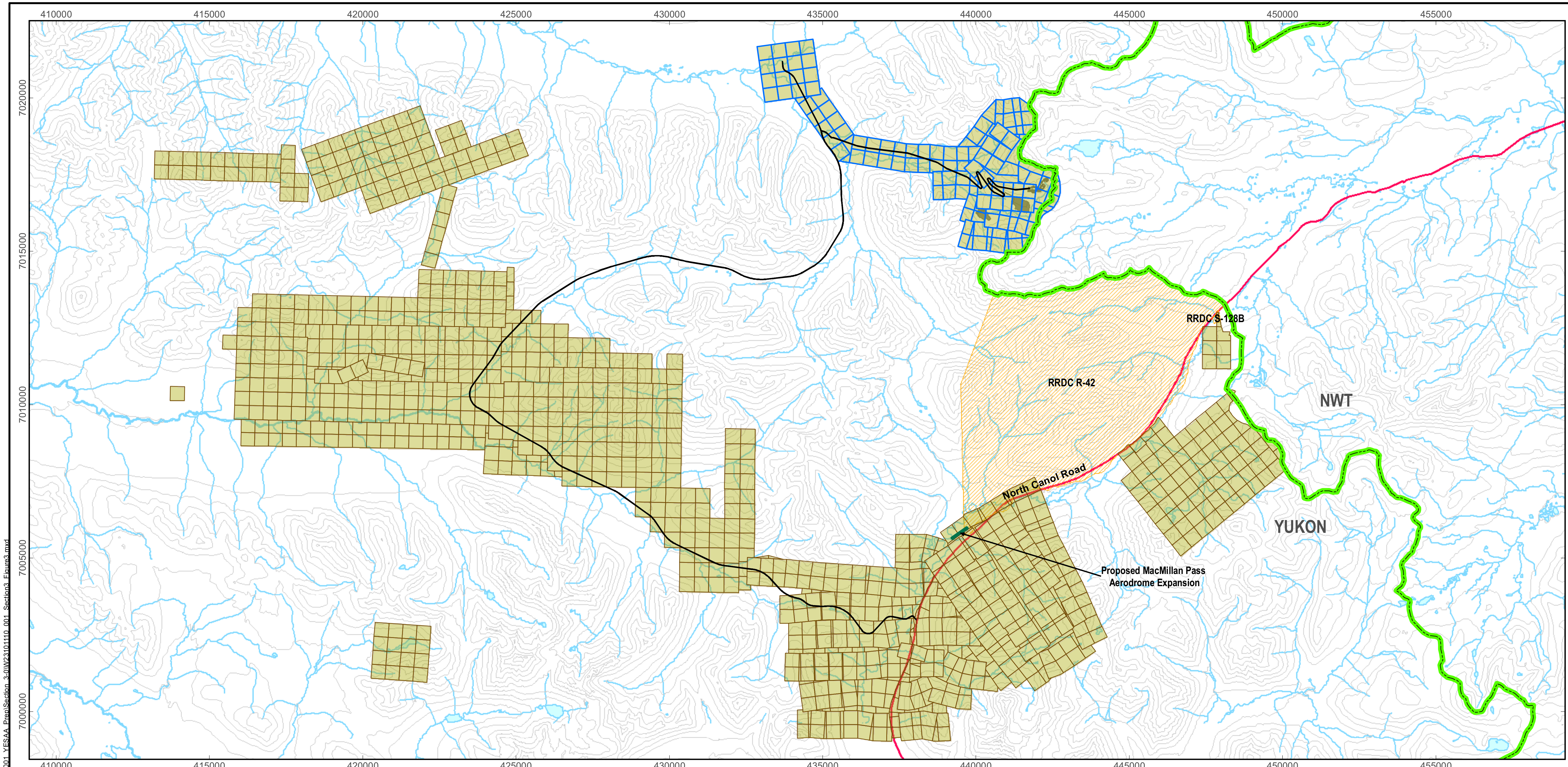
In the vicinity of the project site there are two interim protected blocks which have been selected by RRDC, these include RRDC R-44 and RRDC R-42. RRDC R-44 is located directly north of the proposed project site and RRDC R-42 is located to the south between the NWT border and the North Canol Road. The western point of the RRDC R-42 block is directly north of the Macmillan Pass Aerodrome. None of these blocks overlap with NATC's mineral claims (see Figure 3.2-2).

Parks and Protected Areas

The North Canol Road does not have any Yukon Government campgrounds for public use, nor are there any parks or protected areas located adjacent to the project site.

Yukon Land Use Planning Region

According to the Yukon Land Use Planning Council, the proposed Mactung project is within the overlap planning region of the Kaska and Northern Tutchone planning regions. Both regions are currently identified as inactive by the Yukon Planning Council.



LEGEND

- Proposed Access Road
- Macmillan Pass Aerodrome
- Mactung Mineral Claims
- Other Mineral Claims
- First Nations Interim Protected Lands
- Proposed Mine Site Infrastructure
- NWT - Yukon Territory Border
- Existing Road
- Contours (100m)
- Watercourse
- Waterbody

NOTES

Base data source: NTDB 1:50K, 1:250K
Site Plan adapted from original provided by Wardrop

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ISSUED FOR USE

MACTUNG

Mactung Area Land Use

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:125,000
2 1 0 2
Kilometers

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FILE NO.
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W23101110.001	MEZ	PR	0

OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 3.2-2

3.3 TRADITIONAL TERRITORY

The Mactung project is proposed to occur in the Traditional Territories of three Yukon First Nations, including: the Ross River Dena Council, the Liard First Nation (both non-settled First Nations) and the First Nation of Nacho Nyak Dun (a settled First Nation). The project site, as currently designed, does not cross settlement land or land set aside by the non-settled First Nations, otherwise known as interim protected land.

3.4 CONSISTENCY WITH OTHER PLANS

In a review of plans available for the area of the proposed Mactung project two plans were identified as relevant; these are the "Community-Based Fish and Wildlife Management Plan: Nacho Nyak Dun Traditional Territory" and the "Integrated Wildlife Management Plan: Ross River Traditional Territory".

Community-Based Fish and Wildlife Management Plan: Nacho Nyak Dun (NND) Traditional Territory

The 2002-2007 NND Management Plan is the third Fish and Wildlife Plan to be developed for the area, and has been completed in coordination with the First Nation of Nacho Nyak Dun, the Mayo District Renewable Resources Council and the Yukon Government Department of Environment. These plans have been developed to guide the management of fish and wildlife within the Traditional Territory of NND in response to local concerns and objectives. The plan specifically deals with concerns relating to moose, caribou, bears, wolves and fish in terms of species population, habitat, harvesting, wildlife viewing, and communication of management practices.

The NND Management Plan, although comprehensive, is predominantly focused on the core areas of the NND Traditional Territory. Given the location of the proposed Mactung project, in the southeastern portion of the region, NATC believe that the proposed activities will not interfere or be inconsistent with the objectives of the plan. A plan which speaks to the following five years, 2008-2013, has not been identified by the Yukon Government's Fish and Wildlife Co-management Agency.

Integrated Wildlife Management Plan: Ross River Traditional Territory

The Integrated Wildlife Management Plan was formed in response to the acceleration of mine development within the Ross River Dena Traditional Territory during the 1990s. Developed in partnership with Yukon Government, the plan identifies its management principles as "Wise use, Conservation and Co-operation". Although the plan appears to focus on the time period between 1990 and 2000, NATC is committed to the principles of wise-use and sustainability, conservation and cooperation. As such, within the effects assessment of this proposal, NATC has developed mitigations addressing potential effects to fish and wildlife which NATC believes are consistent with the over-arching principles of the management plan.

Special Management Guidelines

NATC also acknowledges the special management plans which are produced by the Yukon government's fish and wildlife co-management arrangements. These documents provide a general outline of the management approach used for harvesting, species population and habitat maintenance. The management guidelines are organized to include caribou, grizzly bear, moose and sheep. Data associated with the guidelines is general to management objectives for large areas, but, where relevant, have been considered within the existing environment and effects assessment sections of this proposal. Specific to the area of the proposed Mactung project the special management guidelines identify the Redstone caribou population, Selwyn Mountain grizzly bear population, North Canol moose survey area and Dall's sheep.

4.0 DESCRIPTION OF EXISTING CONDITIONS

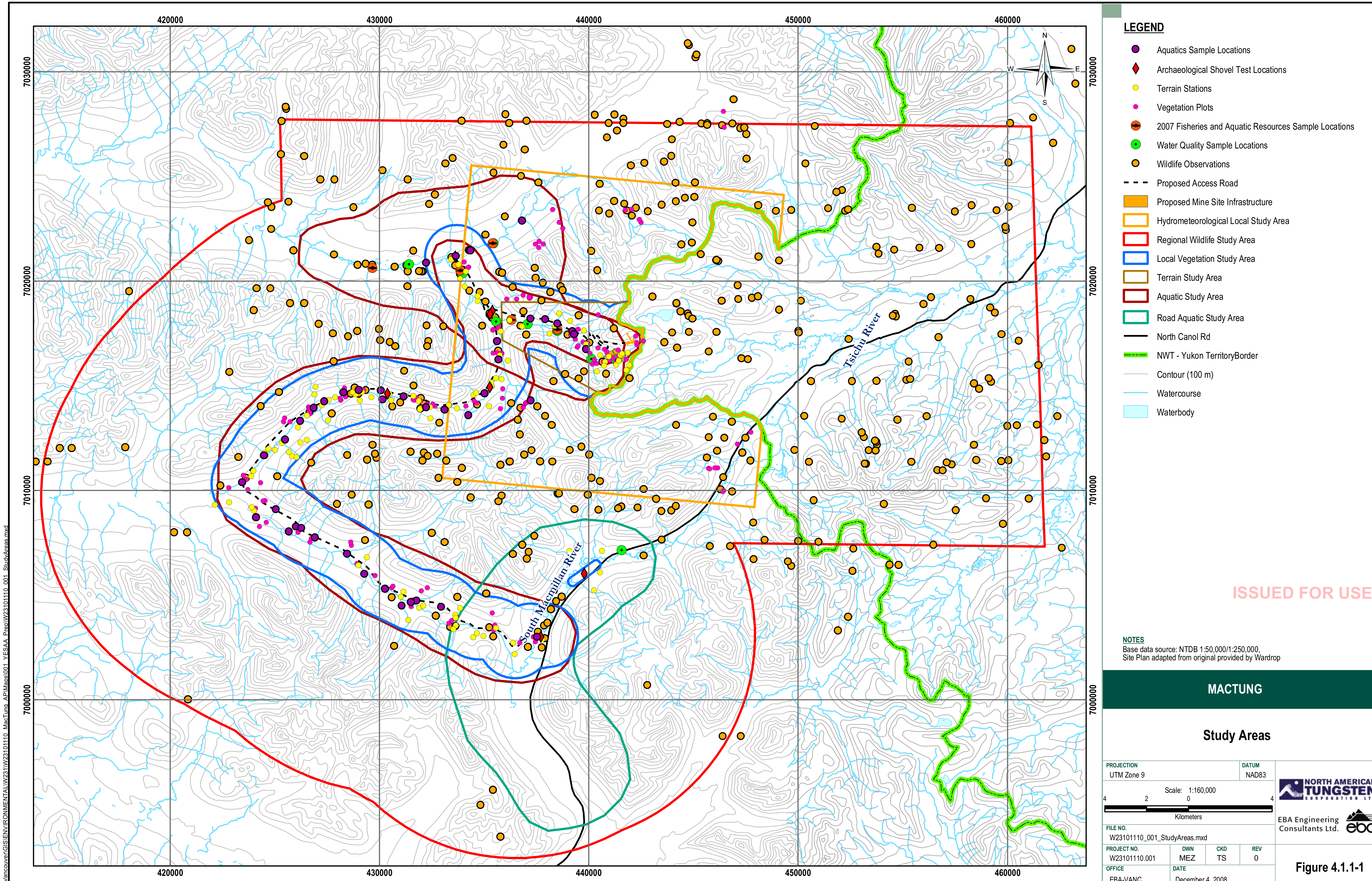
4.1 ENVIRONMENTAL CONDI TIONS

4.1.1 Scope of the Project/Study Area

The existing conditions component of this project proposal has been broken into sections by discipline. Local study areas (LSAs) and regional study areas (RSAs) have been identified, according to standard professional and academic methods, for the purpose of studying the various valued components within each discipline. Each of the subsections (see Table 4.1.1-1) contain the rationale for each LSA and/or RSA boundary. Figure 4.1.1-1 shows the overall study boundaries or sampling locations for each discipline.

TABLE 4.1.1-1 CORRESPONDING DOCUMENT SECTIONS FOR EACH DISCIPLINE

Environmental Setting Component	Document Section
General Physiography	4.1.2
Surficial Geology/ Soils	4.1.3
Terrain Hazards	4.1.4
Climate	4.1.5
Air Quality	4.1.6
Noise Levels	4.1.7
Vegetation	4.1.8
Wildlife	4.1.9
Water Resources	4.1.10
- Hydrology	4.1.10.1
- Water Quality	4.1.10.5
- Hydrogeology	4.1.10.6
Aquatic Ecosystems and Fisheries Resources	4.1.11
Archaeology	4.1.12


420000
430000
440000
450000
460000
7030000
7020000
7010000
7000000
N
S
E
W
Tsichu River
South Macmillan River
LEGEND
Aquatics Sample Locations
Archaeological Shovel Test Locations
Terrain Stations
Vegetation Plots
2007 Fisheries and Aquatic Resources Sample Locations
Water Quality Sample Locations
Wildlife Observations
Proposed Access Road
Proposed Mine Site Infrastructure
Hydrometeorological Local Study Area
Regional Wildlife Study Area
Local Vegetation Study Area
Terrain Study Area
Aquatic Study Area
Road Aquatic Study Area
North Canol Rd
NWT - Yukon TerritoryBorder
Contour (100 m)
Watercourse
Waterbody
ISSUED FOR USE
NOTES
Base data source: NTDB 1:50,000/1:250,000,
Site Plan adapted from original provided by Wardrop
MACTUNG
Study Areas
PROJECTION
UTM Zone 9
DATUM
NAD83
Scale: 1:160,000
4 2 0 4
Kilometers
NORTH AMERICAN TUNGSTEN CORPORATION LTD
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FILE NO.
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PROJECT NO.
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Figure 4.1.1-1

4.1.1.1 Traditional Knowledge

The Yukon Environmental and Socio-economic Assessment Act (YESAA) requires that proponents give equal consideration to scientific knowledge and traditional knowledge (TK), where available, throughout their project proposal.

YESAB's Discussion Document on the Incorporation of Traditional Knowledge into Assessments quotes the TK definition as provided in YESAA (Statutes of Canada, 2003).

The definition reads:

> *"The accumulated body of knowledge, observations and understandings about the environment, and about the relationship of living beings with one another and the environment, that is rooted in the traditional way of life of First Nations."*

YESAB's Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions states:

> *"The proponent is encouraged to develop a sound understanding of First Nations issues and expectations with respect to the incorporation of traditional knowledge."*

For this proposal NATC sought TK from the First Nation of Nacho Nyak Dun, Ross River Dena Council and Liard First Nation. The following information regarding NATC's efforts to obtain TK for inclusion in this proposal is provided below.

First Nation of Nacho Nyak Dun (FNNND)

Following discussions with Chief and Council about the proposed Mactung project and NATC's attendance at FNNND's General Assembly in Mayo in June, 2008, NATC received a letter from FNNND stating their position regarding TK. The letter is dated September 18, 2008 and is appended to this proposal (Appendix A4). In short, the letter states that FNNND has no TK to provide NATC regarding this project.

Ross River Dena Council (RRDC)

Discussions between NATC and RRDC regarding the Mactung project and TK collection have been on-going since January 2008 (Section 2 and Appendix A1). Although a formal TK collection process has not been forthcoming from RRDC to date, some TK has been made available to NATC through meetings, e.g., the trapping and use of hoary marmots, the mineral licks in the Mactung area and the importance of overall biodiversity, and not just individual components that make up the natural environment. NATC plans to continue to work with RRDC to collect TK that is relevant to the Mactung project. NATC is currently looking forward to receiving a revised TK protocol and budget from RRDC.

Liard First Nation (LFN)

NATC has made efforts to meet with LFN since January 2008 to discuss the Mactung project and TK collection (see Section 2 and Appendix A3). However, to date, no TK has been made available to NATC. NATC will be pleased to continue to work with LFN to collect TK that is relevant to the Mactung project.

4.1.2 General Physiography

The Mactung mine is entirely located within the Selwyn Mountain Ecoregion of the Taiga Cordillera Ecozone of Canada. Distinguishing characteristics of the region include the Hess and Logan Mountain ranges that form the border between the Yukon and Northwest Territories. Keele Peak is the highest point in the ecoregion at approximately 3400 m. Boundaries of ecodistricts within the Selwyn Mountain Ecoregion have not formally been defined.

The Selwyn Mountain Range is characterized by sharp peaks, steep side slopes and narrow rounded valleys. This generally forms the landscape of the project area that varies from gentle to flat terrain on the valley floor to steep relief on upper bedrock slopes. The lower valley areas were affected by continental ice sheets that deposited varying thicknesses of glacial moraine (till), while the upper elevations have been affected more recently by alpine glaciation. Valley slopes have also been covered in colluvium due to erosion processes, landslides and surface flow slides. Minor fluvial and periglacial geomorphological processes are active and a number of rock glaciers exist in the area. Elevations in the region range from 745 m a.s.l. to 2,970 m a.s.l.

Mean annual temperatures for the region are between -5 °C and -8°C, with daily temperature averages that range between -20 °C in January to 8 °C in July. Overall land cover for the Selwyn Mountain Ecoregion is approximately 65% boreal/subalpine coniferous forest, 20% alpine tundra, and 15% rockland (Smith *et al.* 2004). The project area lies in the discontinuous permafrost zone of the Yukon.

The Selwyn Mountains have the second highest annual precipitation levels (600-700 mm) in Yukon next to the Coast Mountains (Smith *et al.* 2004). The Mactung project area is situated in the Yukon River watershed next to the continental drainage divide, within a valley drained by a west-flowing tributary of the Hess River.

The climate is relatively cold, with a mean annual temperature of -8°C and approximately 60 to 75 mm of precipitation per year, most of which falls as snow.

Bedrock in the area of the deposit consists of laminated shales and phyllites, which are intruded by granitic rocks that form the higher, more resistant peaks.

Most of the project operation area is located in unforested high alpine terrain, and forest stands occur only at lower elevations below about 1400 m a.s.l. Upper bedrock and colluvium slopes are mostly bare and lower valley slopes and valley floors are typically vegetated with grasses, mosses, lichens and alpine willow and birch.

4.1.3 Surficial Geology/Soils

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

4.1.3.1 Mactung Property

The general site geology of the project area has been extensively described and documented in previous reports (J.F. Allen 1963; AMAX 1974 and 1979; F.R. Harris, T.J.R. Godfrey 1975). Detailed terrain mapping in the project area was completed in 2006 (Figure 4.1.3-1). The complete terrain mapping report is appended to this report as Appendix C1.

Soils in the project area originate from glacial, colluvial and minor fluvial processes. The higher areas of the mountains have little or no surficial soils while the lower slopes and valley bottoms are covered with thin deposits of residual soils, colluvium and glacial tills. Kame deposits are visible on the north valley sideslopes and extend westward towards the Hess River.

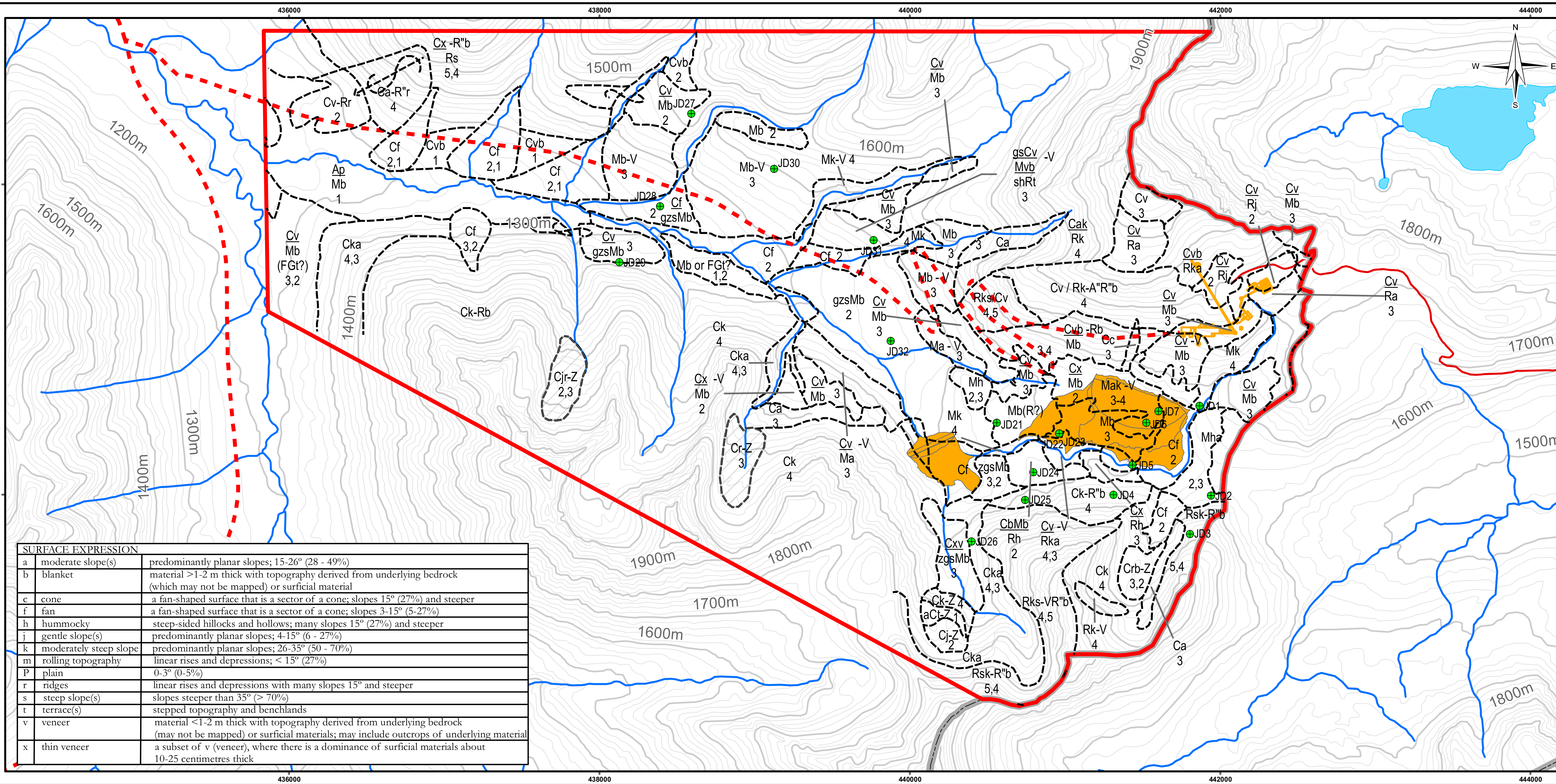
Till (moraine) is the most common surficial material mapped in the project area and occurs on middle to lower valley hillslopes. Till deposits in the study area are the result of basal, lateral and terminal moraines and other intra-glacial deposits. Textures range from gravelly silty sand to silty sand and most commonly consist of a sand matrix with variable silt and gravel content.

Colluvium on upper valley hillslopes is most commonly coarse blocky talus on moderately steep (50-70%) to moderate (27-49%) gradient, well drained slopes derived from ongoing erosion of upslope bedrock headwalls. Colluvium on lower gradient (moderate to gentle) lower valley slopes and on the valley floor ranges from sandy gravel with some silt to silt with some sand; and is more weathered and typically covered by a thin organic horizon with ground vegetation. Lower valley slopes are typically moderately drained to moderately well drained with some imperfectly drained zones next to the valley floor. Colluvial fans are abundant on the lower reaches of tributary streams, where material has been deposited from debris flows and alluvial processes. Fans are typically imperfectly drained near the toe.

Recent fluvial deposits of silt and sand have accumulated in some low gradient stream channel areas and on the flat areas of the valley floor have formed small, silt-rich plains.

Low soil temperatures, short growing season and slow rates of plant reproduction, organic accumulation and decomposition contribute to poorly developed soil profiles. Soils are absent on the upper, steep to moderately steep slopes where erosional processes are active. Most of the residual soils in the study area are Regosols or Brunisols. Regosols occur at high elevations in association with till deposits and Brunisols generally occur at lower elevations in well drained locations. Organisols have developed in flat, poorly drained areas on the valley floor. Crysosols exist in some areas where organic layers provide sufficient insulation to allow frozen soil horizons to develop. Palsas – hummocks of frozen peat with ice-rich cores – occur in the region but were not observed in the proposed Mactung project area.

Due to the typically weak and fissile nature of the parent rocks in the area, which are generally highly schistose metamorphic rocks, most granular deposits are of poor quality.



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

LEGEND

- Waterbody
- Terrain Study Area
- Proposed Access Road
- Streams
- NWT - Yukon Territory Border
- Proposed Mine Site Infrastructure
- Existing Road
- 100m Contour
- 20m Contour
- Field Stations
- Terrain Boundary
- Rock glacier

Terrain Unit Symbols

Surficial material texture → aCk- Rb ← geomorphological process; surface expression

TEXTURE	Specific Clastic Terms	
c	clay	< 2 µm
z	silt	2 - 62.5 µm
s	sand	62.5 µm - 2 mm
a	blocks	> 256 mm; angular particles

Composite Units: Up to 3 letters may be used to describe any characteristic. Processes follow the dash "-" symbol.

Cb-Mb — indicates "Cb" and "Mb" are roughly equal in extent

Mv/Rk — indicates "Mv" is more extensive than "Rk" (about 2/1 or 3/2)

Stratigraphic Units: when one or more surficial materials overlie a different material or bedrock

e.g. Mw / Rr — indicates that "Mw" overlies "Rr"

GEOMORPHOLOGICAL PROCESSES		
V	Gullying	Slope affected by gully erosion
W	Washing	Winnowing of fines by flowing water resulting in development of lag deposits.
Xp	Permafrost processes	Processes related to the presence of permafrost, permafrost aggradation and degradation. (p= palsa)
Z	Periglacial Processes	Solifluction, cryoturbation and nivation occurring within the same unit. Most Z processes noted in the terrain study area indicate rock glaciers.
Rb	Rapid Mass Movement	Slope or parts of slope affected by rockfall
Rr	Rapid Mass Movement	Slope or parts of slope affected by rockslide.

MATERIALS		
C	Colluvium	Products of gravitational slope movements; materials derived from local bedrock and major deposits derived from drift; includes talus and landslide deposits. Includes up to 20% bedrock.
FG	Glaciofluvial sediments	Sands and gravels transported and deposited by meltwater streams; includes kames, eskers and outwash plains.
M	Till	Material deposited by glaciers without modification by flowing water. Typically consists of a mixture of pebbles, cobbles and boulders in a matrix of sand, silt and clay; diamicton. Includes up to 20% bedrock and/or colluvium.
O	Organic materials	Material resulting from the accumulation of decaying vegetative matter; includes peat and organic soils.
R	Bedrock	Outcrops and bedrock within a few centimetres of the surface. Includes up to 20% colluvium.

NOTES:
Base Data Source: NTS 1:50,000,
Site Plan Design adapted from original provided by Wardrop

ISSUED FOR USE

MACTUNG

Terrain Study Area

PROJECTION: UTM Zone 9 — DATUM: NAD83

Scale: 1:25,000 — 0.5 0.25 0 0.5 Kilometers

FILE NO.: W23101110_001_Terrain_YU.mxd

PROJECT NO.: W23101110.001 — DWN: MEZ — CKD: JD — REV: 0

OFFICE: EBA-VANC — DATE: December 4, 2008

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Figure 4.1.3-1

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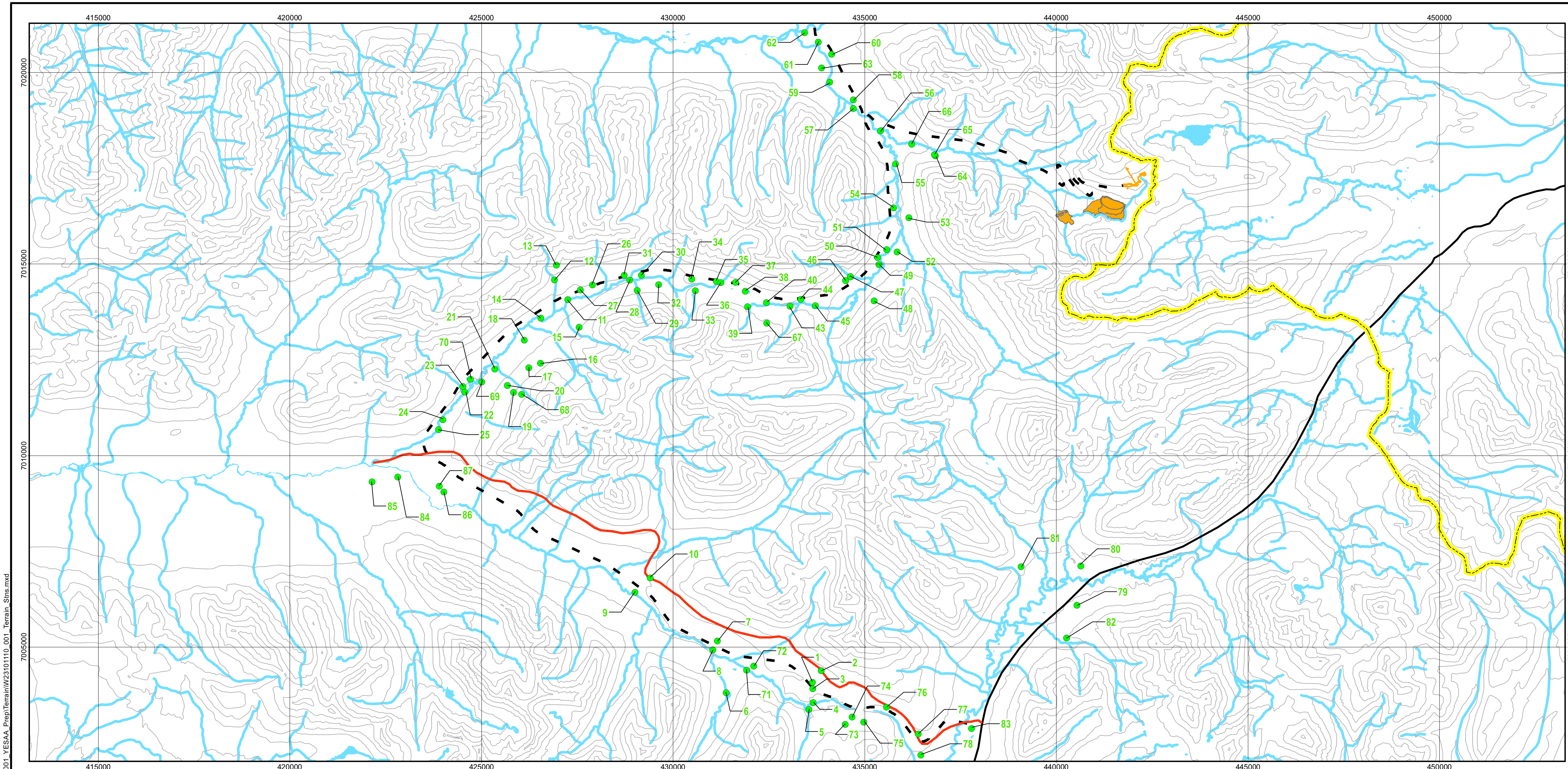

LEGEND

- Terrain Stations
- Proposed Access Road
- Existing Trail/Road Track
- Existing Roads
- Proposed Mine Site Infrastructure
- NWT - Yukon Territory Border
- Contours (100m)
- Watercourse
- Waterbody

NOTES

Base data source: NTDB 1:50,000
Site Plan Design adapted from original provided by Wardrop

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MACTUNG

Terrain Field-Checking Stations

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:100,000

1 0.5 0 1 2 3
Kilometers

FILE NO.
W23101110_001_Terrain_Stns.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JD	1

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EBA-VANC	December 4, 2008

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EBA Engineering Consultants Ltd.

Figure 4.1.3-2

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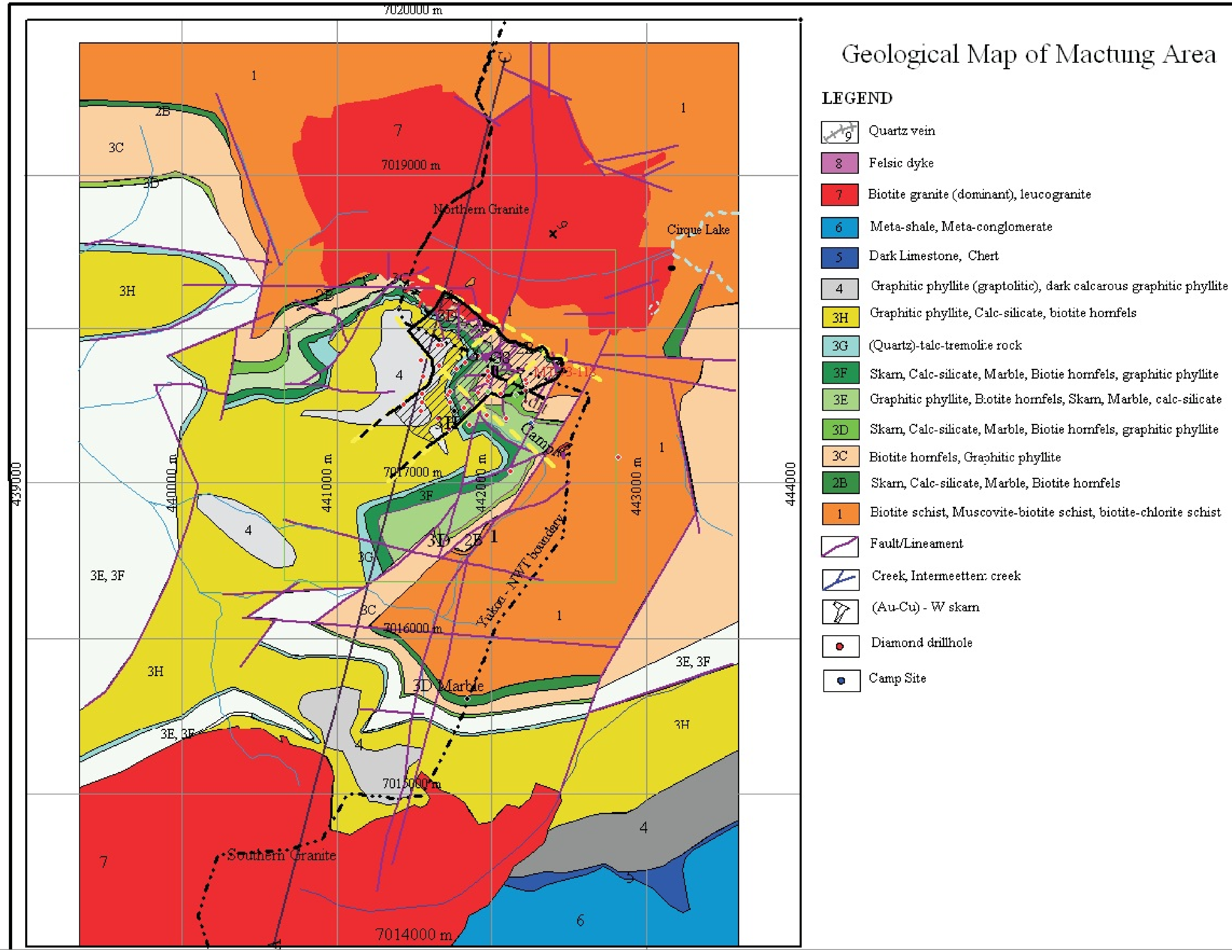


NOTES
Source: Gebru, A.L. and Lentz, D.R., 2008. Geochemistry and Chronology of Granitoids Adjacent to the Mactung Au-Cu-W Skarn.
Poster Presentation at Goldschmidt 2008 Conference, University of British Columbia, Vancouver , Canada.

0 500 1000
meters

ISSUED FOR USE

CLIENT
NORTH AMERICAN TUNGSTEN CORPORATION LTD

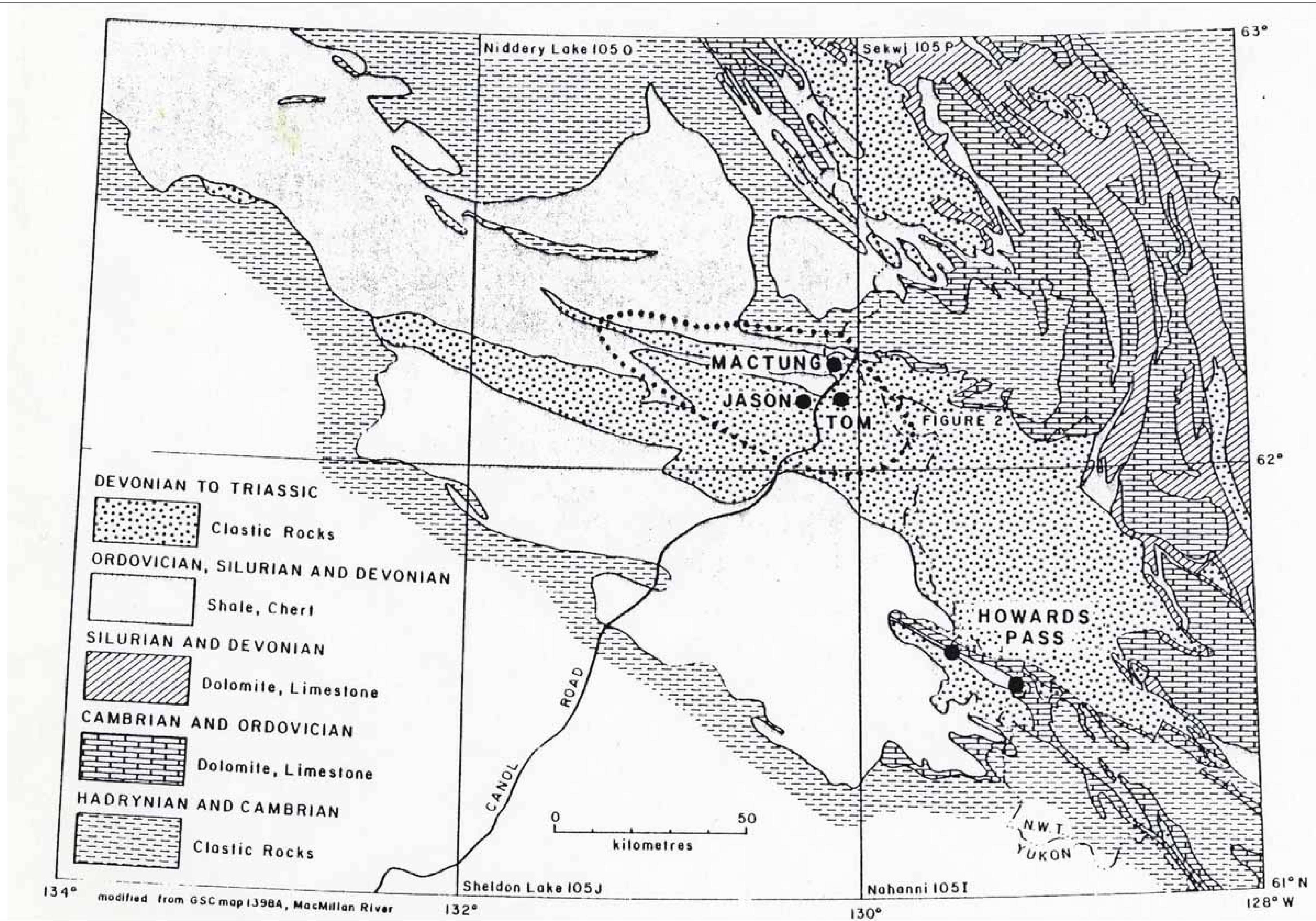
EBA Engineering Consultants Ltd.

MACTUNG

Mactung Deposit Geology

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JD	0
OFFICE	DATE		
EBA-VANC	December 4, 2008		

Figure 4.1.3-3



NOTES

Source: Department of Indian Affairs and Northern Development,
Location and Geological Setting of MacMillan Fold Belt, Open File 1983-1, 1982.

ISSUED FOR USE

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Mactung Regional Geology

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JD	0
OFFICE	DATE		
EBA-VANC	December 4, 2008		

Figure 4.1.3-4

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No granular deposits suitable for road surfacing or concrete aggregates have been identified and initial indications are that these materials may have to be obtained by crushing local competent bedrock.

A borrow site located in gentle gradient terrain along the valley floor between UTM 7016250N to 7018000N and 439500E to 440500E is proposed to supply material for the ravine dam construction. The area is identified by terrain mapping as a blanket of glacial moraine underlain by bedrock. Field testing indicates that the material is relatively consistent gravelly sand or sand and gravel with trace silt (< 10%) to silty (20-35%) and trace to negligible clay. Typical density of undisturbed parent material is compact (medium density) and grain size analysis indicates that high permeability is expected. Average moisture content of tested samples was 8.7% and ranged from less than 1% to 19%.

Steep terrain and climate factors such as rain and snowmelt contribute to potentially high surface soil erosion hazard on the lower and middle slopes from May to September, particularly during spring freshet. Natural erosion will be particularly acute in steep-sided stream valleys incised deeply into thick deposits of lateral moraine on the east valley sideslopes.

Predominantly coarse-textured soils and the associated low soil detachability, abundant surface coarse fragments and good drainage indicate potentially low susceptibility to erosion throughout most of the project area, which is underlain by colluvium and montaine glacial till. Susceptibility to soil erosion increases in areas with restricted layers such as shallow bedrock, increased slope gradients and during sensitive climatic events such as high precipitation. Limited soil development and generally coarse soil texture indicates a low probability of detrimental soil compaction.

The project area is high elevation northern alpine and as such is mostly above tree line. Run-off is rapid on upper valley slopes (mostly bedrock) and middle valley slopes (mostly blocky colluvium with some coarse textured till) where slope gradients are steep to moderate and ground vegetation cover is nil to thin. Infiltration rate is expected to be high in areas of thicker colluvium and till. However, shallow bedrock, permafrost and seasonally frozen soils may inhibit vertical percolation.

Permafrost

The region lies in the zone of discontinuous permafrost (Oswald and Senyk, 1977). No permafrost was intersected in any of the shallow hand pits used for terrain assessment during the ground-truthing program. Soil drainage all along the proposed route was generally well-drained and there is judged to be a low probability of intersecting ice-rich soils. Surficial material along the proposed route was observed to be dominantly coarse-textured and is expected to be generally thaw-stable. Frozen bedrock was encountered during drilling on the mine site and ground temperature arrays were installed to determine the extent. The frozen bedrock was determined to be ice-poor based on the drilling program.

Ground temperature monitoring instrumentation was installed at five locations on the valley floor in the fall of 2007. Data was collected at one station on March 26, 2008 and recorded a temperature gradient of -1.9°C to -0.7°C from 1 m to 10 m depth. Ground temperature data recorded in July and August 1983 at two sites on the valley floor about 2 km east of the study area in the NWT showed thaw conditions, with average ground temperatures of +7.5°C and +4.9°C at 1 m depth and 0°C and +0.8°C at 10 m depth. Geotechnical logs from boreholes and test pits completed in September 2007 indicate discontinuous zones of permafrost at some test sites. No visible ground ice was observed at any of the 2007 test sites.

Bedrock Geology

The stratigraphy of the Macmillan Pass area is made up of sedimentary rocks ranging in age from late Proterozoic through Triassic at the boundary between Mackenzie Platform and Selwyn Basin. Figure 4.1.3-3 shows the main Mactung deposit geology and Figure 4.1.3-4 shows the Mactung deposit in relation to the five main subdivisions within the sedimentary rocks. The Mactung deposit lies on the eastern margin of the Selwyn Basin with Late Proterozoic-Paleozoic age miogeosynclinal sedimentary rocks that have been regionally folded along northwest trending axes and cut by northwesterly and easterly trending faults. The deposit is within a 30 km-wide, 60 km-long belt of folds and faults (Macmillan Fold Belt) that trends northwest across the generally northern structural grain. Country rocks at the Mactung deposit are intruded by Cretaceous granitic stocks and batholiths. The deposit occurs in skarn developed at the contact between a Cretaceous quartz monzonite stock and Lower Paleozoic calcareous sedimentary rocks.

Extensive drilling to outline the extent of mineralization in the 1960s, 1970s and early 1980s resulted in an estimated total mineral resource of almost 33 million tons of 0.88% grade WO^3. Borehole locations are showon on Figure 4.1.3-5. WO^3 is tungsten tri-oxide, obtained from the minerals scheelite, wolframite and ferberite. The valuable tungsten mineral at the Mactung deposit is scheelite ($CaWO^4$) with minor amounts of ferberite ($FaWO^4$) as an accessory mineral. (J.F. Allen, Southwest Potash Corp., 1973; Amax, 1974, 1975, 1980 and 1982)

Major rock types present are quartz monzonite, argillite, shale, hornfels, chert and limestone. Quartz monzonite is typically light grey, medium grained, vaguely porphyritic biotite quartz monzonite grading to light grey to buff, equigranular, medium-grained biotite near the contacts with the country rock. Two thin, probably discontinuous limestone layers are interstratified with shales and cherts, which are underlain by well foliated limy phyllites and quartz mica schists. The lower limestone bed is approximately 12 m to 15 m thick and interstratified with limy and siliceous shales and argillites. It is converted to a garnet-epidote-diopside skarn adjacent to the quartz monzonite stock, with fine-grained scheelite disseminated throughout the skarn. The upper limestone bed is over 30 m thick and is mostly barren, with skarn mineralogy limited to faults near the quartz monzonite contact. Mineralogy has differentiated pyroxene skarn, pyrrhotite skarn, pyroxene marble skarn, light green cherty skarn and chlorite skarn.

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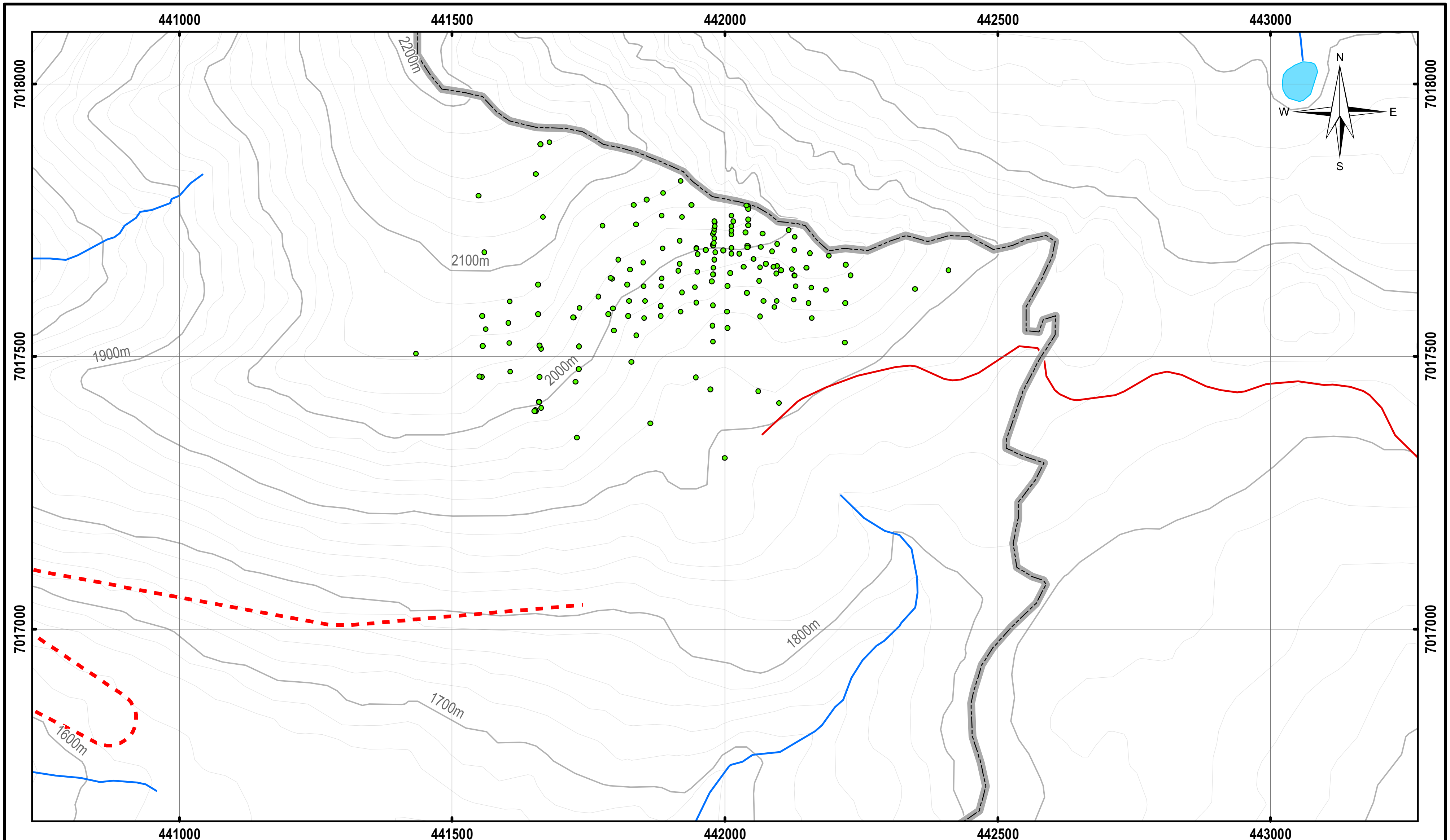

LEGEND

- Borehole Locations
- Proposed Access Road
- NWT - Yukon Territory Border
- Existing Road
- 100m Contour
- 20m Contour
- Streams
- Waterbody

ISSUED FOR USE

NOTES
Base data source: NTS 1:50,000.
Site Plan Design adapted from original provided by Wardrop

Scale: 1:10,000
200 100 0 200
Meters

PROJECTION	DATUM
UTM Zone 9	NAD83

FILE NO.
W23101110_001_Dep_Boreholes.mxd

NORTH AMERICAN TUNGSTEN CORPORATION LTD
EBA Engineering Consultants Ltd.

MACTUNG

Mactung Deposit Exploration Borehole Locations

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JD	0

OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 4.1.3-5

Dominant bedding orientation at the Mactung deposit strikes roughly east-west and dips 20 to 30 degrees south. Numerous steep, north-trending normal faults cut both the sediments and granodiorite. Sediments are cut by granitic dykes characterized by equigranular texture and abundant muscovite. Plan and Cross-section of property geology are appended.

Quartz veins are numerous in the quartz monzonite, especially near the mineralized skarn. Other veins include carbonate, chlorite, zeolite and pyrrhotite-chalcopyrite. Accessory vein mineralization includes calcite, dolomite, pyrrhotite, and tremolite with minor amounts of scheelite, chalcopyrite, molybdenite, pyrite, diopside, idocrase, biotite, tourmaline, and rare arsenopyrite and sphalerite.

Petrographic analyses of lithologies are summarized in Table 4.1.3-1. A complete mineralogical analysis of a composited adit ore sample was determined using microcopic techniques and x-ray diffraction analysis (AMAX 1969). Non-sulfide gangue minerals are pyroxene, amphibole, quartz, plagioclase, muscovite-biotite mica, chlorite, garnet, calcite, apatite and collophane. Sulphide gangue minerals are pyrrhotite, pyrite and non-economic chalcopyrite.

Terrain Hazards

Active geomorphological processes in the study area include rockfall, debris slides, debris flows, avalanches, gully erosion and periglacial processes, e.g., rock glaciers.

Rapidly drained bedrock slopes of the upper valley walls and cirques are typically steep (greater than 70%) and moderately steep (50 to 70%). Rockfall is the primary erosional process on these slopes and the moderately steep to steep slopes are likely subject to avalanche. Rockfall involves the release of relatively small masses of rock (e.g., a single block or a few cubic metres) and movement downslope by freefall, rolling and bouncing. This is the most common process in the area and results in the formation of extensive talus slopes.

TABLE 4.1.3-1: RESULTS OF PETROGRAPHIC ANALYSIS FOR LITHOLOGIES AT MACTUNG

	Quartz monzonite	Quartz monzonite	Quartz monzonite	Phyllite	Plagioclase Mica-Schist	Volcanic Conglomerate	Argillaceous Siltstone	Argillite	Pelitic Hornfels	Pelitic Hornfels	Pelitic Hornfels	Marble	Marble	Marble	Marble	Light Skarn	Light Skarn	Light Skarn	Light Skarn	Light Skarn	Light Skarn	Phyllite	Calc-silicate	Calc-silicate	Calc-silicate	Dark Skarn	Dark Skarn	Dark Skarn	Dark Skarn	Dark Skarn	Dark Skarn	Dark Skarn
K-feldspar	35	34	35																													
Plagioclase	20	24	24		70					30						18	50	60	25		7	25					5		15		10	10
Quartz	31	33	33	25	5				20-40	26	63	2		30	20	2	5	23	7	45	8	10	10	40	27	2	5	3	5	15	5	50
Biotite	10	5	5	5	15				30	30	10											30										
Muscovite	3	3	2	60	5				10	2	25																					
Opaques				5						10	2	1	1	5	30	1	3			5	4				3	2	40	5	3	1		5
Andalusite				5																												
Chlorite					5					2																	2					
Lava (feldspar)						90																										
Calcite						V										1	2				3		5		30	5		2	6	2	5	
Quartz/ Feldspar/ Muscovite							60-70	50-60																								
Pyrite (fine-grained)							U																									
Carbonate matrix								U				94	95	35	30																	
Diopside												2	1	30	15	70	30	10	5	30	75	5	1			20	40	65	35	70	75	30
Tremolite													1		5					5	3		64	60								
Wollastonite																8	10	5	60	15												
Tourmaline																		2	3													
Clinozoisite																						30					2					
Talc																							20		30							
Garnet																										56		10	10	10		
Fluorite																										15		2	1			
Sphene																											1		1			
Scheelite																											5	5	4	2		5
Horneblende																												5	10			
Other minerals	1	1	1			V													U-N									3-D	1-S		5-F	

(AMAX, 1969) V= variable; U = amount unknown; F = ferroactinolite; S = scapolite; D = idocrase; N = dark unknown mineral.

Debris slides occur when a mass of glacial drift or colluvium becomes detached from a hillside and moves rapidly downslope by sliding along a shear plane. The shear plane may coincide with the contact between weathered till and unweathered till, between colluvium and till, or between any of these materials and bedrock. There were no recent active debris slides observed in the area during the field checking in July 2006. A possible relic (inactive) debris slide about 10 ha in area was identified on a north valley hillslope about 6 km west of the Yukon / NWT border.

A debris flow is the rapid flow of a mass of viscous material consisting of mud, sand, stones and/or organic debris. A debris flow is often initiated when a debris slide enters a stream channel and may move downslope for several hundred metres or more. They are a major source of stream sediment and deposition on colluvial fans in lower reach run-out zones. Although no recent debris flows were observed during the 2006 fieldwork, the dynamics of the terrain of steep sided deeply incised gullies through moraine on the north valley hillslopes indicates at least a moderate debris flow potential. Small, periodic debris flows are probably an ongoing process within valley sideslope stream channels and contribute to colluvial fan deposits mapped in the study area (Appendix C1).

Avalanches are rapid slides or flows of snow. Snow accumulations in the project area are heavy and the moderately steep to steep slopes have potential for avalanching. Avalanches are likely an annual occurrence in this region and probably play a part in some downslope transport of colluvial material in the study area. A preliminary avalanche study was completed (Appendix C3).

Gully erosion on the valley sideslopes is seasonally active, particularly in the thick moraine deposits on the north side, with most erosion probably taking place during spring run-off. Gullies are small ravines with v-shaped profiles that form in drift and bedrock. Prominent gullies are incised into kame terraces on the north valley hillslopes.

A number of rock glaciers are mapped in the study area, mostly on north-facing slopes outside areas of the proposed Mactung development. Rock glaciers are typically thick talus deposits with an ice-rich core and have a lobate, tongue-shaped form. They can form where deep blocky colluvium overlying permafrost receives sub-surface flow from an upslope basin. Rock glaciers are usually active, moving downslope at a very slow rate, and have a moderately steep, active escarpment on the downslope face.

The project area is located in an area of moderate seismic hazard, rated 3 on a scale of 5 (GSC, 2005[1]). The maximum ground accelerations associated with 1:475 and 1:1000 year return earthquakes are 0.137 g and 0.179 g respectively (g = peak ground acceleration).

The mine site is located in high alpine where bedrock or blocky colluvium are the dominant surface covers and subsidence potential is judged to be low. Most of the area is well to rapidly drained with a well developed network of upper watershed streams and the flood hazard is low.

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[1] Natural Resources Canada. National Building Code of Canada Seismic Hazard Values. 2005.

Avalanche Hazard

Avalanche classification is based on the combined effect of four controls of avalanche likelihood: incline, elevation, slope curvature, and proximity to free-wind ridges. Forest cover, ground irregularity, slope dimensions, altitude and location are also influencing factors. The primary terrain requirement for avalanche initiation is slope incline that will allow an avalanche to start and accelerate. Other terrain features are secondary.

Slopes between 25º and 40º, and in some case up to 60º, are generally considered typical for inducing an avalanche. Avalanches tend to start on recognized geomorphological features such as convex and planar slopes or along corniced ridges. Dry snow avalanches usually initiate where a portion of the slope has an incline of greater than 25º; lower inclines can produce wet avalanches, e.g., during spring thaw conditions.

Many of the slopes in the project area meet the conditions for avalanche formation. Slope gradients on the upper and middle hillslopes are steep and fall within the upper range (35º to 42º) of avalanche inducing terrain. Regional climatic conditions include sufficient snowfall to support avalanche activity. Most upper slopes have steep gradients and are probably subject to constant sloughing and thus a reduced likelihood of heavy snow accumulation to support large volume avalanches. There is some potential for avalanche initiation on the slopes above the present camp, although the probability, volume and impact may be reduced due to the exploration trail network that has created an irregular slope configuration, the slope shape and the slope length.

To date there are no known historical records of snow avalanches in the mountains surrounding the project area. It is assumed that this is due to the fact that there has been little or no winter activity and that avalanche hazard has not previously been identified for assessment and monitoring.

It is expected that potential avalanches in the project area, if large enough to impact mine infrastructure, could likely be controlled by appropriate avalanche management or the construction of avalanche deflection/control structures. Therefore avalanche hazard is unlikely to be an insurmountable natural slope process that would set back the project feasibility. Preliminary avalanche studies have been completed. Ongoing avalanche assessment and management is planned and is recommended for the overall mine management plan. Avalanche study results and recommendations are included in the surficial geology report for the Mactung Property, which is included as Appendix C1 (see also Appendix C3).

4.1.3.2 Proposed Access Road

The overall length of the planned access road is about 35 km (Figure 4.1.3-2). It starts at about km 447 on the Canol Road, three kilometres south of the Macmillan Pass Aerodrome. The proposed route starts in the valley of the South Macmillan River and follows an abandoned exploration road for approximately 17.5 km that crosses a drainage divide at about km 4 into a northwest-flowing tributary of the Hess River. At km 17.5 west of the Canol Road, the proposed route heads northeast for approximately 17 km where it crosses a drainage divide into a north flowing tributary of the Hess River. The route turns east into the project area valley about 10 km west of the mine site.

A stereoscopic overview of the study area terrain was completed in May 2008 using high level, 1:31,000 scale, black and white aerial photographs. This overview was completed in order to plan ground-truthing, which took place from July 14 to July 17, 2008. The schedule for ground-truthing was dependent on other seasonal commitments and was completed prior to detailed terrain mapping. The mapping was to be done using large-scale air photographs that were scheduled to be flown in 2008. Weather conditions in the project area throughout the summer were unpredictable and unsuitable to plan the air photography, and this work could not be completed. In the absence of these large scale air photographs, detailed terrain mapping was not completed and is planned following acquisition of new aerial photography in 2009. Ground-truthing was completed with relatively closely-spaced field stations and provides a basis for describing the surficial geology along the proposed road alignment. At one 4 km-long section located about 15 km west of the Canol Road, forest cover and terrain conditions precluded helicopter access and ground-truthing was limited to aerial observations. The 2008 terrain mapping report is appended to this proposal (Appendix C2).

Bedrock Geology

The access road route is located on the eastern margin of the Selwyn basin with Late Proterozoic-Paleozoic age miogeosynclinal sedimentary rocks that have been regionally folded along northwest trending axes and cut by northwesterly and easterly trending faults. The area is mapped as mostly rocks of the Earn Group, a complex assemblage of submarine fan and channel deposits including siliceous shale, chert and small occurrences of felsic volcanics. Zones of the Road River-Selwyn formation, which includes black shale, chert, orange siltstone and buff platy limestone, are also mapped in the area.

General Surficial Geology

Soils in the project area originate from glacial, colluvial and minor fluvial processes. Organic soil deposits have developed on the plains of drainage receiving areas of major valley floors, particularly in the Macmillan River valley and the broad valley downslope of the existing mining road west of the Canol Road. The results of field observations are summarized in Table 4.1.3-2 and field station locations are shown on Figure 4.1.3-2.

Upper slopes of the main valleys are mostly bedrock with negligible or thin deposits of rubbly colluvium soil. Middle valley hill slopes are typically covered by rubbly colluvium originating from rockfall and erosion of upper bedrock slopes. Lower slopes and valley bottoms are typically covered with deposits of residual soils from mountain glaciation processes (till).

Till (moraine) is the most common surficial material mapped in the study area. Morainal soil is typically coarse-textured, mostly gravel and sand with negligible to some silt.

Compaction of near surface till is consistently loose throughout most of the study area. The potential for erosion in soils developed from till is generally recognized to be low except on moderately steep (50% to 70% gradient) and steep (> 70% gradient) slopes.

Colluvium on valley hillslopes is most commonly coarse blocky talus on moderately steep (50-70%) to moderate (27-49%) gradient, well drained slopes derived from ongoing erosion of upslope bedrock headwalls. Colluvium on lower gradient (moderate to gentle) lower valley slopes is developed from till and/or talus and is typically well drained. Colluvial fans are common on the lower reaches of tributary streams, where material has been deposited from debris flows and alluvial processes. Fans may be imperfectly drained near the toe.

Recent fluvial deposits of silt and sand have accumulated in some low gradient stream channel areas and on the flat areas of the valley floor. These deposits are often overlain by a veneer (less than 1 m thick) organic soil cover, particularly in the broad valley west of the Canol Road.

TABLE 4.3.1-2: PROPOSED MACTUNG MINE ACCESS ROAD – TERRAIN AND SOILS FIELD STATION

Station	Texture	Drainage	Terrain Symbol
JD-08-1	PEAT	p	pOp
JD-08-2	sandy GRAVEL, trace silt	m	sgCa
JD-08-3	GRAVEL, some sand	w	sgMb
JD-08-4	SILT, some sand, trace gravel	m	szCk
JD-08-5	sandy GRAVEL, trace silt	w	zxgCx/Rka
JD-08-6	sandy GRAVEL	w	Mvd/R
JD-08-7	SAND and GRAVEL	m	sgMb
JD-08-8	blocky, shaly ROCK	w	Cxd/Rs
JD-08-9	GRAVEL, some sand	r	sgCx/Rs
JD-08-10	SAND and GRAVEL	w	Mxd and Cv/R
JD-08-11	gravelly SAND	w	gsMb
JD-08-12	SAND and GRAVEL	w	gsMb/R
JD-08-13	GRAVEL, some sand	w	sgCv/shRkr
JD-08-14	GRAVEL and SAND	w	sgMb
JD-08-15	GRAVEL and SAND, trace silt	m	sgCv/Rak
JD-08-16	gravelly SAND to GRAVEL and SAND	m	gsMb
JD-08-17	sandy GRAVEL	w	sgCv
JD-08-18	silty, gravelly SAND	w	gsMb
JD-08-19	sandy GRAVEL	w	sgCv/R
JD-08-20	sandy GRAVEL	m	sgCv(b)
JD-08-21	SAND, some gravel, some silt	m	gsMb
JD-08-22	gravelly SAND, some silt	m	gzsDj/tR
JD-08-23	fine SAND and boulders	m	Dr/tR(f)j
JD-08-24	GRAVEL and SAND, trace silt	m	sgCv
JD-08-25	silty SAND, some gravel	m	gzsMb
JD-08-26	gravelly SAND, trace silt	m	gsMb
JD-08-27	gravelly SAND, trace silt	w	gsMb
JD-08-28	gravelly SAND	w	gsMb

TABLE 4.3.1-2: PROPOSED MACTUNG MINE ACCESS ROAD – TERRAIN AND SOILS FIELD STATION			
Station	Texture	Drainage	Terrain Symbol
JD-08-29	gravelly SAND, trace silt	w	sgMb/R
JD-08-30	gravelly SAND, trace silt	w	gsMb
JD-08-31	gravelly SAND, trace silt	w	gsMb
JD-08-32	fine GRAVEL and SAND	m	sgMb
JD-08-33	sandy GRAVEL	w	sgMh
JD-08-34	GRAVEL and SAND	w	sgM(FG?)rh
JD-08-35	SAND and GRAVEL, trace silt	w	gsMb
JD-08-36	bouldery, cobbly SAND	w	rCf - A
JD-08-37	GRAVEL, some sand	w	rCvb
JD-08-38	GRAVEL and SAND	w	gsMhm
JD-08-39	GRAVEL and SAND	w	sgMb(v)/shRm
JD-08-40	SAND and GRAVEL	w	gsMr-H
JD-08-41	gravelly SAND	w	gsMb/shR
JD-08-42	--	-	Mb
JD-08-43	GRAVEL and SAND	w	sgMr
JD-08-44	--	w	aCv/Mb(?)/R
JD-08-45	GRAVEL and SAND	w	gsMb/shR
JD-08-46	GRAVEL and SAND	w	gsMrh
JD-08-47	sandy GRAVEL	-	sgMb/R
JD-08-48	SAND, some silt, some gravel	w	zgsMht
JD-08-49	GRAVEL and SAND	w	sgMb-H
JD-08-50	--	-	Mx/R
JD-08-51	gravelly SAND	w	gsMhr-H
JD-08-52	gravelly SAND	w	gsMhr-H
JD-08-53	GRAVEL and SAND	w	gsMhr
JD-08-54	gravelly SAND	w	gsMb
JD-08-55	gravelly SAND	w	Mb(t)
JD-08-56	gravelly SAND	w	gsMt
JD-08-57	sandy GRAVEL	-	sgFp
JD-08-58	gravelly SAND	w	gsMb-H/LGd
JD-08-59	SAND and GRAVEL	w	gsMb(t)-H(?)
JD-08-60	gravelly SAND, trace silt	w	gsMt
JD-08-61	gravelly SAND	w	gsFGt
JD-08-62	GRAVEL and SAND	w	gsFGt/R
JD-08-63	GRAVEL and SAND	w	gsFGt
JD-08-64	bouldery, cobbly GRAVEL, trace sand	w	rCk
JD-08-65	GRAVEL and SAND	w	sgMh
JD-08-66	SAND, some gravel, trace silt	w	gsMvb/shR
JD-08-67	gravelly SAND	w	gsM
JD-08-68	GRAVEL and SAND	w	sgCv/Rh
JD-08-69	gravelly SAND, trace silt	-	gsMb
JD-08-70	gravelly SAND, trace silt	w	gsMb
JD-08-71	sandy GRAVEL, trace silt	w	sgCk/shRh
JD-08-72	gravelly SAND	w	gsMb

TABLE 4.3.1-2: PROPOSED MACTUNG MINE ACCESS ROAD – TERRAIN AND SOILS FIELD STATION			
Station	Texture	Drainage	Terrain Symbol
JD-08-73	SAND and GRAVEL, trace silt	-	sgCv/shRh
JD-08-74	SAND, some gravel, trace silt	w	gsMb
JD-08-75	gravelly SAND, trace silt	mw to w	M + C
JD-08-76	SAND, some gravel	-	gsFG
JD-08-77	--	-	Cv/shR; /Mx
JD-08-78	--	w	Mb
JD-08-79	GRAVEL and SAND, trace silt	w	sgCv/Rr; /Mx
JD-08-80	GRAVEL and SAND, trace silt	w	gsCv/shR
JD-08-81	GRAVEL and SAND	w	sgFGh (M?)
JD-08-82	GRAVEL and SAND	w	sgCv/shRr
JD-08-83	SAND and GRAVEL	w	FG (M?)
JD-08-84	SAND and GRAVEL, trace silt	-	gsFG (M?)
JD-08-85	gravelly SAND, trace silt	w	gsMb
JD-08-86	SAND, some gravel, trace silt	mw	gsMb
JD-08-87	SAND, some gravel	w	gsFGh

Terrain symbols include the surficial material in upper case prefixed by soil texture and followed by landform description; "/" symbol indicates the first material overlying the second.

TERRAIN SYMBOLS MATERIAL: C –colluvium; F –fluvial; FG –glaciofluvial; LG –glaciolacustrine; M –till;
LANDFORM: b –blanket; d –discontinuous; f –fan; h –hummocky; j –gentle; k –moderately steep; m –rolling; p –plain; r –ridged; s –steep; t –terraced; v –veneer; x –thin veneer; -H –kettled (and hummocky) glacial ice-melt deposits; A –avalanched;

DRAINAGE: p –poorly drained; m –moderately well drained; w –well drained; r –rapidly drained;

Soils

Low soil temperatures, short growing season and slow rates of plant reproduction, organic accumulation and decomposition contribute to poorly developed soil profiles. Soils are absent on the upper, steep to moderately steep slopes where erosional processes are active. Most of the residual soils in the study area are Regosols or Brunisols. Regosols occur at high elevations in association with till deposits and Brunisols generally occur at lower elevations in well drained locations. Organisols have developed in flat, poorly drained areas on the valley floor. Crysosols may exist in some areas where organic layers provide sufficient insulation to allow frozen soil horizons to develop.

Steep terrain and climate factors such as rain and snowmelt contribute to potentially high surface soil erosion hazard on the lower and middle slopes from May to September, particularly during spring freshet. Natural erosion will be particularly acute in steep-sided stream valleys incised deeply into thick deposits of lateral moraine.

Predominantly coarse-textured soils and the associated low soil detachability, abundant surface coarse fragments and good drainage indicate potentially low susceptibility to erosion along most of the proposed access road route, which is underlain by till and colluvium. Susceptibility to soil erosion will increase in areas with restricted layers such as shallow bedrock, increased slope gradients and during sensitive climatic events such as high precipitation. Limited soil development and generally coarse soil texture indicates a low probability of detrimental soil compaction.

Run-off is rapid on upper valley slopes (mostly bedrock) and middle valley slopes (mostly blocky colluvium with some coarse textured till) where slope gradients are steep to moderate and ground vegetation cover is nil to thin. The infiltration rate is expected to be high in most areas along the proposed route where surficial material is dominantly thick deposits of coarse-textured till or colluvium. Vertical percolation may be inhibited by shallow bedrock, permafrost or seasonally frozen soils; however, these conditions were not observed to be dominant along the proposed alignment.

Potential Construction Materials

In the absence of suitable-scale air photography, specific deposits of construction borrow material were not delineated. However, most of the till and glaciofluvial material observed throughout the study area is typically coarse-textured and should be favourable for use as construction material. Extensive deposits of sand and gravel glaciofluvial material were observed near the Macmillan Pass Aerodrome, where the existing mining road leaves the Canol Road, at the confluence of two valleys about 16 km west of the Canol Road and at the Hess River at the terminus of the pump house access road about 10 km west of the Mactung mine. Thick till deposits with favourable granular textures cover the valley floor and lower hill slopes of the valleys of the proposed route from the end of the existing mining road (about 16 km west of the Canol Road) to the terminus of the pump house access road about 10 km west of the Mactung mine.

The proposed route is located almost exclusively through Quaternary deposits of till, glaciofluvial material and colluvium. Bedrock is expected to be a minor component underlying the road. Extensive deposits of favourable granular material are located throughout the proposed access road route and will likely form most, if not all, of the borrow material used for road construction.

Permafrost

The region lies in the zone of discontinuous permafrost (Oswald and Senyk, 1977). There is limited data collected to date to characterize permafrost in the study area. No permafrost was intersected in any of the shallow hand pits used for terrain assessment during the ground-truthing program for the access road. Soil drainage all along the proposed route was generally well-drained and there is judged to be a low probability of intersecting ice-rich soils. Surficial material along of the proposed route was observed to be dominantly coarse-textured and is expected to be generally thaw stable. Frozen bedrock was encountered during drilling on the mine site and ground temperature arrays were installed to determine the extent. The frozen bedrock was determined to be ice-poor based on the drilling program.

Terrain Hazards

Active geomorphological processes observed in the study area include rockfall, gully erosion and avalanche. Some of the fan deposits were likely formed by debris flows, however this process may be mostly inactive in most of the study area. Detailed terrain mapping is required to assess the debris flow activity along the route.

Rapidly drained bedrock slopes of the upper valley walls and cirques are typically steep (greater than 70%) and moderately steep (50 to 70%). Rockfall is the primary erosional process on these slopes and the moderately steep to steep slopes are likely subject to avalanching. Rockfall involves the release of relatively small masses of rock (e.g., a single block or a few cubic metres) and movement downslope by freefall, rolling and bouncing. This is the most common process in the area and results in the formation of extensive talus slopes.

A debris flow is the rapid flow of a mass of viscous material consisting of mud, sand, stones and/or organic debris. A debris flow is often initiated when a debris slide enters a stream channel and may move downslope for several hundred metres or more. Debris flows likely were a significant source of stream sediment and deposition on colluvial fans in lower reach run-out zones. No recent debris flows were observed during the 2008 field work and this process is likely infrequent and not a dominant erosional process in the study area.

Avalanches are rapid slides or flows of snow. Snow accumulations in the project area are heavy and the moderately steep to steep slopes have avalanche potential. Avalanches are an annual occurrence in this region and probably play a part in some downslope transport of colluvial material in the study area. Portions of the proposed access road and the mine site occupy terrain with some avalanche hazard. Observations to support an avalanche risk study have been acquired in 2008 and will continue in conjunction with other environmental studies.

Gully erosion on some valley sideslopes is seasonally active, particularly in thick moraine deposits. Gullies are small ravines with v-shaped profiles that form in glacial drift and bedrock. Gully erosion is probably most active during spring run-off.

The project area is located in an area of moderate seismic hazard, rated 3 on a scale of 5 (GSC 2005[2]). The maximum ground accelerations associated with 1:475 and 1:1000 year return earthquakes are 0.137 g and 0.179 g respectively (g = peak ground acceleration).

Most of the area is well to rapidly drained with a well developed network of upper watershed streams with low flood hazard.

[2] Natural Resources Canada. National Building Code of Canada Seismic Hazard Values. 2005.

4.1.4 Acid Rock Drainage/Metal Leaching Conditions

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

This section presents summary results of the geochemical characterization studies completed for the Mactung property in 2008 (Appendix D1). Observations made during 2008 in the region surrounding the Mactung property indicate that natural acid rock drainage is present in the project area. The area traversed by the proposed access road has evidence of past mineral exploration activities and exposed gossans (weathered and stained outcrops) in most drainages. Water quality monitoring was completed in May 2008 to evaluate current levels of acidity in the existing drainages. Station WQ-2A located at Tributary A (see Figure 4.1.10-11), upstream of the confluence with Tributary C, was observed to have a pH of 6.11 which is below the lower CCME limit of 6.5. Alkalinity in Tributary A upstream of the confluence with Tributary C was low which indicates low natural neutralization potential in this drainage basin. Monitoring in Tributary C has shown that pH remains neutral to slightly alkaline.

Discussions with Government of Yukon personnel familiar with the acid potential of rocks in the region surrounding the Mactung deposit, indicated that shale deposits in the Macmillan Pass area are considered to have some ARD potential. Sampling has not been conducted along the proposed access road or in the area of the proposed aerodrome expansion. Characterization of materials used for construction of the road and aerodrome will come from borrow site locations to be determined during the detailed design of these facilities.

Table 4.1.4-1 shows the acid rock drainage (ARD) classification system for materials based on the Neutralization Potential Ratio (NPR) (Price, 1997). Material with an NPR ratio between 2 and 4 is classified as non-acid generating (NAG) unless the characteristics of the material are such that the sulphide mineralization is highly reactive and the neutralization potential is non-reactive. Materials with an NPR ratio of less than 2 are classified as being potentially acid-generating (PAG).

TABLE 4.1.4-1 ACID ROCK DRAINAGE CLASSIFICATION SYSTEMS FOR MATERIALS

Neutralization Potential Ratio	Acid Rock Drainage Potential	Classification
NPR< 1	Likely	Likely acid generating unless sulphides are non-reactive.
1 < NPR< 2	Possibly	Possibly acid generating if NP insufficiently reactive or is depleted faster than sulphides.
2 < NPR< 4	Low	Not PAG unless: significant preferential exposure of sulphides in fractures zones, or highly reactive sulphides with non-reactive NP.
NPR > 4	None	No ARD concern.

Proposed Mine site Area

The bedrock geology was previously described in Section 4.1.3 in terms of the various mineral types present in the deposit. Geology personnel working on the Mactung project have grouped the various rock types into major units. Table 4.1.4-2 contains a summary of the individual units and the rock types present in each. The proposed underground mining will primarily affect Unit 1, Unit 2B and Unit 3C with Unit 2B containing the mineralized ore grade materials.

TABLE 4.1.4-2 MACTUNG ROCK UNITS AND ROCK TYPES

Unit ID	Rock Types
1	Pyllite (Mica Schist). Basement rock type for deposit.
2B	Skarnified Limestone Slump Breccias
3C	Hornfelsed Black Shale with Interbeds of Limestone
3D	Partially Skarnified Interbedded Shale and Limestone Slump Breccia
3E	Partially Skarnified Pellitic Interbedded Black Shale and Grey to Black Limestone
3F	Partially Skarnified Interbedded Black Shale and Grey to Black Limestone
3H	Hornfelsed Black Carbonaceous Pyritic Shale
4	Graphitic Black Shale
5/6	Bioclastic Grey Limestone, Shale and Chert Conglomerates

The bedrock exposures in the area of the mine site are variable in sulphidic content and neutralization potential (NP) and contain both potentially acid generating (PAG) and non-acid generating (NAG) materials. The mine site area is above treeline and there is considerable exposed bedrock that has been subject to weathering. A geochemical characterization program for rock at the mine site was conducted using standard acid base accounting (ABA) methods as described in Price (1997) and the results of this analysis are contained in Table 4.1.4-3. This characterization program includes assessment of bedrock at potential borrow sites on the mine site. The results of ABA testing of the existing waste materials at the site are also contained in Table 4.1.4-3.

Figure 4.1.4-1 shows the relation between sulphur and Sobek-NPR for the geochemical program samples. This figure shows that all samples greater than 2% sulphur content are classified as PAG. Samples with less than 2% sulphur are classified as being either PAG or NAG and would require additional testwork. A comparison of total carbon content to the Sobek-NPR did not reveal any relations that would allow for simplified classification of materials at the site.

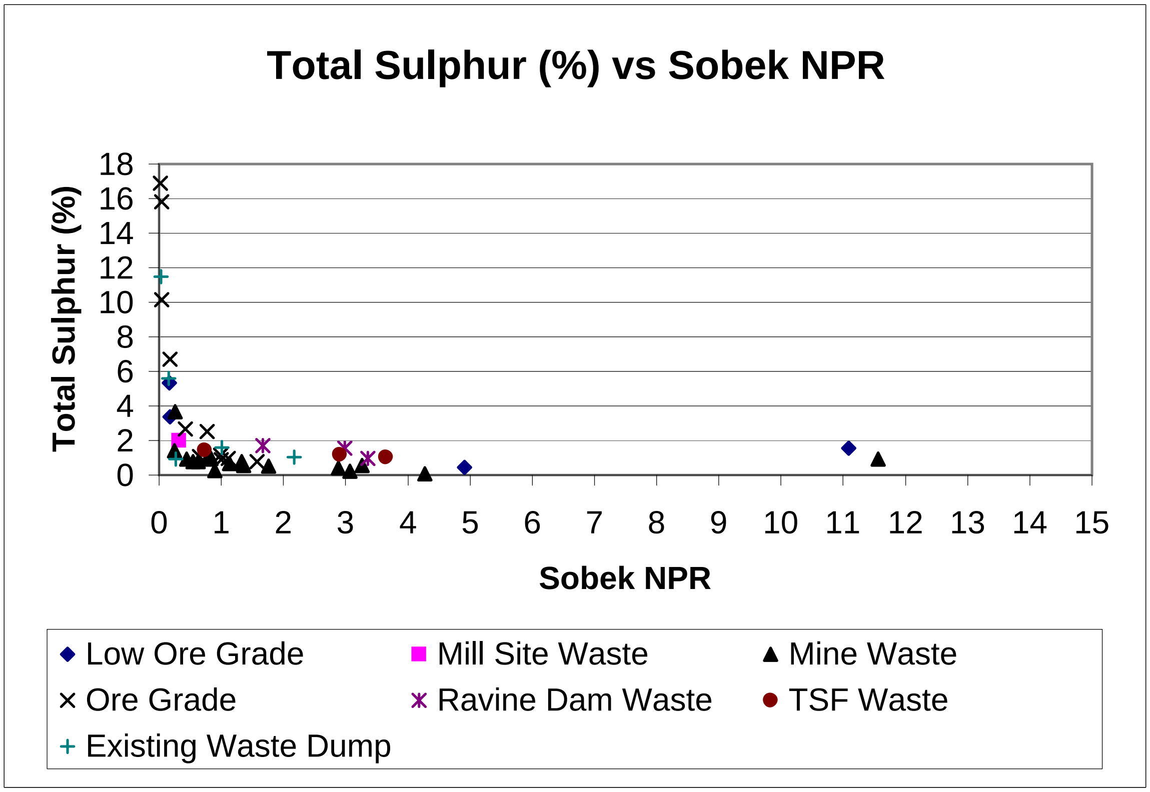
TABLE 4.1.4-3: ACID BASE ACCOUNTING RESULTS FOR MACTUNG ROCK TYPES

Sample	Unit	Rock Type	Mining Classification	MPA	Fizz Rating	NNP	Sobek-NP	pH	Sobek-NPR	ARD Classification	Total Sulphur	Sulphate Sulphur	Del-S	Sulphide Sulphur	Carbon	CO2	Carb-NP	Carb-NPR
				tCaCO3/1000t ore	Unity	tCaCO3/1000t ore	tCaCO3/1000t ore	Unity	Unity		%	%	%	%	%	%	tCaCO3/1000t ore	Unity
36001	1	Hornfels	Waste	29.4	1	-16	13	9.2	0.44	Likely	0.94	0.04	0.01	0.9	0.05	0.2	4.6	0.16
36002	1	Hornfels	Waste	23.8	1	-9	15	8.8	0.63	Likely	0.76	0.04	0.01	0.72	<0.05	<0.2	4.6	0.19
36003	1	Hornfels	Waste	23.8	1	-11	13	8.7	0.55	Likely	0.76	0.04	0.01	0.72	<0.05	<0.2	4.6	0.19
36004	1	Phyllite	Waste	12.5	2	24	36	8.6	2.88	Low	0.4	0.03	0.01	0.37	<0.05	<0.2	4.6	0.37
36005	1	Phyllite	Waste	1.9	1	6	8	8.4	4.27	No concern	0.06	0.03	0.01	0.03	<0.05	<0.2	4.6	2.42
36006	1	Phyllite	Waste	21.3	1	3	24	9.3	1.13	Possible	0.68	0.04	0.01	0.64	<0.05	<0.2		0.00
36007	1	Schist	Waste	17.5	2	40	57	7.7	3.26	Low	0.56	0.06	0.01	0.5	0.24	0.9	20.6	1.18
36008	1	Schist	Waste	28.4	2	-6	22	8.7	0.77	Likely	0.91	0.05	0.01	0.86	0.1	0.4	9.2	0.32
36009	1	Schist	Waste	7.8	1	-1	7	7	0.9	Likely	0.25	0.03	0.01	0.22	<0.05	<0.2	4.6	0.59
36010	2B	Skarn	Ore	209.4	2	-174	35	7.9	0.17	Likely	6.7	0.08	0.03	6.62	0.32	1.2	27.5	0.13
36011	2B	Skarn	Ore	528.1	1	-515	13	5.8	0.02	Likely	16.9	0.12	0.07	16.8	<0.05	0.2	4.6	0.01
36012	2B	Skarn	Ore	493.8	1	-476	18	7.3	0.04	Likely	15.8	0.06	0.02	15.75	<0.05	<0.2	4.6	0.01
36013	2B	Skarn	Ore	28.1	2	0	28	8.9	1	Possible	0.9	0.06	0.02	0.84	0.08	0.3	6.9	0.24
36014	2B	Skarn	Ore	35.3	2	0	35	8.4	0.99	Likely	1.13	0.08	0.01	1.05	0.06	0.2	4.6	0.13
36015	2B	Skarn	Ore	317.2	1	-303	14	7.3	0.04	Likely	10.15	0.07	0.01	10.1	<0.05	<0.2	4.6	0.01
36016	2B	Skarn	Ore	78.8	2	-18	61	8.2	0.77	Likely	2.52	0.06	0.02	2.46	<0.05	<0.2	4.6	0.06
36017	2B	Skarn	Ore	105.3	1	-86	19	8.8	0.18	Likely	3.37	0.06	0.01	3.31	<0.05	<0.2	4.6	0.04
36018	2B	Skarn	Ore	83.1	2	-48	35	7.7	0.42	Likely	2.66	0.07	0.04	2.59	<0.05	<0.2	4.6	0.06
36019	2B	Skarn	Ore	14.1	2	55	69	8.8	4.91	No Concern	0.45	0.04	0.01	0.41	<0.05	<0.2	4.6	0.33
36020	2B	Skarn	Ore	24.1	2	14	38	8.6	1.58	Possible	0.77	0.05	0.01	0.72	<0.05	0.2	4.6	0.19
36021	2B	Skarn	Ore	166.9	2	-141	26	8.1	0.16	Likely	5.34	0.04	0.01	5.3	0.12	0.4	9.2	0.05
36022	2B	Skarn	Ore	48.4	4	489	537	9	11.09	No Concern	1.55	0.04	0.01	1.51	3.17	11.6	265.9	5.49
36023	2B	Skarn	Ore	29.7	2	3	33	9.1	1.11	Possible	0.95	0.04	0.01	0.91	0.23	0.9	20.6	0.69
36024	2B	Skarn	Ore	34.1	2	-12	22	8.8	0.65	Likely	1.09	0.04	0.01	1.05	0.07	0.3	6.9	0.20
36025	3	Hornfels	Waste	44.4	1	-33	11	8.7	0.25	Likely	1.42	0.02	0.01	1.4	<0.05	<0.2	4.6	0.10
36026	3	Hornfels	Waste	24.1	2	8	32	8.9	1.33	Possible	0.77	0.02	0.01	0.75	<0.05	<0.2	4.6	0.19
36027	3	Hornfels	Waste	7.5	2	16	23	8.7	3.07	Low	0.24	0.02	0.02	0.22	0.05	0.2	4.6	0.61
36028	3	Pelite	Waste	16.9	2	6	23	9	1.36	Possible	0.54	0.02	0.01	0.52	0.05	0.2	4.6	0.27
36029	3	Pelite	Waste	30	2	-5	25	9.3	0.83	Likely	0.96	0.01	0.01	0.95	<0.05	<0.2	4.6	0.15
36030	3	Pelite	Waste	15.9	1	12	28	7.6	1.76	Possible	0.51	0.02	0.01	0.49	<0.05	<0.2	4.6	0.29
36031	2BL	Limestone	Waste	27.8	4	731	759	9.1	27.29	No Concern	0.89	0.02	0.01	0.87	8.32	30.5	699.3	25.15
36032	2BL	Limestone	Waste	29.1	3	307	336	8.4	11.56	No Concern	0.93	0.03	0.01	0.9	3.87	14.2	325.6	11.19
36033	2BL	Limestone	Waste	114.4	2	-84	30	8.2	0.26	Likely	3.66	0.07	0.01	3.59	0.24	0.9	20.6	0.18
36034	3	Pelite	Mill Site Waste	62.2	1	-42	20	6.9	0.32	Likely	1.99	0.04	0.05	1.95	0.05	0.2	4.6	0.07
36035	3	Skarn	Mill Site Waste	0.6	4	621	622	9.5	995.2	No Concern	0.02	0.02	0.02	0.01	2.09	7.7	176.5	294.22
36036	3	Black Shale	Ravine Dam Waste	30.3	3	72	102	8.3	3.36	Low	0.97	0.04	0.01	0.93	1.22	4.5	103.2	3.40
36037	3	Black Shale	Ravine Dam Waste	52.8	3	35	88	8.2	1.67	Possible	1.69	0.05	0.01	1.64	1	3.7	84.8	1.61
36038	3	Black Shale	Ravine Dam Waste	48.1	3	96	144	7.9	2.99	Possible	1.54	0.05	0.01	1.49	1.36	5	114.6	2.38
36039	3	Pelite	Tailings Area Waste	36.6	3	69	106	8.5	2.9	Low	1.17	0.04	0.01	1.13	0.69	2.5	57.3	1.57
36040	3	Pelite	Tailings Area Waste	31.9	3	84	116	9.3	3.64	Low	1.02	0.02	0.01	1	1.22	4.5	103.2	3.23
36041	3	Pelite	Tailings Area Waste	45.3	2	-12	33	8.9	0.73	Likely	1.45	0.02	0.01	1.43	0.11	0.4	9.2	0.20
PAD 1	N/A	Unknown	Existing Waste Dump	29.4	1	-21	8	4.5	0.27	Likely	0.94	<0.01	0.08	0.94	<0.05	<0.2	4.6	0.16
PAD 1b	N/A	Unknown	Existing Waste Dump	359.4	2	-350	9	5	0.03	Likely	11.5	0.26	0.4	11.25	0.05	0.2	4.6	0.01
PAD 2	N/A	Unknown	Existing Waste Dump	174.7	2	-148	27	6.7	0.15	Likely	5.59	0.42	0.43	5.17	0.18	0.7	16.0	0.09
PAD 3	N/A	Unknown	Existing Waste Dump	32.2	2	38	70	8	2.17	Low	1.03	0.01	<0.01	1.02	0.61	2.2	50.4	1.57
PAD 4	N/A	Unknown	Existing Waste Dump	50.3	2	1	51	7.8	1.01	Possible	1.61	<0.01	0.01	1.61	0.54	2	45.9	0.91
BG 1	N/A	Unknown	Existing Waste Dump	2.2	1	1	3	5.5	1.37	Possible	0.07	<0.01	0.01	0.07	<0.05	<0.2	4.6	2.09

Table 4.1.4-4 contains a summary of the ARD classification by rock type for the proposed Mactung underground workings. The Hornfels is predominantly PAG while the phyllite and schist waste rock types contain a mixture of PAG and NAG materials. The limestone rock type in Unit 2B was overall NAG with one mineralized sample having a PAG classification. The skarn rock type which hosts the Unit 2B mineralized material is almost entirely PAG with minor NAG content.

TABLE 4.1.4-4 ARD CLASSIFICATION OF MACTUNG ROCK TYPES

Rock Type	Average NPR	ARD Classification
Phyllite	2.76 (Unit 1)	1 PAG, 2 NAG
Hornfels	0.54 (Unit 1) 1.55 (Unit 3C)	3 PAG 2 PAG, 1 NAG
Schist	1.64 (Unit 1)	2 PAG, 1 NAG
Limestone	13.04 (Unit 2B)	1 PAG, 2 NAG
Calc Silicate Skarn	1.46 (Unit 2B)	13 PAG, 2 NAG



NOTES

Blue Data from Exploration Program Assay Results
Other Data from Geochemical Program Assay Results

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Sulphur versus Sobek-NPR
for Mactung Geochmical Samples

PROJECT NO.	DWN	CHK	REV
W23101110.001	SCD	BD	0
OFFICE	DATE		
EBA-WHSE	October 2008		

Figure 4.1.4-1

Rock that will be exposed during surface infrastructure construction (Mill Pad and Ravine Dam) consists of minor volumes of PAG rock. The PAG component will be blended with larger volumes of non-acid generating waste rock present in these areas to ensure overall net-neutralization of the proposed surface waste rock pads. Some of the core used for the geochemical characterization program was from exploration drilling conducted in the 1970's. The paste pH of this older core was found to be still neutral to slightly alkaline which indicates that the material is still net-neutralizing (Table 4.1.4-1).

Sampling conducted on waste materials deposited near the existing adit were found to be acid-generating based on a paste pH below 5.5. The duration of surface exposure of the materials in the current waste dump is at least 25 years. Testing of the waste dump showed evidence of weathering and iron staining in the upper surfaces of the dump. Samples of the hematitic rock showed little to no neutralization potential remaining and were classified as being acid-generating, based on the reported paste pH values. The shorter time to acidity of the waste dump materials to that of the core samples is a result of the core being stored in a covered area where water and freeze-thaw processes are limited.

Excavated pit within waste rock adjacent to existing exploration adit

Vegetation was noted to be growing around the perimeter of the waste materials with some minor vegetation growing on the waste rock. Examination of the thin soils showed iron staining which suggest that there has been some transport of run-off from the waste rock Two linear strips of iron stained rock down gradient from the existing waste rock may be associated with the waste rock; however, the staining may be related to previous exploration disturbances.

4.1.4.1 Contained Metals Analyses

Metals analyses were conducted on samples from the Mactung deposit collected from the 2005 and 2008 exploration drill programs, and the 2008 geochemical characterization program. Metals concentrations within the rock types are determined through inductively coupled plasma with mass spectroscopy (ICP-MS). The aqua regia method of dissolution was used for the exploration samples while a stronger 4-acid, "near-total" dissolution method was used for samples collected for the geochemical program. The "near-total" dissolution method uses a series of acids to dissolve the various metals and the results of this technique represent the maximum theoretical metals loading that can result from a material as it weathers.

Exploration Program Samples

Samples of diamond drill core from the 2005 and 2008 Mactung exploration programs were analyzed for metals concentrations as part of ongoing exploration activities at the site. The analysis was conducted at Global Discovery Labs, which is owned and operated by Teck Cominco. The results of the analysis were evaluated to determine the variability of metal concentrations within the individual units present in the deposit. Table 4.1.4-5 contains a summary metals concentrations for each major unit present at the site. Selenium and sulphur were not analyzed as part of the 2005 exploration program but were added to the 2008 program which explains the discrepancy between the sample sizes.

TABLE 4.1.4-5: SUMMARY STATISTICS FOR MACTUNG ROCK METAL CONCENTRATIONS

Unit	Lithology	Statistic	Cu	Pb	Zn	Ag	As	Ba	Cd	Co	Ni	Fe	Mo	Cr	Bi	Sb	V	Sn	W	Sr	Y	La	Mn	Mg	Ti	Al	Ca	Na	K	P	S	Se
Unit 1	All	n	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	31	31
		Max	1271	51	566	0.6	46	1450	7	36	119	9.34	135	179	171	15	1215	16.7	4195	504	22	51.5	1270	12300	5050	99700	47000	7600	28100	4981	4.96	36
		Min	19.2	4	32	0.04	0.3	61	0.03	6	18	1.71	0.54	31	0.39	0.05	25	2	3.9	28	3	11	199	0.2	0.04	1.52	1.24	0.08	0.07	292	0.07	1
		Median	125.25	4	73	0.4	3	252.5	1	14.8	35.55	3.24	4	73.5	8	5	66.5	4.5	311.5	80.25	10	19.5	425	1.14	0.155	3.015	3.955	0.195	1.01	835.5	0.76	5
	Hornfels	n	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		Max	834	42	566	0.6	11	1180	5	22	119	6.35	46.6	114	171	5	1215	15.3	4195	504	22	39.8	1270	11900	4180	81200	47000	6400	20900	3692	3.65	36
		Min	36	4	57	0.12	0.7	63	0.06	7	23.8	1.96	2	60	1.97	0.06	25	2	20.4	28	3	11	214	0.29	0.04	1.52	1.24	0.1	0.15	292	0.22	2
		Median	126.5	4	78.5	0.4	2.5	238.5	1	13.6	36.5	2.93	4.39	84.5	8	5	73.5	4.5	158	87	9	21	418	1.14	0.155	2.96	3.61	0.21	1.025	671.5	0.77	5
	Phyllite	n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4
		Max	310	15	80	0.4	12	1110	1	30	52.9	4.85	135	179	23	15	92	9	1195	421	18.5	48.1	546	11100	5050	99700	32700	7300	28100	3462	1.31	5
		Min	19.2	4	32	0.04	0.3	239	0.03	11.7	18	1.71	0.54	43	0.44	0.05	42	5	3.9	51.4	7	18	199	1.14	0.14	3.62	3.71	0.19	0.96	390	0.07	1
		Median	93.7	11.8	65	0.11	3	480	0.07	16.5	38.5	3.16	3.33	73	1.67	0.41	71	6.3	805	71	14	39.1	342	3900	3330	50400	6100	2000	16100	622	0.585	1.5
Unit 2B	All	n	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	560	233	233
		Max	6741	73	1139	4.6	362	402	17	143	84	35.66	567	245	1329	89	640	76.7	13410	1002	103	65	9200	40000	3190	76400	284000	4500	16200	23810	18.26	95
		Min	9	1.8	1	0.39	0.2	5	0.22	1	1	0.27	2	4	3.06	0.14	2	2	2	2	2	2	30	0.01	0.01	0.08	0.17	0.01	0.01	104	0.05	3
		Median	463	6	42	1	5	25	1	14	19	5	6	32	34	5	14	7	912	70	6	16	566	0	0	3	5	0	0	1355	4	10
	Sulphides	n	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	26	26
		Max	5422	42	790	3.4	98	277	7	143	74	35.66	88	111	885	89	291	23	13410	463	103	65	4519	2.9	0.15	7.73	26.64	0.39	1.92	14720	18.26	95
		Min	9	4	5	0.4	2	5	1	1	1	0.48	2	4	5	5	2	2	18	9	2	2	138	0.04	0.01	0.38	0.76	0.02	0.01	231	1.97	5
		Median	452	6	42	1	5	25	1	14	19	5	6	32	32	5	14	7	920	70	6	16	566	0	0	3	5	0	0	1363	4	10
	Calc Skarn	n	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	131	131
		Max	6741	46	1139	4.6	362	350	12	94	65	30	328	137	943	72	295	76.7	9396	916	35	56	9200	40000	3190	76400	284000	4500	16200	14350	14.57	72
		Min	11	1.8	1	0.39	0.2	5	0.22	1	1	0.43	2	4	3.06	0.14	2	2	2	2	2	2	40	0.01	0.01	0.14	0.17	0.01	0.01	104	0.16	3
		Median	368	5	45	1	6	25	1	12	19	4	6	33	37	5	16	8	917	68	6	18	719	0	0	2	5	0	0	1087	4	10
	Hornfels	n	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	1	1
		Max	495	39	988	1	16	152	17	11	84	3.33	46	117	145	15	640	32	2541	314	12	33	521	0.71	0.14	6.54	21.54	0.24	0.34	6066	2.09	12
		Min	25	4	1	0.4	2	7	1	1	1	0.98	2	6	5	5	2	2	247	52	2	2	176	0.05	0.01	0.36	2.42	0.04	0.01	322	2.09	12
		Median	130	8	35	0	2	72	1	6	35	2	18	77	13	5	59	3	440	116	7	17	263	0	0	2	5	0	0	748	2	12
	Limestone	n	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	2	2
		Max	2681	22	153	2.4	18	402	1	65	26	17.53	256	50	1329	31	9	14	3246	1002	10	33	1259	1.7	0.12	8.68	27.37	0.37	0.32	12740	0.57	5
		Min	10	4	1	0.4	2	5	1	1	1	0.45	2	4	5	5	2	2	52	35	2	2	160	0.02	0.01	0.27	4.07	0.03	0.01	178	0.51	5
		Median	74	8	27	1	3	22	1	5	7	2	4	12	37	7	3	7	489	233	4	4	607	0	0	1	14	0	0	1279	1	5
Unit 2BL	All	n	13	12	12	12	12	12	12	12	12	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	3	3
		Max	1070	14	174	1.3	26	1200	1	43.2	37.8	8.53	59.5	46	51	23	72	35.1	3130	676	15.5	35.6	2750	18100	2830	73200	327000	3000	17600	2020	3.52	6
		Min	25.2	4	9	0.09	2	13	0.16	1	5	0.97	1.75	9	2.26	0.77	2	6	41.9	68	2	2	412	0.05	0.01	0.22	4.45	0.03	0.01	204	0.83	2
		Median	96	6	29	1	3	104	1	5	10	3	5	22	5	9	4	10	1353	217	4	6	741	0	0	1	17	0	0	737	1	5
	Sulphides	n	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	n/a	n/a
		Max	757	10	58	1.3	12	115	1	21	17	8.19	32	37	51	14	8	14	1707	405	5	19	1123	0.25	0.05	2.58	22.85	0.09	0.13	1303	n/a	n/a
		Min	35	4	9	0.4	2	13	1	1	5	0.97	2	9	5	5	2	6	231	77	2	2	412	0.05	0.01	0.22	4.87	0.03	0.01	204	n/a	n/a
		Median	86	5	24	1	2	69	1	4	8	3	5	20	5	10	4	10	1232	205	3	2	699	0	0	1	15	0	0	523	n/a	n/a
Unit 3C	All	n	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	55	55
		Max	5640	25	1431	4.7	93	2570	25	72	96	18.61	212	225	1102	97	918	16	10530	493	37	47	6184	13300	3680	53000	35500	2800	23900	67360	11.81	89
		Min	32	4	18	0.07	0.2	5	0.06	1	1	1.05	2	9	0.26	0.06	2	0.9	4.2	17	2	2	74	0.03	0.01	0.55	1.77	0.03	0.01	250	0.17	3
		Median	280	6.3	61	0.4	4	105	1	9	44	3.04	15.85	80	16.5	5	116.5	3	919.5	91.5	13	19	343.5	0.5	0.08	2.64	3.73	0.13	0.265	4229.5	1.13	9
	Calc Skarn	n	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	14	14
		Max	2886	15	1077	2.8	45	386	23	52	52	18.61	65	139	1102	72	304	16	5620	144	37	32	2936	0.65	0.12	3.51	13.84	0.21	0.41	60320	10.38	27
		Min	85	4	22	0.4	2	5	1	2	1	1.52	2	20	5	5	6	2	258	17	2	4	175	0.03	0.01	1.15	2.58	0.03	0.01	541	0.72	5
		Median	548	4	41	0.5	3	36	1	11	28	4.64	13	42	48	5	24	4	1063	61	9	15	615	0.22	0.03	1.94	3.7	0.1	0.04	1782	2.47	15.5
	Hornfels	n	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	23	23
		Max	2865	25	1300	1.3	40	2340	13	72	96	13.19	212	225	358	47	765	11	10530	317	30	37	620	10800	3250	49900	35500	2800	23900	32130	9.31	89
		Min	60.5	4	18	0.07	0.2	27	0.06	3	22	1.05	2	39	0.26	0.06	32	0.9	4.2	48	6	9	113	0.13	0.02	1.87	1.99	0.06	0.01	250	0.25	3
		Median	271	4	67	0.4	4	168	1	9	51.2	2.64	22.2	111	8	5	185	2.9	776	89	15	17	249	0.67	0.11	3.06	3.36	0.14	0.45	5394	0.91	8
	Pelites	n	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	3	3
		Max	1033	14	1431	0.9	31	2570	25	25	75	6.91	87	163	89	62	743	14	4371	299	32	47	721	13300	3680	53000	33900	2300	19000	27140	0.98	10
		Min	88.1	4	24	0.16	0.3	21	1	5	23	1.74	2	11	0.66	0.1	2	1	10.1	35	5	14	74	0.15	0.02	1.18	1.77	0.09	0.04	531	0.5	7
		Median	347	9	69	0.4	2	105	1	10	52	3.5	18.35	81	16	12	187	4	1043	91	13	30	299	0.69	0.1	3.59	3.44	0.14	0.47	3293	0.55	7
	Limestone	n	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	n/a	n/a
		Max	1647	16	125	0.9	25	247	2	32	55	10.21	11	78	191	97	104	14	7648	493	25	44	1181	0.87	0.07	3.26	21.71	0.16	0.24	67360	n/a	n/a
		Min	32	4	33	0.4	3	17	1	1	2	1.12	2	9	5	5	5	2	89	58	6	2	113	0.17	0.02	0.55	3.5	0.09	0.03	2839	n/a	n/a
		Median	112	10	53	0.4	11	84	1	8	19	2.94	7	35	24	33	29	5	2067	153	16	16	667	0.39	0.04	1.78	8.9	0.12	0.1	22280	n/a	n/a

TABLE 4.1.4-5: SUMMARY STATISTICS FOR MACTUNG ROCK METAL CONCENTRATIONS

Unit	Lithology	Statistic	Cu	Pb	Zn	Ag	As	Ba	Cd	Co	Ni	Fe	Mo	Cr	Bi	Sb	V	Sn	W	Sr	Y	La	Mn	Mg	Ti	Al	Ca	Na	K	P	S	Se
Unit 3D	All	n	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	73	73
		Max	2502	31	330	2.4	252	7847	10	88	98	22.28	73	194	1300	360	225	21	25240	573	39	48	3505	1.3	0.1	3.79	28.54	0.22	0.67	97710	12.89	128
		Min	13	4	1	0.4	2	5	1	1	1	0.17	2	4	5	5	2	2	75	6	2	2	28	0.01	0.01	0.07	0.48	0.01	0.01	97	-0.05	5
		Median	323	7	49	0.4	8	76	1	9	34	3.41	6	48	9	18	40	6	3754	114	15	18	593	0.33	0.03	1.72	8.19	0.08	0.08	25550	1.56	22
	Sulphides	n	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	n/a	n/a
		Max	1520	31	290	1.5	33	634	7	39	88	10.4	40	75	364	110	86	18	18500	287	39	36	1993	1.13	0.06	3.51	18.8	0.21	0.51	84830	n/a	n/a
		Min	18	4	3	0.4	2	5	1	1	1	0.43	2	4	5	5	3	2	184	15	2	2	34	0.01	0.01	0.51	0.8	0.01	0.01	97	n/a	n/a
		Median	347	17	53	0.7	7	58	1	8	40	3.84	5	44	5	33	33	7	4153	100	16	9	677	0.34	0.02	1.95	8.18	0.1	0.07	30420	n/a	n/a
	Calc Skarn	n	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	156	48	48
		Max	1639	20	330	2	252	7847	10	48	98	20.42	73	127	1031	360	216	16	25240	374	31	48	3505	1.3	0.1	3.64	19.85	0.21	0.67	74370	12.89	128
		Min	13	4	5	0.4	2	5	1	1	2	1.04	2	12	5	5	2	2	75	27	4	2	102	0.03	0.01	0.36	1.17	0.02	0.01	1324	-0.05	5
		Median	342	6	49	0.4	8	83	1	10	33.5	3.55	7	50	13	15.5	41	6	3851	118.5	14	19	618	0.34	0.03	1.715	8.68	0.08	0.08	26115	1.75	22
	Hornfels	n	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	10	10
		Max	2502	17	243	2.2	23	949	3	88	78	22.28	24	194	561	79	225	13	11830	573	38	48	1456	0.97	0.09	3.79	28.54	0.22	0.63	97710	4.64	69
		Min	60	4	9	0.4	2	13	1	3	10	1.08	2	15	5	5	16	2	175	60	10	4	91	0.07	0.01	0.99	2.78	0.02	0.01	3826	0.22	5
		Median	460.5	7	41	0.4	7.5	98	1	9	36	3.55	6	65.5	29.5	5	49.5	4	2485	105	13.5	19	284.5	0.305	0.04	2.005	4.38	0.095	0.15	12120	2.115	17.5
	Limestone	n	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	n/a	n/a
		Max	167	19	77	2.4	35	2880	5	17	35	5.9	31	47	1300	196	108	21	15320	571	36	24	1334	0.62	0.04	2.04	27.45	0.14	0.2	83100	n/a	n/a
		Min	24	4	26	0.4	2	10	1	1	10	1.48	3	15	5	5	7	2	847	62	8	2	209	0.13	0.01	0.84	5.23	0.02	0.01	9708	n/a	n/a
		Median	68	11	55	0.4	11	69	1	4	16	2.24	8	20	31	56	29	6	4415	224	17	10	758	0.28	0.03	1.49	11.81	0.1	0.05	34610	n/a	n/a
Unit 3E	All	n	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	6	6
		Max	1962	40	738	1.9	93	303	12	82	118	11.68	108	145	551	115	220	20	8730	370	25	56	1701	1.16	0.18	5.41	14.1	0.32	0.62	58880	1.35	31
		Min	10	4	1	0.4	2	5	1	1	1	0.39	2	9	5	5	2	2	29	27	4	2	56	0.01	0.01	0.71	1.64	0.04	0.01	174	0.24	5
		Median	106	9	34.5	0.4	5	37.5	1	7	19	1.92	7	44	7.5	10	21	3	974	130.5	10	25	197	0.16	0.07	2.815	4.06	0.15	0.05	1632	0.895	10.5
	Sulphides	n	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	n/a	n/a
		Max	1962	21	134	1.3	16	198	4	82	82	11.68	19	56	21	115	38	14	8730	337	25	29	1701	0.53	0.06	3.57	14.1	0.15	0.16	58880	n/a	n/a
		Min	89	5	2	0.4	2	6	1	2	3	0.92	2	10	5	5	2	2	266	54	6	2	84	0.03	0.01	0.71	2.74	0.07	0.01	252	n/a	n/a
		Median	453.5	9.5	36	0.55	6	67	1	12.5	27	3.79	5.5	31	5	26.5	18	9.5	2179	155.5	16	16	402	0.265	0.025	1.8	8.225	0.13	0.06	27600	n/a	n/a
	Calc Skarn	n	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	n/a	n/a
		Max	935	19	738	1.9	93	192	12	37	40	8.6	28	104	551	39	94	11	4190	237	14	38	1009	0.72	0.12	4.26	7.78	0.23	0.13	3011	n/a	n/a
		Min	14	4	10	0.4	2	5	1	1	1	0.39	2	12	5	5	2	2	79	27	4	9	87	0.01	0.01	1.04	2.43	0.05	0.01	174	n/a	n/a
		Median	65	8	22	0.4	6	26	1	5	11	1.82	9	41	33	7	16	3	648	136	9	29	225	0.07	0.07	2.8	4.36	0.14	0.01	842	n/a	n/a
	Hornfels	n	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	3	3
		Max	334	40	316	0.8	18	167	5	22	118	4.59	43	145	138	30	150	10	2986	253	20	38	377	0.86	0.16	4.41	6.03	0.3	0.62	12770	1.35	24
		Min	10	4	1	0.4	2	11	1	1	1	0.47	2	9	5	5	2	2	32	64	4	10	60	0.02	0.01	1.43	2.27	0.08	0.01	362	0.78	6
		Median	121	7	31	0.4	5	42	1	7	16	1.89	7	52	5	10	27	3	1005	125	9	26	180	0.17	0.07	2.82	3.86	0.15	0.09	1612	1.01	15
	Pelites	n	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	n/a	n/a
		Max	854	25	421	1.1	59	303	3	26	53	5.76	108	102	276	60	113	20	5075	370	24	56	971	1.16	0.16	5.41	13.14	0.32	0.38	8223	n/a	n/a
		Min	23	4	12	0.4	2	8	1	1	5	0.52	2	16	5	5	2	2	29	61	5	8	94	0.03	0.02	1.61	1.66	0.04	0.01	588	n/a	n/a
		Median	99	11	45	0.4	4	41	1	7	24	1.96	6	46	9	14	28	4	1026	127	9	22	209	0.18	0.07	2.86	4.05	0.17	0.08	2041	n/a	n/a
	Limestone	n	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	n/a	n/a
		Max	112	18	35	0.4	11	51	1	3	28	1.91	11	100	40	33	19	6	3258	271	13	35	250	0.05	0.13	3.93	7.51	0.2	0.02	1150	n/a	n/a
		Min	32	11	10	0.4	2	21	1	1	10	0.75	5	24	5	6	6	2	489	115	6	12	118	0.03	0.04	2.18	2.8	0.11	0.01	674	n/a	n/a
		Median	83	16	19	0.4	6.5	37.5	1	2	15	1.655	9.5	39	10	21	15	3.5	1290.5	154	6.5	17	189.5	0.04	0.05	3.645	4.065	0.135	0.01	896.5	n/a	n/a
	Black Shale	n	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	n/a	n/a
		Max	465	21	180	0.7	27	81	2	28	61	7.44	65	112	85	44	164	11	3882	169	17	43	1053	0.78	0.17	3.7	5.76	0.25	0.53	5596	n/a	n/a
		Min	64	6	29	0.4	2	9	1	8	23	1.33	3	36	5	5	29	2	50	71	10	22	85	0.12	0.07	1.79	2.35	0.06	0.07	1504	n/a	n/a
		Median	123	15	50	0.4	2	33	1	13	35	2.2	5	73	5	14	60	2	1524	102	10	29	173	0.19	0.09	3.12	4.22	0.21	0.11	2431	n/a	n/a
Unit 3F	All	n	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	244	5	5
		Max	1580	22	172	1.9	282	329	3	83	57	12.18	75	115	747	96	99	16	7919	401	18	53	3225	1.62	0.18	4.27	23.47	0.23	0.42	10280	0.6	21
		Min	1	4	1	0.4	2	5	1	1	1	0.22	2	4	5	5	2	2	20	21	2	2	60	0.02	0.01	0.29	1.76	0.01	0.01	119	0.25	5
		Median	67	6	29.5	0.4	5	29	1	4.5	7	1.91	12	29	72	6	9	5	778.5	124.5	5	23	366.5	0.16	0.04	2.145	4.2	0.1	0.02	921.5	0.39	17
	Calc Skarn	n	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	n/a	n/a
		Max	1580	21	172	1.9	282	329	2	83	56	12.18	75	100	747	96	80	16	7919	351	17	39	3225	1.62	0.15	3.84	18.69	0.18	0.33	10280	n/a	n/a
		Min	1	4	2	0.4	2	5	1	1	1	0.33	2	4	5	5	2	2	84	21	2	2	85	0.03	0.01	0.46	2.11	0.02	0.01	119	n/a	n/a
		Median	63.5	6	31	0.4	6	26.5	1	4	4.5	2.155	14	26	119	5	9.5	5	723.5	108	5	23	431	0.15	0.035	1.965	4.18	0.09	0.02	746	n/a	n/a
	Hornfels	n	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	n/a	n/a
		Max	640	18	78	1.2	23	234	3	32	57	5.22	57	102	706	72	67	13	7591	392	18	38	1170	0.79	0.18	4.27	23.47	0.23	0.41	8600	n/a	n/a
		Min	10	4	1	0.4	2	5	1	1	1	0.6	2	4	5	5	2	2	20	68	2	2	60	0.02	0.01	0.29	2.09	0.01	0.01	181	n/a	n/a
		Median	83.5	6.5	23.5	0.4	4	28.5	1	5	11.5	1.815	9	33	33.5	8.5	6.5	5	1013	135	6	23.5	326.5	0.195	0.04	2.28	3.98	0.11	0.035	1299	n/a	n/a
	Limestone	n	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	n/a	n/a
		Max	203	12	93	0.5	42	95	2	19	37	3.42	33	115	371	29	82	14	3180	401	17	53	624	0.62	0.14	3.92	19.5	0.23	0.42	5747	n/a	n/a
		Min	18	4	11	0.4	2	5	1	1	1	0.22	2	5	5	5	2	2	34	56	3	13	70	0.03	0.02	1.09	2.22	0.07	0.01	347	n/a	n/a
		Median	68	6	26	0.4	2	35	1	5	18	1.71	8	34	22	7	5	4	869	151	9	27	228	0.13	0.09	2.7	4.64	0.16	0.06	1295	n/a	n/a
Unit 3G	All	n	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	n/a	n/a
		Max	1268	9	56	1.6	11	266	1	15	23	8.96	163	145	718	15	66	7	1693	402	5	27	386	2.65	0.08	4.34	3.92	0.16	0.74	1824	n/a	n/a
		Min	6	4	4	0.4	2	6	1	1	3	0.56	2	30	5	5	2	2	126	31	2	12	39	0.07	0.01	0.45	1.18	0.04	0.01	50	n/a	n/a
		Median	28	4	17	0.4	2	33	1	2.5	6.5	1.315	18	44.5	46	5	2.5	2	432	191	2	19	130	0.31	0.01	1.76	2.575	0.075	0.03	565	n/a	n/a
Unit 3G	Calc Skarn	n	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	n/a	n/a
		Max	1268	8	25	1.6	11	97	1	15	8	8.96	163	79	718	5	5	2	375	247	3	23	312	0.63	0.04	2.31	3.33	0.12	0.05	683	n/a	n/a
		Min	22	4	4	0.4	2	6	1	1	3	0.9	14	30	5	5	2	2	225	112	2	13	73	0.07	0.01	1.42	1.83	0.07	0.01	119	n/a	n/a
		Median	86	5	19	0.4	4	32	1	4	4	2.16	33	36	54	5	2	2	297	193	3	21	174	0.13	0.01	1.87	2.85	0.08	0.01	552	n/a	n/a

1 **A value equal to the detection limit was used for samples with concentrations less than the method detectino limit for the above statistical analyses**
2 **No exploration samples from Unit 3G and Unit 2BL were submitted for anlytical anlalysis during 2008**

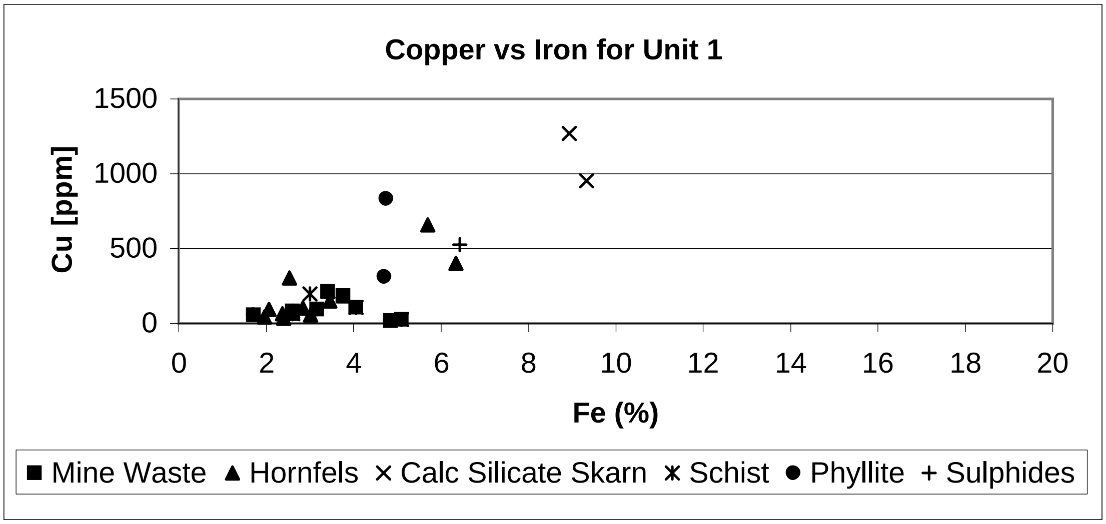
The values in Table 4.1.4-5 show that copper is elevated above average crustal abundance for most units with the largest concentrations being hosted in Unit 2B. Sulphur is present in all of the tested rock units. Selenium which is also of interest in the project area is elevated in Unit 2B but the highest concentrations of this metalloid are hosted within the sedimentary rocks of Unit 3D and Unit 3E.

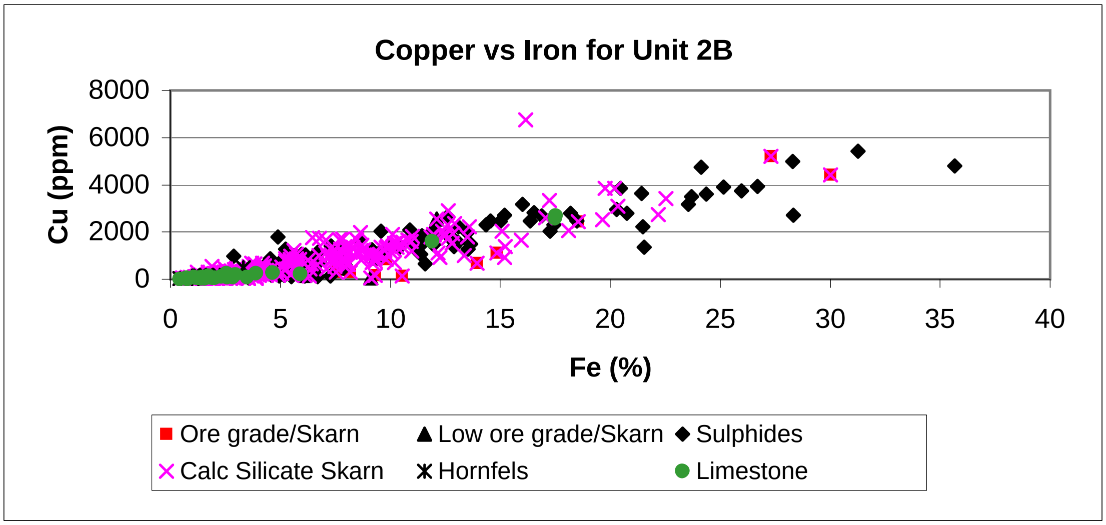
Plots comparing copper versus iron, iron versus sulphur and selenium versus sulphur were prepared in order to better understand the chemistry of the units at the site. Figure 4.1.4-2 through Figure 4.1.4-4 show the relation between copper and iron for the various units. The results of this comparison show that there is generally good correlation between copper and iron concentrations for all of the units. Copper concentration increases with increasing iron content. Figure 4.1.4-5 and Figure 4.1.4-6 show the relation between iron and sulphur. These figures show that there is good correlation between these elements. The correlation between iron and sulphur is not surprising given that most of the sulphide mineralization present of the site are iron bearing. Figure 4.1.4-7 and Figure 4.1.4-8 compare selenium and sulphur content for samples submitted during the 2008 exploration program. These graphs show a generally good correlation between selenium and sulphur content for Unit 1, Unit 2B, Unit 3C and Unit 3D. The correlation between selenium and sulphur shows that selenium is associated with the sulphide mineralization present in the individual mineralized units. The correlation between copper, iron, selenium and sulphur shows that much of these three elements are associated with the sulphide mineralization present in the rock types present at the Mactung site.

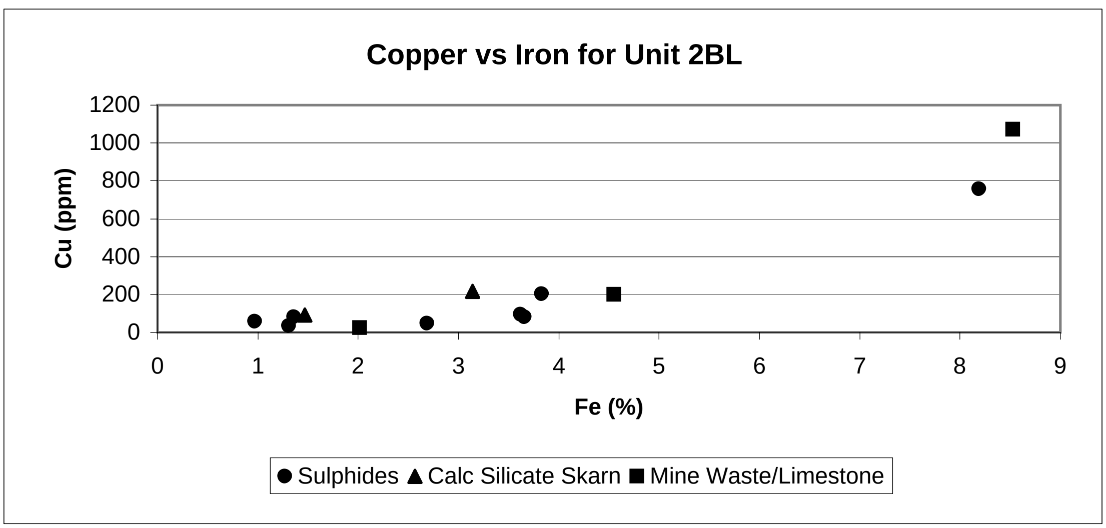
Geochemical Characterization Program Samples

The solids chemistry of the samples submitted for the geochemical characterization program was evaluated using a 48 elemental ICP analytical package at ALS Chemex Laboratories in Vancouver, BC. The four-acid "near total" digestion method was used for this testwork. Price (1997) suggested that analytes at concentrations at 10 times the crustal abundance provides an initial identification of significant concentrations of minerals. Elevated concentrations of certain elements reflect the mineralized nature of the deposit and does not necessarily indicate that there will be environmental impacts from these elements. In some instances metals at normal concentrations have been found to have environmental impacts. Table 4.1.4-6 contains a summary of the comparison of metal concentrations compared to the crustal abundances as reported in Price (1997). The discussion below focuses only on elements with potential for environmental impacts at the Mactung site.

The results of the elemental analysis show concentrations of sulphur and selenium for all material types consistently above 10 times the average crustal concentration. The ore grade material types are generally also above 10 times the average crustal concentration in tungsten and tin content. Molybdenum is noted to be higher in concentration in the existing waste rock and some of the ore grade material samples.







NOTES

Blue Data from Exploration Program Assay Results
Other Data from Geochemical Program Assay Results

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Copper versus Iron for Mactung Rock Units

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W2310110.001	SCD	SDD	0
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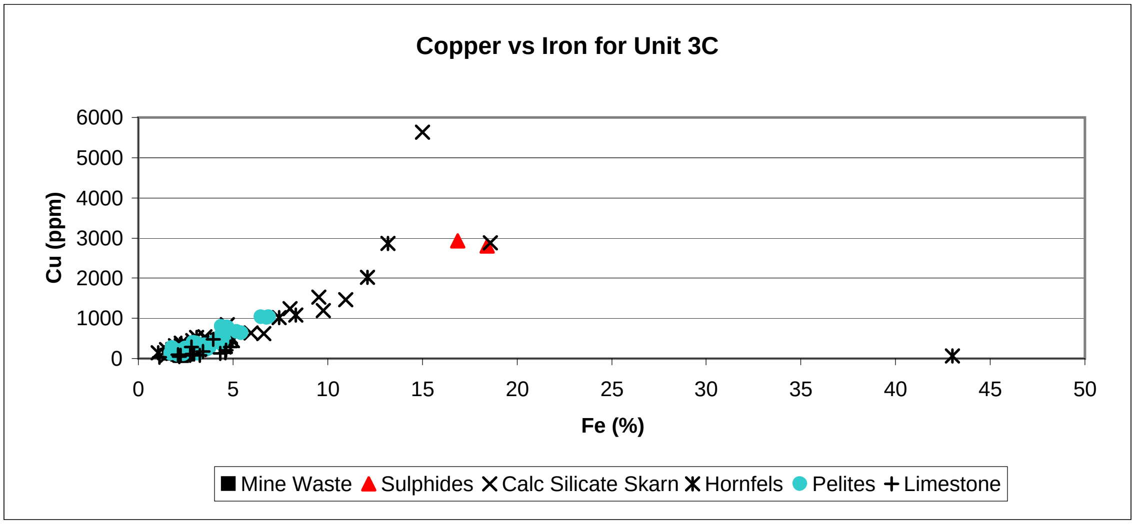
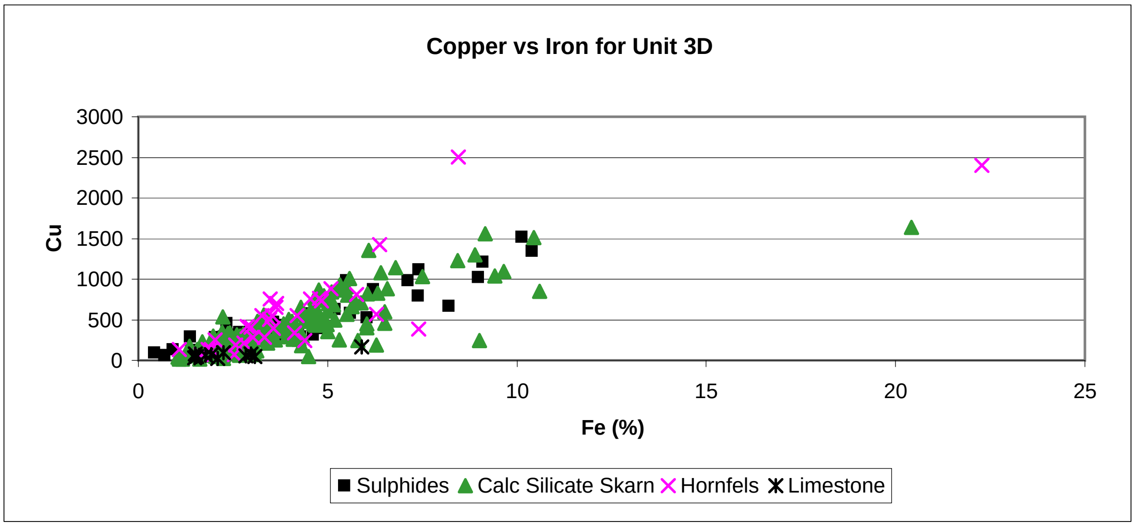
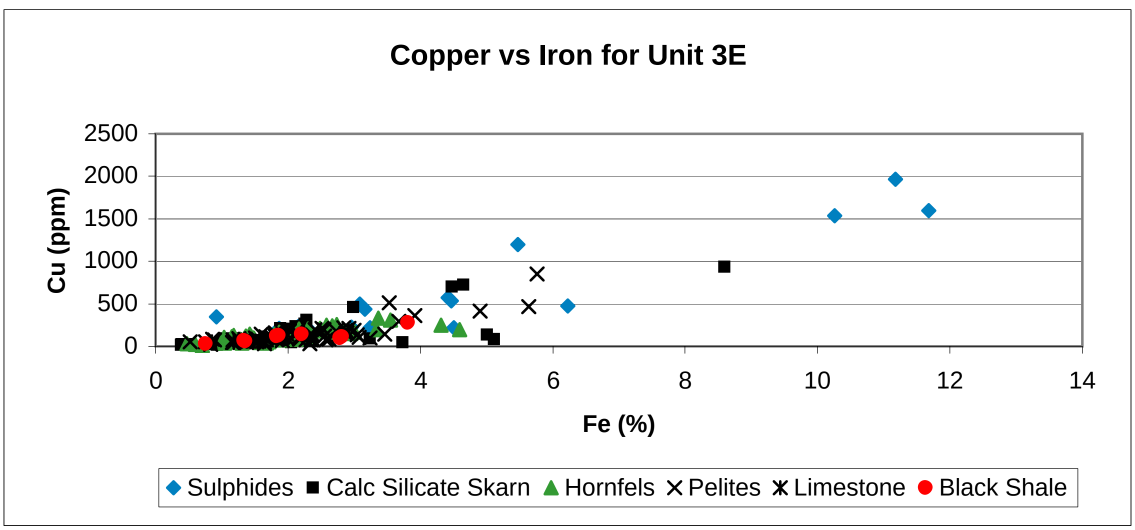
Figure 4.1.4-2







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Copper versus Iron
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W23101110.001	SCD	SCD	0
OFFICE	DATE		
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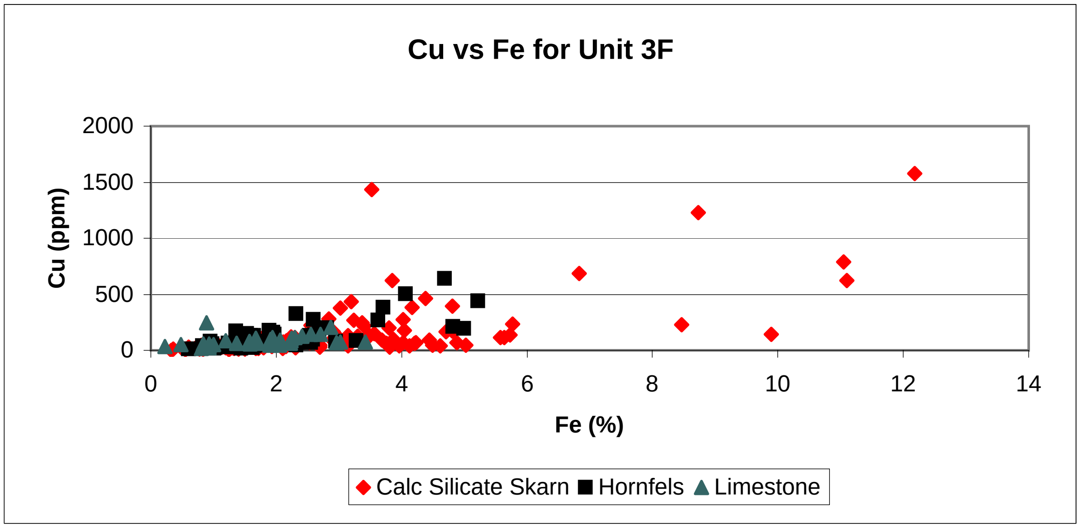
Figure 4.1.4-3



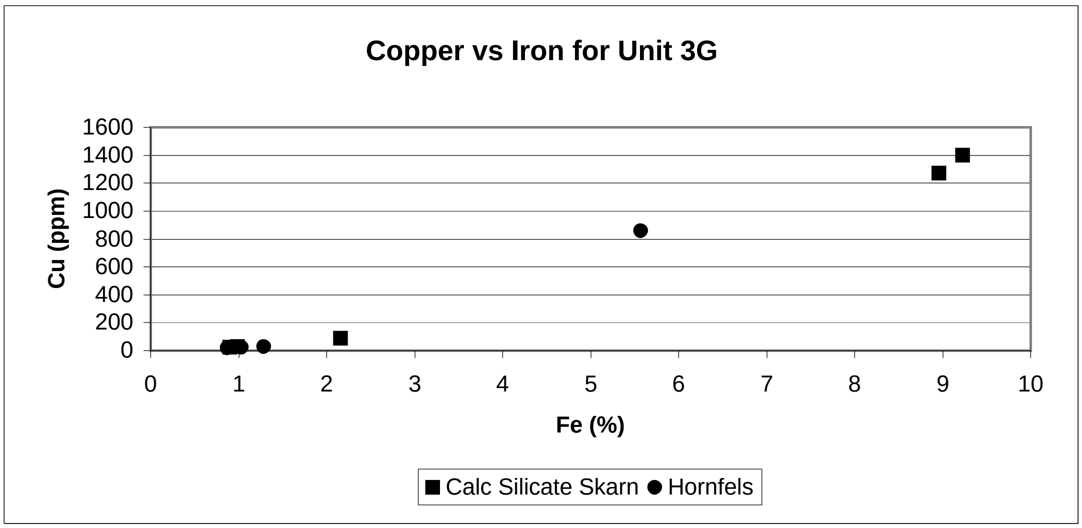


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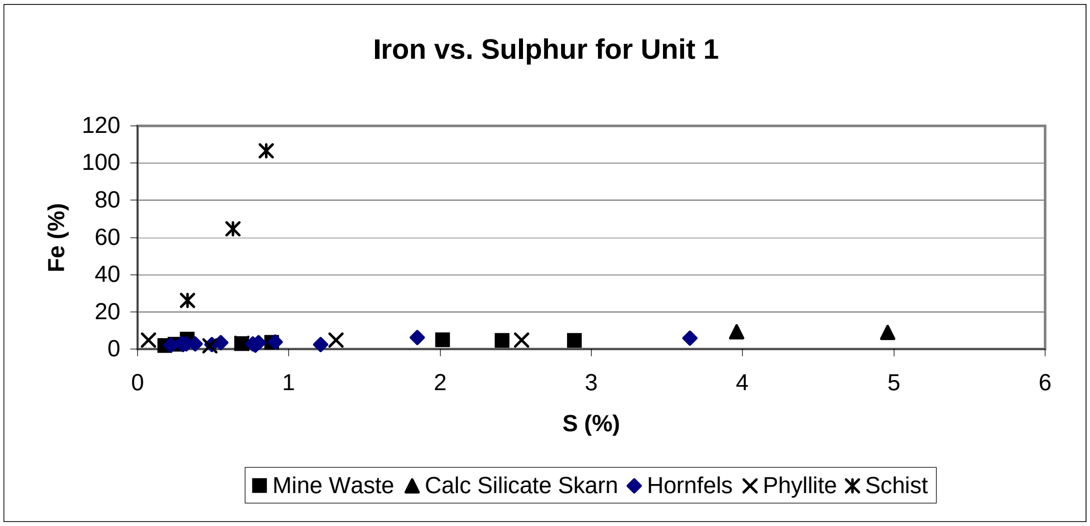
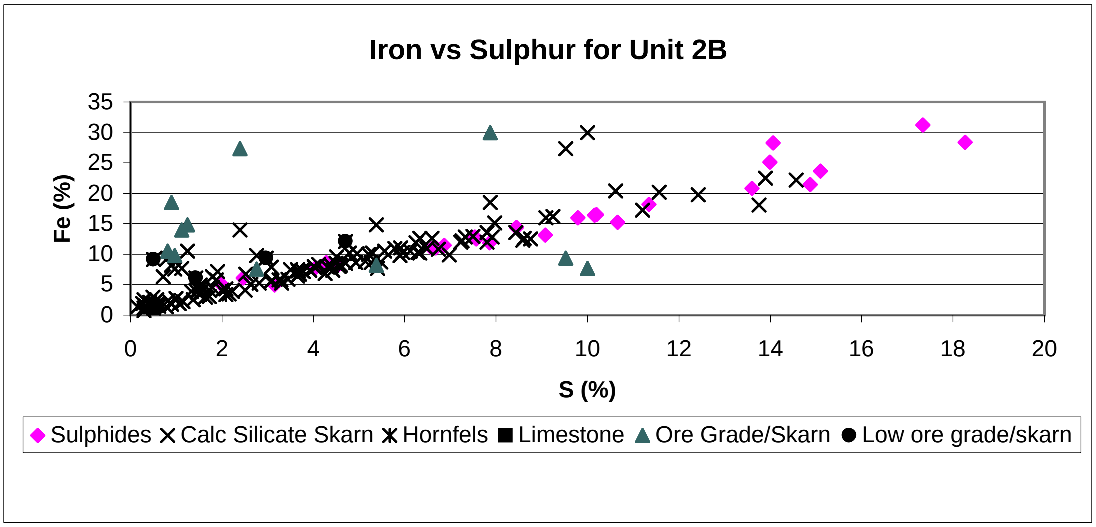
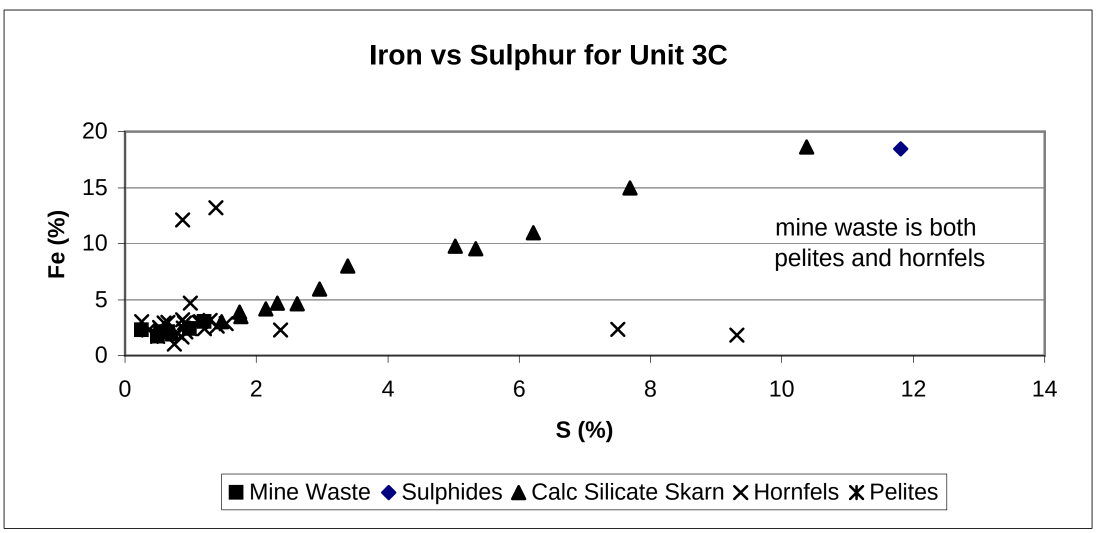
Figure 4.1.4-4







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Iron versus Sulphur for Mactung Rock Units

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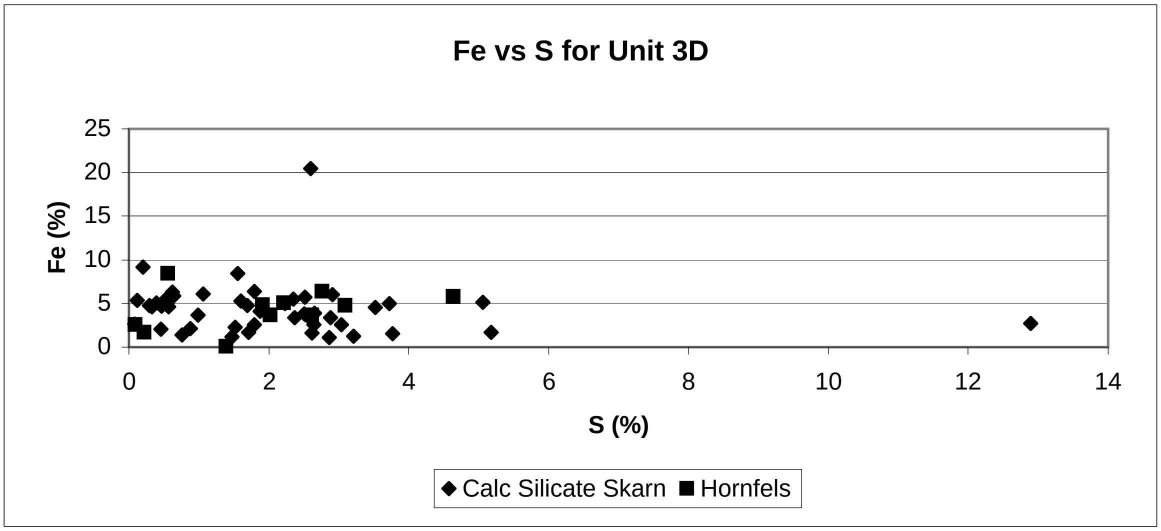
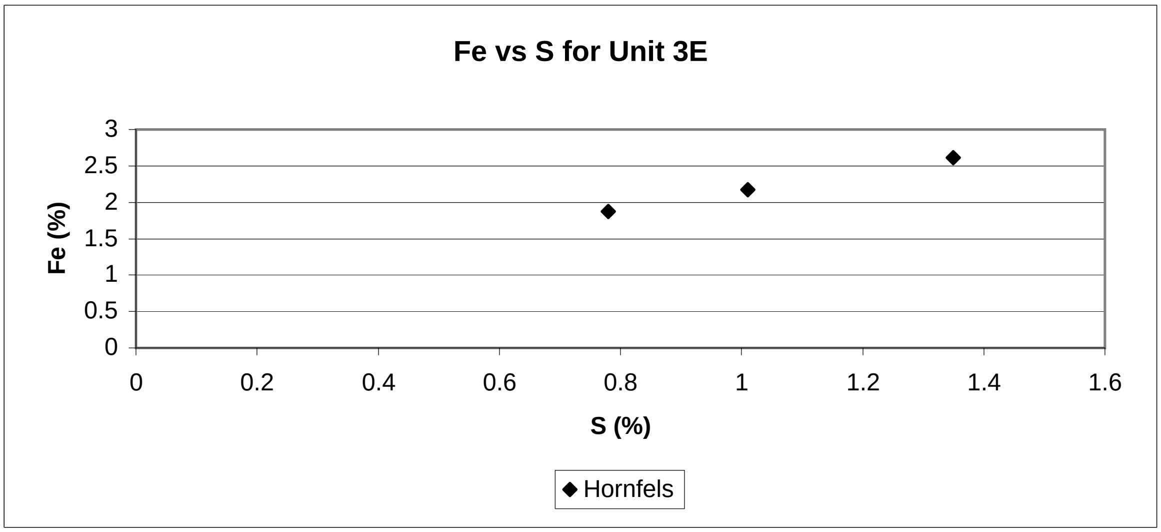
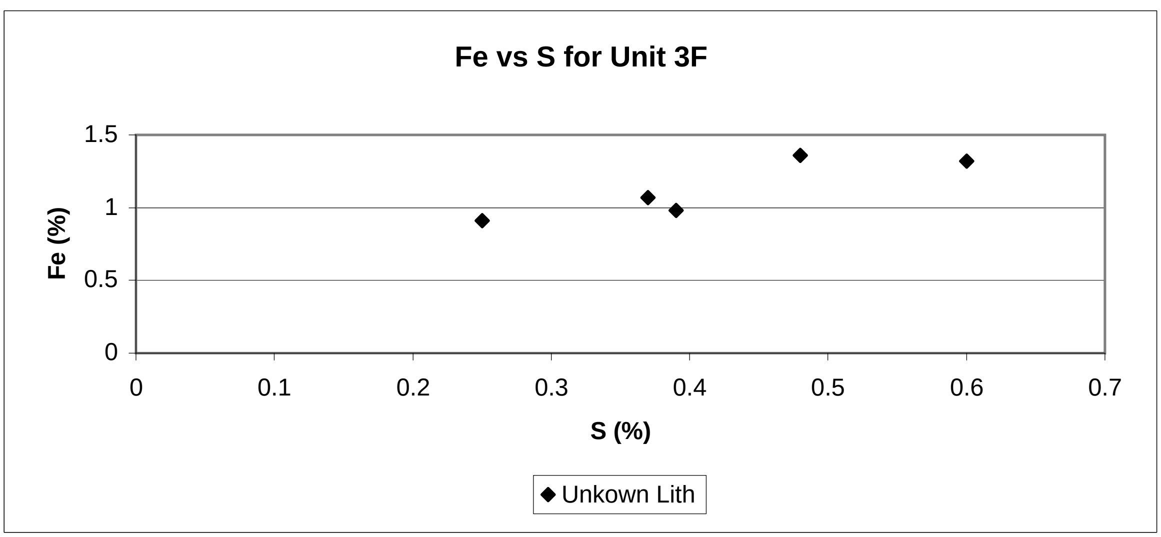
Figure 4.1.4-5







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Iron versus Sulphur
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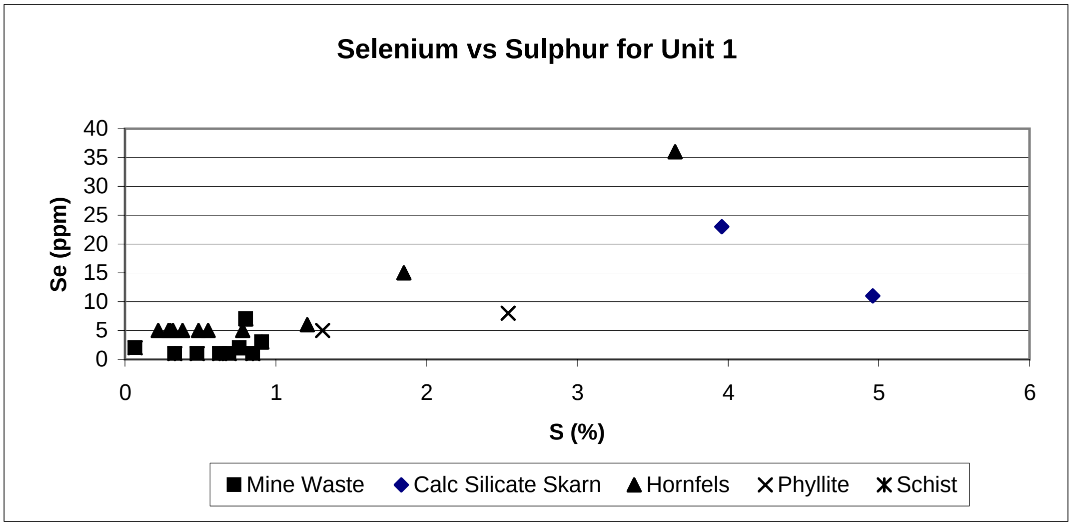
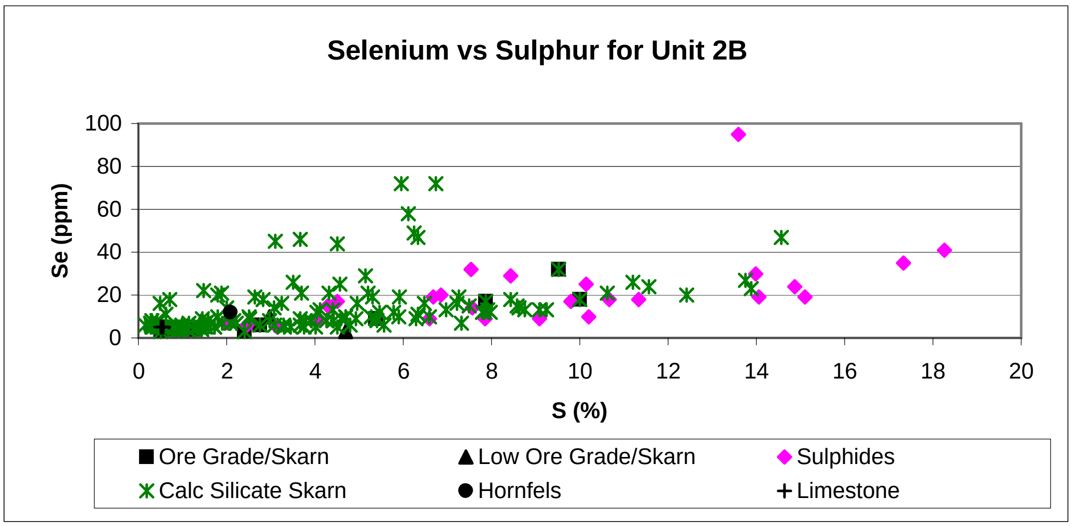
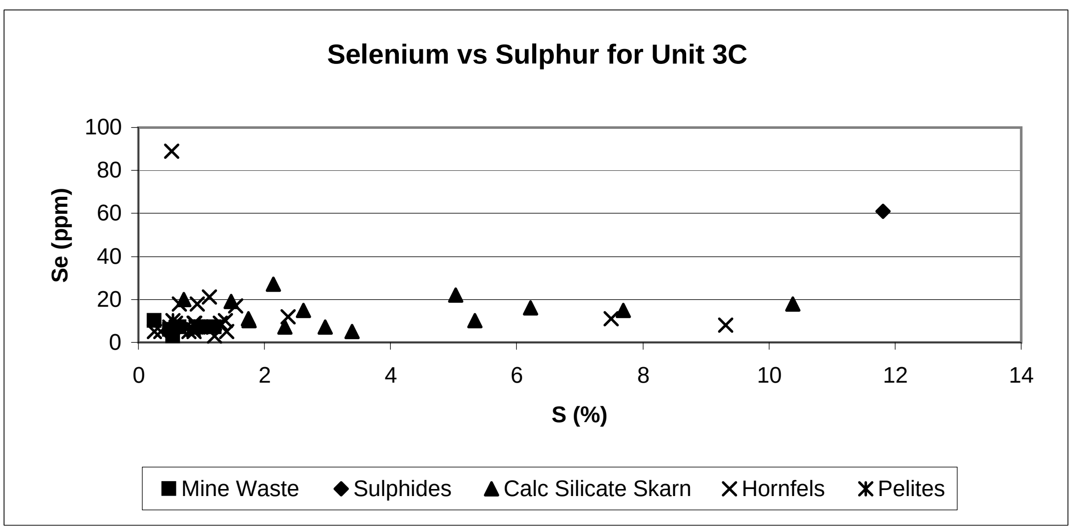
Figure 4.1.4-6







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Selenium versus Sulphur for Mactung Rock Units

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W23101110.001	SCD	SCD	0
OFFICE	DATE		
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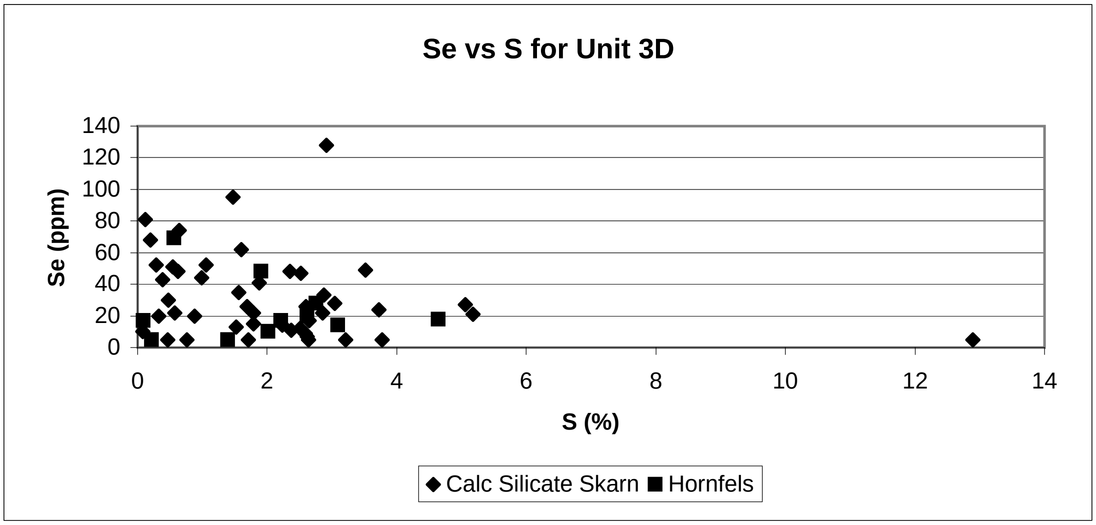
Figure 4.1.4-7



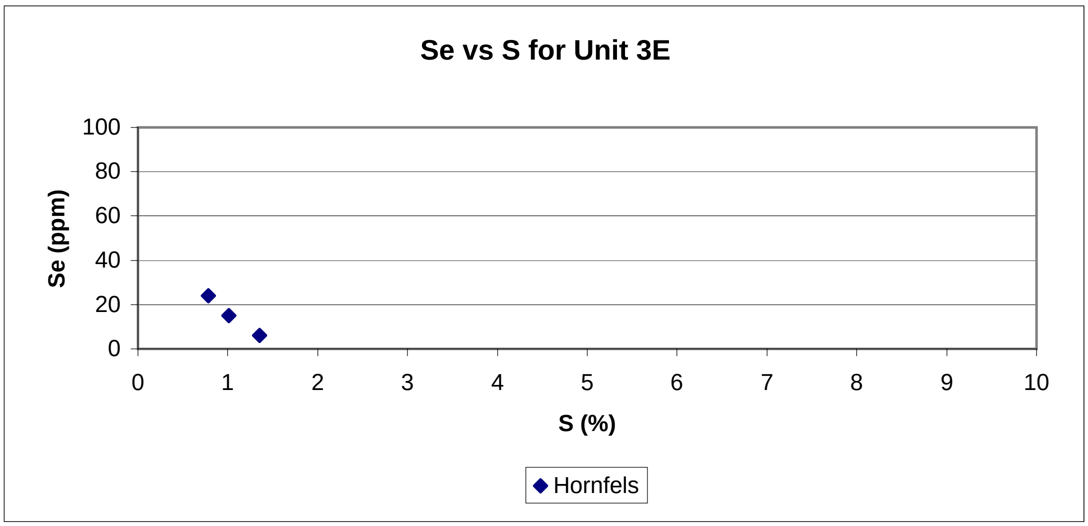


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Figure 4.1.4-8

TABLE 4.1.4-6: ICP METALS DETERMINATION FOR GEOCHEMICAL PROGRAM SAMPLES - MACTUNG

MATERIAL TYPE	SAMPLE DESCRIPTION	Ag ppm	Al ppm	As ppm	Ba ppm	Be ppm	Bi ppm	Ca ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm	Cs ppm	Cu ppm	Fe ppm	Ga ppm	Ge ppm	Hf ppm	In ppm	K ppm	La ppm	Li ppm	Mg ppm
	Crustal Abundance (ppm):	0.075	82300	1.8	425	2.8	0.0085	41500	0.15	66.5	25	102	3	60	56300	19	1.5	3	0.25	20900	39	20	23300
	10 x Crustal Abundance (ppm):	0.75	823000	18	4250	28	0.085	415000	1.5	665	250	1020	30	600	563000	190	15	30	2.5	2E+05	390	200	2E+05
Mine Waste	36001	0.15	75800	0.7	1180	3.13	**1.97**	30900	0.06	78	15	65	24.4	185	37700	20.8	0.2	1.9	0.046	18400	39.8	104.5	11900
Mine Waste	36002	0.21	55300	1.8	730	4.97	**33.3**	47000	**2.37**	49	9.8	84	11.55	214	34100	21.5	0.2	2.7	0.461	9400	28.2	78	10300
Mine Waste	36003	0.12	81200	1.1	860	5.55	**2.77**	35000	1.07	71.9	13	67	20.9	81.6	26100	23.6	0.1	2.4	0.095	20900	32	96	10400
Mine Waste	36004	0.11	99700	5	890	15.85	**0.87**	32700	0.05	85	15	66	25.9	56.8	17100	27.6	0.2	2.6	0.058	28100	39.8	**201**	3900
Mine Waste	36005	0.04	87800	1.9	1110	3.54	**0.44**	6100	0.03	99.4	17	73	**32.3**	19.2	48500	24.8	0.2	2.4	0.087	26400	48.1	141	11100
Mine Waste	36006	0.07	50400	0.3	480	1.73	**1.67**	13700	0.07	79.6	12	43	23.2	93.7	31600	15.6	0.1	3.2	0.052	16100	39.1	107.5	8600
Mine Waste	36007	0.12	75900	3.9	1150	4.71	**19.6**	35100	0.04	79.2	18	60	23.1	64.8	26100	24.6	0.1	2.5	0.08	24400	39.9	111	11800
Mine Waste	36008	0.13	93800	1.3	1450	3.94	**2.18**	20600	0.04	98.6	17	73	28.1	106.5	40600	31.2	0.2	2.7	0.09	28000	50.6	157	12300
Mine Waste	36009	0.1	94600	**39.9**	910	3.31	**0.39**	3000	0.21	96.4	27	74	20.5	26.2	51000	26.5	0.2	2.2	0.066	26800	51.5	114	4800
Ore Grade	36010	**1.41**	51600	11	100	6.3	**492**	104500	0.38	47.3	50	33	1.7	**1100**	148500	21.3	0.6	1.3	0.949	1500	25.3	18.1	15100
Ore Grade	36011	**2.41**	38600	1	10	15	**3.26**	59100	0.55	9.15	81	5	1.38	**4410**	300000	35.3	0.7	0.2	0.281	1000	4.3	14.3	8100
Ore Grade	36012	**3.56**	46700	0.2	60	6.69	**796**	32400	0.58	30.3	53	13	17.25	**5210**	273000	43.8	0.6	0.6	0.231	11100	14.5	92.3	10900
Ore Grade	36013	0.39	76400	17	350	9.99	**26.8**	107500	0.5	71.3	15	49	4.16	290	75300	40.9	1	2	0.796	8000	38.4	31.5	11500
Ore Grade	36014	**1.25**	58800	**20**	100	**29.7**	**91.1**	141000	0.25	43.2	23	27	4.29	129.5	105500	35.8	0.7	1.2	1.205	1100	22.5	27.8	11000
Ore Grade	36015	**1.53**	67200	0.4	330	11.65	**343**	54400	0.5	58.5	36	41	16.2	**2450**	185500	44.8	0.9	1.4	0.459	16200	31.2	91.7	15900
Ore Grade	36016	0.61	24100	16	10	14.45	**6.3**	160500	0.47	8.59	44	5	0.09	**691**	139500	25.2	0.5	0.3	0.839	100	3.6	10.6	11600
Low Grade Ore	36017	**0.76**	60600	5	260	8.74	**23.2**	104000	0.26	62.2	30	36	5.3	**907**	93100	29.8	0.7	1.5	0.566	5700	30.8	32.2	35300
Ore Grade	36018	**0.85**	40500	4.1	170	25.1	**25.6**	83300	0.3	28.2	16	26	6.2	**828**	98100	43.7	0.7	0.6	1.035	1000	14.5	36.1	7100
Low Grade Ore	36019	0.45	73100	**20**	340	21.9	**31.1**	167500	0.28	56.7	13	36	1.2	49.4	91200	34.1	0.6	1.4	1.195	3200	31.1	26.2	9100
Ore Grade	36020	0.46	54700	10	50	13.5	**15.85**	128000	0.22	53	9.5	37	3.04	159	93300	37.3	0.6	1.8	0.831	800	29.8	18	14900
Low Grade Ore	36021	**1.73**	54300	1.5	30	16.95	**420**	82300	0.45	42.9	38	39	1.82	**2540**	121000	56.3	0.7	1.1	0.538	1000	21.9	21.4	14400
Low Grade Ore	36022	0.54	25100	10	270	13.65	**6.74**	284000	0.47	25.6	12	21	1.34	170.5	61100	16.6	0.5	0.6	0.529	1500	12.9	17.1	11800
Ore Grade	36023	0.43	62200	**19**	140	11.45	**3.06**	145500	0.28	61.9	17	33	2.98	292	81700	27.8	0.5	1.4	0.724	1700	32.3	29.4	40000
Ore Grade	36024	**0.86**	71200	14	20	20.8	**111**	130000	0.29	67	9.8	36	1.56	**960**	76900	46.9	0.6	1.2	1.395	700	37.1	14.6	28700
Mine Waste	36025	0.21	45100	0.4	1080	1.72	**2.21**	13000	0.06	42.7	11	39	9.12	170.5	30400	13	0.3	2.3	0.026	17700	23.8	71.1	7700
Mine Waste	36026	0.24	44800	1.4	900	1.93	**7.27**	35500	**1.88**	44.8	7.3	72	7.29	163	21100	12.7	0.3	2.2	0.032	20300	25.3	48.6	10800
Mine Waste	36027	0.07	49900	0.2	2340	2.07	**0.26**	18400	0.1	35	9.3	61	8.04	60.5	23000	13.1	0.3	2.6	0.019	23900	19.5	79	10000
Mine Waste	36028	0.16	42800	0.3	1010	4.38	**0.82**	25400	**1.72**	44.1	7	71	9.27	124	17400	13.5	0.3	2.8	0.051	17400	24.6	52.4	7900
Mine Waste	36029	0.28	53000	0.5	1320	2.38	**1.15**	33900	**1.79**	51.9	8.9	67	7.47	106	23900	15.6	0.4	2.8	0.043	15800	29.2	48.7	11900
Mine Waste	36030	0.49	45200	12.4	2570	3.16	**0.66**	27400	1.14	56	8.5	60	9.17	88.1	20900	12.7	0.4	2.5	0.017	19000	30.2	46.9	13300
Mine Waste	36031	0.09	20100	9	1200	1.52	**2.26**	327000	0.18	18.6	5	14	0.87	25.2	20200	5.45	0.2	0.5	0.075	2900	9.7	13.5	6900
Mine Waste	36032	0.48	48400	**26**	490	11	**4.98**	199000	0.54	48.5	12	31	2.35	198	45500	21.5	0.7	1.6	0.373	6500	25.5	20.1	16500
Mine Waste	36033	**0.76**	73200	6	740	6.97	**21.7**	57200	0.16	66.2	43	46	16.9	**1070**	85300	38.7	0.7	1.5	0.201	17600	35.6	82.9	18100
Borrow Waste	36034	0.5	63400	0.9	690	2.53	**0.59**	24300	0.21	42.2	18	47	7.52	48.3	30800	18.5	0.3	4.2	0.033	35600	24.4	89.5	9000
Borrow Waste	36035	0.1	20600	11	30	0.65	**3.52**	324000	**2.07**	47.9	4	10	0.12	5.8	16200	6.06	0.3	2	0.3	400	29.1	6.5	6900
Borrow Waste	36036	**1.38**	21000	**18.5**	1310	1.55	**0.64**	41500	**9.63**	17.7	5	103	5.31	62.7	14500	10.3	0.2	1.4	0.048	9200	13.1	22.9	2400
Borrow Waste	36037	**1.23**	27600	**35.5**	860	1.66	**0.21**	33800	**8.67**	27.8	6.1	94	4.7	98.5	16400	9.59	0.3	1.7	0.034	12600	21	51.1	3300
Borrow Waste	36038	**1.19**	34000	**30.4**	600	2.06	**0.25**	44000	**5.19**	30.7	7	85	5.7	22.3	25500	10.9	0.3	2.1	0.029	11800	22.3	123.5	12800
Borrow Waste	36039	**1.45**	52700	7.5	930	2.05	**0.2**	45500	**3.94**	48.7	9	69	10.05	165.5	24200	14.5	0.3	3.1	0.025	31000	31	89	19300
Borrow Waste	36040	**1.1**	56600	3	1820	2.05	**0.16**	41400	**3.46**	31.3	9.3	50	10.2	103	25700	15.1	0.3	2.9	0.035	32600	19.1	101.5	25400
Borrow Waste	36041	**1.01**	62200	**18.8**	930	2.29	**0.2**	27000	**4.66**	53.5	15	63	7.97	121	29600	16.7	0.4	2.9	0.065	36900	29.6	70.1	18500
Old Mine Waste	PAD 1	0.61	63600	**40.6**	1940	4.18	**70.7**	26100	0.92	67.3	13	70	12	459	51100	23.2	0.3	2.6	0.191	19300	34.8	67.7	12000
Old Mine Waste	PAD 1b	**2.89**	39600	2.1	60	13.15	**724**	57900	0.59	23.9	51	11	3.68	**4010**	20700	48.3	0.3	0.5	0.802	2500	12.4	27	7000
Old Mine Waste	PAD 2	**1.23**	38200	**85.8**	350	6.51	**251**	54700	**3.38**	38.3	26	57	7.8	**1665**	10300	24.6	0.3	1.6	0.431	5800	21.2	30.7	8500
Old Mine Waste	PAD 3	0.34	45400	**24.6**	1400	2.89	**7.08**	31400	**5.16**	48	11	78	13.8	228	27400	13	0.2	2.5	0.075	18600	26.9	58.1	9600
Old Mine Waste	PAD 4	0.36	73700	10.2	1350	5.16	**81.3**	32600	1.14	80.3	18	62	19.05	449	52600	25	0.3	2.4	0.184	23400	40.4	85.9	12600
Background	BG 1	0.15	110500	16.4	1410	2.71	1.08	<5000	0.21	137	2.9	93	21.3	36	59100	32.6	0.2	2.8	0.095	39800	67.9	113	2800

MATERIAL TYPE	SAMPLE DESCRIPTION	Mn ppm	Mo ppm	Na ppm	Nb ppm	Ni ppm	P ppm	Pb ppm	Rb ppm	Re ppm	S ppm	Sb ppm	Sc ppm	Se ppm	Sn ppm	Sr ppm	Ta ppm	Te ppm	Th ppm	Ti ppm	Tl ppm	U ppm	V ppm	W ppm	Y ppm	Zn ppm	Zr ppm
	Crustal Abundance (ppm):	950	1.2	23600	20	84	1050	14	90	0.0007	350	0.2	22	0.05	2.3	370	2	0.001	9.6	5650	0.85	2.7	120	1.25	33	70	165
	10 x Crustal Abundance (ppm):	9500	12	236000	200	840	10500	140	900	0.007	3500	2	220	0.5	23	3700	20	0.01	96	56500	8.5	27	1200	12.5	330	700	1650
Mine Waste	36001	465	**19.2**	6400	12.8	25.1	460	9.9	188.5	**<0.002**	**9100**	0.07	12.8	**3**	8.6	136.5	0.88	**0.06**	15	4030	1.36	1.7	76	**66.9**	16.4	57	64.2
Mine Waste	36002	1270	**46.6**	2800	16.2	84.3	710	4.3	98.7	**0.079**	**8000**	0.13	10.8	**7**	14.6	106	1	**0.34**	9.2	4180	0.95	16.8	**1215**	**351**	22	279	92.1
Mine Waste	36003	391	4.78	4200	11.9	23.8	360	10.5	90.4	**<0.002**	**7600**	0.06	15.6	**2**	15.3	203	0.9	**0.06**	13.1	4130	1.2	2.2	91	**20.4**	17.1	106	76.1
Mine Waste	36004	199	3.33	7300	11	52.9	530	14.8	164	0.006	**4800**	0.41	13.2	**1**	8	421	0.76	**0.05**	15.9	3330	1.47	3.9	71	**880**	14	32	88.2
Mine Waste	36005	342	0.54	2000	18	38.5	390	11.8	166	**<0.002**	700	0.05	17.4	**2**	6.2	51.4	1.35	**0.07**	18.1	5050	1.59	2.6	92	3.9	18.5	73	78.8
Mine Waste	36006	432	1.1	4000	11.8	18	930	6	173	**<0.002**	**6900**	0.06	9.3	**1**	6.3	51.8	1	**<0.05**	15.3	3390	1.27	3.5	42	**80.1**	18.1	48	96.5
Mine Waste	36007	476	2.08	2700	14.6	28.7	490	18	155.5	0.005	**6300**	0.29	16.3	**1**	15.2	165	1.09	**0.36**	15.6	3400	1.51	2	81	**780**	19.1	64	80.6
Mine Waste	36008	418	1.93	7600	14.2	35.1	570	11.8	234	0.002	**8500**	0.15	19.2	**1**	16.7	79.5	1.15	**0.06**	19.5	4660	1.93	2.3	92	**214**	20.4	68	86.4
Mine Waste	36009	548	**16.8**	1800	13.2	47.9	510	16	187.5	**<0.002**	3300	**12.7**	15.1	**1**	3.7	50.5	1	**<0.05**	18.6	3500	2.03	2.7	66	**19.1**	13.2	448	72
Ore Grade	36010	3220	3.9	1600	9.7	37.3	490	7	11.4	**0.058**	**53800**	1.44	6.4	**9**	**67.6**	134	0.56	**8.5**	8.8	2420	0.47	2.3	37	**6290**	13.9	218	35.7
Ore Grade	36011	1330	**13.1**	2000	15.2	15.1	3530	5.6	14.8	**0.054**	**100000**	0.16	2.4	**18**	3.4	35.4	0.3	**0.6**	1.2	390	0.43	2.1	25	**9350**	4.6	48	7.4
Ore Grade	36012	905	6.1	3600	11.9	21.5	4070	8.4	199.5	**0.033**	**95200**	0.41	5.9	**32**	4.9	74.4	0.06	**11.1**	3.6	910	1.46	2.9	30	**6180**	10.6	77	22.8
Ore Grade	36013	4230	9.28	4500	16.2	30.1	1730	8.9	48	**0.055**	**9700**	0.17	14.5	**4**	**26.6**	122	0.82	**0.84**	11.8	2980	0.73	5.8	164	**4520**	17.8	206	69.5
Ore Grade	36014	6080	**15.9**	1500	24.3	16.7	980	8.8	10.6	**0.08**	**12500**	**2.61**	11.2	**4**	**51.1**	134.5	0.67	**2.45**	10.7	2760	0.79	3.3	44	**8920**	12.4	327	35.7
Ore Grade	36015	2100	3.99	3700	13.5	22	1440	8.4	176	**0.107**	**78700**	0.26	10.1	**17**	11.1	100.5	0.61	**4.9**	10.3	2540	1.99	3.1	36	**9230**	12.6	110	49.2
Ore Grade	36016	9200	**328**	200	0.6	28.5	560	1.8	0.5	**0.041**	**24000**	0.48	4	**3**	**76.7**	32.1	0.05	**0.13**	0.6	390	0.26	0.7	33	**2440**	10.1	395	10.2
Low Grade Ore	36017	3850	4.85	2500	11.2	27.5	1990	5	57.1	**0.041**	**29700**	0.14	11.5	**8**	**39.7**	124.5	0.62	**0.61**	8.9	2270	0.66	3.2	64	**3990**	21	153	53
Ore Grade	36018	6340	9.41	1600	4.3	12.5	1520	3.6	8.9	**0.032**	**27600**	0.6	8.2	**6**	**30**	45.1	0.05	**0.65**	4.5	1170	0.36	2.8	32	**7710**	12.9	188	18.9
Low Grade Ore	36019	5530	8.96	2500	16.5	18.2	530	6.7	15.8	**0.027**	**5000**	1.61	12.5	**3**	**51.7**	189.5	0.75	**0.88**	10.6	3190	0.3	3.1	70	**2500**	13.3	278	41.9
Ore Grade	36020	5290	**69**	1700	19.9	31.9	3980	3.1	4.6	**0.069**	**8100**	0.35	12.6	**4**	**24.3**	169	0.79	**0.55**	8.5	3120	0.54	7	295	**6460**	24.5	252	71.1
Low Grade Ore	36021	4500	4.47	1500	11.1	35.9	1670	4	14.1	**0.05**	**47000**	0.3	12.4	**10**	17.9	80.9	0.45	**4.29**	6.7	1930	0.51	3.6	110	**4750**	16.9	126	35.7
Low Grade Ore	36022	3980	6.26	200	6.2	7.9	640	3.9	8.7	**0.019**	**14300**	1.93	7.1	**4**	**52.8**	345	0.24	**0.14**	3.5	1060	0.23	2.1	27	**1770**	8.6	172	16.1
Ore Grade	36023	4650	3.52	2000	15.9	33.5	300	4.5	18.9	**<0.002**	**9000**	0.88	9.2	**4**	**54.8**	170	1.03	**0.18**	11.2	2900	0.02	2.1	58	**590**	16.9	290	43.3
Ore Grade	36024	5750	2.09	1600	15.5	10.4	450	3.7	9.5	**0.03**	**11200**	0.24	12.8	**4**	**52.8**	140	0.75	**1.6**	10.5	2750	0.31	1.5	40	**2690**	12.1	265	43.8
Mine Waste	36025	155	**24.3**	2800	7.1	51.2	250	5.8	112.5	**0.012**	**12100**	0.12	9.5	**6**	2.9	62.7	0.45	**0.06**	7.3	2220	0.95	6.1	274	**14.6**	10.6	42	90.3
Mine Waste	36026	207	**19.2**	1900	12	49.2	6120	6.6	107.5	**0.036**	**6500**	0.16	9.1	**7**	6.2	149	0.75	**0.28**	7.2	2920	0.73	8.3	633	**32.3**	26.4	207	85
Mine Waste	36027	220	**22.2**	1900	10.6	51.5	470	7.6	139.5	**0.041**	2500	0.06	10.2	**3**	0.9	84.1	0.71	**<0.05**	8.3	3250	1.02	8	537	4.2	16.3	83	102
Mine Waste	36028	169	**15.8**	2300	18	51.2	1650	7	104	**0.04**	**5000**	0.1	8	**7**	4	106	1.12	**0.06**	7.4	3680	0.83	12.4	505	10.1	28	186	115
Mine Waste	36029	161	**18.4**	1400	9.5	49.5	3970	4.1	93.1	**0.035**	**9800**	0.16	10.7	**7**	1	107	0.64	**0.07**	8.9	2780	0.77	8.8	421	11.4	27.6	208	109
Mine Waste	36030	203	**15.9**	1000	14.6	66.3	4030	4.9	103.5	**0.031**	**5500**	1.59	9.2	**10**	2.5	85	0.88	**0.06**	8.7	3080	0.68	8.8	577	10.3	32	133	99.8
Mine Waste	36031	764	1.75	500	3.6	8.7	2020	4.1	12.1	0.002	**8300**	1.17	4.4	**2**	7.2	676	0.2	**<0.05**	3.2	1020	0.11	2.4	28	**41.9**	6.9	52	17.1
Mine Waste	36032	2750	3.48	1000	13.5	18.3	1370	6.8	31.5	**0.012**	**10100**	1.88	11.6	**5**	**35.1**	378	0.7	**0.16**	8.4	2830	0.29	3.3	60	**1130**	14.9	174	54.5
Mine Waste	36033	1225	**59.5**	3000	17.8	37.8	1290	10.3	176.5	**0.036**	**35200**	0.77	14.7	**6**	10.2	199	0.85	**0.71**	10.5	2720	1.23	2.8	72	**3130**	15.5	97	50.9
Borrow Waste	36034	153	11.7	5700	30.9	35.7	830	16.2	120.5	**0.009**	**18700**	1.71	14.6	**5**	2.8	137	1.87	**0.08**	9.7	5010	0.64	7.6	158	**32.1**	22.4	59	168.5
Borrow Waste	36035	1295	0.35	100	18.4	2.6	3280	3.6	1.9	**<0.002**	200	0.38	4.2	**3**	**226**	251	0.64	**0.06**	4.7	2370	**<0.02**	2.7	33	**34**	25.8	86	77.6
Borrow Waste	36036	161	**40.8**	300	13.6	147	730	16	49.2	**0.024**	**9500**	**2.58**	5	**8**	3.1	102	0.6	**0.08**	2.9	1720	1.05	12.1	693	4.8	7.6	630	68.2
Borrow Waste	36037	159	**45.3**	300	15.8	154	900	8.3	54.1	**0.02**	**15700**	**2.33**	6.8	**11**	1.2	111.5	0.8	**0.06**	3.7	2090	1.17	17	814	3.3	14.8	484	71.8
Borrow Waste	36038	475	**40.8**	600	16.6	146.5	1050	9.1	49.7	**0.013**	**15500**	**5.89**	11.4	**7**	0.8	75.2	0.88	**0.15**	4.2	2260	1.41	13.5	818	3.3	24.8	380	82.4
Borrow Waste	36039	141	10.6	700	19.1	65.7	**>10000**	12.2	128.5	**0.037**	**11100**	**5.12**	9.5	**10**	1.4	121	1.11	**0.1**	8.1	3120	0.88	12.9	518	3.3	32.9	332	126.5
Borrow Waste	36040	227	**22.5**	1700	9.2	57.5	1220	14.5	135	**0.033**	**10000**	**6.73**	9.1	**7**	1.3	127	0.58	**0.08**	9.4	2530	0.87	10.9	417	1.8	17	318	111
Borrow Waste	36041	154	11.6	2100	10.5	61.1	3960	17.7	140.5	**0.031**	**12800**	**5.55**	10	**8**	1.4	224	0.62	**0.1**	10.8	2720	0.84	9.9	280	2.2	25.9	471	113
Old Mine Waste	PAD 1	912	9.6	0.19	13.4	39.8	2990	**883**	135	**0.017**	**9600**	1.18	12.9	**6**	15.3	98.3	1.05	**0.58**	11.7	3540	0.97	6.6	297	**1300**	21.5	147	101.5
Old Mine Waste	PAD 1b	3160	5.71	0.2	9.6	14	2660	18.7	36.9	**0.053**	**87100**	0.66	3.9	**21**	12.7	54.1	0.13	**7.52**	3.3	890	0.68	2.8	34	**8530**	7.1	93	17.9
Old Mine Waste	PAD 2	1985	**23.2**	0.14	11.5	59.4	2990	12	55.4	**0.092**	**52200**	**4.56**	7.4	**14**	15.9	106.5	0.68	**2.12**	5.4	2480	0.87	9.4	607	**6370**	20.6	321	63.9
Old Mine Waste	PAD 3	342	**31.7**	0.1	13.4	68.1	2440	63.9	118.5	**0.051**	**10800**	1.66	10.1	**11**	5.3	210	0.99	**0.14**	7.5	3420	0.98	11.8	709	**199**	25.3	433	90.1
Old Mine Waste	PAD 4	1105	9.34	0.2	13.3	36.6	1480	32.6	189	**0.021**	**16400**	**3.16**	14	**5**	13.8	79.2	1.08	**1.62**	12.9	3750	1.3	4.9	188	**2000**	20.7	140	89.5
Background	BG 1	131	2.13	0.21	17.7	6.9	650	53.3	207	<0.002	800	3.67	20.2	2	6	108	1.52	<0.05	21.6	5060	1.31	3	89	25.2	19.7	43	90.5

Red values indicate exceedance of 10x crustal abundance

No comparison available for similar deposits

The geochemical program samples are also plotted along with the exploration samples in Figure 4.1.4-2 through Figure 4.1.4-8. The geochemical program samples show generally good agreement with the exploration program samples. The iron concentration for Unit 2B is lower than the remainder of the higher sulphide samples for this unit. This is a result of the iron method detection limit for the geochemical program samples having a maximum concentration of 10%. The samples for Unit 3C are on the lower end of the iron and sulphur content for this unit.

The samples from the existing waste dump had variable metal concentrations which is likely a reflection of the limited number of samples. Samples from Pad 1b and Pad 2 have copper, sulphur and tungsten concentrations consistent with the ore grade materials at the site while the other pads are more representative of the other waste rock type present in the waste dump.

4.1.4.2 Metal Leaching Conditions

Mactung Property

A total of 19 samples from the Mactung property were submitted during 2008 for shake flask analysis to evaluate metal leaching (ML) potential. The shake flask analyses were conducted by ALS Environmental of Vancouver, BC. Comparisons to water quality guidelines in this section include both the federal Metal Mining Effluent Regulations (MMER) and the Canadian Council of Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life. CCME is the body that sets water quality objectives on a nation-wide level. The CCME standards are taken to be applicable to the Mactung property in the absence of Yukon specific receiving water quality guidelines.

The Mactung property will be subject to the federal MMER once in operation. Table 4.1.4-7 contains a comparison of shake flask leachate metal concentrations relative to the MMER guidelines. As shown in Table 4.1.4-7, all samples tested returned metal concentrations below the MMER monthly mean guidelines for all elements with most results being less than the method detection limit. This indicates that there should not be significant metal leaching associated with the Mactung ore and waste rock used for site development purposes. No waste rock samples from the underground working were submitted for analysis as no fresh samples were available. Older core from the 1970s is available; however, this core may have already been subject to some metal leachate of the outer surfaces and may not be representative of freshly disturbed waste rock.

TABLE 4.1.4-7 SHAKE FLASK METAL CONCENTRATIONS COMPARED TO MMER GUIDELINES

Sample ID	Material Type	Arsenic [mg/L]	Copper [mg/L]	Lead [mg/L]	Nickel [mg/L]	Zinc [mg/L]
MMER – Monthly Mean		0.5	0.3	0.2	0.5	0.5
MMER - Grab		0.75	0.45	0.3	0.75	0.75
36010	Ore grade	< 0.0013	< 0.004	< 0.00005	0.00254	0.0013
36011	Ore grade	< 0.0003	< 0.03	0.00015	< 0.001	0.0059
36013	Ore grade	0.00763	< 0.0013	< 0.00005	<0.0005	0.0024
36014	Ore grade	< 0.0034	< 0.005	< 0.00005	< 0.0005	0.0014
36016	Ore grade	< 0.0011	< 0.004	< 0.00005	0.00068	0.0014
36017	Ore grade	< 0.0016	< 0.0026	< 0.00005	< 0.0005	0.001
36019	Ore grade	0.00618	< 0.0006	< 0.00005	< 0.0005	< 0.001
36020	Ore grade	0.00824	< 0.0015	< 0.00005	< 0.0005	0.0018
36021	Ore grade	< 0.0005	< 0.0042	< 0.00005	0.00096	0.0014
36022	Ore grade	< 0.0024	< 0.0009	< 0.00005	< 0.0005	0.0011
36023	Ore grade	0.0111	< 0.0027	< 0.00005	< 0.0005	0.0011
36034	Waste – Mill Site	< 0.0003	< 0.009	< 0.00005	0.00919	0.0029
36035	Waste – Mill Site	< 0.0011	< 0.0011	0.000051	< 0.0005	0.0016
36036	Waste – Ravine Dam	< 0.0014	< 0.0015	< 0.00005	0.0163	0.0033
36037	Waste – Ravine Dam	< 0.002	< 0.0022	< 0.00005	0.015	0.0035
36038	Waste – Ravine Dam	< 0.0011	< 0.0022	< 0.00005	0.00239	0.0013
36039	Waste – Main Dam	< 0.0022	< 0.0016	< 0.00005	< 0.0005	0.0012
36040	Waste – Main Dam	< 0.0022	< 0.0016	< 0.00005	< 0.0005	0.001
36041	Waste – Main Dam	< 0.0045	< 0.0022	< 0.00005	0.00068	0.0014

Table 4.1.4-8 contains a comparison of shake flask leachate metal concentrations relative to the CCME Guidelines for the Protection of Aquatic Life. As noted above, the leachate from the shake flask test would indicate the maximum concentration that might be observed in the pore water of the sample, at a dilution of 3 to 1. The leachate from the same material that would be noted in the field would be substantially lower. The comparison of results in Table 4.1.4-8 to the CCME guidelines is complicated by the variable detection limits for different samples. The variability of the detection limits for the analytical testwork is a result of matrix interference with other elements and is a function of the sample matrix and spikes in the method blanks during analysis. If a spike is detected in the method blank then a different detection limit must be used to ensure acceptable data quality. To interpret the shake flask testwork results if the concentration of the parameter was below the detection limit, the detection limit was assumed to be the upper boundary of the readily mobile metals concentrations expected to be leached from the different rock types. Where the detection limit was higher than the CCME guideline for the specific parameter and the concentration of the parameter was below that limit, that concentration was used to determine the dilution factor required to meet the CCME guideline.

TABLE 4.1.4-8: SHAKE FLASK METAL CONCENTRATIONS COMPARED TO CCME GUIDELINES - MACTUNG

Sample ID	Material Type	Aluminum [mg/L]	Arsenic [mg/L]	Cadmium [mg/L]	Chromium [mg/L]	Copper [mg/L]	Iron [mg/L]	Lead [mg/L]	Mercury [mg/L]	Molybdenum [mg/L]	Nickel [mg/L]	Phosphorus [mg/L]	Selenium [mg/L]	Silver [mg/L]	Thallium [mg/L]	Zinc [mg/L]
CCME – aquatic life		**0.1**	**0.005**	**0.000017**	**.001/.00891**	**0.002**	**0.3**	**.0001-.0007**	**0.000026**	**0.073**	**0.025-0.15**	**0.04-0.1**	**0.001**	**0.0001**	**0.0008**	**0.03**
36010	Ore grade	0.0469	<0.0013	<0.00005	<0.0005	**<0.004**	<0.03	<0.00005	<0.0001	0.00246	0.00254	<0.3	**0.0026**	<0.00001	<0.0001	0.0013
36011	Ore grade	<0.011	<0.0003	<0.0001	<0.001	**<0.03**	**93**	0.00015	<0.0001	0.00021	<0.001	<0.3	**0.0075**	<0.00002	<0.0002	0.0059
36013	Ore grade	**0.723**	**0.00763**	<0.00005	<0.0005	<0.0013	<0.03	<0.00005	<0.0001	0.00368	<0.0005	<0.3	<0.001	<0.00001	<0.0001	0.0024
36014	Ore grade	**0.102**	<0.0034	<0.00005	<0.0005	**<0.005**	<0.03	<0.00005	<0.0001	0.054	<0.0005	<0.3	**0.002**	0.000013	<0.0001	0.0014
36016	Ore grade	<0.009	<0.0011	<0.00005	<0.0005	**<0.004**	<0.03	<0.00005	<0.0001	0.0518	0.00068	<0.3	**0.0012**	<0.00001	<0.0001	0.0014
36017	Ore grade	**0.162**	<0.0016	<0.00005	<0.0005	**<0.0026**	<0.03	<0.00005	<0.0001	0.00191	<0.0005	<0.3	<0.001	<0.00001	<0.0001	0.001
36019	Ore grade	**0.372**	**0.00618**	<0.00005	<0.0005	<0.0006	<0.03	<0.00005	<0.0001	0.00398	<0.0005	<0.3	<0.001	<0.00001	<0.0001	<0.001
36020	Ore grade	**0.305**	**0.00824**	<0.00005	<0.0005	<0.0015	<0.03	<0.00005	<0.0001	0.0149	<0.0005	<0.3	**0.0019**	<0.00001	<0.0001	0.0018
36021	Ore grade	0.0997	<0.0005	<0.00005	<0.0005	**<0.0042**	<0.03	<0.00005	<0.0001	0.00247	0.00096	<0.3	<0.001	<0.00001	<0.0001	0.0014
36022	Ore grade	0.032	<0.0024	<0.00005	<0.0005	<0.0009	<0.03	<0.00005	<0.0001	0.00277	<0.0005	<0.3	<0.001	<0.00001	<0.0001	0.0011
36023	Ore grade	**0.29**	**0.0111**	<0.00005	<0.0005	**<0.0027**	0.052	<0.00005	<0.0001	0.0269	<0.0005	<0.3	<0.001	<0.00001	<0.0001	0.0011
36034	Waste – Mill Site	0.0157	<0.0003	<0.00005	<0.0005	**<0.009**	<0.03	<0.00005	<0.0001	0.00171	0.00919	<0.3	**0.0013**	<0.00001	<0.0001	0.0029
36035	Waste – Mill Site	<0.012	<0.0011	<0.00005	<0.0005	<0.0011	<0.03	0.000051	<0.0001	0.00102	<0.0005	<0.3	<0.001	<0.00001	<0.0001	0.0016
36036	Waste – Ravine Dam	0.0431	<0.0014	**0.000106**	<0.0005	<0.0015	<0.03	<0.00005	<0.0001	0.148	0.0163	<0.3	**0.0129**	**0.000704**	<0.0001	0.0033
36037	Waste – Ravine Dam	0.0556	<0.002	**0.000199**	<0.0005	**<0.0022**	<0.03	<0.00005	<0.0001	0.283	0.015	<0.3	**0.0091**	**0.000581**	<0.0001	0.0035
36038	Waste – Ravine Dam	**0.138**	<0.0011	<0.00005	<0.0005	**<0.0022**	<0.03	<0.00005	<0.0001	0.01	0.00239	<0.3	**0.0061**	**0.000216**	<0.0001	0.0013
36039	Waste – Main Dam	**0.309**	<0.0022	<0.00005	<0.0005	<0.0016	<0.03	<0.00005	<0.0001	0.0216	<0.0005	<0.3	**0.002**	0.000043	<0.0001	0.0012
36040	Waste – Main Dam	**0.302**	<0.0022	<0.00005	<0.0005	<0.0016	<0.03	<0.00005	<0.0001	0.0211	<0.0005	<0.3	**0.0018**	0.000039	<0.0001	0.001
36041	Waste – Main Dam	**0.339**	<0.0045	<0.00005	<0.0005	**<0.0022**	<0.03	<0.00005	<0.0001	0.00972	0.00068	<0.3	**0.0097**	0.000098	<0.0001	0.0014
Dilution Factors to meet CCME		<10	<3	<12	none	152	none	none	<4	none	none	32	<13	<10	none	none

1 the CCME guideline for Chromium is dependent on speciation. Cr (III) is 0.0089 mg/L while Cr (VI) is 0.001 mg/L.

2 dilution factor shown represents required dilution for detection limit samples. No sample concentrations above detection limit.

Copper and selenium required the highest dilution factors to meet CCME guidelines based on the shake flask results (15 and 13 times, respectively). The dilution required for copper was based on the concentrations being less than the detection limits so the dilution factor shown in Table 4.1.4-8 would be substantially higher than actually required. Aluminum, cadmium and silver also required a greater than 10x dilution factor to achieve CCME guidelines. The cadmium and silver dilutions that were higher than the guidelines were all in waste rock and not from the ore grade or low ore grade material types.

The geochemical characterization of rock types to be potentially impacted at the Mactung mine shows that there will be some potentially acid-generating (PAG) materials encountered during the operation phase. The tailings for the site are anticipated to be PAG based on the ABA results from the ore samples. The potential effects of acid rock drainage at the site should be manageable and there is not expected to be significant effects on the receiving environment as a result of the proposed project. Information on how NATC will separate and manage PAG waste rock and tailings is detailed in Section 5.

4.1.5 Climate

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

4.1.5.1 Meteorological Stations

Meteorological data for the Mactung area have been collected for a number of years (1998-2005) using an Environment Canada weather station located close to the Macmillan Pass adjacent to the North Canol Road.

A three-metre meteorological station equipped with instrumentation to measure wind speed and direction, air temperature, relative humidity and incident solar radiation was installed at the Mactung property on July 15, 2005, approximately 50 m from the existing Mactung camp (see Figure 4.1.10-1, hydrology section). Weather data have been collected and analyzed for a period of more than two years, from the date of installation until August 31, 2007.

Precipitation data recorded from 1998 to 2005 at the Meteorological Service of Canada Macmillan Pass meteorological station, were used to estimate yearly precipitation at the Mactung Property. The Macmillan Pass station is located at the Yukon Territory/NWT border adjacent to the North Canol Road (481 m lower in elevation), approximately 16 km southeast of the Mactung Property at 63º 14' 36.9" N and 130º 2' 7.1" W.

Figure 4.1.10-1 (hydrology section) shows the location of the two stations relative to the Mactung site.

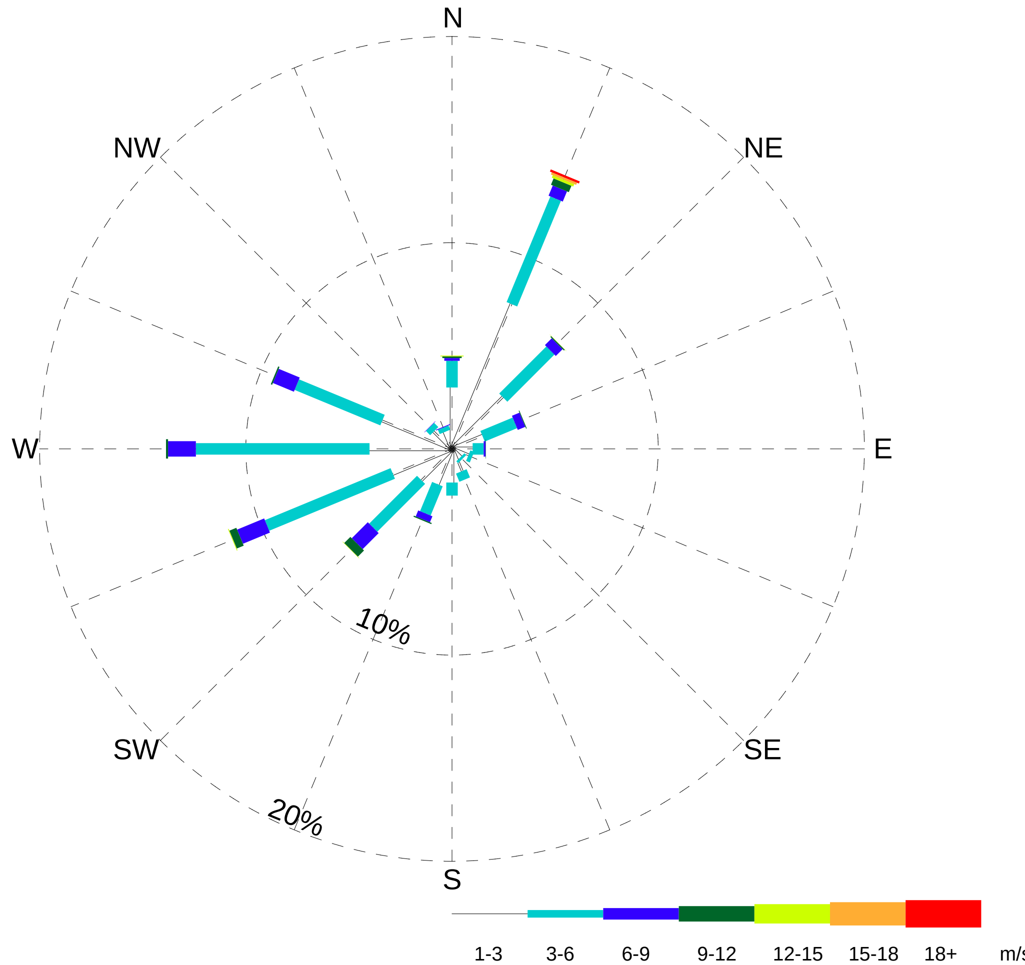
The 2006, 2007 and 2008 hydrometeorlogical reports that provide the details of the climate studies are appended to this proposal (Appendix E1, E2 and E3 respectively).

4.1.5.2 Wind

The speed and direction of wind at the Mactung property have been recorded for 698 days since the meteorological station was installed. Winds at the site are observed to come predominantly from the W/SW and from the NE/NNE. Over the period of record, winds from these directions were recorded about 53% of the time. Wind speeds at the site were less than 6 m/s 91% of the time. The wind rose and frequency table in Figure 4.1.5-1 show the frequency of occurrence of wind speed and direction recorded at the meteorological station.

The monthly wind roses for 2006 and 2007 provided in Appendix C of the Mactung Hydrometeorological Survey report (Appendix E2) indicate that wind speeds greater than 6 m/s tend to occur more often during the winter months.

Daily maximum wind gusts at the Mactung Property are typically of the order of 7 m/s. The maximum wind gust recorded over the entire record was 23 m/s. Higher wind gust speeds tend to occur in the winter months. The daily maximum recorded wind speed for the entire period of record is illustrated in Figure 4.1.5-2.



Wind Speed & Direction Frequency Distribution Table

Direction	Percent Occurrence (%) 0-1 m/s	1-3 m/s	3-6 m/s	6-9 m/s	9-12 m/s	12-15 m/s	15-18 m/s	18+ m/s	Total (%)
ENE	-	1.60	1.70	0.39	0.04	-	-	-	3.73
NE	-	3.52	3.23	0.47	0.06	0.01	-	-	7.28
NNE	-	7.59	5.55	0.54	0.33	0.12	0.11	0.11	14.35
N	-	2.98	1.29	0.13	0.08	0.04	-	-	4.53
NNW	-	0.89	0.22	0.04	-	-	-	-	1.16
NW	-	1.22	0.29	0.02	-	-	-	-	1.52
WNW	-	3.65	4.50	1.11	0.07	-	-	-	9.32
W	-	4.00	8.42	1.35	0.10	-	-	-	13.87
WSW	-	3.11	6.60	1.42	0.37	0.04	-	-	11.53
SW	-	2.12	3.28	1.10	0.42	0.02	-	-	6.94
SSW	-	1.85	1.53	0.31	0.06	-	-	-	3.76
S	-	1.63	0.63	-	-	-	-	-	2.27
SSE	-	1.18	0.43	-	-	-	-	-	1.61
SE	-	0.57	0.12	-	-	-	-	-	0.70
ESE	-	0.85	0.20	-	-	-	-	-	1.05
E	-	1.00	0.54	0.09	0.02	-	-	-	1.64
Calm	14.72	-	-	-	-	-	-	-	14.72
Total (%)	14.72	37.77	38.54	6.96	1.54	0.25	0.12	0.11	100.00

Station Name: Mactung
NAD 27 Location:
N63° 16' 50.2" W130° 8' 50.3"
Elev. above SL: 1860 m
Tower height: 3 m
Record length: 1059 of 1140 days
Start Date: July 14, 2005
End Date: August 27, 2008

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NOTES

No data for the following periods
Sep. 06 - Sep. 26 2005
Jan. 07 - Jan. 17 2005
Feb. 20 - Mar. 21 2006
Sep. 12 - Nov. 15 2006

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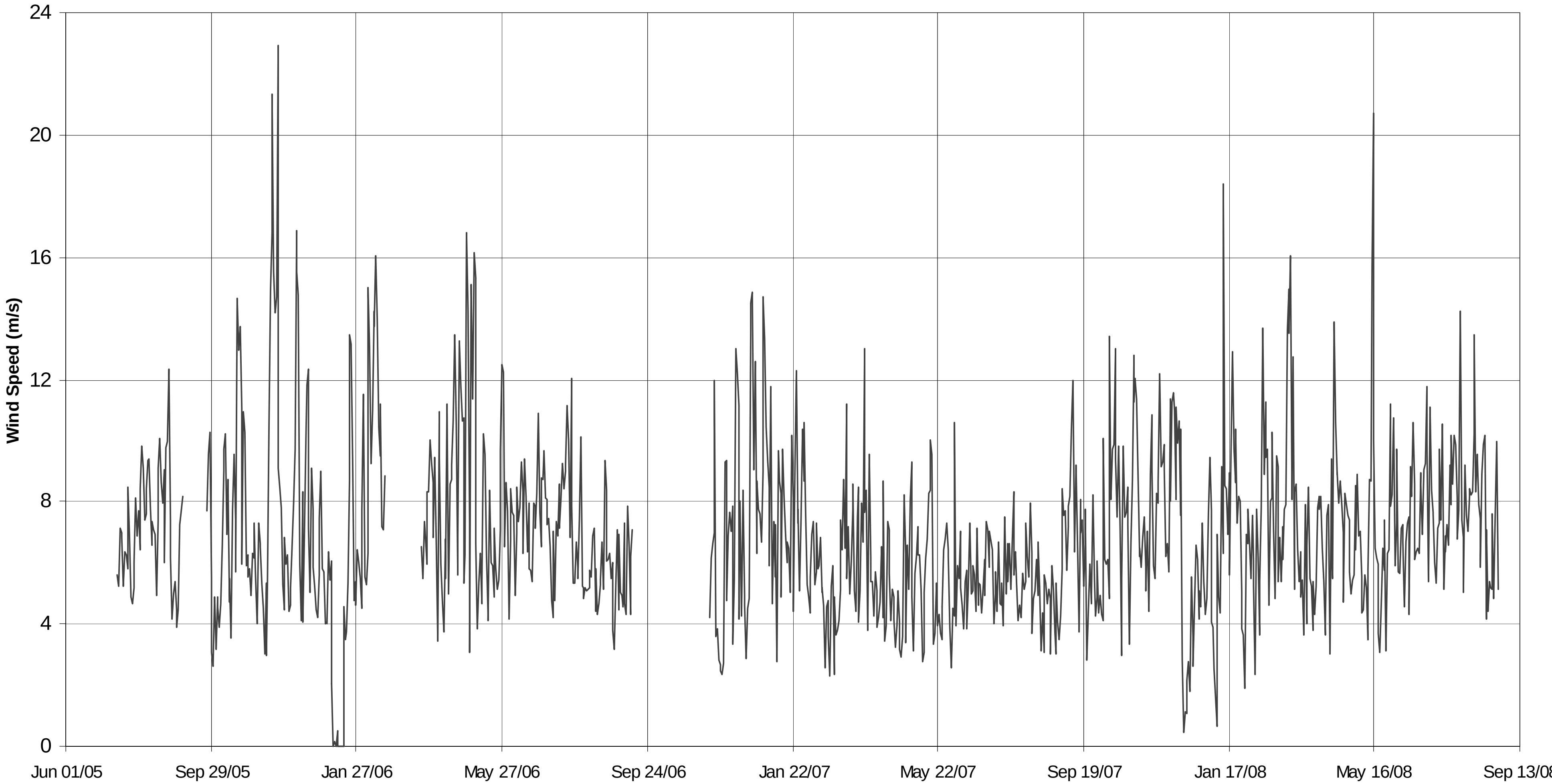
MACTUNG

Mactung Station
Wind Rose
July 14, 2005 - August 27, 2008

PROJECT NO.	DWN	CHK	REV
W23101110.001	RED	JAS	0
OFFICE	DATE		
EBA-VANC	October 2008		

Figure 4.1.5-1

Thu Nov 20 09:58:42 2008:Q:\Vancouver\Data\0201-WHI\PROJECTS\1200163 - Mactung\Mactung\RED\Meteorology\Camp Station\Wind_roses\Wind_rose_data_reduction



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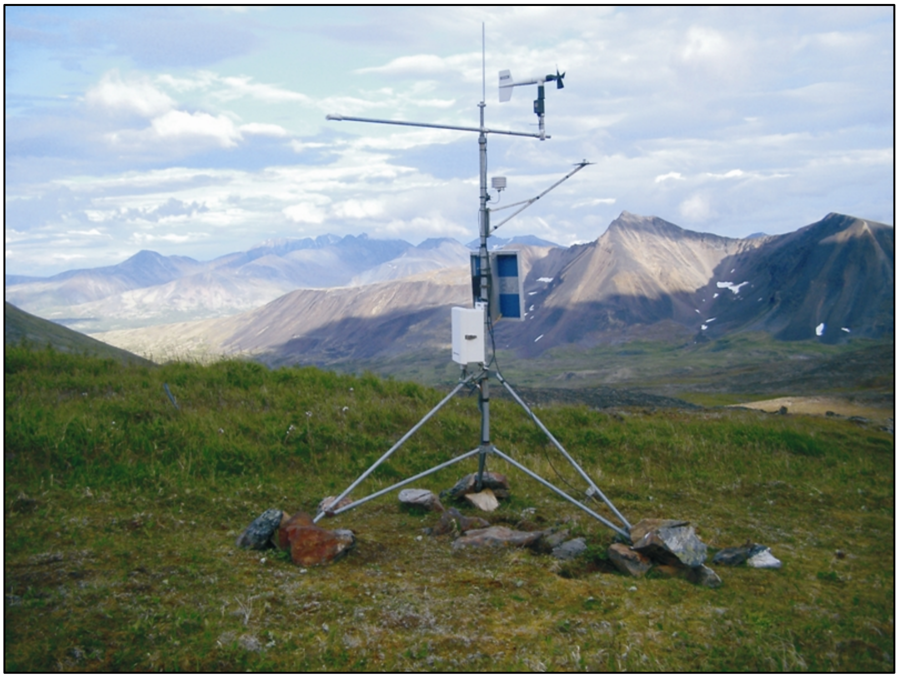
Mactung Camp Daily Maximum Wind Speed

PROJECT NO.	DWN	CKD	REV
W23101110.001	RED	JAS	0
OFFICE	DATE		
EBA-VANC	October, 2008		

Figure 4.1.5-2



Meteorological station at the Mactung property

4.1.5.3 Air Temperature

The mean summer air temperature is typically between 5°C and 10ºC, with daily maximums around 15ºC and minimums around 5°C. The maximum air temperature recorded at the station over the study period was 20.0°C. Mean winter temperatures have more day-to-day variation, but are typically between -10°C and -20°C. The minimum air temperature recorded at the site over the period of record was -36.6°C. During the winter season, air temperatures rarely rise above freezing. The daily maximum, mean and minimum air temperatures for the entire period of record are illustrated in Figure 4.1.5-3.

The warmest period of the year is from June to late August. October through March represents the coldest period, with seasonal transitions occurring in April and May and from late August through September. Average daily maximum, minimum mean and extreme air temperatures at Mactung for the period of record are summarized by month in Table 4.1.5-1.

4.1.5.4 Relative Humidity

Relative humidity at the Mactung Property is typically near 90% throughout the year, but frequently drops to 30% or lower for periods of up to a day. During the winter months, the maximum relative humidity tends to be slightly lower than during the summer. During the summer months, relative humidity tends to have a larger daily range (±30% from the daily mean) than during the winter (±17%). The lowest relative humidity observed at the site over the period of record was 12.5%. The daily maximum, mean and minimum relative humidity for the period of record are illustrated in Figure 4.1.5-4.

4.1.5.5 Incident Solar Radiation

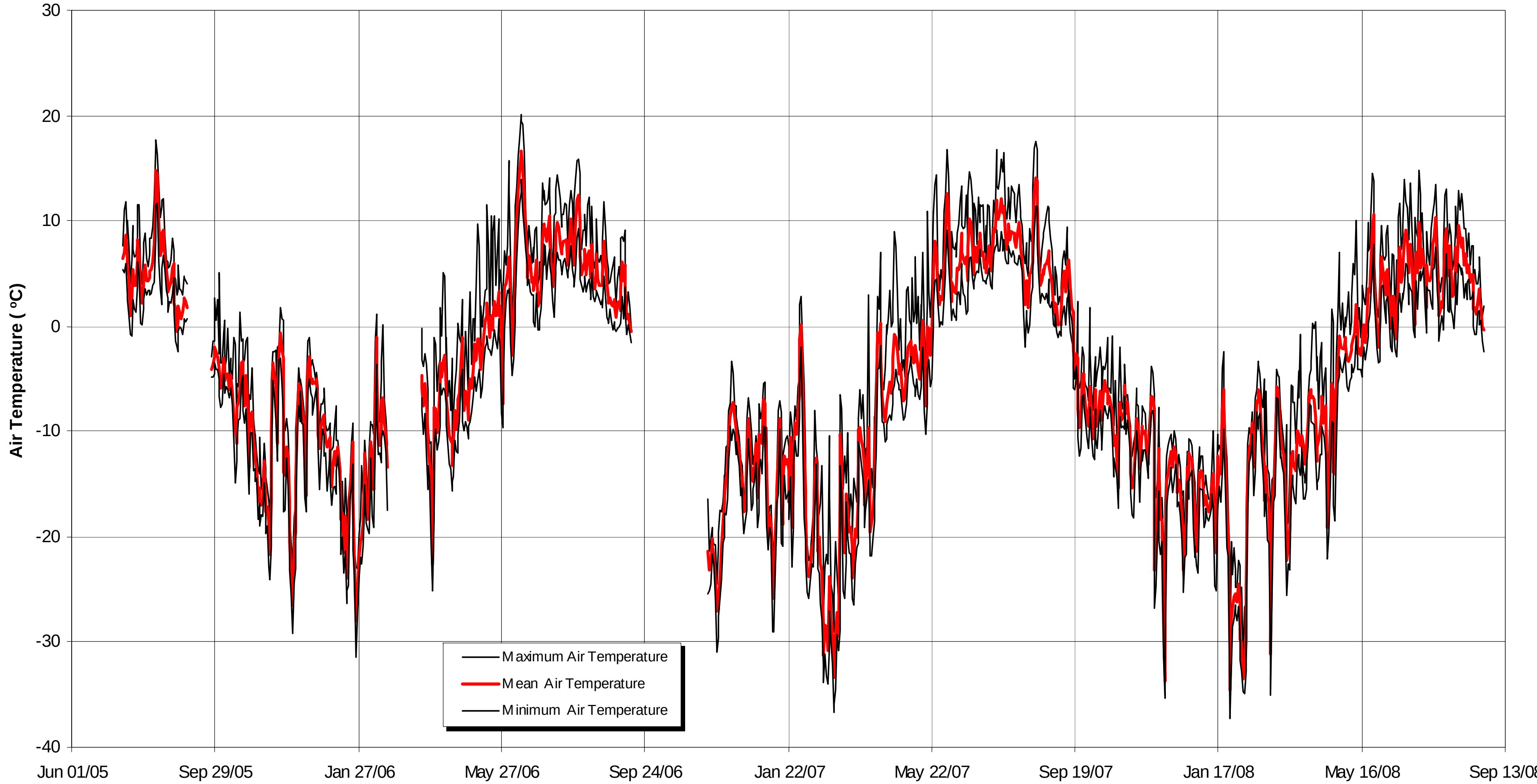
The site receives the highest amount of daily solar radiation between April and August. Maximum incident solar radiation during this period is up to 900 W/m^2. During December and January, daily maximums are near 50 W/m^2. There are about 20 hours of daylight on June 21 (summer solstice), only about 4 hours on December 21 (winter solstice). The maximum incident solar radiation recorded for a day during the period of record is presented in Figure 4.1.5-5.

4.1.5.6 Precipitation

Precipitation data recorded at the Environment Canada Macmillan Pass meteorological station were used to estimate yearly precipitation at the Mactung Property.

An analysis of the data showed that an average of 663 mm of precipitation (water-equivalent) per year fell from 2003 to 2005. Based on the entire period that the Macmillan Pass station has been operational (1998 to 2005) the average annual precipitation is 672 mm. The average monthly distribution of precipitation for Macmillan Pass is presented in Table 4.1.5-1.

Months with greater than 50 mm of precipitation commonly occur throughout the year, with January seeing the least, typically less than 30mm. Based on temperature data recorded at the Mactung Property, this precipitation can be expected to fall as snow from October to April. Precipitation occurring in September and May has the potential to fall as snow, freezing rain, rain or mixed precipitation.



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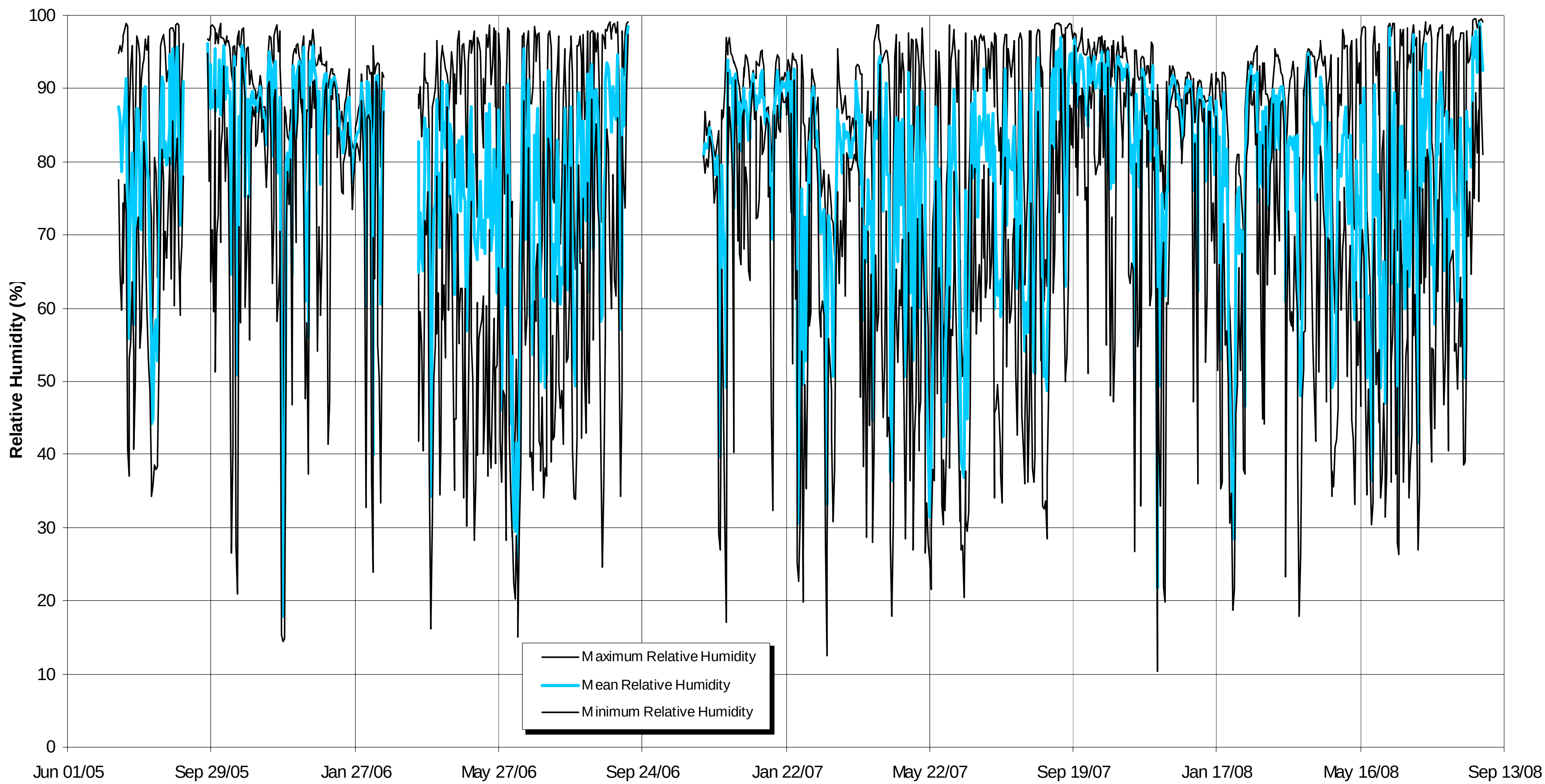
MACTUNG

Mactung Camp Daily Maximum, Mean & Minimum Air Temperatures

PROJECT NO.	DWN	CKD	REV
W23101110.001	RED	JAS	0

OFFICE	DATE
EBA-VANC	October, 2008

Figure 4.1.5-3



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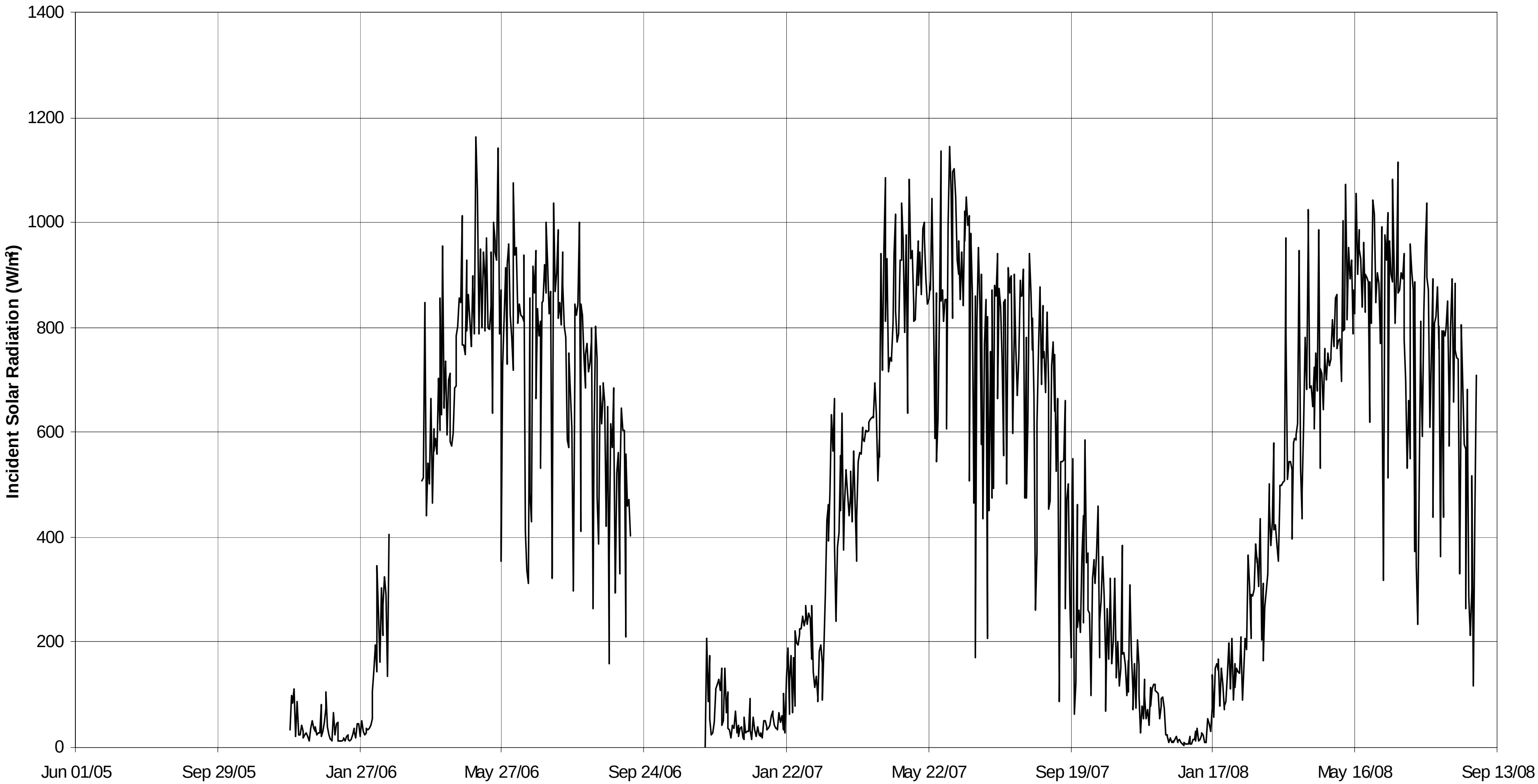
Mactung Camp Daily Maximum, Mean & Minimum Relative Humidity

PROJECT NO.	DWN	CKD	REV
W23101110.001	RED	JAS	0
OFFICE	DATE		
EBA-VANC	October, 2008		

Figure 4.1.5-4



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Mactung Camp Daily Maximum, Mean & Minimum Incident Solar Radiation

PROJECT NO.	DWN	CKD	REV
W23101110.001	RFD	JAS	0

OFFICE	DATE
EBA-VANC	October, 2008

Figure 4.1.5-5

TABLE 4.1.5-1: MACMILLAN PASS TEMPERATURE AND PRECIPITATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature													
Average Daily Maximum (ºC)	-13.2	-12.0	-12.3	-2.6	4.0	10.3	11.6	8.7	4.1	-3.2	-12.4	-9.1	-2.2
Average Daily Minimum (ºC)	-18.2	-18.9	-19.7	-10.2	-3.6	3.5	6.0	3.2	-0.3	-8.6	-17.9	-13.5	-8.2
Daily Mean ºC)	-15.7	-16.4	-16.4	-7.1	-0.7	6.6	7.6	5.6	1.6	-6.4	-15.5	-11.2	-5.7
Extreme Maximum (ºC)	-4.9	2.9	3.0	8.9	14.4	20.1	16.8	17.8	9.4	5.1	1.8	-1.1	20.1
Extreme Minimum (ºC)	-31.4	-34.0	-36.6	-21.8	-10.2	-4.8	-0.9	-2.5	-4.9	-16.0	-30.9	-29.2	-36.6
Period of record from July 14, 2005 to September 13, 2007													
Precipitation													
Precipitation (mm)	26	58	64	74	30	70	56	78	44	61	48	63	672.0

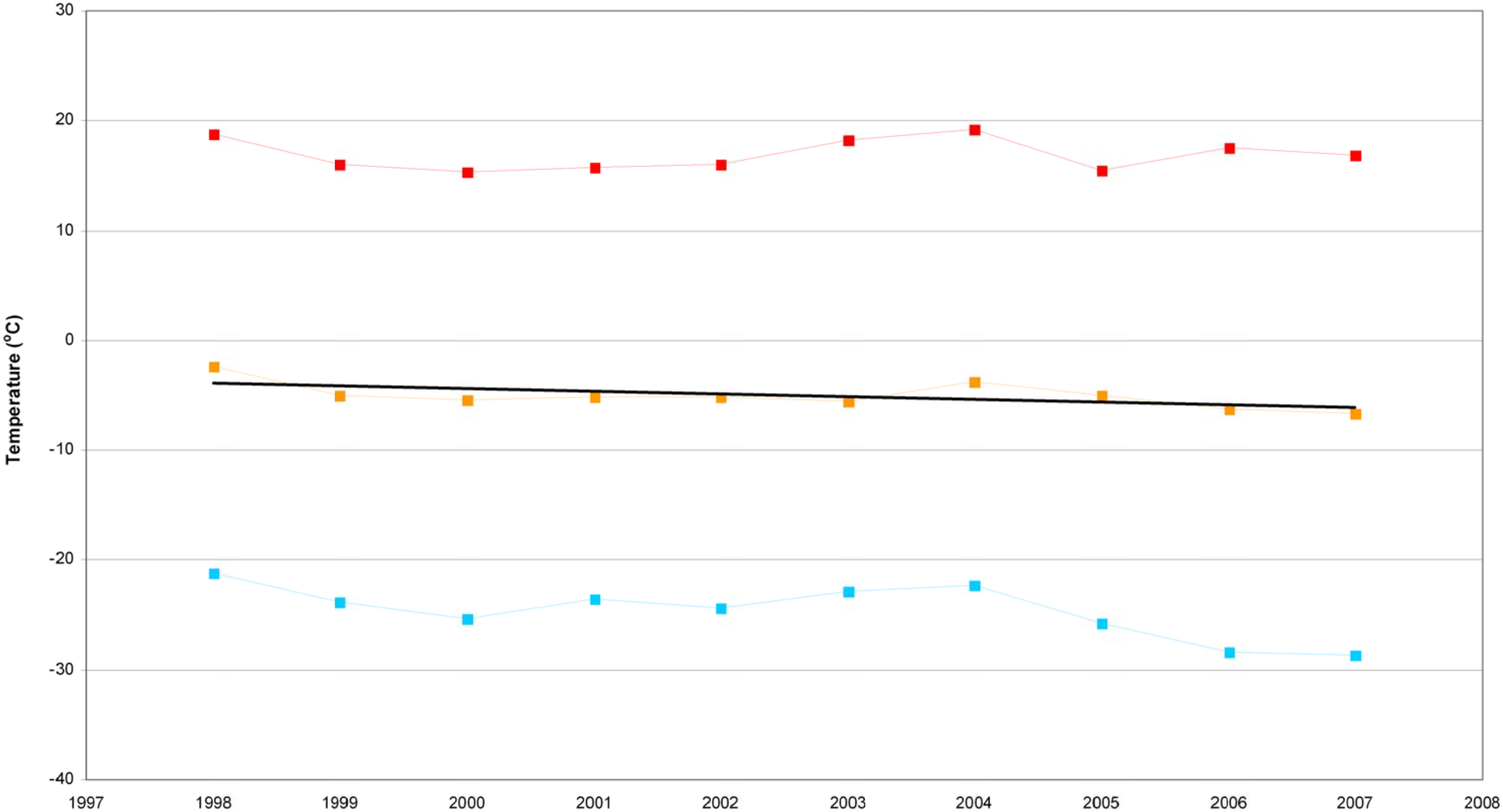
Source: Meterological Service of Canada - Macmillan Pass (Climate ID# 2100693) monthly data (period from 1998 - 2005)

4.1.5.7 Climate Trends

The Macmillan Pass meteorological station has been active since February 1998, providing a climate record of ten years. Data from 2006 and 2007 have undergone only preliminary quality checking by Environment Canada, but were included in the climate trend analysis. The yearly mean air temperature over the period of record is illustrated in Figure 4.1.5-6. The mean monthly temperature for the warmest month of the year and the coldest month of the year are also shown. The data show that the mean annual temperature has been decreasing by 0.25°C per year since 1998.

Figure 4.1.5-7 shows the records of daily mean air temperature at the Mactung property and Macmillan Pass stations since July 2005. When plotted against each other, the correlation coefficient between the data sets is 0.953. This correlation infers a climate trend with respect to air temperature at the Mactung property and from the data obtained at the Macmillan Pass meteorological station. However, a longer period of climate data is necessary to establish a meaningful long term temperature trend for the area.

The Degree Day Number, which is the sum of the mean daily temperatures within a year, indicates an overall negative temperature structure at the Mactung property. The July 2005 to July 2006 period had a degree day number of -1575°C and the July 2006 to July 2007 period had a degree number of -1934°C (Table 4.1.5-2). This negative energy regime in the region was also confirmed by the daily mean temperature record from the Environment Canada Macmillan Pass station. A list of long term degree day numbers for this station is shown in Table 4.1.5-2.



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LEGEND

- Summary Maximum Mean
- Yearly Mean Temperature
- Winter Minimum Mean
- Linear (Yearly Mean Temperature)

NOTE

Temperature data from 2006 and 2007 has undergone only preliminary quality checking by Environment Canada.

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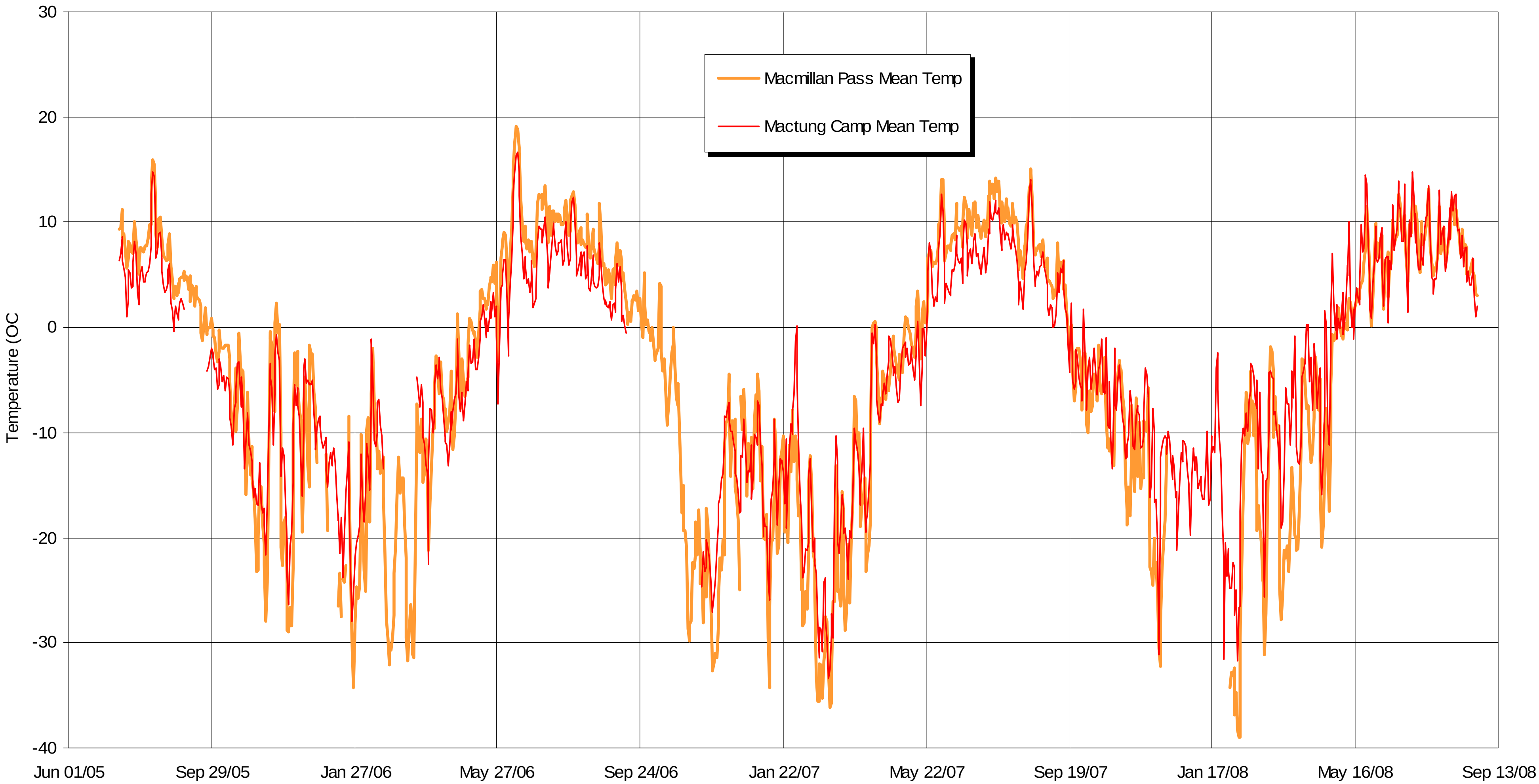
Annual Temperature Trend
Macmillan Pass
(1998 - 2007)

PROJECT NO.	DWN	CKD	REV
W23101110.001	TF	AC	2
OFFICE	DATE		
VANC	December 4, 2008		

Figure 4.1.5-6



ISSUED FOR USE

NOTES

Mactung Camp data is missing for the period of September 13, 2006 to November 15, 2006.
Macmillan Pass data is missing for the period of December 11, 2007 to January 31, 2008.

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG PROJECT
2008 HYDROMETEOROLOGICAL SURVEY

Comparison of Air Temperature Means
Mactung Property
& Macmillan Pass

PROJECT NO.	DWN	CKD	REV
W23101110.001	RED	JAS	0

OFFICE: EBA-VANC

DATE: October, 2008

Figure 4.1.5-7

TABLE 4.1.5-2 MACMILLAN PASS LONG TERM DEGREE DAY NUMBER									
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
Degree Day Number	-1301	-1943	-1837	-1841	-1968	-1036	-1438	-1746	-1378

The magnitude of the Degree Day calculations for the area show that a negative energy balance would be sustained even with a two degree increase in average air temperature. The previously identified decrease of -0.25°C per year that has been observed in this area supports the assertion of a stable long term negative energy deficit.

4.1.6 Air Quality

The proposed mining area of the Mactung property is located within a wilderness area that has no other sources that would affect the air quality. It is assumed that the air quality in the area would be in the same range as background levels for the Canadian north.

There is currently no air quality monitoring equipment at the mine site or any other adjacent sites. The only ongoing air quality monitoring in the Yukon is conducted in Whitehorse. The Whitehorse station is part of the National Air Quality Surveillance (NAPS) Network. The air pollutants monitored in Whitehorse include carbon monoxide, nitrogen dioxide, nitric oxide, ground level ozone, and fine particulate matter (PM_{25}). The monitored ambient air pollutants in Whitehorse are compared with the National Air Quality Objectives (NAQOs). Summary reports for 1998, 2000, 2001 and 2004 were reviewed for this station. Overall, the reports conclude that the ambient air pollutant levels monitored at the Whitehorse NAPS station are good and rarely exceed the levels specified in the NAQOs.

A direct comparison cannot be made between Whitehorse ambient air pollution levels and those at the Mactung property. However, it is assumed that due to the location of the proposed mine site, the comparatively lower levels of traffic and comparatively lower levels of wood burning than in Whitehorse, the ambient air quality is considered to be higher quality than in Whitehorse.

Winds at the mine site originate from two prevailing wind directions at the Mactung camp station. This duality in prevailing wind direction is due to the orientation of the valley in which the Mactung property is located. Winds come from the west about 34% of the year and from the northeast approximately 24% of the year. During the winter months, winds blow more frequently from the northeast. Over the period of record, northeast winds in November 2006, February 2007 and March 2007 had a frequency of occurrence of more than 30%. In the summer, winds were observed to be blowing more frequently from the west and southwest.

A maximum wind gust of 23 m/s was recorded at the Mactung property between July 2005 and August 2007. The average maximum gust on a daily basis is approximately 7.0 m/s. On a calm day, maximum wind gusts are in the order of 4.0 m/s, whereas on a windy day maximum gusts are in the order of 10.0 m/s. The wind speed data indicate that there is sufficient air movement through the mine site to disperse any possible air pollutants.

4.1.7 Noise Levels

Noise is often described as unwanted sound. Sound is defined as any pressure variation in air that the ear can detect. If the pressure variations occur frequently (at least 20 times per second) they can be heard by the human ear and are called "sound". The number of pressure variations per second is called the frequency of sound, and is expressed in cycles per second and called Hertz (Hz). The relative loudness or intensity of sound energy is measured in decibels (dB).

Environmental noise is usually measured in A-weighted decibels (dBA) and typically fluctuates over time. A dBA is a decibel corrected for the variation in frequency response of the typical human ear at commonly encountered noise levels.

Noises in the rural or remote settings can seem amplified if there are no barriers to the source. Noise levels are reduced by increasing distance, air density, wind, and obstructions (trees, buildings, and natural landscape features).

4.1.7.1 Existing Noise Levels

The proposed Mactung mine site is situated in a remote area where ambient (background) noise consists of natural sounds. Background sources of natural noise range from short-term soft sounds, as in the sound of the wind in the trees (30-50 db), to short-term loud cracks and rumbles, as in the sound of falling rocks (60-80 db). Ambient noise can also be loud and constant, as in the sound of a large waterfall (100 db). Ambient forest noise comes from both natural and human-caused sources. Some noise is short-term; some is constant. The following is a list of the various sources of human-made noise that can be expected at the proposed mine:

- Exploration, e.g., drilling, ground traffic;
- Construction, e.g. trucks, earth moving equipment;
- Mine operations, e.g., generators, mill operations; and
- Air traffic (helicopters).

Noise levels at the mine site are currently not monitored but are commensurate with regular summer exploration activities. Ambient noise is expected to be mainly of a temporary nature and will only affect the immediate vicinity of the above-mentioned activities. The daily and long-term averages for ambient noise in the area are anticipated to be low.

4.1.8 Vegetation

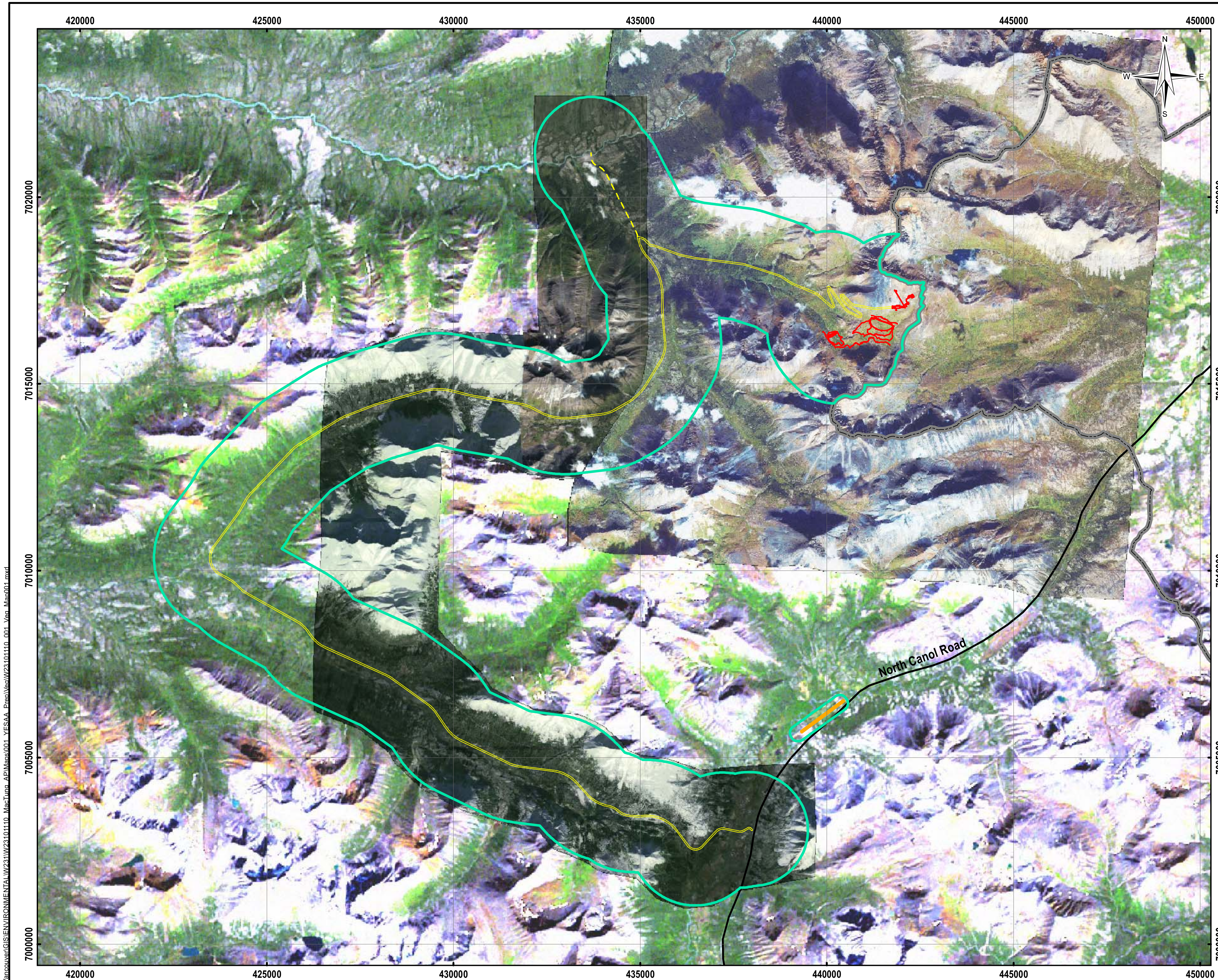
4.1.8.1 Background Information

The Mactung local study area (LSA) (see Figure 4.1.8-1) for the vegetation baseline studies includes a 1.5 km buffer around the mine site (the Mine), and proposed access road (the Road). This area includes the service road to the pumphouse as it was part of the original baseline study completed in 2008. The results presented are limited to vegetation and ecosystems observed in the Yukon. The LSA lies within the Selwyn Mountain Ecoregion of the Taiga Cordillera Ecozone of Canada. Ecodistricts for the LSA have not been formally defined; however for the purposes of this report, a Selwyn-Yukon Ecodistrict (YN) has been designated.

Vegetation is highly variable in the LSA due to elevation, aspect, microtopography, and soil conditions. Approximate land cover in the Selwyn Mountain Ecoregion is 65% boreal/subalpine coniferous forest, 20% alpine tundra, and 15% rockland (Smith *et al.* 2004). Valley bottoms tend to be vegetated by willow and scrub-birch thickets, wetlands, and sedge-forb meadows. Black and white spruce communities are rare in the Hess Tributary. Subalpine fir dominates the Wooded Taiga from 1,200 m a.s.l. to 1,550 m a.s.l. At higher elevations the canopy becomes sparse and is typically replaced by Krummholz and dwarf shrub communities in the Alpine. At elevations above 1,800 m a.s.l., vascular plants become rare and bare rock and epilithic lichen communities dominate.

4.1.8.2 Previous Relevant Studies

A literature search conducted prior to fieldwork in 2006 identified two historical reports relevant to the vegetation and ecosystems of the area. These reports were for AMAX Northwest Mining Company Limited (1982) which is based on information from Kershaw and Kershaw (1983). Although these reports did not document the full Mactung LSA, they did provide a detailed investigation into all physical, biological, and cultural aspects of their study area (500 km^2). The vegetation section of the AMAX (1982) report presents a summary of both the existing vegetation and plant communities and potential environmental impacts associated with the construction of the then proposed mine. The report identified 17 plant communities within the study area. The report also stated that upon review of rare species lists from the Yukon and the NWT, four species were to be considered rare with a potential to occur in the area. None of the four plant species were identified or recorded in areas planned for construction.



LEGEND

- North Canol Road
- NWT-Yukon Territory Border
- Proposed Mine Footprint
- Proposed Pumphouse Service Road Footprint
- Proposed Access Road Footprint
- Proposed Macmillan Pass Aerodrome Expansion Footprint
- Vegetation Local Study Area

ISSUED FOR USE

NOTES

Base data source: Site Plan Drawing adapted from original provided by Wardrop

MACTUNG

Vegetation Baseline Local Study Area

PROJECTION			DATUM
UTM Zone 9			NAD83

Scale: 1:100,000

2 1 0 2

Kilometers

FILE NO.			
W23101110_001_Veg_Map001.mxd			
PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0
OFFICE	DATE		
EBA-VANC	December 4, 2008		

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Figure 4.1.8-1

4.1.8.3 Objectives of the Vegetation Study

The objectives for the vegetation and ecosystem land classification (ELC) component of the environmental baseline studies for the Mactung project Local Study Area were to:

- Provide information on land cover types and forest cover;
- Document and map plant communities to the species level on the sites that may be disturbed as a result of development;
- Describe vegetation assemblages including protected areas and any identified rare, sensitive, and/or endangered species;
- Identify any wetlands in the project area; and
- Collect and present baseline information relating to trace element concentrations in vegetation in and around the footprint of the mine.

Upon review of the 2006 vegetation and ELC baseline studies (Appendix F1) it was determined that gaps in the data existed. The objectives of the 2007 vegetation component of the biophysical assessment (Appendix F2) were to satisfy recommendations made as a result of the 2006 vegetation and ELC baseline studies. These included a rare plant survey, an ELC update, and baseline trace element concentration sampling. Objectives of the 2008 vegetation and ELC baseline studies (Appendix F3) concentrated on meeting the above stated objectives with respect to the proposed access road.

4.1.8.4 Ecosystem Land Classification

Field data collection occurred from July 4th to 10th 2006; August 13th to August 15th, 2007; and July 3rd to July 8th, 2008. Sampling of vegetation was completed using full forms (FS 882) and ground inspection forms (GIF's) (FS212-2) produced by the Resources Inventory Committee (RIC). Visual inspections used site description forms from the Yukon Department of Environment. All forms were completed according to the methods outlined in the *Field Manual for Describing Terrestrial Ecosystems* (BCMoF 1998). Sample plots consisted of a 20 m by 20 m square plot delineated using a measuring tape. Full and ground inspection plots included a soil pit dug to 40 cm below the surface or until bedrock was encountered. All plot positions were recorded using a Garmin 60Cx Global Positioning System with accuracy of between 5-8 m. Vegetation nomenclature followed Cody (1996) and Cody *et al.* (1998; 2000; 2001).

Mapping of vegetation adhered to the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998). Guidelines and nomenclature for ELC are from EBA (Appendix F1), which was further based upon Kershaw and Kershaw (1983) and Zoladeski *et al.* (1996). Ecosystem units were mapped according to best professional judgement based on clearly defined vegetation units at a resolution of 1:20,000. The imagery used for ELC mapping was created from two satellite images which covered the Mine LSA and a majority of the Road LSA. Imagery for the Road was supplemented with digitized aerial photography to fill minor gaps in coverage. The satellite imagery consisted of tasked, ortho-rectified Quickbird imagery acquired August 21, 2006 and September 29, 2007. The Quickbird satellite collects panchromatic imagery at 60-70 cm resolution and multi-spectral imagery at 2.4-2. 8m resolution. Aerial photography used to supplement gaps in coverage in the Road LSA consisted of two photographs (A122343-241 and 242) from the Energy, Mines and Resources Library, Government of Yukon, Whitehorse.

In 2006, 2007, and 2008 a total of two Full plots, 58 ground inspection plots, 61 ground visual plots, and 10 air visual plots were sampled for a total of 113 sample plots within the LSA and 18 in adjacent areas of the Yukon. Using ArcGIS, 272 polygons were mapped for the LSA. The 113 plots sampled within 272 polygons represent a sampling intensity of 41%. The sampling ratio was adjusted in the field to acquire the greatest amount of vegetation information as possible. There were only two full plots recorded because concurrent terrain and soils data were being collected by a separate team of scientists. To maximize sampling efficiency, field effort concentrated on increasing the number of ground and visual inspections. Average polygon size was determined to be 124 hectares.

Bioclimate zones and landscape units are major classification levels used to map ecosystems in the Yukon by incorporating vegetation, elevation, climate, and terrain features. A summary of these units observed in the Mactung LSA are presented in Table 4.1.8-1. Alpine landscape units comprised 27.7% or 3,944.6 ha of the LSA. The Alpine generally occurs as dwarf shrub and herbaceous plant communities above 1650 m a.s.l. Shrub Taiga comprised 12.6% or 1,801.3 ha of the LSA. The Shrub Taiga is generally dominated by tall and low shrubs and acts as a transition area between Alpine and Wooded Taiga. Wooded Taiga comprised the greatest area within the LSA at 58.6% or 8,356.1 ha and generally occurs below elevations of 1,475 m a.s.l. The large portion of the LSA in the Wooded Taiga is due to the road being proposed at lower elevations, while Alpine units occur around the proposed mine site. Water represents less than 1% or approximately 5.2 ha of the LSA, mainly in the form of small ponds. For 1.0% of the LSA, "No Data" was recorded. This includes areas that could not be mapped due to cloud cover and shadows in the imagery.

TABLE 4.1.8-1 SUMMARY BIOCLIMATE ZONES WITHIN THE MACTUNG LSA

Landscape Units	Area (Ha)	Percent Cover
Alpine	3,944.6	27.7
Shrub Taiga	1,801.3	12.6
Wooded Taiga	8,356.1	58.6
Water	5.2	0.0
No Data	149.5	1.0
Total	**14,252.9**	**100.0**

Ecosystem units are the most detailed level of classification according to Francis and Steffen (2003) and incorporate parameters such as vegetation composition, soil moisture and soil nutrients. Fifteen distinct ecosystem units and 21 complex ecosystem polygon associations were mapped based on sampling performed by EBA in 2006, 2007, and 2008 (Table 4.1.8-2; Table 4.1.8-3, Figure 4.1.8-2). Complex polygons were assumed to comprise an equal area of each ecosystem unit included. One new ecosystem unit, Spruce-Moss, was observed in 2007 at lower elevations (below 1,200 m a.s.l.) in the Hess River basin. The ecosystem units with the greatest percent cover within the LSA are the Alpine unit Epilithic Lichen (18.75%); the Wooded Taiga units Fir-Moss: Spruce-Moss (12.24%) and Fir-Moss-Willow Slope (9.91%); the Wooded Taiga riparian unit Willow-Sedge (5.49%); and the ecosystem unit Birch-Lichen which occurs on well-drained terraces and slopes in the Wooded and Shrub Taiga. Wetland and riparian areas totalled approximately 7.35% of the LSA.

TABLE 4.1.8-2 DESCRIPTION OF VEGETATION UNITS WITHIN THE MACTUNG LOCAL STUDY AREA

Ecosystem Unit	Unit Code	Description
Alpine		
Epilithic Lichen	EL	These areas are mainly exposed bare rock, talus or boulderfields covered with crustose lichen communities that occur above 1,650 m a.s.l. At lower elevations, dwarf shrub species and graminoid species may be observed sporadically.
Fescue-Sedge	FC	These areas are dry alpine meadows observed in the alpine between 1,870 m a.s.l. and 1,515 m a.s.l. in Yukon. The vegetation unit is dominated by *Festuca altaica* and *Cladina* species, although, *Carex* and *Poa* species may occur in high abundance on moister soils. These sites are generally on exposed, well drained soils, convex micro-topography and/or warm aspects.
Fescue –Willow	FS	These areas are moist alpine meadows observed in the alpine between 1,780 and 1,590 m a.s.l. in Yukon. The vegetation unit is dominated by fescue (*Festuca altaica*) and moss species, although, sedge (*Carex*), hairgrass (*Deschampsia*), and rush (*Luzula*) species may occur in high abundance. These sites are characterized by the occurrence of dwarf shrub species such as *Salix arctica, Salix reticulata, and Salix barrattianna.* Fescue-Salix vegetation units are generally less exposed than Fescue-Sedge and occur on well drained soils, concave micro-topography and cool aspects.
Heath-Lichen	CC	These areas are dwarf shrub communities observed in the alpine of the Yukon. The vegetation unit is dominated by dwarf shrub species mountain heather (*Cassiope tetragona, Phyllodoce* species), crowberry (*Empetrum nigrum*), Lingonberry (*Vaccinium vitis idea*), and lichen species. Few plants grow taller than 20 cm high. These sites are generally on exposed and well drained soils.
Shrub Taiga		
Birch-Lichen	BC	These areas were observed in the Shrub Taiga of the Yukon between

TABLE 4.1.8-2 DESCRIPTION OF VEGETATION UNITS WITHIN THE MACTUNG LOCAL STUDY AREA		
Ecosystem Unit	Unit Code	Description
		1,530 m a.s.l. and 1,350 m a.s.l. and in the Wooded Taiga mainly on upland terraces in the Yukon between 1,406 and 1,175 m a.s.l. The vegetation unit is dominated by scrub birch (Betula nana) and lichen species (*Cladina, Cetraria, and Cladonia*). On upland terraces in the Yukon *Ledum decumbens* occurred with high abundance. These sites are generally on exposed well drained soils, convex micro-topography and/or warm aspects.
Birch-Moss	BM	These areas were observed in the Shrub Taiga of the Yukon between 1,420 m a.s.l. and 1,385 m a.s.l. The vegetation unit is dominated by scrub birch (*Betula nana*) and a moss understory (*Hylocomnium splendens* and *Polytrichum commune*). Birch-Moss is generally favoured on sheltered, moist, well drained soils, concave micro-topography and/or cool aspects.
Sedge–Bluebell	CM	These areas were observed in the lower Alpine and Shrub Taiga of the Yukon between 1,620 m a.s.l. and 1,370 m a.s.l. The vegetation unit is dominated by *Carex podocarpa* and a diverse mix of forbs including *Mertensia paniculata, Senecio triangularis, Artemesia arctica, and Polemonium acutiflorum*. These sites are generally gentle sloping, with moderately drained submesic to mesic soils, in sheltered valleys. This unit is similar to Willow-Mertensia and may occur at higher elevations with submesic soils. These units are may indicate seepage areas.
Willow –Bluebell	SM	The Willow-Bluebell unit occurs adjacent to streams and seepage areas. These areas were observed in the lower Alpine and Shrub Taiga of the Yukon between 1,525 m a.s.l. and 1,455 m a.s.l. and in the Wooded Taiga at 1,400 m a.s.l.. The dense canopy is dominated by medium to tall willow species *Salix planifolia, Salix glauca, Salix alaxensis, and Salix barrattianna*. The understory is a diverse mix of forbs including *Mertensia paniculata, Senecio triangularis, Artemesia arctica, and Polemonium acutiflorum*. These sites are generally gentle sloping, moderately drained, with moist to wet soils, in sheltered valleys.
Willow (med/tall)-Slope	WS	These areas were observed on steep slopes such as avalanche chutes in the Wooded Taiga of the Yukon between 1,450 m a.s.l. and 1,250 m a.s.l. The dense canopy is dominated by medium to tall willow species *Salix planifolia, Salix alaxensis, and Salix glauca*. An overstory of alpine fir was observed along the Road at lower elevations. The herbaceous (c) layer is characterized by sedge species (*Carex aquatilis and C. podocarpa*), *Salix reticulata*, and/ or a mix of forbs. These sites are steep slopes, with well drained, with submesic to xeric soils.
Wooded Taiga		
Fir-Lichen	AC	These areas were observed in the Wooded Taiga of the Yukon between 1,445 m a.s.l. and 1,200 m a.s.l. The vegetation unit is dominated by alpine fir (*Abies lasiocarpa*) and lichen species. The canopy is usually open and may a have Scrub birch B2 layer. These sites are generally on exposed, well drained soils, convex micro-topography and/or warm aspects.

TABLE 4.1.8-2 DESCRIPTION OF VEGETATION UNITS WITHIN THE MACTUNG LOCAL STUDY AREA

Ecosystem Unit	Unit Code	Description
Fir-Moss	AM	These areas were observed in the Wooded Taiga of the Yukon between 1,450 m a.s.l. and 1,200 m a.s.l. The vegetation unit is dominated by alpine fir (*Abies lasiocarpa*) and a moss understory (*Hylocomnium splendens and Polytrichum commune*). Percent canopy cover is higher than in the Fir-Lichen vegetation unit. Fir-Moss is generally favoured on sheltered, moist, well drained soils, concave micro-topography and/or cool aspects. This community also occurs adjacent to seeps streams.
Spruce-Moss	PM	These areas were observed in the Wooded Taiga of the Yukon below 1,400 m a.s.l. The vegetation unit is dominated by white spruce (*Picea glauca*) and a moss understory (*Hylocomnium splendens and Polytrichum commune*). White spruce is usually a co-dominant species with subalpine fir along the Road. Black spruce (*Picea mariana*) may also occur in valley bottoms and intermixed with white spruce on lower slopes. Spruce-moss is replaced by fir-moss/ fir-lichen at elevations above approximately 1400 m a.s.l.
Wetland and Riparian		
Sedge –Sphagnum	CS	This area was observed in low-lying depressions along the access road and generally occurs as a continuous "fen" wetland system. The vegetation unit is dominated by *Carex aquatilis* with a minor component of *Carex podocarpa* and *Potentilla palustris*. These sites are generally depressional to flat areas with poorly drained, subhygric soils in valleys bottoms. The groundcover was dominated by *Sphagnum* species such *Sphagnum fuscum* and moss species including glow moss (*Aulacomnium palustre*) and golden fuzzy moss (*Tomenthypnum nitens*)
Willow – Sedge	SC	The Willow-Sedge unit occurs adjacent to streams and rivers in floodplains. These areas were observed in the Shrub Taiga between 1,500 m a.s.l. and 1,450 m a.s.l. and the Wooded Taiga between 1,300 and 1,150 m a.s.l. The dense canopy is dominated by medium to tall willow *species Salix alaxensis, Salix planifolia, and Salix glauca*. The understory is characterized by sedge species (*Carex aquatilis and C. podocarpa*), *Equisetum* species, and moss species. These sites are generally flat, moderately to well drained, with submesic to mesic soils.
Wetland	WD	In the southeast LSA along the North Canol Road graminoid and shrubby fens were observed in the Wooded Taiga along the Macmillan River at elevations of 1,300 m a.s.l.. These fens were observed to be dominated by willow and *Sphagnum* species. Other wetland areas include low-lying depressions along the Hess River where poor drained soils support shrubby fens and intermixed with black spruce
Other		
Pond	PD	Small body of water greater than 2 m deep and less than 50 ha in area.
No Data	ND	No data includes areas which were unmappable due to cloud cover and shadow effects.

TABLE 4.1.8-3 SUMMARY OF ECOSYSTEM UNITS WITHIN THE MACTUNG LSA			
Map Unit	Ecosystem Unit	Area (Ha)	Percent Cover
Alpine			
EL	Epilithic Lichen	2643.95	18.75
CC	Heath-Lichen	940.13	6.67
FC	Fescue-Sedge	189.48	1.34
FS	Fescue-Willow	123.89	0.88
CC:FC	Heath-Lichen: Fescue-Sedge	210.73	1.49
Shrub Taiga			
BC	Birch-Lichen	664.34	4.71
BM	Birch-Moss	89.98	0.64
CM	Sedge-Bluebell	26.79	0.19
WS	Willow-Slope	341.66	2.42
BC:CC	Birch-Lichen: Heath-Lichen	318.52	2.26
WS:FC	Willow-Slope: Fescue-Sedge	295.84	2.10
WS:FS	Willow-Slope: Fescue-Willow	118.49	0.84
BC:FC	Birch-Lichen: Fescue-Sedge	38.58	0.27
BC:BM	Birch-Lichen: Birch-Moss	14.22	0.10
Wooded Taiga			
PM	Spruce Moss	703.78	4.99
AC	Fir-Lichen	556.46	3.95
AM	Fir-Moss	145.59	1.03
AM:PM	Fir-Moss: Spruce-Moss	1726.48	12.24
AM:WS	Fir-Moss: Willow Slope	1396.85	9.91
AC:BC	Fir-Lichen: Birch-Lichen	804.21	5.70
AM:BM	Fir-Moss: Birch-Moss	656.64	4.66
AC:AM	Fir-Lichen: Fir-Moss	292.19	2.07
PM:BC	Spruce Moss: Birch-Lichen	253.78	1.80
PM:SC	Spruce Moss: Willow-Sedge	154.29	1.09
AM:BC	Fir-Moss: Birch-Lichen	128.73	0.91
PM:BM	Spruce Moss: Birch-Moss	74.04	0.53
Wetland and Riparian Areas			
SC	Willow-Sedge	774.46	5.49
CS	Sedge-Sphagnum	81.49	0.58
SM	Willow-Bluebell	67.91	0.48

TABLE 4.1.8-3 SUMMARY OF ECOSYSTEM UNITS WITHIN THE MACTUNG LSA			
Map Unit	**Ecosystem Unit**	**Area (Ha)**	**Percent Cover**
SC:BC	Willow-Sedge: Birch-Lichen	64.02	0.45
FS:CS	Fescue-Willow: Sedge-Sphagnum	14.30	0.10
SC:FC	Willow-Sedge: Fescue Sedge	12.38	0.09
SC:CS	Willow-Sedge: Carex-Sphagnum	9.86	0.07
BC:CS	Birch-Lichen: Sedge-Sphagnum	5.95	0.04
SC:WD	Willow-Sedge: Marsh/Fen	3.58	0.03
WD	Marsh/Fen	1.85	0.01
Other			
ND	No Data	149.51	1.06
OW	Open Water	4.15	0.03
GB	Gravel Bar	1.35	0.01
PD	Pond	1.07	0.01

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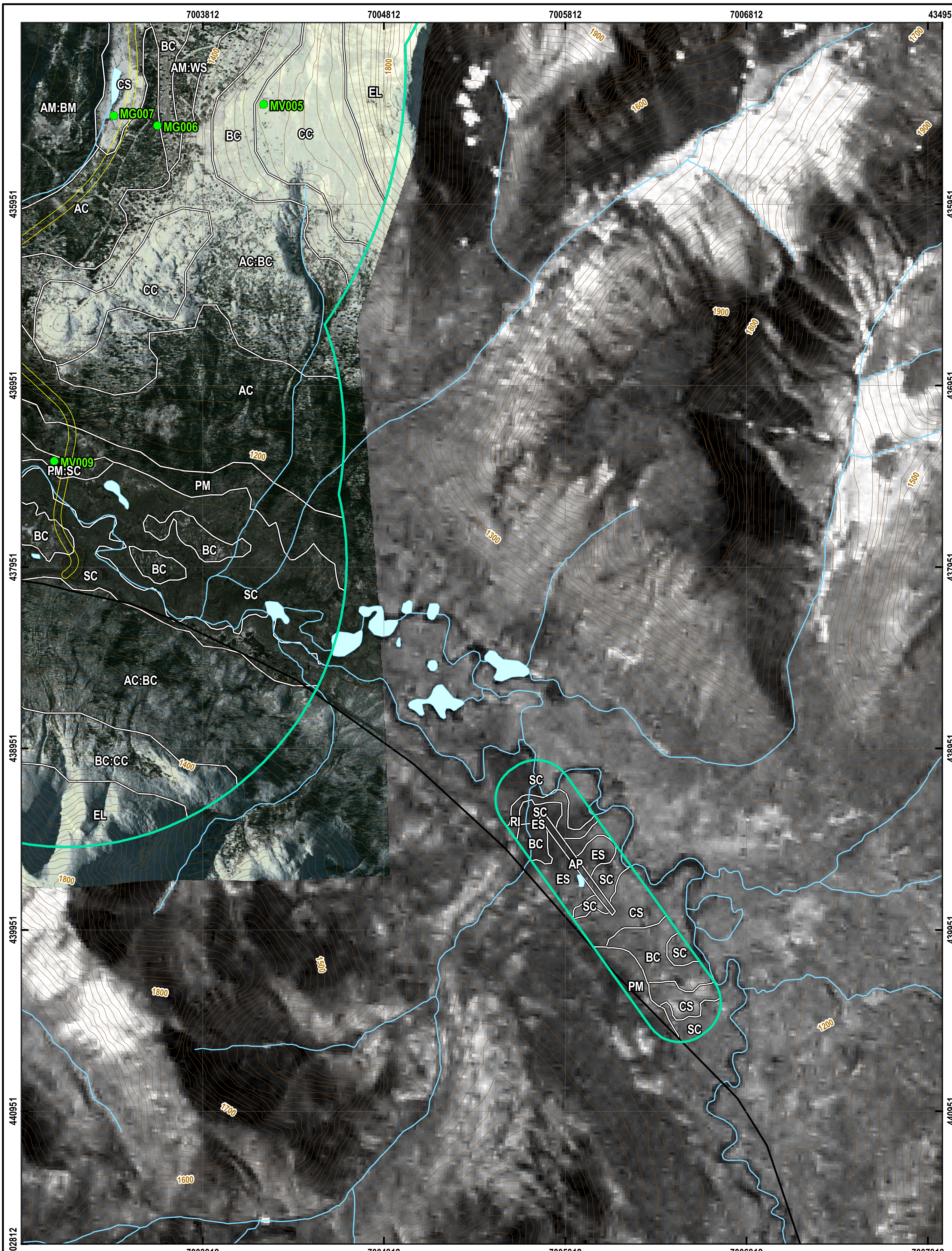
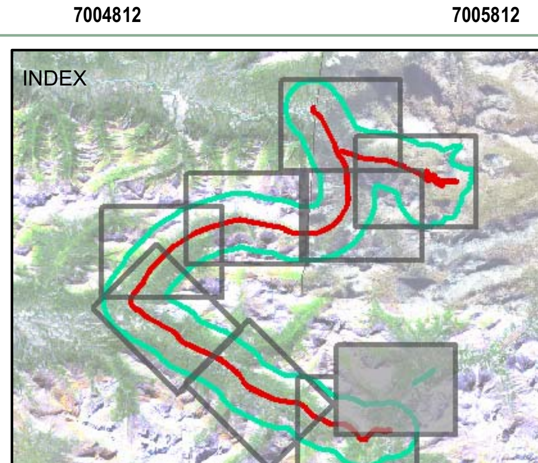


LEGEND

- Vegetation Plot
- Ecological Land Classification
- Mine Footprint
- Proposed Pumphouse Service Road
- Proposed Access Road Footprint
- Vegetation Local Study Area
- NWT-Yukon Territory Border
- Contours
- Watercourse
- Waterbody

NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE



MACTUNG

Ecosystem Land Classification

PROJECTION: UTM Zone 9	DATUM: NAD83

Scale: 1:20,000
400 200 0 400
Meters

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd. eba

FILE NO.: W23101110_001_Veg_Map002.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0

OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 4.1.8-2a

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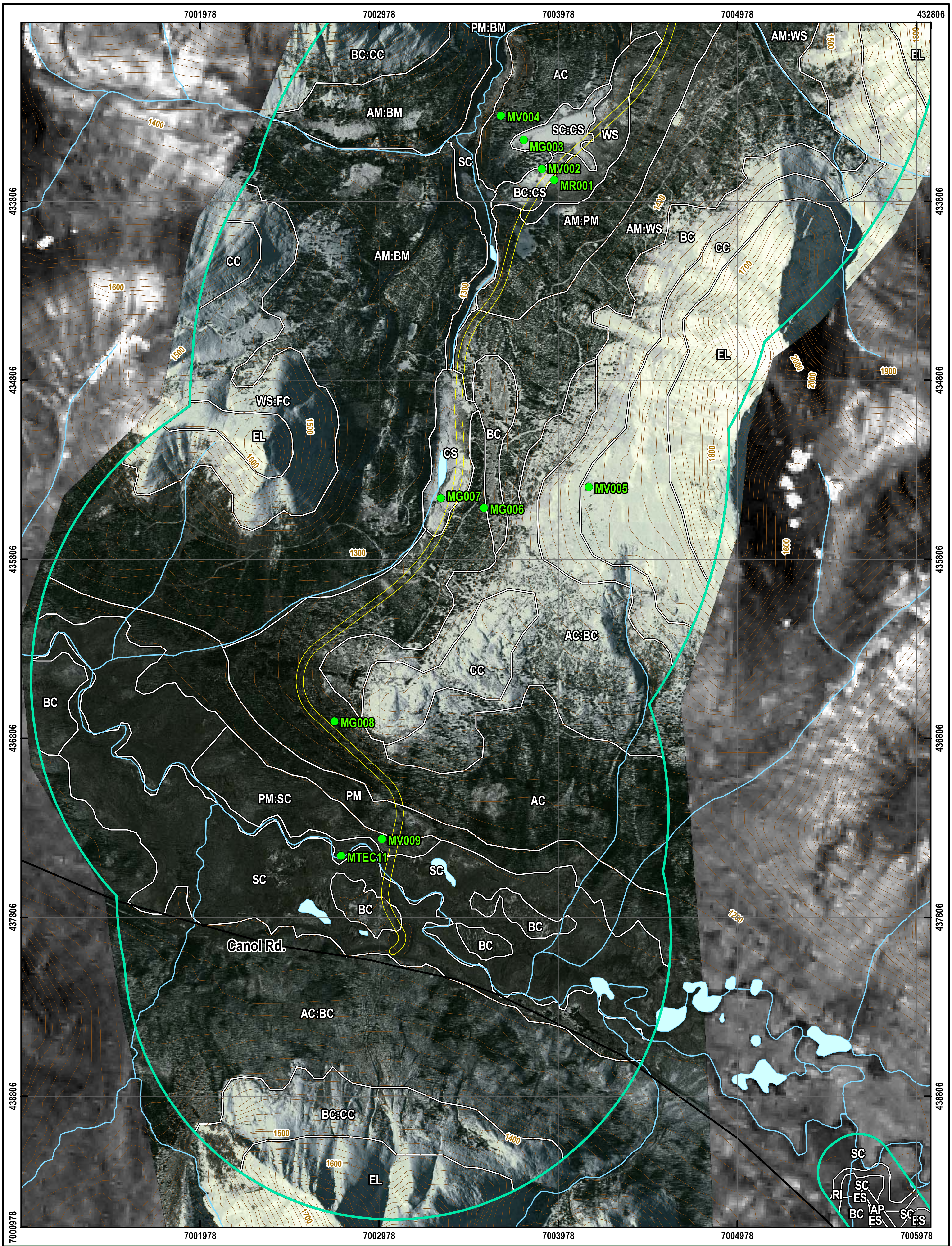

LEGEND

- Vegetation Plot
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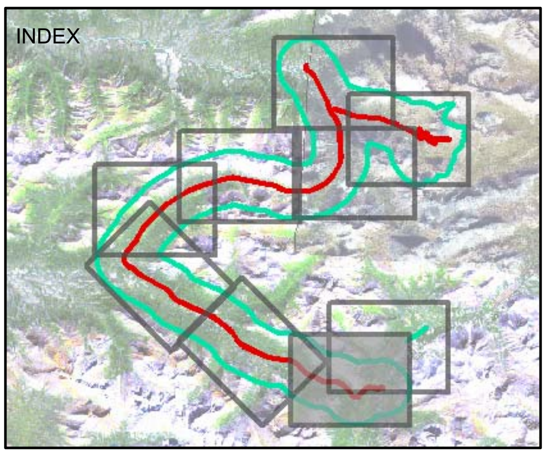

NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

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MACTUNG

Ecosystem Land Classification

PROJECTION: UTM Zone 9	DATUM: NAD83

Scale: 1:20,000
400 200 0 400
Meters

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PROJECT NO.: W23101110.001	DWN: MEZ	CKD: JS	REV: 0
OFFICE: EBA-VANC	DATE: December 4, 2008		

Figure 4.1.8-2b

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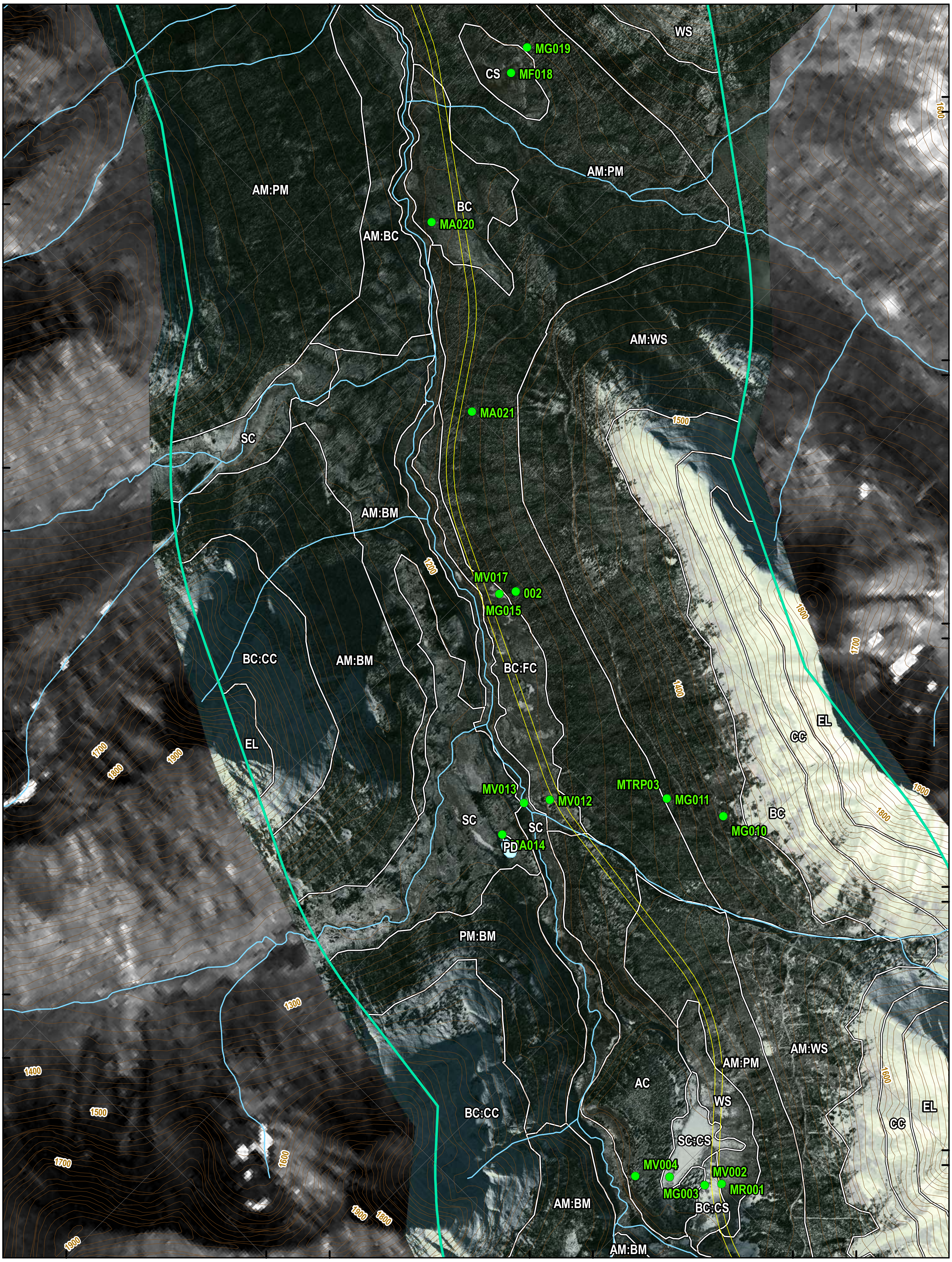
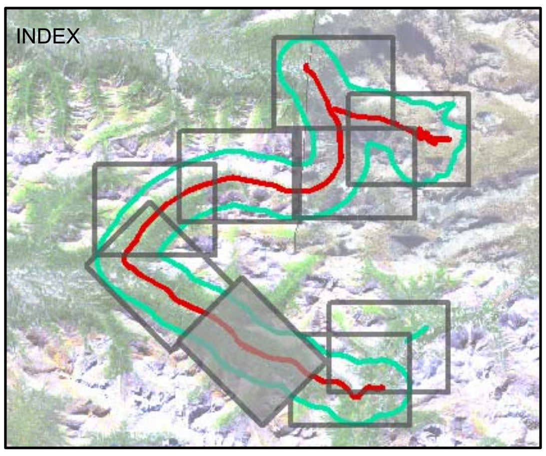


LEGEND

- Vegetation Plot
- Ecological Land Classification
- Mine Footprint
- Proposed Pumphouse Service Road
- Proposed Access Road Footprint
- Vegetation Local Study Area
- NWT-Yukon Territory Border
- Contours
- Watercourse
- Waterbody



NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

MACTUNG

Ecosystem Land Classification

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:20,000
400 200 0 400
Meters

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OFFICE	DATE		
EBA-VANC	December 4, 2008		

Figure 4.1.8-2c

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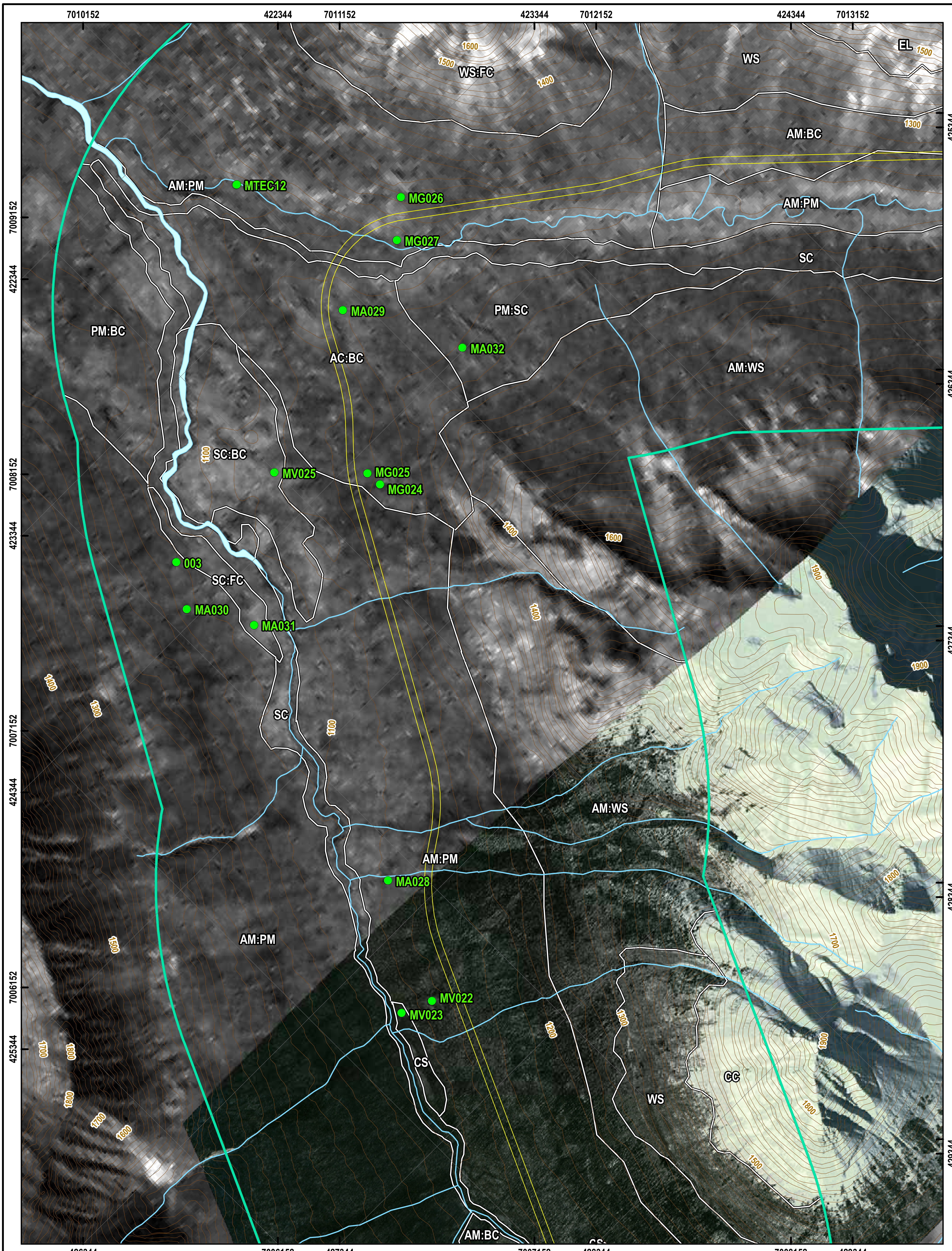
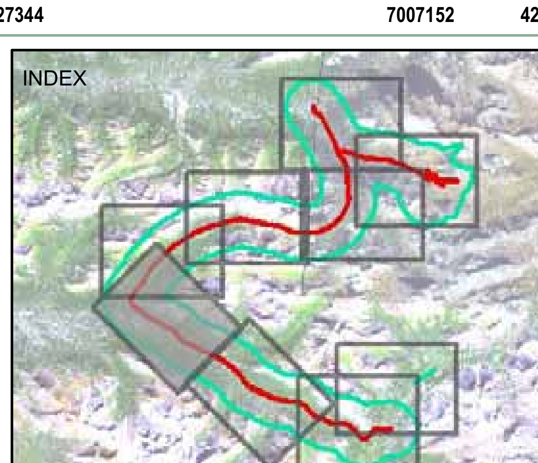


LEGEND

- Vegetation Plot
- Ecological Land Classification
- Mine Footprint
- Proposed Pumphouse Service Road
- Proposed Access Road Footprint
- Vegetation Local Study Area
- NWT-Yukon Territory Border
- Contours
- Watercourse
- Waterbody



NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

MACTUNG

Ecosystem Land Classification

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:20,000
400 200 0 400
Meters

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FILE NO.
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PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0

OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 4.1.8-2d

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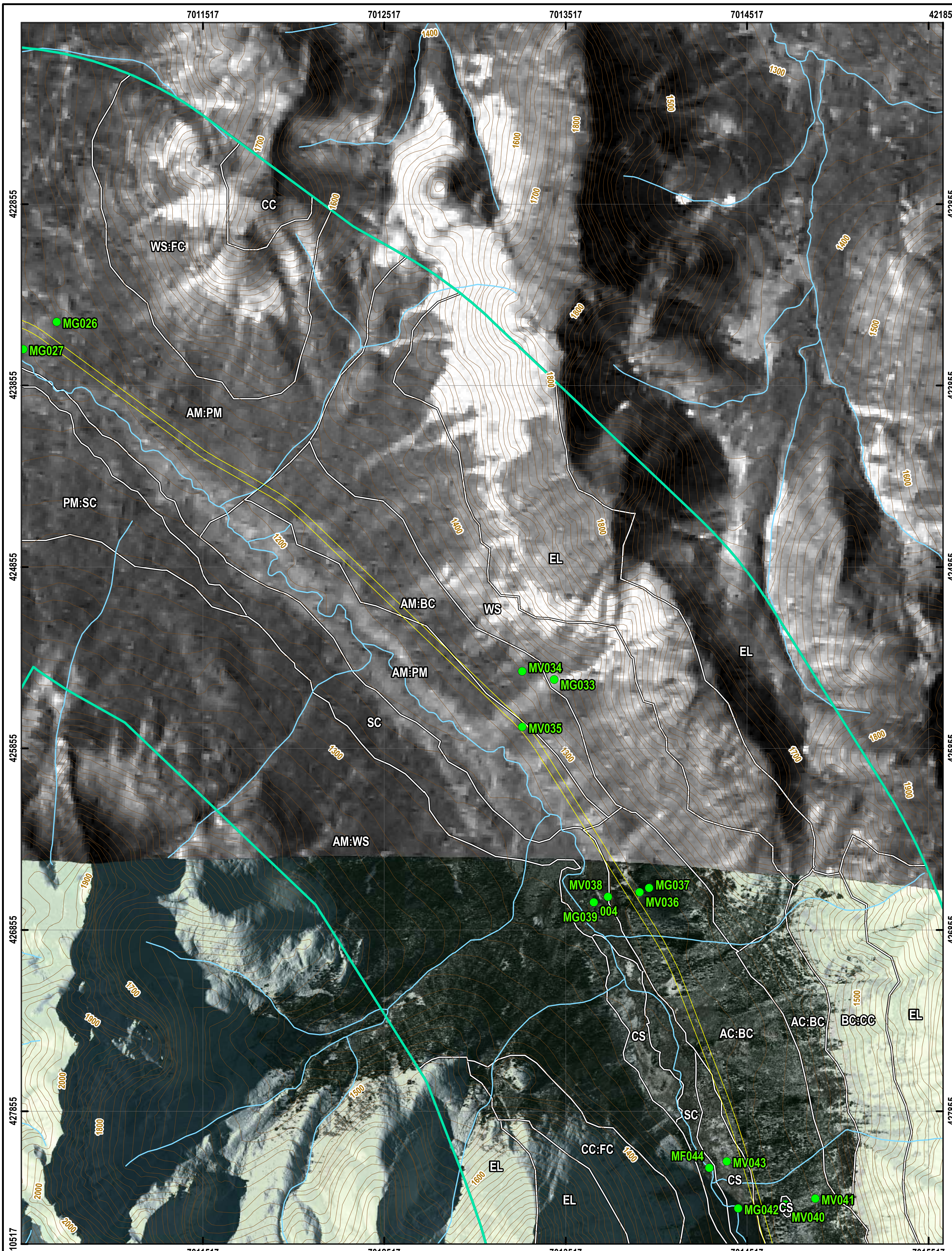
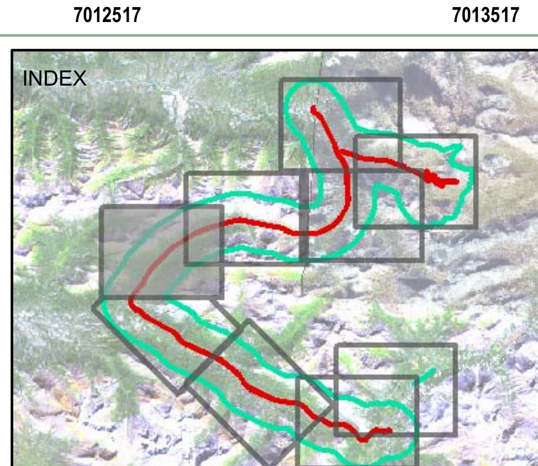


LEGEND

- Vegetation Plot
- Ecological Land Classification
- Mine Footprint
- Proposed Pumphouse Service Road
- Proposed Access Road Footprint
- Vegetation Local Study Area
- NWT-Yukon Territory Border
- Contours
- Watercourse
- Waterbody



NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

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MACTUNG

Ecosystem Land Classification

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:20,000
400 200 0 400
Meters

FILE NO.
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PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0

OFFICE	DATE
EBA-VANC	December 4, 2008

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Figure 4.1.8-2e

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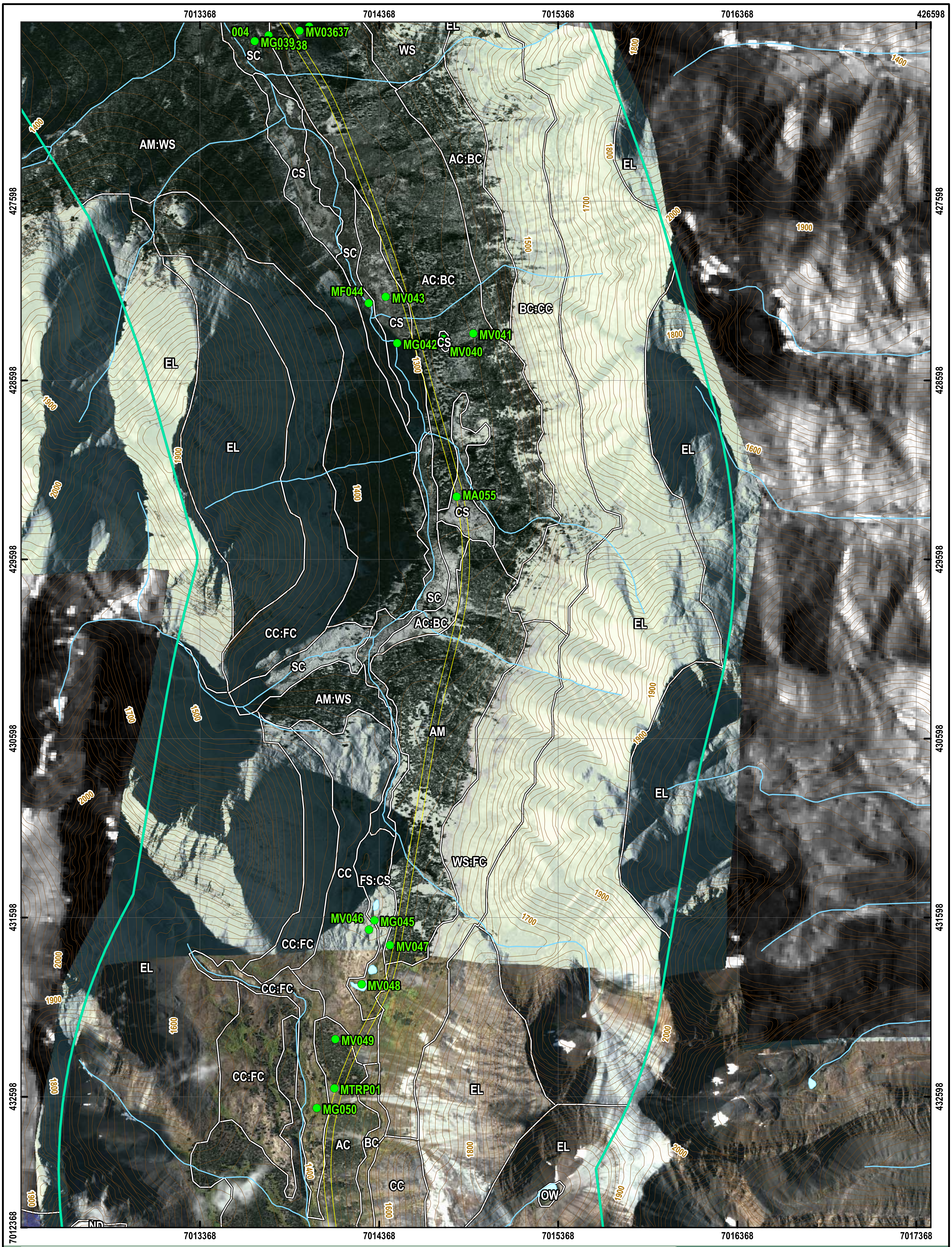
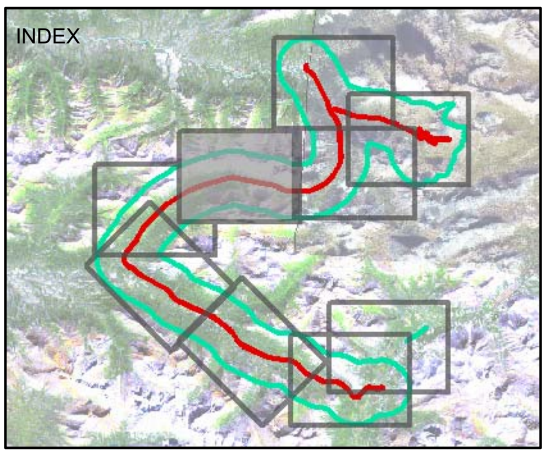


LEGEND

- Vegetation Plot
- Ecological Land Classification
- Mine Footprint
- Proposed Pumphouse Service Road
- Proposed Access Road Footprint
- Vegetation Local Study Area
- NWT-Yukon Territory Border
- Contours
- Watercourse
- Waterbody



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E

NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

MACTUNG

Ecosystem Land Classification

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:20,000
400 200 0 400
Meters

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

FILE NO.
W23101110_001_Veg_Map002.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0

OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 4.1.8-2f

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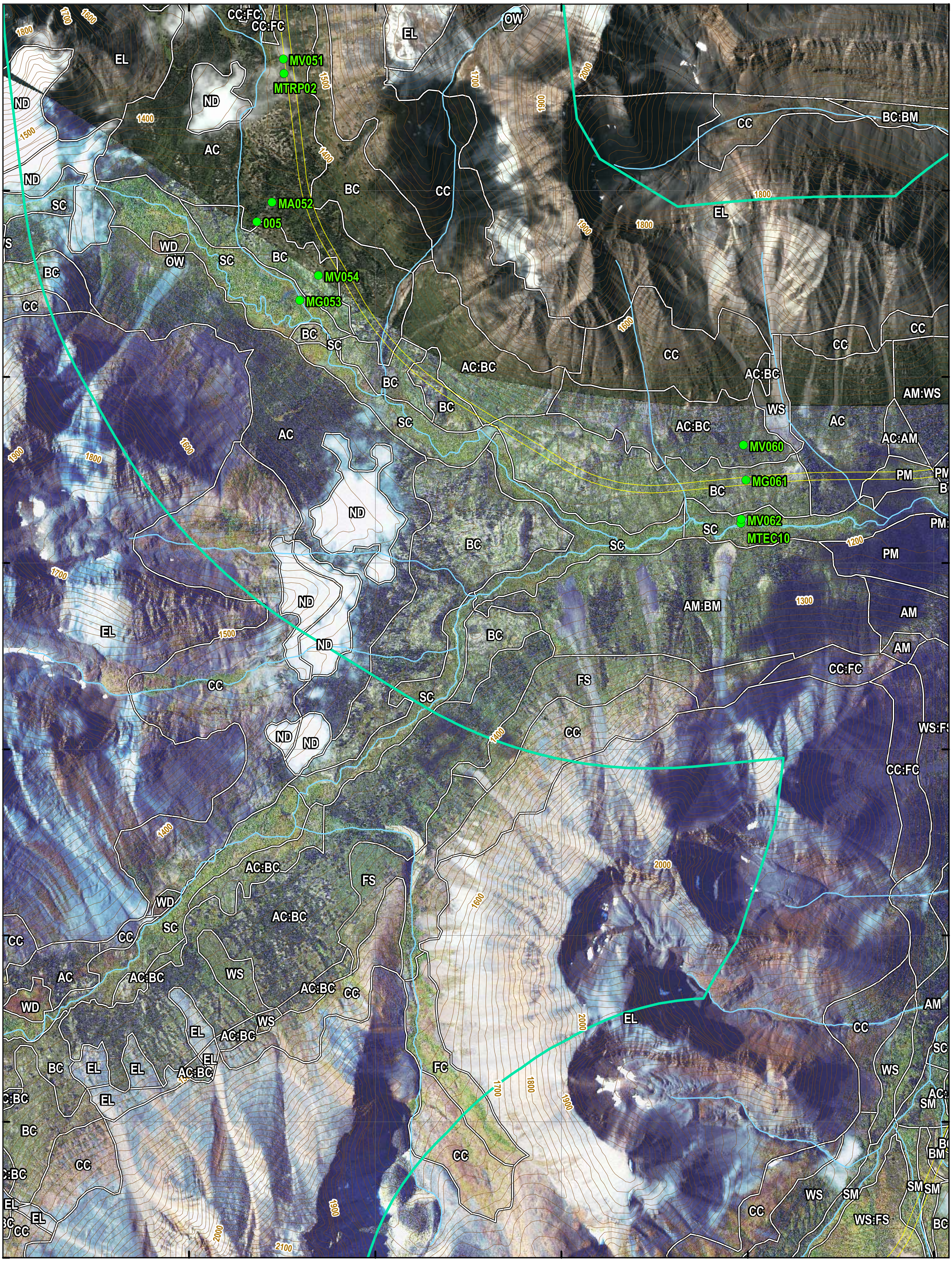
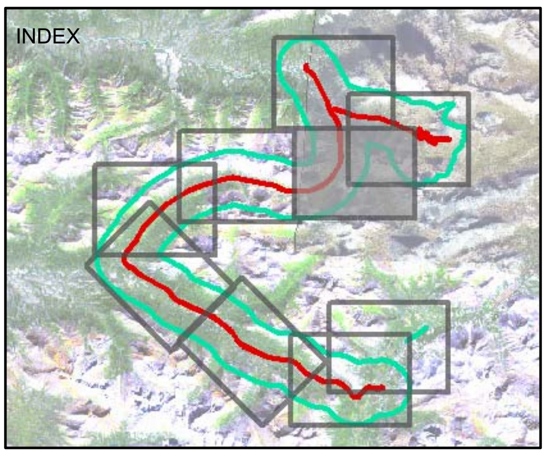


LEGEND

- Vegetation Plot
- Ecological Land Classification
- Mine Footprint
- Proposed Pumphouse Service Road
- Proposed Access Road Footprint
- Vegetation Local Study Area
- NWT-Yukon Territory Border
- Contours
- Watercourse
- Waterbody



NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

MACTUNG

Ecosystem Land Classification

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:20,000
400 200 0 400
Meters

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

FILE NO.			
W23101110_001_Veg_Map002.mxd			
PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0
OFFICE	DATE		
EBA-VANC	December 4, 2008		

Figure 4.1.8-2g

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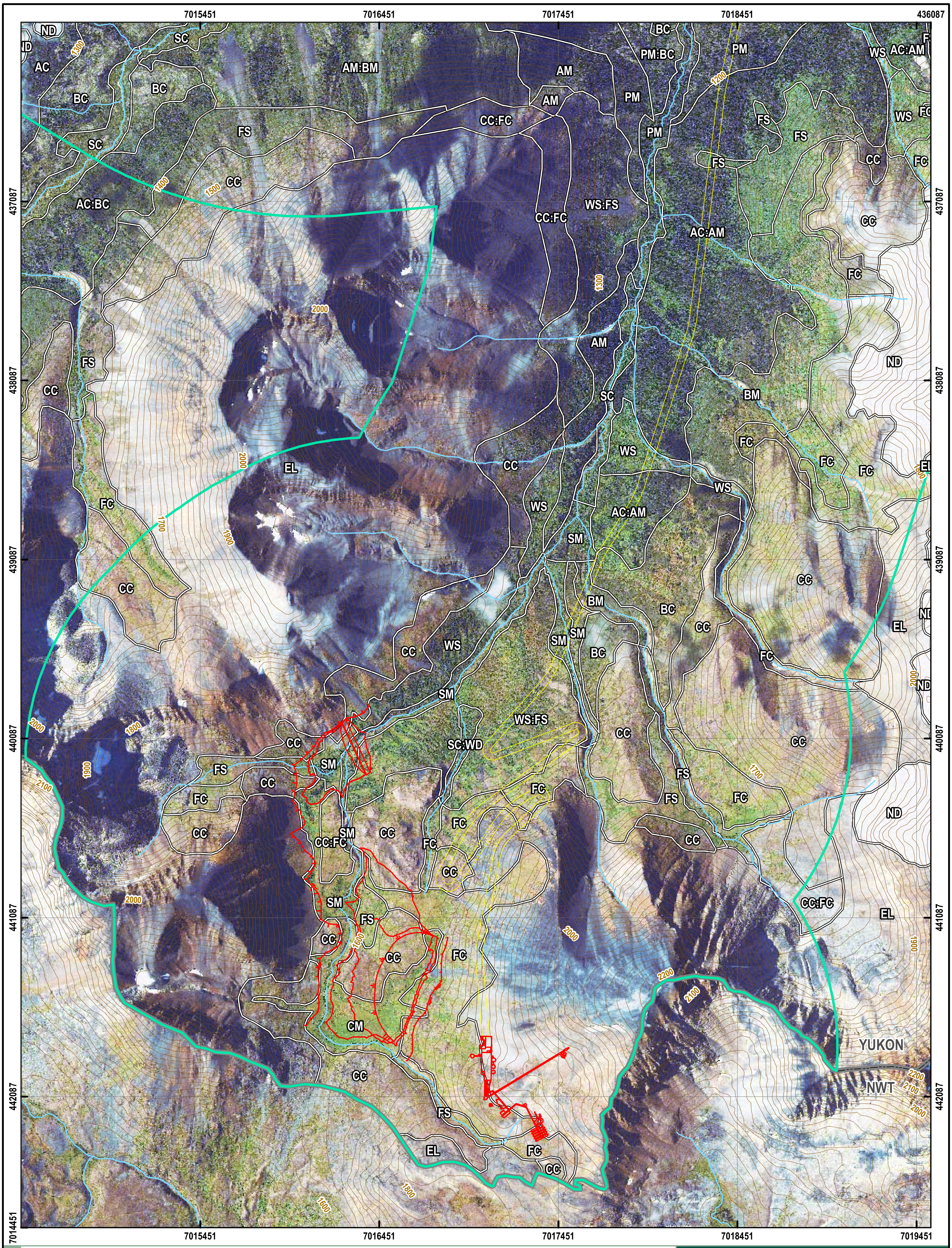
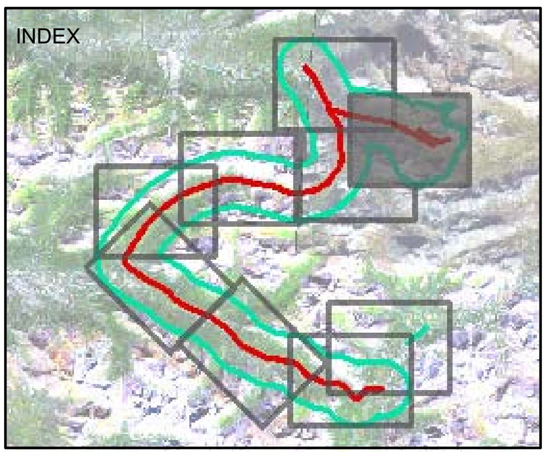


LEGEND

- Vegetation Plot
- Ecological Land Classification
- Mine Footprint
- Proposed Pumphouse Service Road
- Proposed Access Road Footprint
- Vegetation Local Study Area
- NWT-Yukon Territory Border
- Contours
- Watercourse
- Waterbody



NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

MACTUNG

Ecosystem Land Classification

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:20,000
400 200 0 400
Meters

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FILE NO.			
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PROJECT NO.	DWN	CKD	REV
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OFFICE	DATE		
EBA-VANC	December 4, 2008		

Figure 4.1.8-2h

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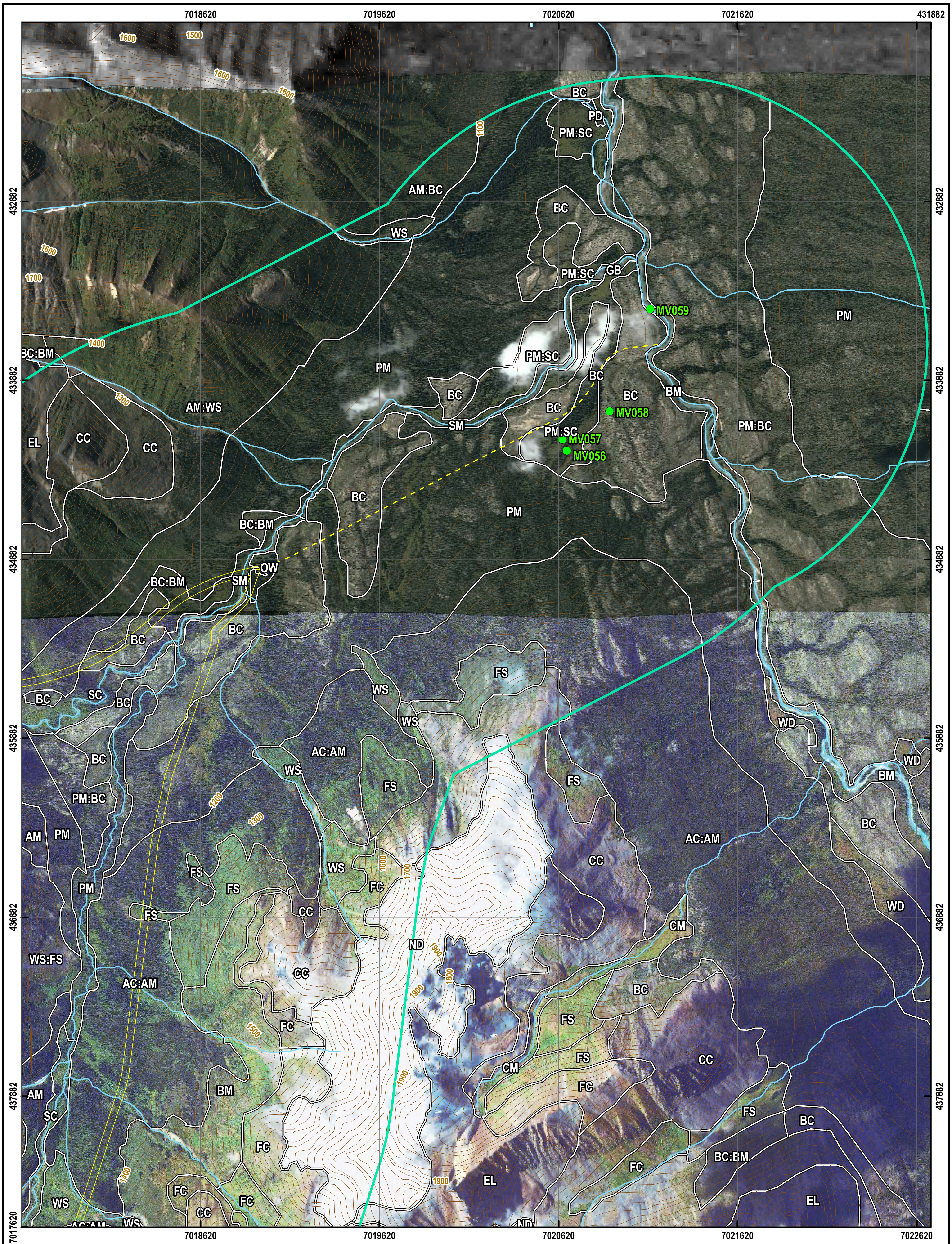
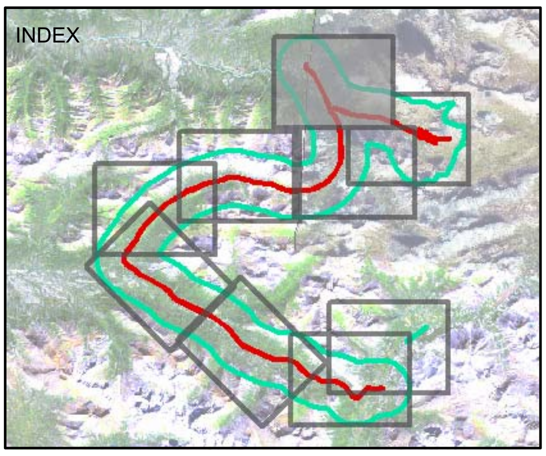


LEGEND

- Vegetation Plot
- Ecological Land Classification
- Mine Footprint
- Proposed Pumphouse Service Road
- Proposed Access Road Footprint
- Vegetation Local Study Area
- NWT-Yukon Territory Border
- Contours
- Watercourse
- Waterbody



NOTES
Base data source: 1:50,000 NTS, Landsat 7, QuickBird, Yukon Geomatics
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

MACTUNG

Ecosystem Land Classification

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:20,000
400 200 0 400
Meters

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

FILE NO.			
W23101110_001_Veg_Map002.mxd			
PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0
OFFICE	DATE		
EBA-VANC	December 4, 2008		

Figure 4.1.8-2i

Height was used to define and quantify the structural stages of vegetation in the Mactung LSA (Table 4.1.8-4). Vegetation greater than five metres in height was categorized as forest, less than five metres to one-half of a metre in height as shrub, and less than one-half metre in height as herbaceous. Five metres in height was used in place of 10 metres as the defining height due to the extreme cold and poor growing conditions found on-site.

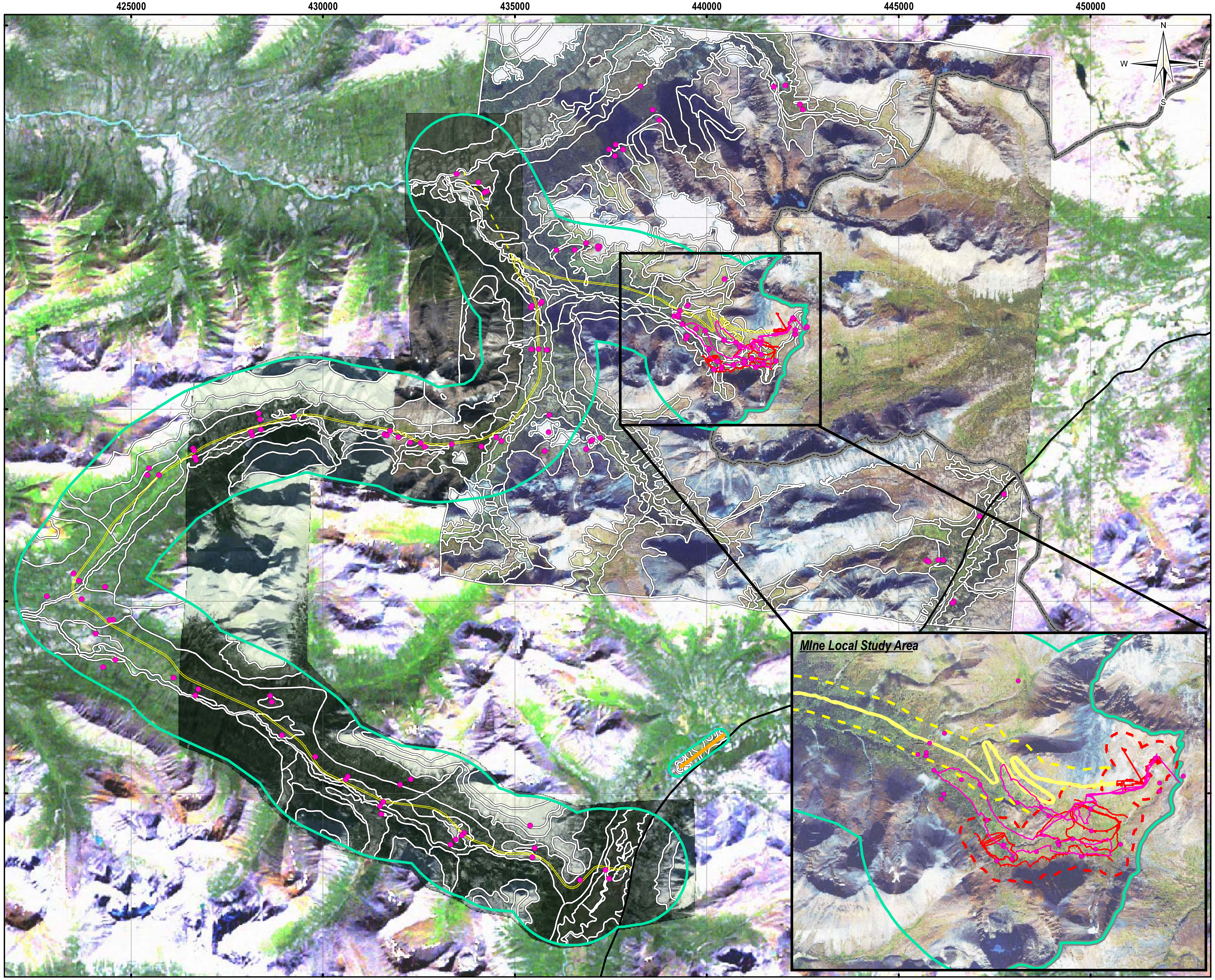
The LSA was fairly evenly distributed between major stand stages of forest, shrub, herb and sparse/ bryoid. Forested areas accounted for 32.64% of the LSA with most being mature stands occurring along the road. Shrub stands accounted for 31.95% of the LSA, with almost all being low shrub in riparian areas, well-drained terraces, and slopes above the treeline. Sparse/ Bryoid areas accounted for 18.54% of the LSA mainly consisting of Epilithic Lichen ecosystem units with less than 10% cover in the high alpine. Herbaceous areas accounted for 15.79% of the LSA with Heath-Lichen ecosystems being the most common.

TABLE 4.1.8-4 SUMMARY OF VEGETATION STRUCTURAL STAGES WITHIN THE MACTUNG LSA

Code	Structural Stage	Area Ha	Percent Cover
1	Sparse/Bryoid	1.4	0.01
1a	Sparse (<10% cover)	2384.8	16.73
1b	Bryoid (>50% cover)	256.2	1.80
2a	Forb	94.7	0.66
2b	Graminoid	754.9	5.30
2d	Dwarf Shrub	1401.2	9.83
3a	Low Shrub (< 2m)	4165.6	29.23
3b	Tall Shrub (2-5m)	387.6	2.72
5	Young Forest (40-80 years)	570.1	4.00
6	Mature Forest (80-250 years)	4081.7	28.64
Not Applicable	Water	5.2	0.04
Not Applicable	No Data	149.5	1.05

Ecosystem Land Classification for the Aerodrome Expansion

The total study area for the aerodrome expansion was 74 ha. Seven distinct ecosystem units were mapped including exposed soil and the aerodrome (Figure 4.1.8-2; Table 4.1.8-2; Table 4.1.8-5). The aerodrome lies in a valley floor between the Macmillan River and the North Canol road. All ecosystem units occur within the Wooded Taiga bioclimate zone. The ecosystem units with the greatest percent cover within the Aerodrome expansion buffer were Willow-Sedge (23.36 ha), Sedge-Sphagnum (14.75 ha), Birch-Lichen (13.00 ha), and exposed soil (9.09 ha). The area is almost completely low shrub with small graminoid fens.



LEGEND

- Vegetation Plots
- Rare Plant Survey Tracks (2007)
- Ecological Land Classification
- North Canol Road
- NWT-Yukon Territory Border
- Proposed Mine Footprint
- Proposed Pumphouse Service Road Footprint
- Proposed Access Road Footprint
- Proposed Macmillan Pass Aerodrome Footprint
- Vegetation Local Study Area

ISSUED FOR USE

NOTES
Base data source: Site Plan adapted from original provided by Wardrop

MACTUNG

Rare Plant Survey Locations for Local Study Area

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:100,000
2 1 0 2
Kilometers

FILE NO.
W23101110_001_Veg_Map003.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0

OFFICE	DATE
EBA-VANC	December 4, 2008

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Figure 4.1.8-3

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4.1.8.5 Vegetation

A total of 145 plant species were observed within the Mactung LSA in 2006 and 2007. Twenty-nine of these recorded plants were identified only to genus and are assumed to be different than those identified to species. A list of plant species observed during the 2006 and 2007 field seasons are appended (Appendix F1; F2 respectively). A list of plant species expected to be on site and based on historical studies is presented in the Mactung report titled Mactung Project 2006 Environmental Baseline Studies Vegetation and Ecosystem Land Classification (Appendix F1).

4.1.8.6 Rare Plant Survey

A rare plant survey (RPS) was completed over a three year period as part of on-going environmental baseline studies by EBA for NATC at Mactung (Appendix F1; F2; and F3). A three day targeted RPS was conducted from August 13 to August 15, 2007 in the proposed disturbance footprint for the Mine (Figure 4.1.8-3). The RPS included a two person team walking in a meandering fashion through the area of interest.

A formal rare plant survey was not conducted during the 2006 and 2008 field seasons due to uncertainty of the disturbance footprint of the mine and road respectively. A rare plant reconnaissance was conducted and vegetation plots were sampled within the area of the proposed footprint during the 2006 and 2008 season. Data collected in July 2006 and 2008 were used to supplement the 2007 RPS.

Prior to conducting the rare plant survey, several sources including McJannet *et al.* (1995); Douglas *et al.* (1981), and NatureServe Yukon (February 2007) were used to compile a list of rare plants species for the Yukon and the NWT that could potentially be present in the Mactung LSA. A list of potential rare plant species with species observed is presented in Table 4.1.8-6. A total of 21 rare plants species were identified as having a potential to occur within the LSA.

TABLE 4.1.8.5 SUMMARY OF ECOSYSTEM UNITS WITHIN THE AERODROME BUFFER AND FOOTPRINT			
Map Unit	Ecosystem Unit	Area (Ha)	Percent Cover Aerodrome Buffer
Wooded Taiga			
BC	Birch-Lichen	13.00	17.56
PM	Spruce Moss	7.47	10.09
Wetland and Riparian Areas			
CS	Sedge-Sphagnum	14.75	19.93
SC	Willow-Sedge	23.36	32.61
Other			
ES	Exposed soil	9.09	12.28
RI	River	3.91	4.19
AP	Aerodrome	2.38	3.22

In 2006, two rare species (*Rubus arcticus* and *Carex albo-nigra*) were observed in the LSA in the Yukon, but not in areas that have been considered for the proposed footprint of the mine. In 2007, no rare species were observed in areas proposed for development. In 2008 one species, *Listera cordata* considered rare by Douglas *et al.* (1981), was observed in the area of the proposed access road. After further communication of the result with NatureServe Yukon (Bruce Bennett, pers. comm.), it was determined that *Listera cordata* is "…not particularly rare, just poorly reported" and is "considered secure in Yukon in the 2005 General Status report." Based on this information, *Listera cordata* is not considered rare and therefore there were no rare plants observed in the proposed footprint for the Mactung mine or road footprint. Although a survey of this type cannot confirm the absence of rare plants at the site, reasonable sampling effort was made to investigate high potential areas for rare plants and areas where construction of the mine may affect rare plants.

TABLE 4.1.8-6 LIST OF POTENTIAL RARE PLANT SPECIES FOR THE MACTUNG LSA			
Yukon			
Species	Habitat	Location[1]	Observed
Angelica lucida	sub-alpine meadow	YT	
Arnica parryi	alpine, steep ravines, ledges	YT	
Carex albo nigra	dry alpine tundra	YT	
Carex arcta	woodland bogs, marshes	YT	
Draba ogilviensis	Montane/alpine meadows	YT	
Draba porsildii	Montane/alpine meadows/scree	YT	
Eritrichium slendons	arctic-alpine scree slopes ledges	YT	
Koeleria astiatica	Shale scree/dry tundra	YT	

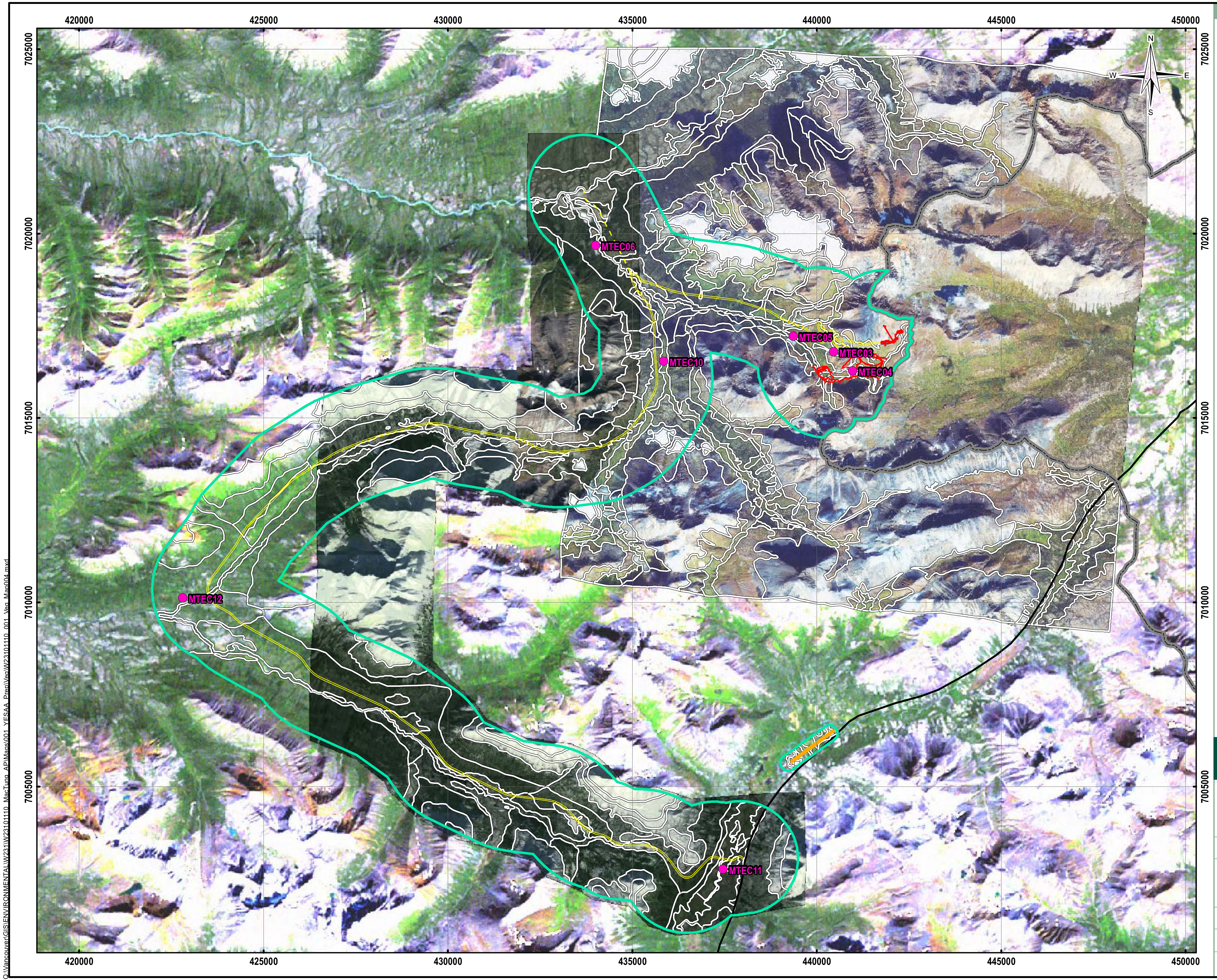
TABLE 4.1.8-6 LIST OF POTENTIAL RARE PLANT SPECIES FOR THE MACTUNG LSA			
Yukon			
Species	Habitat	Location[1]	Observed
Listera cordata	Coniferous forest	YT	✓
Phegopteris connectilis	alpine cliff ledges/rocky slopes	YT	
Phylodoce glanduliflora	alpine/sub-alpine slopes-moist	YT	
Poa porsildii	alpine/sub-alpine slopes-moist	YT	
Podisteva macounii	ridgetops/rock	YT	
Polystichum lonchitis	limestone cliffs, rocky/talus slopes	YT	
Ranunculus turneri	sub-alpine meadows	YT	
Rubus arcticus spp. acaulis	alpine and sub-alpine meadows	YT	✓
Rumex acetosa	Arctic-alpine moist meadows	YT	
Salix arctophila	wet/dry mossy tundra	YT	
Saxifraga aizoides	Moist calcareous. and gravel	YT	
Viola selkirkii	alpine tundra	YT	
Woodsia ilvensis	dry cliffs/talus slopes	YT	

A literature search and field reconnaissance for protected areas and rare, sensitive, and/or endangered plant communities was conducted for the LSA. There are no national parks, territorial parks, habitat protection or wildlife management zones in the area of the Mactung Project LSA. A list of rare plant communities does not currently exist for the Mactung LSA. In general, wetlands and arctic/alpine communities are considered sensitive communities. Wetlands and riparian areas have a higher potential for rare plants as wetlands and riparian zones are generally rarer communities in the Yukon than, for example, a spruce-moss community. Wetlands and riparian areas have a high wildlife habitat value, are sensitive to potential contamination, are sensitive to disturbance and may take longer to reclaim. Alpine plant communities also have a higher potential for rare plants, are sensitive to disturbance and may take longer to reclaim. Wetland and riparian areas in the Local Study Area should be considered sensitive plant communities.

4.1.8.7 Trace Element Concentrations in Plant Tissues

A baseline assessment of trace element concentrations (TEC) in plant tissue was undertaken within the LSA to establish baseline values for TEC in plants in and around the Project area. A total of 14 vegetation samples were collected with two samples collected at each of seven sample locations (Figure 4.1.8-4). All TEC samples were collected at ELC sample locations so that a general plant species list and soil characteristics from each site were recorded. The current year's foliage was collected from above-ground tissues from both willows (*Salix* species) and horsetails (*Equisetum* species) with a focus on newest growth. Literature on baseline concentrations or standards is currently not available in the Yukon for metal concentrations in plants. However, results were compared to the within group sample mean and to the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CCME) for parkland to give some comparison values.

Results of TEC analyses of vegetation samples collected in the Yukon were generally within one standard error of the mean and less than CCME soil standards (Appendix F2). The few exceptions to this included cadmium concentrations in horsetail at locations MTEC 10, 11, and 12; selenium concentrations in horsetail at locations MTEC 05 and 06; and zinc concentrations in all willow samples. In addition, arsenic was elevated compared to other sites, but just less than the CCME guideline for arsenic in soil.



LEGEND

- Trace Element Concentration Samples
- Ecological Land Classification
- North Canol Road
- NWT-Yukon Border
- Proposed Mine Footprint
- Proposed Pumphouse Service Road Footprint
- Proposed Access Road Footprint
- Proposed Macmillan Pass Aerodrome Expansion Footprint
- Vegetation Local Study Area

ISSUED FOR USE

NOTES

Base data source: Site Plan adapted from original provided by Wardrop

MACTUNG

Trace Element Sampling Locations for Local Study Area

PROJECTION		DATUM
UTM Zone 9		NAD83

Scale: 1:100,000

2 1 0 2

Kilometers

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FILE NO.			
W23101110_001_Veg_Map004.mxd			
PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	JS	0
OFFICE	DATE		
EBA-VANC	December 4, 2008		

Figure 4.1.8-4

4.1.9 Wildlife

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

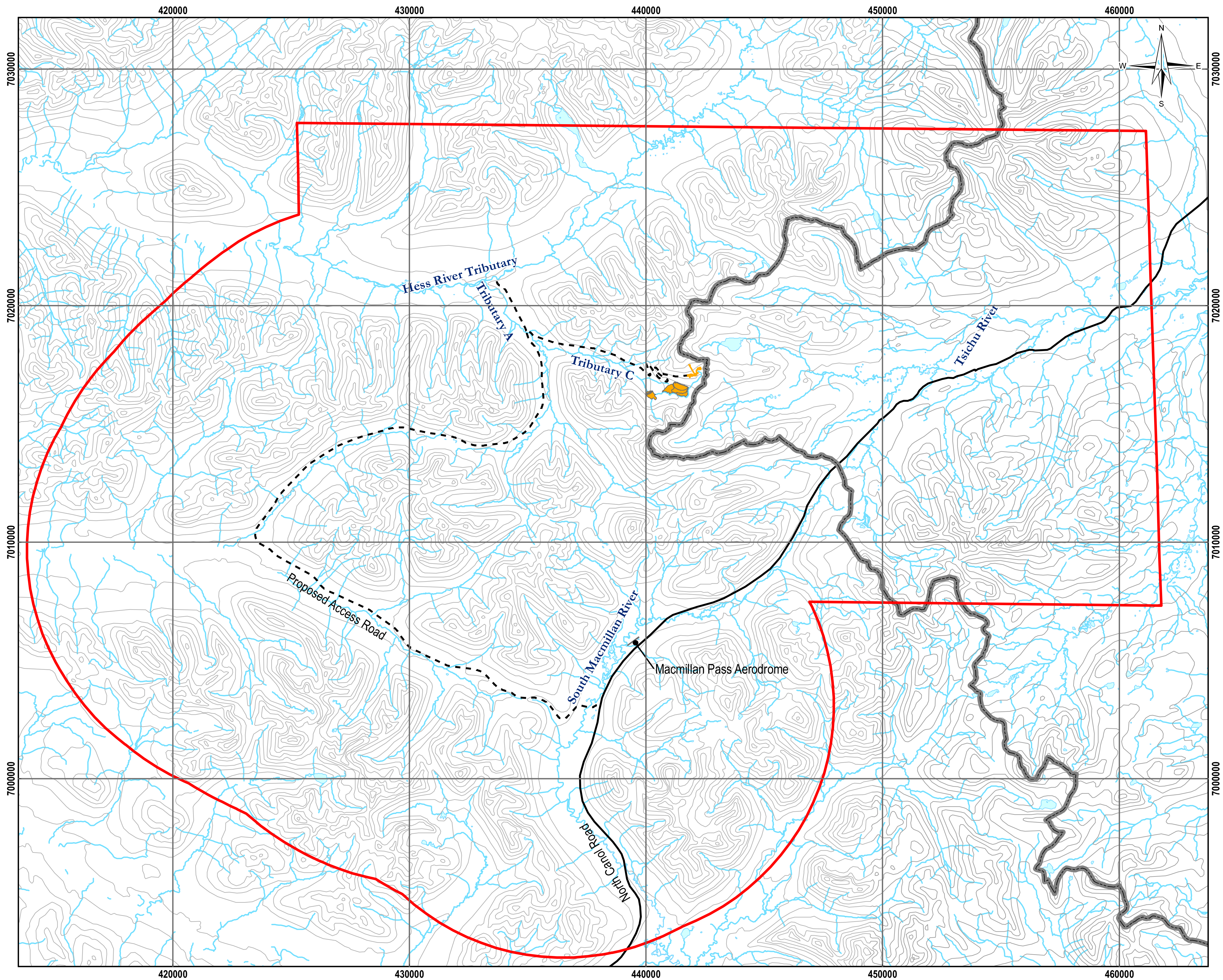
4.1.9.1 Background Information

Contemporary baseline wildlife studies have been conducted in the Mactung area from 2005 to 2008. In 2005 to 2007, wildlife baseline studies were conducted in a 720 km^2 area centred on the existing Mactung camp, referred to as the Regional Wildlife Study Area (RWSA) (Figure 4.1.9-1). In 2008, an 830 km^2 area was added to incorporate the proposed mine access road. The RWSA totals approximately 1,200 km^2. Due to poor weather conditions, particularly, low cloud cover in alpine areas, the total survey area varied slightly with each survey event. Therefore, survey areas used for density estimates and relative abundance indices varied. These differences are noted in the discussions of the survey results.

The objectives for these wildlife studies were to document and characterize wildlife at and near the potential mine site to establish baseline wildlife presence, distribution and relative abundance. Aerial and ground based surveys, as well as literature reviews, commenced in 2005 and continued into 2008. Results of the field surveys and literature reviews are provided below.

4.1.9.2 Historic and Contemporary Wildlife Studies

The study area provides appropriate habitat for a number of resident and transient wildlife species. Contemporary wildlife field surveys were completed from 2005 to 2008 to document existing baseline wildlife resources, including wildlife species and species groups occupying the study area and/or neighboring properties (Table 4.1.9-1) (Appendix G1, G2, G3). These field surveys targeted a number of wildlife species or species groups occupying the area, including ungulates, waterfowl, raptors and other breeding birds (Table 4.1.9-1).



LEGEND

- Proposed Mine Site Infrastructure
- Proposed Access Road
- Regional Wildlife Study Area
- Macmillan Pass Aerodrome
- North Canol Rd
- NWT - Yukon Territory Border
- Contour (100 m)
- Watercourse
- Waterbody

ISSUED FOR USE

NOTES

Base data source: NTDB 1:50,000/1:250,000,
Site Plan adapted from original provided by Wardrop

MACTUNG

Regional Wildlife Study Area Map

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:160,000

4 2 0 4

Kilometers

FILE NO.
W23101110_001_WL_StudyArea.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KL	1

OFFICE	DATE
EBA-VANC	December 4, 2008

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Figure 4.1.9-1

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TABLE 4.1.9-1: GENERAL SUMMARY OF EXISTING WILDLIFE CONDITIONS IN THE STUDY AREA

Wildlife Species/Groups	Field Results		Seasonal Use of Habitats within the Study Area				
	Field survey dates (2005 – 2008)	No. of Visual Observations in the Study Area (including incidentals)	Reference Figure Number	Spring (April – May)	Summer (June – August)	Fall (September – October)	Winter (November – March)
Caribou	Aerial surveys March, June, July, August, September and October	1,600	Figure 4.1.9-3	1) Tsichu, Hess Tributary and Macmillan river valleys at mid to high elevations approximately 1,300 m – 1,650 m for migration 2) Plateaus and upland sites throughout the study area for calving	1) Plateaus and upland sites throughout the study area for gravid cows or cows with a young calf 2) Moist alpine and subalpine tundra and open meadows 3) Alpine snow patches 4) On average, caribou forage in habitats at lower elevations in June and higher elevations in July and August 5) Sedge – bluebell, sedge – cinquefoil, fescue – willow, fescue – sedge and heath – lichen habitats in the alpine and subalpine favoured 6) Birch – lichen and birch – moss habitats in lower elevations and river valleys less favoured	1) Tsichu, Hess Tributary and Macmillan river valleys at mid to high elevations approximately 1,300 m – 1,650 m for migration 2) Moist alpine and subalpine tundra and open meadows 3) On average, caribou forage in habitats at lower elevations in September 4) Sedge – bluebell, sedge – cinquefoil, fescue – willow, fescue – sedge and heath – lichen habitats in the alpine and subalpine favoured 5) Birch – lichen and birch – moss habitats in lower elevations and river valleys less favoured	Not present in the study area
Moose	Aerial surveys March, June, July, August, September and October	117	Figure 4.1.9-4	1) Large river and tributary valleys, including the Hess Tributary and Macmillan rivers for calving 2) Subalpine habitats ranging from 1,300 m – 1,500 m also used for calving 3) Any site with a dense growth of tall shrubs or mature mixed forests with a moderately dense to dense shrub understory for calving	1) Similar to Spring habitats for gravid cows or cows with a young calf 2) Hess Tributary, Tsichu and Macmillan river valleys and their tributaries 3) Birch – lichen, willow – sedge, willow – bluebell, willow – slope and spruce – moss habitats 4) Aquatic habitats (rivers, streams, wetlands and beaver ponds) 5) Mineral licks, including those known along the Hess River tributary	1) Hess Tributary, Tsichu and Macmillan river valleys and their tributaries 2) Mid-elevation river valleys in open conifer (such as fir – moss and spruce – moss habitats) and birch – lichen habitats 3) Birch – lichen, willow – sedge, willow – bluebell, willow – slope and spruce – moss habitats 4) Mineral licks, including those known along the Hess River tributaries	1) Willow riparian and mixed willow/conifer habitats 2) Riparian willow habitat along the Tsichu River and related tributary valleys 3) Hess River and its primary tributaries including Tributary A (and the vicinity of the primary mineral lick)
Dall's Sheep	Aerial surveys March, June, July, August, September and October	3	Figure 4.1.9-5	1) South and south-west facing scree slopes with steep escape terrain 2) Mineral licks	1) High elevational habitats from 1,650 m to 2,100 m adjacent to steep escape terrain 2) South facing slopes 3) Mineral licks 4) Sedge – bluebell, fescue – sedge, fescue – willow and heath – lichen habitat types	1) High elevational habitats from 1,650 m to 2,100 m adjacent to steep escape terrain 2) Northwest and northeast slopes 3) Mineral licks 4) Sedge – bluebell, fescue – sedge, fescue – willow and heath – lichen habitat types	1) High elevational habitats from 1,800 to 2,100 m adjacent to steep escape terrain 2) Snow free, wind exposed plateaus and ridges, timberline and other areas with shallow snow 3) Mountain blocks orientated in an east-west direction 4) Heath – lichen habitat type
Grizzly Bear	Incidental observations during March, June, July,	34	Figure 4.1.9-6	1) Generally steep alpine slopes between 1,402 - 1,829 m most favoured for denning; however subalpine and forest dens have also	1) All habitats with available food resources, including plants, small mammals and other opportunistic prey 2) Generally, occupy alpine areas in	1) Generally occupy subalpine and alpine habitats equally for foraging 2) Fescue – willow, sedge – bluebell, willow – bluebell and heath – lichen	1) Generally steep alpine slopes between 1,402 - 1,829 m most favoured for denning; however subalpine and forest dens have also

TABLE 4.1.9-1: GENERAL SUMMARY OF EXISTING WILDLIFE CONDITIONS IN THE STUDY AREA

Wildlife Species/Groups	Field Results		Reference Figure Number	Seasonal Use of Habitats within the Study Area			
	Field survey dates (2005 – 2008)	No. of Visual Observations in the Study Area (including incidentals)		Spring (April – May)	Summer (June – August)	Fall (September – October)	Winter (November – March)
	August, September and October			been reported 2) Slopes with southeasterly aspects most favoured for denning 3) Fescue – willow and epilithic – lichen habitats with appropriate soil conditions for denning 4) All habitats with available food resources, including plants, small mammals and other opportunistic prey 5) Generally occupy alpine habitat following den emergence 6) Sedge – bluebell and willow – sedge habitat types	June and July, and subalpine areas in August following plant phenology 4) Fescue – willow, sedge – bluebell, willow – bluebell, sedge – cinquefoil, willow – sedge and heath – lichen habitat types	habitat types 3) Generally steep alpine slopes between 1,402 - 1,829 m most favoured for denning; however subalpine and forest dens have also been reported 4) Slopes with southeasterly aspects most favoured for denning 5) Fescue – willow and epilithic – lichen habitats with appropriate soil conditions for denning	been reported 2) Slopes with southeasterly aspects most favoured for denning 3) Fescue – willow and epilithic – lichen habitats with appropriate soil conditions for denning
Wolf	Incidental observations during March, June, July, August, September and October	7		1) Valley forests and subalpine habitats for denning 2) Dens constructed in the ground, within a rock crevice, or overturned stump 3) Pack remains relatively close to den site 4) Wherever appropriate prey exist 5) Game trails, ridges, roads and other linear features as travel corridors	1) Wherever appropriate prey exist 2) Game trails, ridges, roads and other linear features as travel corridors	1) Wherever appropriate prey exists 2) Game trails, ridges, roads and other linear features as travel corridors	1) Wherever appropriate prey exists 2) Game trails, frozen waterways, roads and other linear features for travel corridors
Wolverine	Incidental observations during March, June, July, August, September and October	2		1) Parturition dens commonly on slopes with southerly exposures in alpine or subalpine habitats (January – April) 2) Wherever appropriate prey exist 3) Generally occupy subalpine and alpine habitats	1) Wherever appropriate prey exist 2) Generally occupy subalpine and alpine habitats	1) Wherever appropriate prey exist 2) Generally occupy low valley and subalpine habitats	1) Parturition dens commonly on slopes with southerly exposures in alpine or subalpine habitats (January – April) 2) Wherever appropriate prey exist 3) Generally occupy low valley and subalpine habitats
Small Mammals	Incidental observations during March, June, July, August, September and October	-		1) All habitat types between valleys to alpine zone	1) All habitat types between valleys to alpine zone	1) All habitat types between valleys to alpine zone	1) All habitat types between valleys to alpine zone
Waterfowl	Aerial and ground surveys in July,	480		1) Low valley aquatic habitats, including beaver ponds, wetlands and mid- to large-sized ponds for nesting	1) Low valley aquatic habitats, including beaver ponds, wetlands and mid- to large-sized ponds for nesting	1) Low valley aquatic habitats, including beaver ponds, wetlands and mid- to large-sized ponds for feeding	Not present in the study area

TABLE 4.1.9-1: GENERAL SUMMARY OF EXISTING WILDLIFE CONDITIONS IN THE STUDY AREA							
Wildlife Species/Groups	Field Results		Seasonal Use of Habitats within the Study Area				
	Field survey dates (2005 – 2008)	No. of Visual Observations in the Study Area (including incidentals)	Reference Figure Number	Spring (April – May)	Summer (June – August)	Fall (September – October)	Winter (November – March)
	August and September			and feeding 2) Mid to high elevation lakes and stream	and feeding 2) Mid- to high elevation lakes, such as Cirque and Emerald lakes for staging 3) Large ponds along the Hess Tributary and Tsichu rivers for staging	2) Mid- to high elevation lakes, such as Cirque and Emerald lakes for staging 3) Large ponds along the Hess Tributary and Tsichu rivers for staging	
Raptors	Aerial surveys in June, July and August	59		1) All habitat types between valleys to alpine zone	1) All habitat types between valleys to alpine zone	1) All habitat types between valleys to alpine zone	1) Over-wintering individuals occupy all habitats with appropriate food resources
Other Upland Birds	June 2006 and 2007	440		1) All habitat types between valleys to alpine zone	1) All habitat types between valleys to alpine zone	1) All habitat types between valleys to alpine zone	1) Low valley habitats, such as fir-moss, spruce-moss and fir-lichen habitats for over-wintering birds

TABLE 4.1.9-2 ORGANIZATION OF EACH SPECIES ACCOUNT		
Species Account Subsections	Local or Regional Scale	Subsection Components
1. Population Status and Regional Harvest Data	Local and Regional	• Yukon population density, if available • Species occurring or potentially occurring within the study area • Species conservation status • Surveys conducted to date and the species observed within the study area • Harvest data from the region, if available
2. General Life History and Habitat Requirements	Regional	• General life requisites, including migrations or movements, feeding, reproduction, staging, and over-wintering • Associated habitat requirements
3. Local Distribution and Habitat Use	Local	• Key areas identified by the Yukon Government • Species estimated densities (where available) and distribution within the study area • Key habitats and seasons of use within the study area, except for those species groups that are diverse and make generalizations difficult (*e.g.* small mammals, raptors and other upland birds)
4. Special Management Requirements and Ongoing Studies	Local	• Management requirements integrated from applicable federal and territorial *Acts,* policies and management boards • Ongoing studies and monitoring programs known within the study area

Species that have not been documented within or adjacent to the study area during the field surveys, and minor species groups, are not addressed in this report. For example, no contemporary field surveys have documented mountain goats residing within or immediately adjacent to the study area. Yukon Environment (Government of Yukon 2006) has mapped key mountain goat areas in the southeast corner of the study area. However, evidence of their occurrence during former and contemporary surveys has not been documented (Gill 1978; Kershaw and Kershaw 1983; AMAX 1983). See also the appended EBA wildlife baseline study reports (Appendices G1 to G5).

4.1.9.3 Woodland Caribou (*Rangifer tarandus caribou*)

CONSERVATION STATUS – WOODLAND CARIBOU	
SARA	Schedule 1 Species of Special Concern
COSEWIC	Species of Special Concern
***Wildlife Act* (Yukon)**	Not listed.

Population Status and Regional Harvest Data

The Redstone caribou herd's range overlaps with the study area. These woodland caribou (northern mountain ecotype) occur throughout the study area in the spring, summer and fall. In 1982, the Redstone herd was estimated at 7,500 individuals (Thomas and Gray 2000, 2002); however, current population estimates are unknown.

Twelve systematic ungulate surveys were flown from 2005 to 2008. Surveys were conducted in March, June, July, August, September and October to document caribou distribution and relative abundance within the study area. From 2005 to 2008, a total of 1,032 caribou were observed within the wildlife study area during the ungulate surveys. An additional 568 caribou were also observed as incidentals during this time.

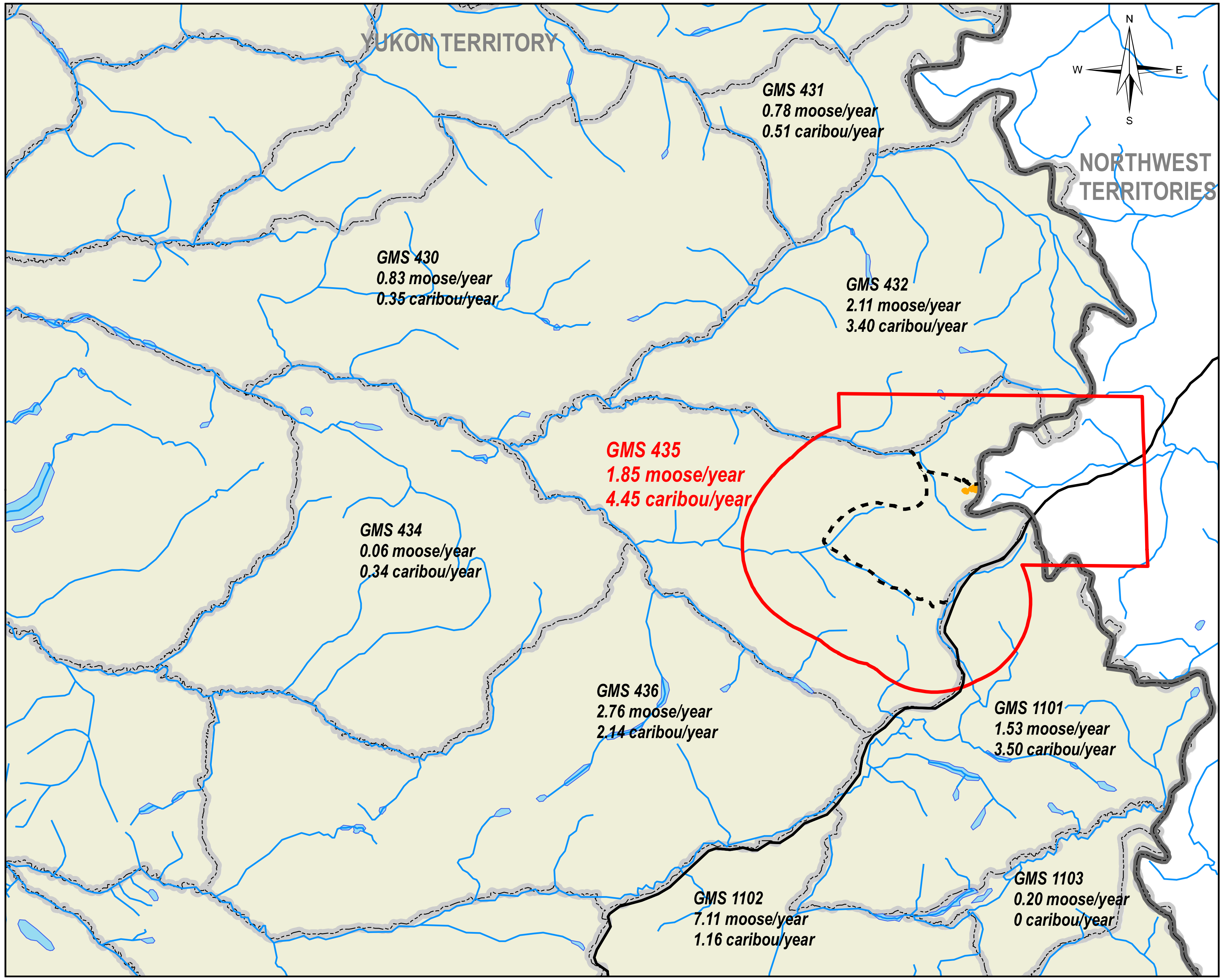
These contemporary surveys maintained similar inventory procedures as Kershaw and Kershaw (1983), who had previously completed wildlife surveys inside the Mactung study area. Kershaw and Kershaw (1983) used fixed-width transects to estimate the relative abundance of ungulates in their study area (approximately 500 km^2) predominantly within the NWT, including the Mackenzie Mountain Barrens).

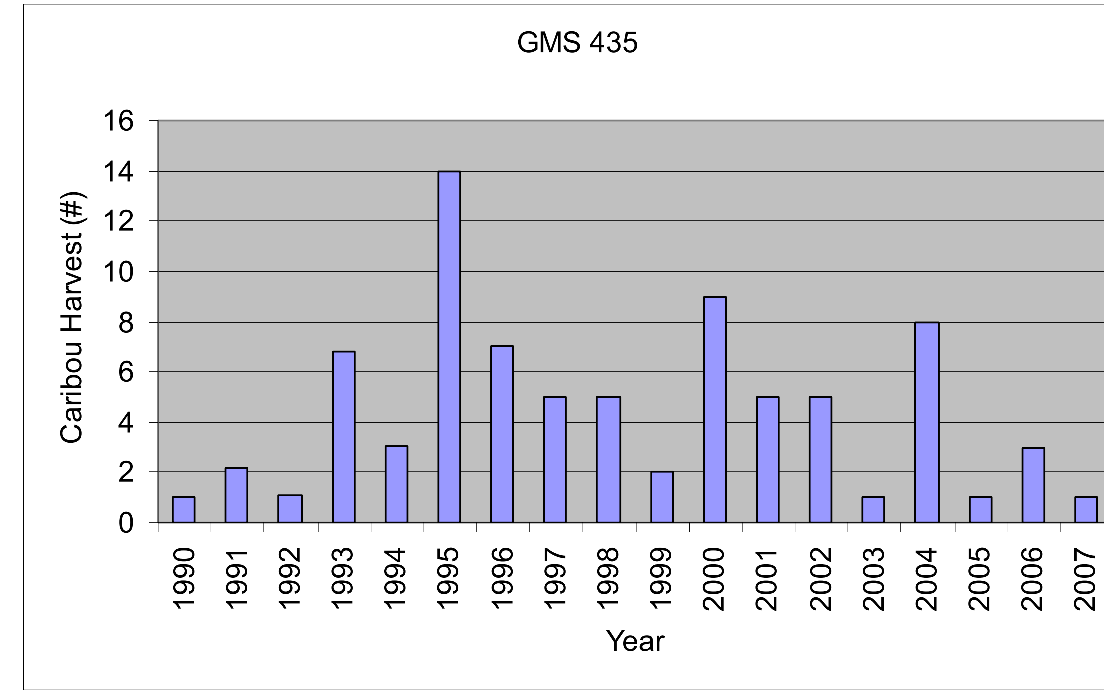
Harvest data from 1990 to 2007 was obtained from Yukon Fish and Wildlife Branch for the Game Management Subzones (GMSs) #435 (which includes the majority of the study area), as well as GMSs 432 and 1101 (Figure 4.1.9-2). Harvest data does not include animals taken by First Nations. From 1990 to 2007, in all three GMSs, a total of 204 caribou were harvested at an average of 3.9 caribou/year (Government of Yukon unpublished data). Yearly averages for each GMS are reported in Figure 4.1.9-2. Harvest rates are not an indicator of population size, but rather an indication of harvest effort.

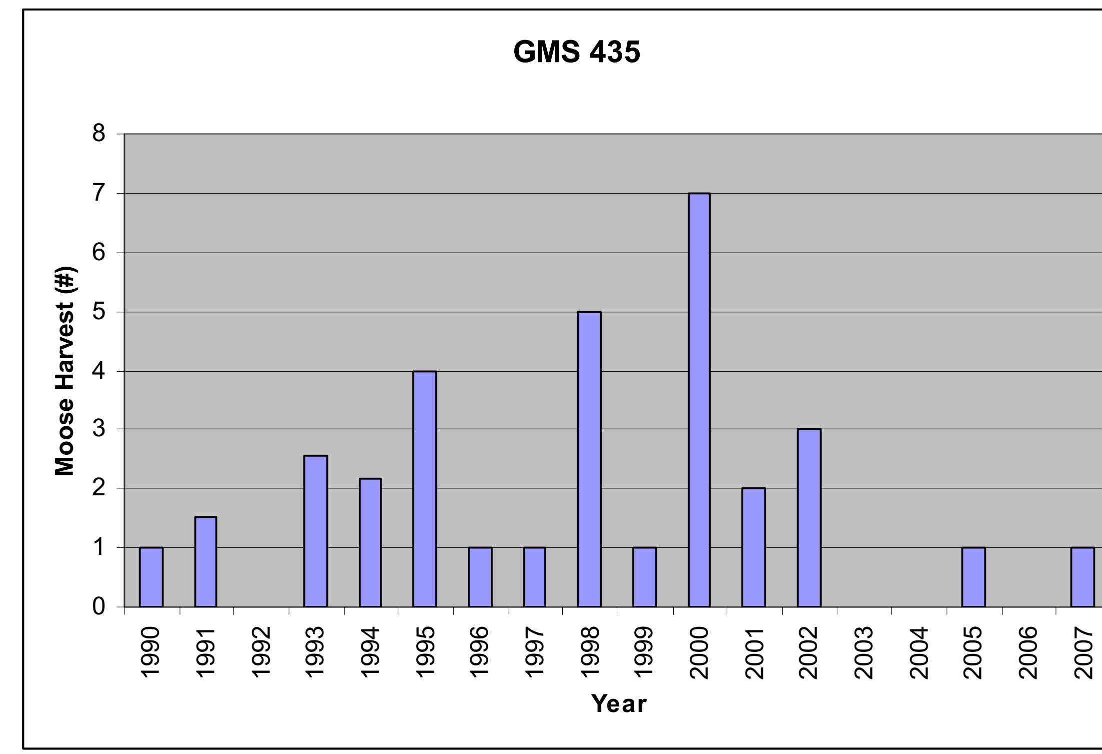
General Life History and Habitat Requirements

Woodland caribou occur throughout the study area in the spring, summer, and fall. The Redstone herd, which occupy summer ranges along the Yukon/NWT border, move down to lower elevations in the NWT during the winter (Olsen *et al.* 2001; Creighton 2006). During winter, woodland caribou forage primarily in spruce – lichen forests by cratering through the snow for terrestrial lichens of the genera *Cladina*, *Cladonia*, *Cetraria* and *Stereocaulon*. Caribou also feed on arboreal lichens as snow hardness increases towards the end of winter, and melt/freeze conditions create the formation of ice crusts, causing cratering for ground lichen to become more difficult. Arboreal lichens are also selected when caribou travel in forested areas between terrestrial lichen sites.

In spring, caribou from the Redstone herd migrate to calving, summer, and rutting ranges within the Mackenzie and Selwyn mountains. While on these ranges, caribou complete vertical movements in response to available food resources, insect harassment and heat stress. During this time, woodland caribou forage wherever forbs, sedges, grasses, lichens, fungi and the leaves of shrubs, particularly willow are available, and where caribou can avoid insect harassment and heat stress (*e.g.* exposed alpine ridges and snow patches).







LEGEND

- Proposed New Road
- Existing Roads
- Regional Wildlife Study Area
- NWT - Yukon Territory Border
- Proposed Mine Site Infrastructure
- Watercourse
- Waterbody
- Game Management Subzones

ISSUED FOR USE

NOTES
Base data source: Yukon Geomatics
Yearly summary for GMS 435 represents harvest closest to the Project Area.
Each mean is represented by the years 1990-2007.

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Mean Harvest Rates for Selected Game Management Subzones (GMS) in the Project Area

PROJECTION: UTM Zone 9	DATUM: NAD83
Scale: 1:600,000 (10 5 0 10 Kilometers)	
FILE NO.: W23101110_001_WL_GMA.mxd	

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KL	1

OFFICE	DATE
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Figure 4.1.9-2

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Woodland caribou breed in late-September and October, with most adult females greater than a year old producing one calf in May or early June. To reduce the risk of predation, pregnant females tend to travel to relatively isolated plateaus and upland areas to calve. Death of calves in the first month is generally high and mortality within the first 12 months averages 50-80%.

Local Distribution and Habitat Use

Yukon Environment (Government of Yukon 2006) mapped key wildlife areas within the study area. Based on these maps, no key woodland caribou migration corridors, rutting areas or winter ranges have been identified within the study area or neighboring areas (Government of Yukon 2006).

Although no key woodland caribou areas have been identified within the study area by the Yukon government, caribou do use the study area as a spring and fall migration corridor, calving (to a limited extent), post-calving area and summer ranges.

Kershaw and Kershaw (1983) surveyed an area overlapping the eastern portion of the study area, which included the Mackenzie Mountain Barrenlands. EBA completed encounter transect surveys across a 720 km^2 RWSA in 2005 and 2007, which centred on the mine site, and within a 550 km^2 area in 2008, which incorporated the proposed mine access road and portions of the RWSA. Encounter surveys provide information on the seasonal distribution of ungulates, including caribou, across a large study area, and allow relative abundance indices (animals per kilometre) to be calculated.

Calculation indices for relative abundances such as the number of caribou per kilometre were calculated over 2006, 2007 and 2008 (no caribou were observed in 2005). Variation among relative abundances during aerial surveys is likely a result of several factors, including (but not limited to) differences in surveyor detection rates and natural caribou dispersal. Surveyors' ability to detect caribou varied with numerous factors including inclement weather conditions and snow cover. In June and July, caribou were easily detected at a distance when on snow patches. By August, snow patches had melted which may have hampered caribou detections at further distances. In addition, upon returning to the study area in late May or early June, caribou had dispersed across their summer habitats in response to available food sources, insect harassment and calving requirements. Caribou abundance in July and August may have been a result of natural caribou dispersal across their summer habitats (Appendix G3). By September, caribou had begun to congregate into larger groups as they moved through the study area to reach their wintering grounds (Appendix G3).

Relative caribou densities within and neighbouring the study area were estimated by EBA (Appendices G2 and G3) and Kershaw and Kershaw (1983), respectively. Between 2006 and 2008, caribou relative abundance indices and density estimates within the study area were calculated and are tabulated in Table 4.1.9-3. Caribou relative abundance and density estimates for the October 2005 field survey were not calculated since no caribou were observed at that time.

TABLE 4.1.9-3 WOODLAND CARIBOU: AERIAL SURVEY OBSERVATION RESULTS[1]							
	Year	Survey Date (Month)					
		March	June	July	August	September	October
Relative Abundance (animals/km)[2]	**2006**	**-**	0.22	0.12	0.15	0.15	-
	2007	**-**	0.33	0.32	0.16	0.45	-
	2008	**0**	-	0.93	-	-	0.04
Density Estimate (animals/1,000 km²)	**1981-1982[3]**	**-**	420	-	530	50	-
	2006-2007	**-**	275	220	155	300	-
	2008	**0**	**-**	926	-	-	44

1. 2006 and 2007 results centred on the Mactung mine site (720 km²). 2008 results from the proposed road area includes a 740 km² survey area for July and an 830 km² area for October.
2. Due to poor weather and/or low clouds the total survey length (km) varied with each survey event. Relative abundance indices were calculated assuming a total survey length of 80 km in October 2005, 204 km in June 2006, 396 km in July and August 2006, 370 km in September 2006, 180 km in June 2007, 396 km in July, August and September 2007, 330 km in July 2008 and 345 km October 2008.
3. 1981 – 1982 density estimates taken from Kershaw and Kershaw (1983) from a survey area overlapping the eastern portion of the RSAW and the Mackenzie Mountain Barrenlands.

For comparison with Kershaw and Kershaw's (1983) results, a 1 km effective survey width was assumed to calculate a caribou density estimate (Table 4.1.9-3). Density estimates provided are considered less accurate and are provided solely for general comparison purposes. Kershaw and Kershaw's (1983) density estimates were higher than those reported by EBA (Appendices G2 and G3), likely because of the Kershaw's inclusion of the Mackenzie Mountain Barrenlands, a high elevation plain that has been documented as a principle calving and post-calving area for this herd (AMAX 1983, Collin 1983).

Spring - Calving

Northern mountain caribou have a high fidelity to calving areas, and between the last week of May and the first week of June, gravid cows disperse to known plateaus and upland sites to calve. The Mackenzie Mountain Barrenlands (approximately 25 km northeast of the Mactung project) is a known calving area (AMAX 1982; Collin 1983), and considered the principal calving and post-calving area for the Redstone herd (Collin 1983). Gill (1978) indicated caribou do not calve in the Macmillan Pass area.

Additional calving areas for this herd had been reported outside the study area between the Tsichu and Intga rivers as well as between the Keele and Natla headwaters. More specific locations of these potential calving areas were not reported; however, they were expected northeast and southeast of the study area, respectively (Collin 1983).

In contrast to published literature, observations from 2006 - 2008 aerial surveys indicated calving occasionally occurred within the study area, although the study area was not considered a critical calving area for this herd (Appendices G2 and G3). On June 14, 2006, a single calf was detected within the RWSA. During the June 16, 2007 ungulate survey, a total of eight calves were observed on high alpine meadows (Appendix G3). Three of these calves were between the ages of 1 – 4 days old (Appendix G3). Calves were recorded in various directions approximately 2 to 11 km away from the existing Mactung camp (Appendix G3). All plateaus and upland sites within the study area may be used as calving and post calving habitats. These habitats occur throughout the study area and are considered sensitive to disturbances. Yearlings, bulls and dry cows were considered the main users of the study area during the calving season (late May – early June) (Appendices G2 and G3).

Spring and Fall Migration

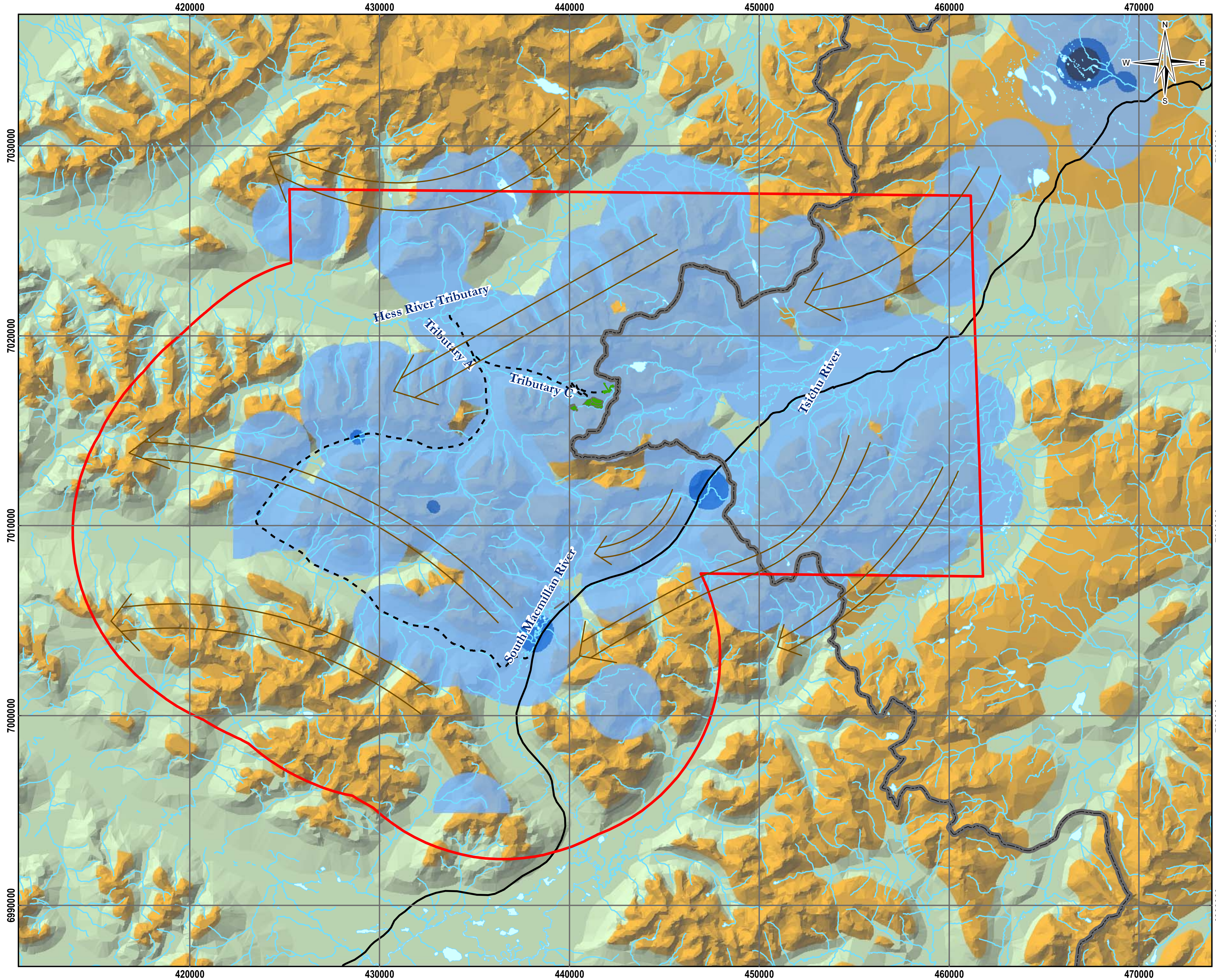
During spring migration, caribou commonly arrive in the Macmillan Pass area in late May to early June and depart at the end of September (although some caribou remain until the end of November) (AMAX 1983; Gill 1978). The timing of spring and fall migrations may vary each year with available food resources, rutting and calving requirements, snow conditions, weather and wind conditions, and prevalence of biting insects (Gill 1978).

Kershaw and Kershaw (1983) reported caribou migrating out of the area by September 19, and consequently, reported small numbers of caribou within their study area at that time. An aerial survey performed on October 6, 2005 yielded multiple detections of caribou tracks and trails, but no caribou observations (Appendix G1). Based on snow and past weather conditions it was estimated caribou had been within the study area at least 48 hours prior to the October aerial survey (Appendix G1). Two years later, on October 6, 2008, no caribou or caribou sign was detected during an additional aerial survey.

Collin (1983) indicated topographic funneling along major river valleys, such as the Keele River valley, occurs during spring and fall migrations. Mid-elevation habitats along large river valleys including the Tsichu, Hess Tributary and South Macmillan rivers are considered important caribou migration corridors within the study area. Caribou tracks and trails were observed at elevations ranging between approximately 1,300 m – 1,650 m (Figure 4.1.9-3; Figure 4.1.9-4) (Appendix G1). These mid-elevation habitats are most sensitive in late May to early June and in late September, during spring and fall migrations (migration times may vary).

Summer – Post Calving

Upon migration, caribou disperse across their summer range in subalpine and alpine habitats which occur throughout the study area. In general, small groups of caribou (including calves) occupied subalpine and alpine meadow habitats throughout the study area in June, July, August and September (Figure 4.1.9-3) (Gill 1978; Kershaw and Kershaw 1983; Appendices G2 to G4). Solitary animals, particularly bulls were also occasionally detected in low valleys including the Tsichu River and Hess River tributaries. Caribou appeared to favour sedge – bluebell, sedge – cinquefoil, fescue – willow, fescue – sedge and heath – lichen habitat types in the alpine and subalpine (Gill 1978; Kershaw and Kershaw 1983; Appendices G2 to G3). Birch – lichen and birch – moss habitat types in lower elevations and river valleys were also used (Kershaw and Kershaw 1983). Habitat types favoured by caribou are distributed throughout the study area.



LEGEND

Estimated Caribou Density (# / Km²)

- 0
- >0 - <10
- >10 - <20
- >20 - 30
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Regional Wildlife Study Area
- North Canol Rd
- NWT - Yukon Territory Border
- Macmillan Pass Aerodrome
- Watercourse
- Waterbody

Habitat Interpretations - Potential Use

- High Use Habitat (>1500m Elevation)
- Caribou Migration Corridor (Late May to Early June)

ISSUED FOR USE

NOTES
Base data source: NTDB 1:50,000, 1:250,000,
Site Plan adapted from original provided by Wardrop

MACTUNG

Summer Caribou Distribution

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:200,000
5 2.5 0 5
Kilometers

FILE NO.
W23101110_001_WL_Caribou_Summer.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KL	1

OFFICE	DATE
EBA-VANC	December 4, 2008

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Figure 4.1.9-3

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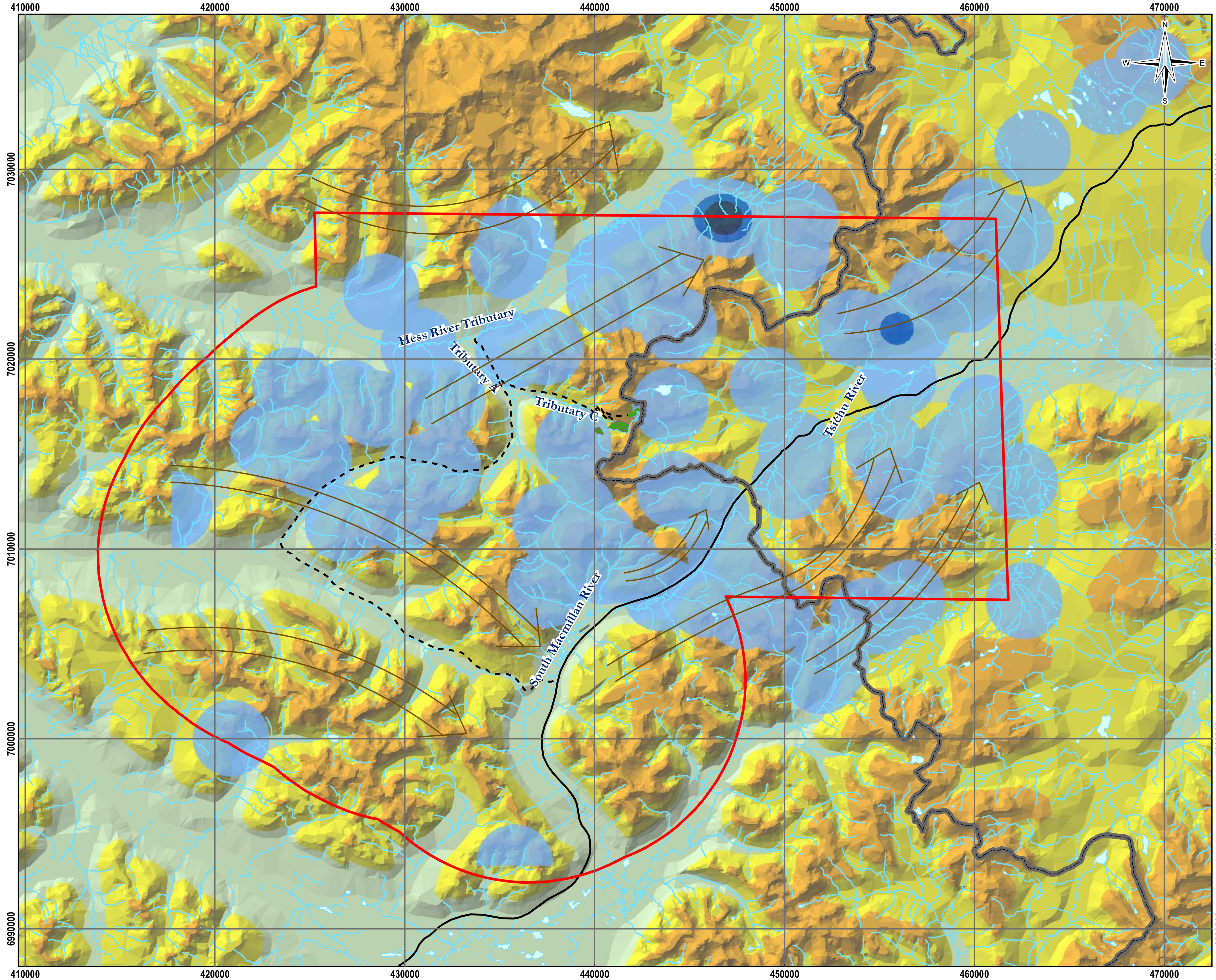

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LEGEND

Estimated Caribou Density (# / Km²)

- 0
- >0 - <5
- >5 - <10
- >10 - 16
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Regional Wildlife Study Area
- North Canol Rd
- NWT - Yukon Territory Border
- Macmillan Pass Aerodrome
- Watercourse
- Waterbody

Habitat Interpretations - Potential Use

- High Use Foraging Habitat (>1650m Elevation)
- High Use Foraging Habitat and Migration Corridor(1300-1650m Elevation)
- Caribou Migration Corridor (Late September to November)

ISSUED FOR USE

NOTES
Base data source: NTDB 1:50,000, 1:250,000.
Site Plan drawing adapted from original provided by Wardrop

MACTUNG

Fall Caribou Distribution

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:200,000
5 2.5 0 5
Kilometers

NORTH AMERICAN TUNGSTEN CORPORATION LTD
EBA Engineering Consultants Ltd.

FILE NO.
W23101110_001_WL_Caribou_Fall.mxd

PROJECT NO.	DWN	CKD	REV
W23101110	MEZ	KL	1

OFFICE	DATE
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Figure 4.1.9-4

By mid-July, some females with calves used the study area as a post-calving area. A total of six calves were detected within the study area in July 2006 (Appendix G2), whereas, a total of 22 and 73 calves were reported during the July 2007 and July 2008 surveys, respectively (Appendices G2 to G4). Post-calving areas include moist alpine tundra and open meadows, which are located throughout the study area (Gray and Panegyuk 1989; Appendices G2 to G4).

In June and September, caribou were observed along or near large valley systems; whereas, in July and August, caribou appeared randomly distributed throughout the study area. Caribou observed during the June surveys may have been slowly dispersing onto summer ranges following spring migration.

Fall

Caribou observed during the September surveys may have been slowly moving towards larger river valleys in preparation for winter migration east of the study area. During July and August, caribou were randomly distributed across their summer range as prompted by available forage, biting insects and heat stress (Gill 1978; Kershaw and Kershaw 1983; AMAX 1983; Appendices G2 and G3). On average, caribou occupied habitats at lower elevations in June and September and higher elevations in July and August (Appendices G2 and G3) (Figure 4.1.9-3).

Winter

Caribou do not occupy habitat within the study area during winter months. The Redstone caribou herd migrates eastward out of the study area in late September (timing of migration may vary depending on conditions) to wintering grounds in the NWT. Caribou or caribou sign were not observed within the study area during an aerial survey conducted on March 26, 2008.

Summary

Key habitats for the Redstone herd migration, calving and post calving seasons within the study area are summarized in Table 4.1.9-4. Habitats identified herein are considered important to fulfill caribou life requisites; however, caribou can be expected to occur in all habitat types throughout the study area.

TABLE 4.1.9-4 SUMMARY OF KEY CARIBOU HABITAT WITHIN THE STUDY AREA AND SEASONS OF USE

Life Requisites	Seasonal Use of Key Habitats		
	Spring (April – May)	Summer (June – August)	Fall (September – October)
Migration (late May to early June and late September to November)	1) Tsichu, Hess Tributary and South Macmillan river valleys at mid to high elevations greater than 1,300 m	-	Tsichu, Hess Tributary and South Macmillan river valleys at mid to high elevations greater than 1,300 m
Calving (last week of May and the first week of June)	1) Plateaus and upland sites throughout the study area	1) Plateaus and upland sites throughout the study area	
Post Calving (June to late September)		1) Moist alpine and subalpine tundra and open meadows 2) Alpine snow patches 3) On average, caribou occupy habitats at lower elevations in June and higher elevations in July and August 4) Sedge – bluebell, sedge – cinquefoil, fescue – willow, fescue – sedge and heath – lichen habitats in the alpine and subalpine favoured 5) Birch – lichen and birch – moss habitats in lower elevations and river valleys less favoured	1) Moist alpine and subalpine tundra and open meadows 2) On average, caribou occupy habitats at lower elevations in September 3) Sedge – bluebell, sedge – cinquefoil, fescue – willow, fescue – sedge and heath – lichen habitats in the alpine and subalpine favoured 4) Birch – lichen and birch – moss habitats in lower elevations and river valleys less favoured
Winter	-	-	-

Special Management Requirements and Ongoing Studies

Special management requirements encompass the SARA, Wildlife Act (*Yukon*), and legislative policy regulating the management and protection of the Redstone caribou herd. Upon implementation of the Yukon First Nations Final Agreement, co-management boards have developed informal management guidelines for various species in the Yukon, including caribou (Caribou Management Team 1996). The Yukon Fish and Wildlife Co-Management Plan (1996a) manages harvestable yields for each caribou herd in the Yukon based on herd size.

A summary of special management requirements and known studies and monitoring programs for the Redstone caribou herd is provided in Table 4.1.9-5.

TABLE 4.1.9-5 SPECIAL MANAGEMENT AND ONGOING STUDIES – NORTHERN MOUNTAIN CARIBOU			
SARA	Wildlife Act (Yukon)	Yukon Fish and Wildlife Co-Management	Ongoing Studies
Draft management plan in preparation – no caribou and caribou habitat requirements to date	1) Manages outfitting and hunting 2) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife.	Guidelines for allowable harvest yields	None known to date for the Redstone herd

4.1.9.4 Moose (*Alces alces*)

CONSERVATION STATUS – MOOSE	
SARA	Unlisted
COSEWIC	Not Evaluated
Wildlife Act (Yukon)	Not listed.

Population Status and Regional Harvest Data

Approximately 65,000 – 70,000 moose are estimated to occur within the Yukon Territory (Government of Yukon, 2008). As of 2005, moose densities were estimated to average 285 moose/1,000 km^2 in the greater region that encompasses the study area (Yukon Government unpublished data). This is generally above the Territory-wide average of 157 moose/1,000 km^2. In the Macmillan Pass area, Gill (1978) indicated a modest number of moose reside.

Although no surveys to estimate moose populations have been completed by the Yukon Government in the region of the study area since 1981, studies in the region of the North Canol Road were conducted in 1987, 1991, 1996 and 2001 (Yukon Government 1986, 1991, 1996 and 2005; Table 4.1.9-6). Based on these studies, moose densities within the region have fluctuated between 186 and 317 moose/1,000 km^2. Herd composition and recruitment rates were also assessed during these surveys. The ratio between the number of bulls and cows ranged from 66 – 106 mature bulls to every 100 cows (Yukon Government unpublished) (Table 4.1.9-6). To ensure all females in a population are bred during the rut, herd composition should be at least 30 bulls for every 100 cows (Moose Management Team, 1996). To maintain stable moose populations, recruitment levels of at least 10 – 20 yearlings per 100 adults are required. In the North Canol Road area from 1987 to 2001, the ratio of yearlings to 100 cows has decreased from 50 to 10 yearlings to 100 cows (Yukon Government unpublished) (Table 4.1.9-6).

TABLE 4.1.9-6 SUMMARY OF MOOSE POPULATION ESTIMATES, NORTH CANOL ROAD AND MACMILLAN PASS AREAS[1]

Year	Area	Survey Date	Survey Area (km^2)	Population Estimate	Moose Density (animals / 1,000km^2	Mature Bulls: 100 Cows	Yearlings: 100 Cows	Calves: 100 Cows
1981/ 1982	Macmillan Pass	Nov./ Mar.	N/A	N/A	N/A	106	73	35
1987	North Canol	Nov.	2,759	514	186	66	50	64
1991	North Canol	Nov.	2,954	938	317	90	38	52
1996	North Canol	Nov.	2,954	728	246	102	41	28
2001	North Canol	Oct./ Nov.	3,088	659	213	76	10	32
Current extrapolation	Macmillan Pass[2]	-	-	-	285	-	-	-

1. Table modified from that provided by Yukon Government (unpublished).
2. The Macmillan Pass area includes a 22,500 km^2 area west of the Yukon – Northwest Territory border and extends south to Ross River. Current moose densities were extrapolated from recent density estimates from the Faro, North Canol and Frances Lake survey areas.

Twelve systematic ungulate surveys were flown from 2005 to 2008. These transect surveys were conducted in March, June, July, August, September and October to document moose distribution and relative abundance within the study area. In total, EBA observed 71 moose on transect during the 2005 - 2008 aerial surveys.

Moose are not specially protected in the Yukon, however, special management guidelines are in place as moose are considered an important harvestable species. Generally, maximum annual allowable harvest rate targets are below 4% of the total population (Yukon Government unpublished data).

Harvest data was obtained from the Yukon Fish and Wildlife Branch from 1990-2007. Figure 4.1.9-2 summarizes these data, which do not include First Nation harvest numbers. In general, targets for maximum annual allowable harvest rates are less than 4% of the total population. The number of moose harvested from 1990 to 2007 is reported by game management area (GMS) in Figure 4.1.9-2, including GMS #435 within which the majority of the study area falls, as well as GMSs #432 and 1101. From 1990 to 2007, a total of 99 moose were harvested from these three GMSs, at a rate of 2.0 moose/year (Government of Yukon unpublished data).

General Life History and Habitat Requirements

Moose are generalist herbivores that feed on herbaceous plants, grasses and sedges, aquatic plants, leaves and the new growth of shrubs and trees, and twigs of woody vegetation (Jackson et al. 1991). They occupy a range of habitat types including shrublands, open water and riparian areas, deciduous and coniferous forests for food, security and thermal cover. Moose populations are often found to be locally abundant approximately 20-25 years after a fire due to high shrub covers (LeResche and Davis 1974).

Characteristic winter habitats provide suitable browse material, limited snow cover, and security from predators. The bulk of their diet during the winter includes browse species, particularly willow. Other shrub or tree species, such as alder, paper birch, rose and spruce may be consumed in winter as willow becomes less available. Forested sites, including sub-climax stages of deciduous and mixed wood forests that contain a dense shrub layer are also used; however, snow depths must generally be less than 90 cm (Kelsall and Prescott 1971). Additionally, in areas with heavy snowfall, moose will move down to lower valleys as winter progresses (Government of Yukon 2007a).

Spring is the time of year when security cover is most critical for gravid cows. Cow moose calve in mid May to mid June. At this time the cow moose seek isolated areas in the subalpine, as well as islands and gravel bars on river floodplains for calving. Landscape features adjacent to water and wetlands, such as sites with a dense growth of tall shrubs (e.g., willows) with canopy covers greater than 50 % and mature mixed wood stands of white spruce and poplar with at least a moderately dense shrub understory provide security cover for cows and calves (Miquelle et al. 1992; MacCracken et al. 1997).

In the summer, moose prefer floodplains of major rivers, regenerating burns, and avalanche chutes in early successional stages as well as riparian communities along streams, lakes and wetlands where the cool water may provide relief from warm ambient temperatures and insects, as well as suitable forage resources. During this time, aquatic plants are a preferred and important part of the moose's diet, and as a result, moose tend to concentrate their feeding activities in and around wetland areas. Some studies indicate moose seek aquatic macrophytes as their primary source of succulent vegetation during the summer. This may be a result of the high mineral content, particularly sodium, of some aquatic vegetation which is thought to be a limiting nutrient to moose.

Local Distribution and Habitat Use

Habitats with three characteristics, adequate browse, protective cover and mineral licks are required to support moose life requisites (Moose Management Team 1996). Each of these habitat characteristics were identified within the project area during past and current baseline studies. These habitats support moose life history functions throughout the year, as detailed below.

EBA recorded a total of 117 moose observations during all wildlife baseline studies conducted from October 2005 to October 2008 (including targeted and incidental observations). Of these, 71 visual observations were recorded during a series of aerial ungulate surveys that were conducted over this time period (Appendices G1 to G4). Nearly all moose observations (including bulls) were reported in low valley and subalpine habitats, including scrub birch – lichen, willow – sedge, wetland/beaver ponds and open coniferous habitats (Appendices G1 to G4).

All aerial surveys followed set transects and included all habitat types, except for the October 2005 survey. During the time of the October 2005 survey, low cloud cover restricted the survey to low valley habitats. For the most part, EBA's baseline aerial ungulate surveys were not designed as compositional or total count/density surveys. Rather, these encounter transect aerial surveys were intended to provide seasonal ungulate distributions throughout the study area. For this reason, no 95% confident intervals of densities were calculated within the study area. However, example minimum estimated densities were calculated from aerial survey data in order to provide a comparison across years and seasons (provided in Table 4.1.9-7). Despite modifications to general aerial survey assumptions, density estimates were found to be extremely low (the highest estimate of 35 moose per 1,000 km^2 recorded in September of 2006), suggesting that the overall use of the project area is likely low.

TABLE 4.1.9-7 MOOSE: AERIAL SURVEY OBSERVATIONS RESULTS				
Date	Year	Total Number of Moose Observed on Transect	Density Estimate (animals/1,000 km^2)[1]	Relative Abundance (animals/ km)*
Winter				
March 26	2008	7	12	0.01
Summer				
June 14	2006	2	10	0.01
June 16	2007	3	17	0.02
July 7	2006	6	15	0.02
July 11	2007	0	0	0
July 6	2008	3	9	0.01
August 5	2006	4	10	0.01
August 15	2007	1	3	0.00
Summer Average		**2.7**	**9.5**	**0.01**
Summer Average				
September 19	2006	13	35	0.04
September 4	2007	7	18	0.02
October 6	2005	17	213	0.21**
October 6	2008	8	23	0.02
Fall Average		**11.3**	**24.7**	**0.07**

Density estimates are not considered to be an accurate representation. Encounter ungulate surveys were conducted, which provide information on the seasonal distribution of ungulates, including moose, across a large study area. However, density estimates assume a 1 km effective survey width, and are provided for comparison purposes only. Due to poor weather conditions the survey area varied slightly between aerial survey events.

*. Due to poor weather and/or low clouds total survey length (km) varied between survey events. Relative abundance indices were calculated assuming a total survey length of 80 km in October 2005, 204 km in June 2006, 396 km in July and August 2006, 370 km in September 2006, 180 km in June 2007, 396 km in July, August and September 2007, 330 km in July 2008 and 345 km October 2008.

**. Due to low cloud cover, the October 6, 2005 aerial survey was restricted to flying low valleys; whereas, all of the other surveys flew straight line transects across valleys, subalpine and alpine habitat.

Relative abundance calculations for the number of moose recorded per kilometre (moose/km) were also calculated for 2006, 2007 and 2008 (Table 4.1.9-7). These relative abundance indices are considered more accurate than compared to density estimates due to the nature of the aerial surveys performed. Moose abundance within the study area is generally low and varies throughout the summer. Moose abundance within the wildlife study area was highest in September and lowest in August. Kershaw and Kershaw (1983) also reported an increase in the number of moose observed during their September surveys.

Winter

Winter moose occupancy tends to be limited by browse material and snow depth, and to a lesser extent thermal cover. During winter surveys from 1975-1976, moose were observed from October 1975 to February 1976, with numbers decreasing as the winter progressed (AMAX 1976). No moose or moose sign were observed during an historical aerial survey conducted on March 20, 1976 or during ground surveys conducted on March 24, 1976 (AMAX 1976). These 1975-1976 surveys indicated that moose may not occupy the study area all year, but rather moose may move out with the progression of winter and deep snow accumulations. Use of riparian habitat areas by moose in the project area, as in all suitable winter habitats, is limited by annual snow depths.

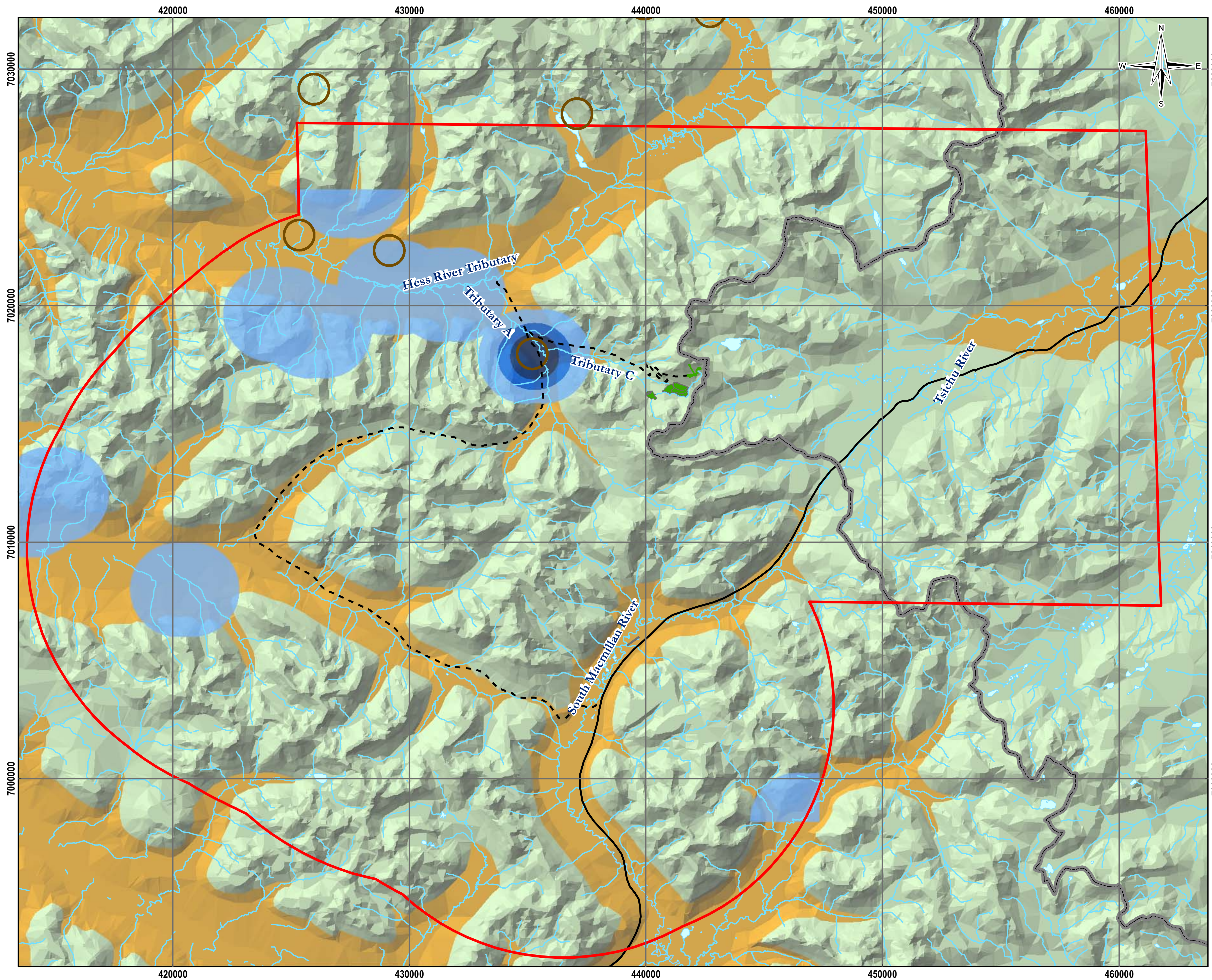
Gill (1978) reported habitats similar to willow-bluebell and willow-sedge were the most important moose habitat in the study area, particularly during winter months. In addition to annual snow depths, the presence of willow, an important browse material, appears to be a major factor determining moose winter distribution within the study area. Kershaw and Kershaw (1983) reported an abundance of suitable riparian willow feeding habitat along the Tsichu River and related tributary valleys, and general snow loads in these lower valley areas were measured at 40 cm (during the winter of 1982). While these conditions were generally favourable to over-wintering moose, only 14 individuals were observed over three survey days (this survey did not extend into the Yukon tributary valleys).

In March of 2008, EBA conducted an aerial survey of the current project area that covered an area of approximately 1,100 km^2. Eight moose were observed during the course of this survey, all of which were occupying willow riparian and mixed willow/conifer habitats. The distribution of individuals, as well as track patterns indicating recent habitat use were generally restricted to several primary tributaries of the Hess River, the lower valley of Tributary A (and the vicinity of the primary mineral lick), as well as smaller adjacent tributaries (Figure 4.1.9-5) (Appendix G4).

Based on the Yukon Environment (Government of Yukon 2006) key wildlife areas maps, there are no important late winter moose habitats within or adjacent to the study area.

Spring - Calving

Cows seek protected areas either at the tree line in the subalpine zone or at river level in the valley bottoms to calve from mid May to mid June (Government of Yukon 2007a). Over a four year period (1974 to 1978), Gill (1978) observed 14 cows with eight calves during moose surveys within the study area. Gill (1978) did not report any incidents of twins being born. AMAX (1983) reported relatively high reproductive rates and three sets of twins over two spring periods (a total of six cows with eight young (calves and yearlings). In 2006, EBA (Appendix G2) observed a total of 12 cows, one calf and three yearlings. By 2007, EBA (Appendix G3) reported a total of ten cows and four calves, including a set of twins, and in 2008, a total of 16 cows and 2 calves were observed. Three cows with calves reported from 2006 - 2008 occupied habitats in the Hess River tributary valley bottom, whereas six cows with calves occupied subalpine habitats ranging from 1,300 m – 1,500 m elevations (Appendices G2 to G5).



LEGEND

Estimated Moose Density (# / Km²)

- 0
- >0 - <1
- >1 - <2.5
- >2.5 - 4
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Regional Wildlife Study Area
- Mineral Lick (Yukon Government, 2006)
- North Canol Rd
- NWT - Yukon Territory Border
- Macmillan Pass Aerodrome
- Watercourse
- Waterbody

Habitat Interpretations - Potential Use

- High Use Habitats (<1300m Elevation)

ISSUED FOR USE

NOTES

Base data source: NTDB 1:50,000, 1:250,000,
Site Plan adapted from original provided by Wardrop

MACTUNG

Winter Moose Distribution

PROJECTION			DATUM
UTM Zone 9			NAD83

Scale: 1:160,000
4 2 0 4
Kilometers

FILE NO.
W23101110_001_WL_Moose_Winter.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KL	1

OFFICE	DATE
EBA-VANC	December 4, 2008

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

Figure 4.1.9-5

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Summer

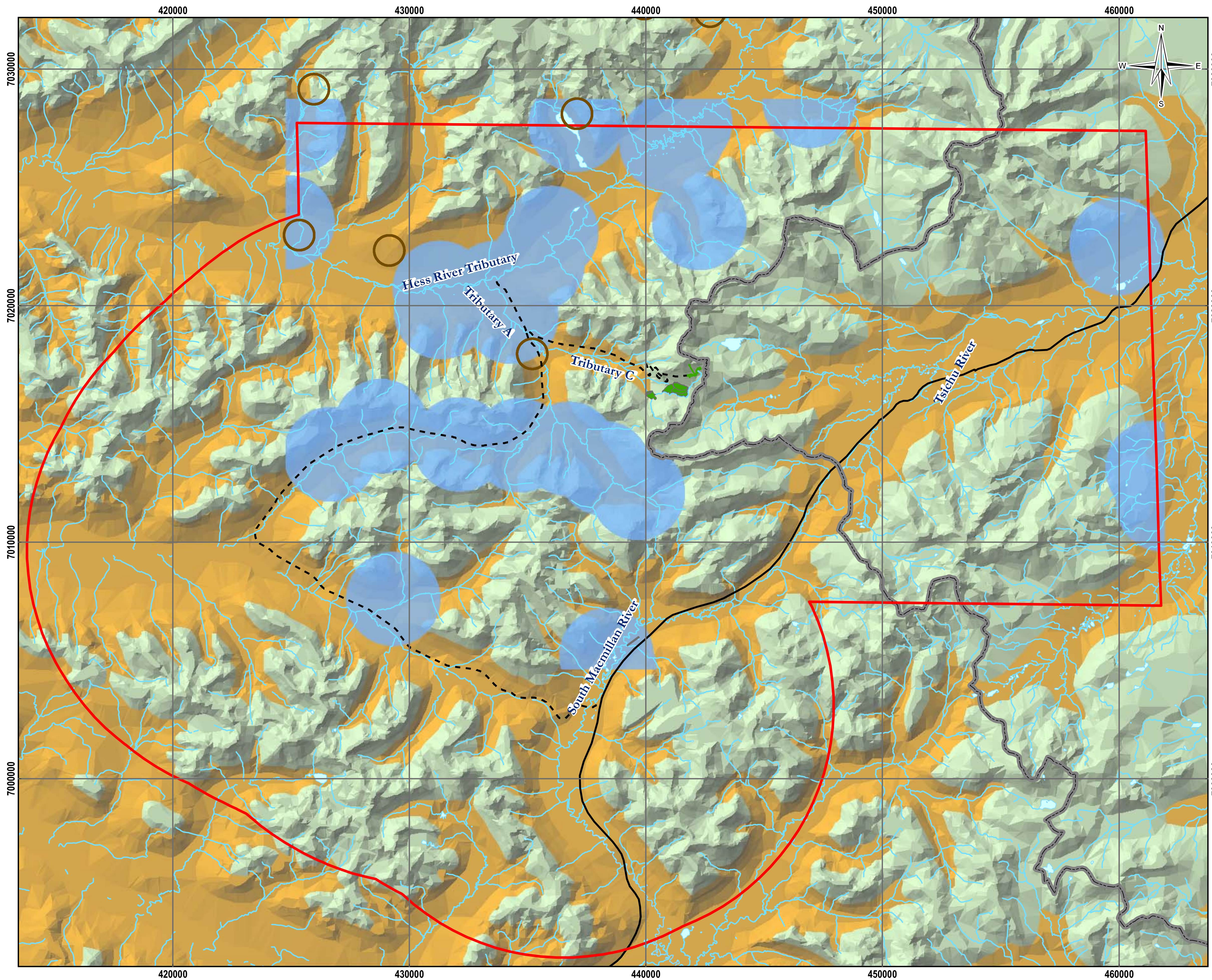
Important browsing habitat occurs in large valley bottoms and subalpine habitats throughout much of the study area, principally along the Hess River tributaries and South Macmillan and Tsichu rivers (Figure 4.1.9-6). Use of aquatic habitats may occur during all non-winter months, but generally peaks during late June to early August when plant nutrition/digestibility (Peek 1998) and summer temperatures, are highest. This period also coincides with moose seeking relief from insect harassment and heat stress.

Moose are poorly adapted to heat, and temperatures greater than -5 degrees Celsius (°C) during winter or greater than 14°C during summer can induce thermal stress (Schwartz and Renecker 1998). Consequently, moose require access to shade during all seasons, such as the forested valleys found in the Hess River tributaries.

Fall - Rutting

During the October 2005 aerial survey, 17 moose (eight bulls and nine cows) were recorded in riparian willow, scrub birch, and open spruce communities in the Hess Tributary and Tsichu river valleys and their tributaries. Moose were typically in groups ranging in size from one to six individuals (average of two individuals per sighting).

As noted above, both recent and historical surveys within the study area have noted an increase in the density of moose during the rut and post-rut periods (September / October). During this time period, groups of moose were noted to be more prevalent in mid-elevation riparian valleys, occupying open conifer and dwarf birch dominated habitats (Figure 4.1.9-7). In particular, concentrations of moose were observed occupying the upper Hess River Tributary and lower Tributary A floodplains.



LEGEND

Estimated Moose Density (# / Km²)

- 0
- >0 - 1
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Regional Wildlife Study Area
- Mineral Lick (Yukon Government, 2006)
- North Canol Rd
- NWT - Yukon Territory Border
- Macmillan Pass Aerodrome
- Watercourse
- Waterbody

Habitat Interpretations - Potential Use

- High Use Habitats (<1500m Elevation)

ISSUED FOR USE

NOTES

Base data source: NTDB 1:50,000, 1:250,000,
Site Plan adapted from original provded by Wardrop

MACTUNG

Summer Moose Distribution

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:160,000

4 2 0 4

Kilometers

FILE NO.
W23101110_001_WL_Moose_Summer.mxd

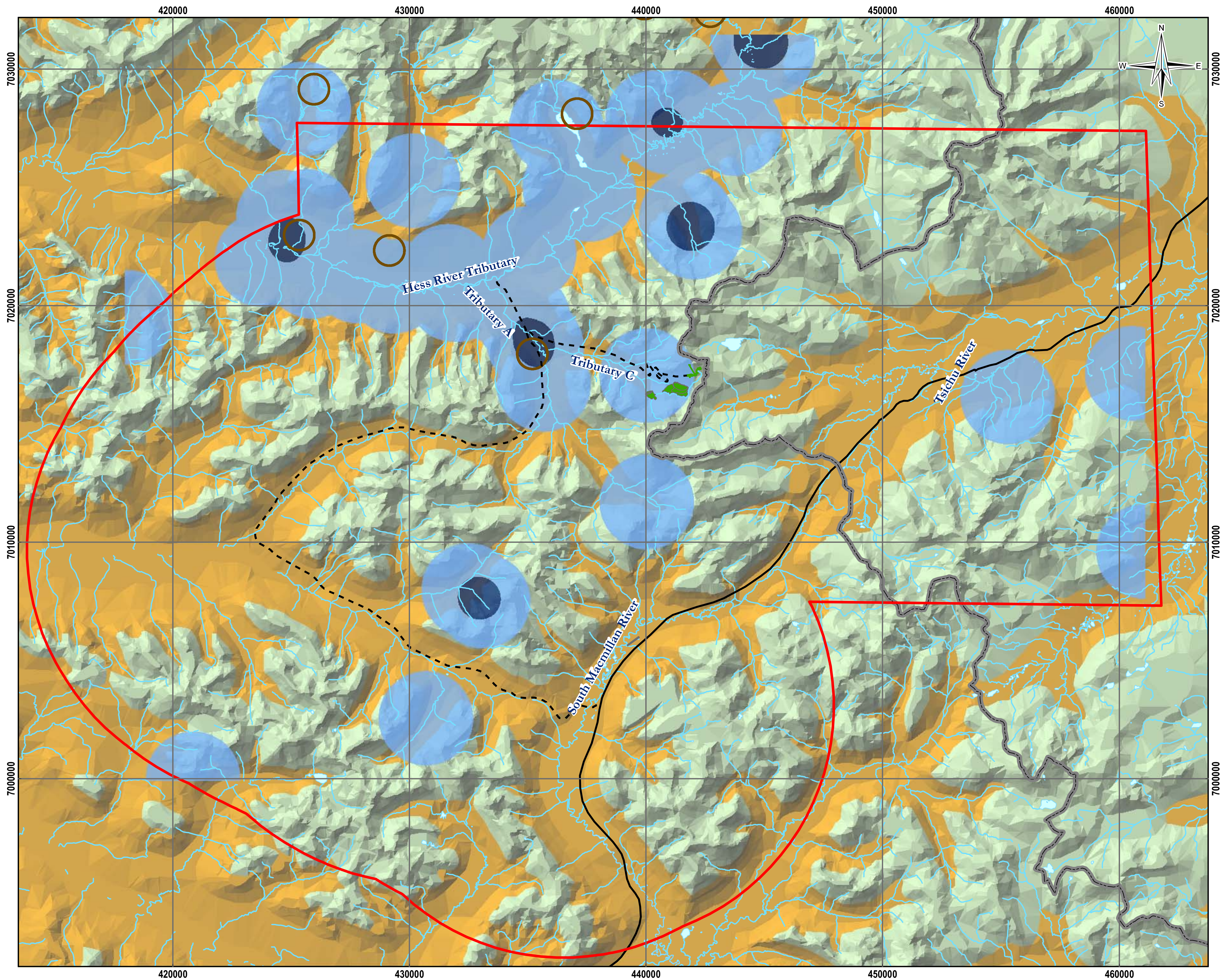
PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KL	1

OFFICE	DATE
EBA-VANC	December 4, 2008

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

Figure 4.1.9-6



LEGEND

Estimated Moose Density (# / Km²)

- 0
- >0 - <1
- >1 - 2
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Regional Wildlife Study Area
- Mineral Lick (Yukon Government, 2006)
- North Canol Rd
- NWT - Yukon Territory Border
- Macmillan Pass Aerodrome
- Watercourse
- Waterbody

Habitat Interpretations - Potential Use

- High Use Habitats (<1500m Elevation)

ISSUED FOR USE

NOTES

Base data source: NTDB 1:50,000, 1:250,000,
Site Plan adapted from original provided by Wardrop

MACTUNG

Fall Moose Distribution

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:160,000

4 2 0 4

Kilometers

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

FILE NO.

W23101110_001_WL_Moose_Fall.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KL	1

OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 4.1.9-7

Mineral Licks

Mineral licks are another important component of moose habitat. Five mineral licks occur within or immediately adjacent to the study area, all along the Hess River tributaries (Yukon Environment 2006). Gill (1978) reported moose visited a primary mineral lick along the Hess River tributary (approximately 9 km northwest of the existing Mactung camp) more than any other ungulate occupying the study area (Figures 4.1.9-5 to 4.1.9-7). Moose fidelity to known mineral licks has been previously suggested (Gill 1978). Heavy use of the mineral lick and surrounding area was documented as evidenced by moose antler sheds and heavy browsing in 2006, 2007 and 2008. In 1976, a total of 44 recently shed moose antlers were documented in the immediate vicinity of this mineral lick (Gill 1978). Late winter use of the Hess River Tributary mineral lick was reaffirmed during a 2008 late winter aerial survey (Appendix G4). A relatively high density of both moose and tracks were concentrated around the lick area, and signs of frequent visits to a small open water area were apparent.

Summary

Key habitats for moose browsing, calving, rutting and over-wintering within the study area are summarized in Table 4.1.9-8. Habitats identified herein are considered important to fulfill moose life requisites; however, moose can be expected to occur in additional habitat types throughout the study area.

TABLE 4.1.9-8 SUMMARY OF KEY MOOSE HABITAT WITHIN THE STUDY AREA AND SEASONS OF USE

Life Requisites	Seasonal Use of Key Habitats			
	Spring (April – May)	Summer (June – August)	Fall (September – October)	Winter (November – March)
Browsing (all year)	1) Hess Tributary, Tsichu and South Macmillan river valleys and their tributaries 2) Birch – lichen, willow – sedge, willow – bluebell, willow – slope and spruce – moss habitats 3) Aquatic habitats (rivers, streams, wetlands and beaver ponds) 4) Mineral licks, including those known along the Hess River tributary	1) Hess Tributary, Tsichu and South Macmillan river valleys and their tributaries 2) Birch – lichen, willow – sedge, willow – bluebell, willow – slope and spruce – moss habitats 3) Aquatic habitats (rivers, streams, wetlands and beaver ponds) 4) Mineral licks, including those known along the Hess River tributary	1) Hess Tributary, Tsichu and South Macmillan river valleys and their tributaries 2) Birch – lichen, willow – sedge, willow – bluebell, willow – slope and spruce – moss habitats 3) Aquatic habitats (rivers, streams, wetlands and beaver ponds) 4) Mineral licks, including those known along the Hess River tributary	1) see Over-wintering
Calving (mid May to mid June)	1) Large river and tributary valleys, including the Hess River tributary 2) Subalpine habitats ranging from 1,300 m – 1,500 m 3) Any site with a dense growth of tall shrubs or mature mixed forests with a moderately dense to dense shrub understory	1) Large river and tributary valleys, including the Hess River tributary 2) Subalpine habitats ranging from 1,300 m – 1,500 m 3) Any site with a dense growth of tall shrubs or mature mixed forests with a moderately dense to dense shrub understory	-	-

TABLE 4.1.9-8 SUMMARY OF KEY MOOSE HABITAT WITHIN THE STUDY AREA AND SEASONS OF USE				
Life Requisites	Seasonal Use of Key Habitats			
	Spring (April – May)	Summer (June – August)	Fall (September – October)	Winter (November – March)
Rutting – Post Rutting (September – October)	-	-	1) Mid-elevation river valleys in open conifer (such as fir – moss and spruce – moss habitats) and birch – lichen habitats 2) Same as fall browsing sites. 3) Aquatic habitats (rivers, streams, wetlands and beaver ponds)	-
Over-wintering	-	-	-	1) Willow riparian and mixed willow/conifer habitats 2) Riparian willow habitat along the Tsichu River and related tributary valleys 3) Hess River and its primary tributaries including Tributary A (and the vicinity of the primary mineral lick)

Special Management Requirements and Ongoing Studies

The *SARA*, the *Wildlife Act* (Yukon), and other legislative policy regulating the management and protection of moose have been assessed for the study area. Upon implementation of the Yukon First Nations Final Agreement, a co-management board developed informal management guidelines for moose in the Yukon (Moose Management Team 1996). The Yukon Fish and Wildlife Co-Management guidelines (Moose Management Team 1996) manages harvestable yields for moose within management units.

A summary of special management requirements and known studies and monitoring programs for moose within the study area is provided in Table 4.1.9-9.

TABLE 4.1.9-9 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES - MOOSE			
SARA	*Wildlife Act* (Yukon)	Yukon Fish and Wildlife Co-Management	Ongoing Studies
Unlisted	1) Manages outfitting and hunting 2) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife.	Guidelines for allowable harvest yields	None known to date

4.1.9.5 Dall's Sheep (*Ovis dalli*)

CONSERVATION STATUS – DALL'S SHEEP	
SARA	Unlisted
COSEWIC	Not Evaluated
Wildlife Act (Yukon)	Not listed

Population Status and Regional Harvest Data

Dall's sheep have not been assessed by COSEWIC (2007) and are not considered Specially Protected under the *Wildlife Act* (Yukon) (Government of Yukon 2007b).

Approximately 18,000 Dall's sheep occur in the Yukon (Government of Yukon 2007c). Dall's sheep densities may vary throughout the Yukon and depend upon habitat quality. In the Macmillan Pass area, Gill (1978) indicated a small resident population of 20 – 25 animals. By the early 1980s, this population had decreased significantly; a total of three ewes were observed on two occasions (AMAX 1983). In 1992, surveys conducted across an area of 4,956 km^2, approximately 200 km north of the study area reported a density of 19 sheep per 1,000 km^2 (Latour 1992).

Twelve aerial ungulate surveys were conducted throughout the study area from 2005 – 2008 (including surveys in March, June, July, August, September and October). Supplementary reconnaissance surveys of areas identified by Gill (1978) as Dall's sheep ranges were also conducted in 2006 and 2007. A single ram was observed in the summer of 2007 and 2008 within the study area, and several observations of Dall's sheep sign (tracks and pellet groups) were recorded from 2006 – 2008.

Dall's sheep harvest data are unavailable from the Yukon Fish and Wildlife Branch at the game management subzone level, but are provided at the much broader game management area level, and are therefore not provided for this report.

General Life History and Habitat Requirements

In the Mackenzie Mountains, Dall's sheep, particularly ewe groups (includes ewes and juvenile rams), commonly confine seasonal movements to a specific mountain block.

Seasonal movements include those between summer and winter ranges, as well as to and from mineral licks. However, Simmons (1982) reported young rams and some adult ewes disperse to other mountain blocks. Local seasonal movements within a mountain block are in response to available food resources.

Sheep graze predominantly on grasses and sedges, and some leaves and stems of shrubs and flowering plants. Most important feeding areas are located adjacent to security habitat in the form of steep terrain. In the summer, Dall's sheep disperse across high elevation slopes to the upper limit of vegetation (in the study area between approximately 1,650 m to 2,100 m) (Gill 1978). In early summer, sheep select south facing slopes to exploit new plant growth. By late summer, sheep select cooler and more humid northwest and northeast facing slopes where new plant growth is delayed (Gill 1978).

Wind swept plateaus and ridges free of snow provide important Dall's sheep winter range, as do timberline and other areas with shallow snow and abundant easily accessible graminoid plants (Simmons 1982). In general, good winter habitat is also good summer habitat (Simmons 1982). Winter weather conditions are a major factor influencing Dall's sheep winter distributions, and ultimately population numbers, as population crashes have been documented during severe winters, particularly refreezing after periods of wet snow or thaw (AMAX 1983).

Southerly and south-westerly-facing talus scree slopes, interspersed with cliffs and other rugged steep terrain, are typical lambing areas. Such areas are commonly sparsely vegetated but comprise suitable lambing habitat as they are generally provide security for birthing, nursing, and resting away from both aerial and terrestrial predation. It is likely that lambing range selection is based on a combination of nutritional and security habitat requirements.

Local Distribution and Habitat Use

Gill (1978) reported three habitats are critical for Dall's sheep: wintering areas, lambing areas and mineral licks. Dall's sheep may occur within the study area as year-round residents, and have been observed using the area during the summer of 2007 and 2008. All three aforementioned critical habitat types exist within the study area.

Yukon Environment (Government of Yukon 2006) has mapped Dall's sheep winter, spring lambing, migration corridors, mineral licks, and rutting areas throughout the Yukon. Only key Dall's sheep winter range has been mapped within the study area (Figure 4.1.9-8) (refer to the winter section below for location details). The nearest key Dall's sheep lambing area exists along the Hess River (Government of Yukon 2006), approximately 26 km northeast of the mine site (or approximately 6 km northeast of the study area border).

Summer

Gill (1978) documented Dall's sheep occupied summer habitat (June to September 1974 – 1977) approximately 3.0 km northwest and 3.5 km south of the Mactung camp. Based on pellet distribution and densities, Dall's sheep were reported to favour sedge – bluebell, fescue – sedge, fescue – willow and heath – lichen habitats in the summer (Gill 1978).

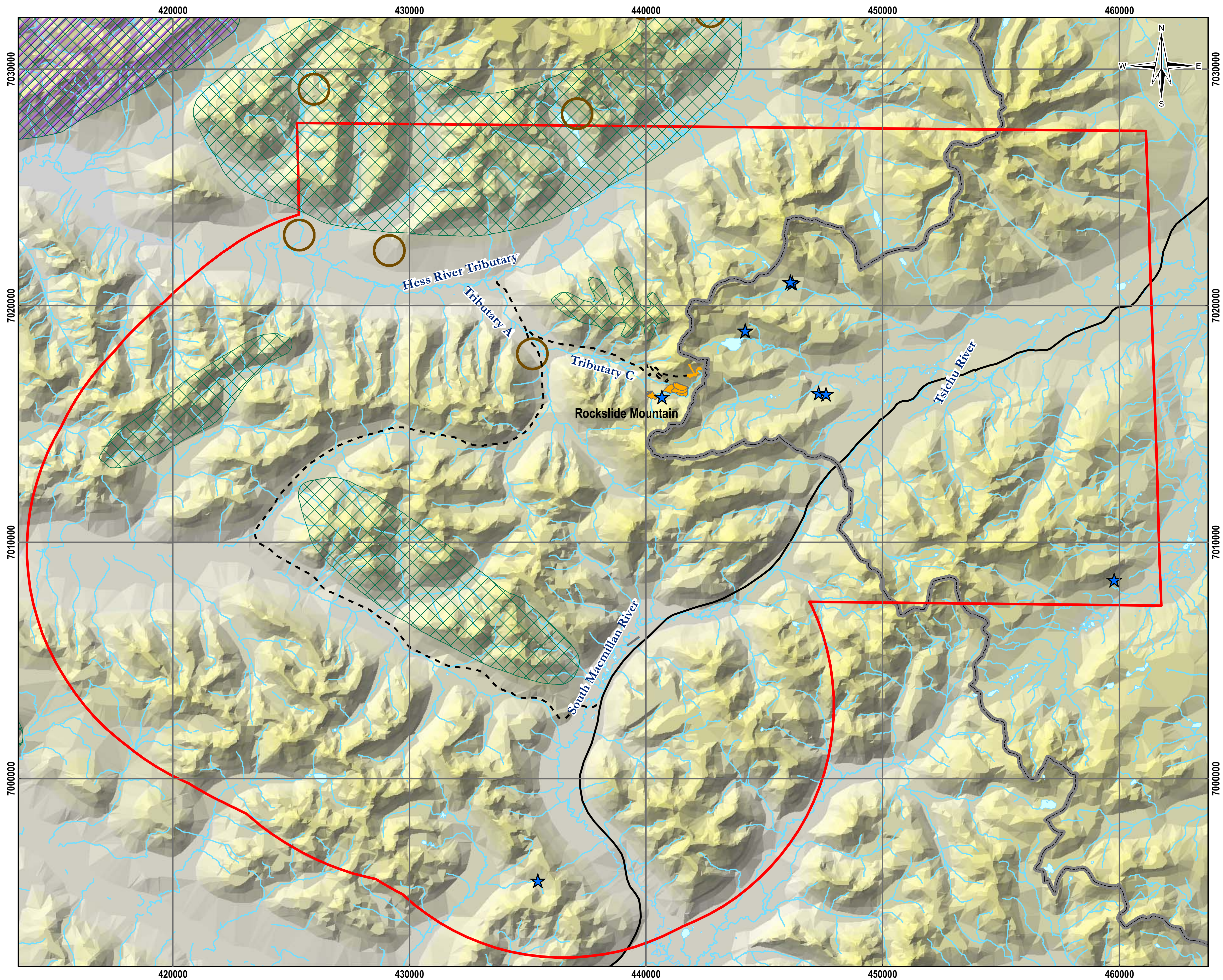
A single mature ram was observed during the summer of 2007, which occupied heath – lichen habitat at mid alpine elevations (Figure 4.1.9-8). Eight observations of Dall's sheep sign (pellet groups and tracks) were recorded in 2006, and a single Dall's sheep track (laid down approximately 2 – 4 weeks prior) was also documented along the Canol Road in June 2007 (Figure 4.1.9-8). Based on these observations, Dall's sheep are presumed to be present in the study area at low densities.

Winter

As indicated by the key areas map (Government of Yukon 2006) and aerial surveys completed in the study area (Gill 1978; AMAX 1983), Dall's sheep winter range occurs in the study area across from the Hess River tributary (northwest corner of the study area approximately 9.5 km northwest of Mactung camp), approximately 2.5 km west of Mactung camp, and in the southwest corner of the study area (approximately 12 km southwest of Mactung camp) (Figure 4.1.9-8). Although Dall's sheep winter range has been delineated within the study area, Gill (1978) indicated the study area provides poor Dall's sheep winter range due to high winter snowfalls. Dall's sheep winter ranges have also been documented outside the study area (Government of Yukon 2006). These mountain blocks are orientated in an east-west direction, which channels prevailing winds and creates areas of less snow. Other mountain blocks in the study area which have higher elevations than these areas, such as Rockslide Mountain (approximately 4 km southwest of Mactung camp) are used solely in the summer due to its poor orientation for winter snow accumulation (Gill 1978). Gill (1978) reported Dall's sheep wintering approximately 3.0 km northwest of camp. Gill (1978) documented that Dall's sheep occupy heath-lichen habitat above 1,800 m elevation within the study area during the winter. Following these winter observations, population declines were observed by AMAX (1983), which appeared to be associated with warm wet conditions in late winter followed by extreme cold (as interpreted from local climate data). These weather conditions would have created thick, hard crusted snow, which may have reduced food availability and resulted in die off and or emigrations outside the study area.

Spring - Lambing

A consequence of this poor winter range is weakened lambs in the spring (Gill 1978). Resident sheep could potentially lamb in the study area based on the presence of broken rugged cliffs which ewes commonly favour. The key areas maps indicate no important spring lambing areas are present in the study area (Government of Yukon 2006). The nearest documented important lambing areas exist approximately 25 km northwest of the Mactung camp, along the Hess River (Figure 4.1.9-8). However, in June 2006, EBA (Appendix G2) reported tracks of a ewe and lamb along the Mactung mine road. As indicated by these tracks, some lambing may occur in the area.



LEGEND

- Dall's Sheep Observations (Visual or Sign) During Baseline Studies 2005-2008
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Regional Wildlife Study Area
- Mineral Lick (Yukon Government, 2006)
- Key Lambing Range (Yukon Government, 2006)
- Key Winter Range (Yukon Government, 2006)
- North Canol Rd
- NWT - Yukon TerritoryBorder
- Macmillan Pass Aerodrome
- Watercourse
- Waterbody

ISSUED FOR USE

NOTES

Base data source: NTDB 1:50,000, 1:250,000,
Site Plan adapted from original provided by Wardrop

MACTUNG

Dall's Sheep Annual Distribution

PROJECTION			DATUM
UTM Zone 9			NAD83

Scale: 1:160,000

4 2 0 4

Kilometers

FILE NO.			
W23101110_001_WL_Sheep_Annual.mxd			
PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KL	1
OFFICE	DATE		
EBA-VANC	December 4, 2008		

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EBA Engineering Consultants Ltd.

Figure 4.1.9-8

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Mineral Licks

Based on the Yukon Environment (Government of Yukon 2006) key areas maps, there are five mineral licks within or immediately adjacent to the study area (all located within the Hess River tributary system) (Figure 4.1.9-8). The nearest mineral lick to the Mactung camp (approximately 9 km northwest of Mactung camp) was surveyed by Gill (1978) and EBA (Appendices G1 to G4). Gill (1978) reported 13% of all Dall's sheep sightings within the study area occurred at this mineral lick. These sightings occurred during early summer and were mostly ewe and lamb groups. Most recent surveys reported a single Dall's sheep track at this mineral lick (Appendix G2).

Fidelity to mineral licks has been reported in Dall's sheep (Simmons 1982). Well-established sheep trails typically lead to licks, which are used most frequently in the spring and early summer. Simmons (1982) suggests the location of mineral licks determines the size and shape of summer ranges in the Mackenzie Mountains. Simmons (1982) reported ewe groups travelled 4.8 to 19.3 km from summer feeding areas to a mineral lick along the Keele River. It has also been suggested mineral licks assists in maintaining genetic diversity among Dall's sheep, since young rams interact with other family groups at mineral licks, and follow them onto new ranges (Simmons 1982).

Summary

Since observations of Dall's sheep and their sign were limited within the study area, it is difficult to delineate key habitats specific to the study area. Key habitats for Dall's sheep within the study area were provided from literature review and former surveys in the study area Table 4.1.9-10.) Habitats identified herein are considered important to fulfill Dall's sheep life requisites; however, they can be expected to occur in additional habitat types throughout the study area, particularly during dispersal and movements to and from mineral licks. It is important to note, Dall's sheep exhibit fidelity to traditional lambing, summer and winter ranges.

TABLE 4.1.9-10 SUMMARY OF KEY DALL'S SHEEP HABITAT WITHIN THE STUDY AREA AND SEASONS OF USE

Life Requisites	Seasonal Use of Key Habitats			
	Spring (April - May)	Summer (June - August)	Fall (September - October)	Winter (November - March)
Lambing (mid to late May)	1) South and south-west facing scree slopes with steep escape terrain	-	-	-
Foraging (all year)	1) Mineral licks 2) Foraging areas dependent upon lambing	1) High elevational habitats from 1,650 m to	1) High elevational habitats from 1,650 m to 2,100 m adjacent to steep escape	1) High elevational habitats from 1,800 to 2,100 m adjacent to steep escape

TABLE 4.1.9-10 SUMMARY OF KEY DALL'S SHEEP HABITAT WITHIN THE STUDY AREA AND SEASONS OF USE				
Life Requisites	Seasonal Use of Key Habitats			
	Spring (April - May)	Summer (June - August)	Fall (September - October)	Winter (November - March)
	requirements for ewe groups 3) South facing slopes	2,100 m adjacent to steep escape terrain 2) South facing slopes 3) Mineral licks 4) Sedge – bluebell, fescue – sedge, fescue – willow and heath – lichen habitat types	terrain 2) Northwest and northeast slopes 3) Mineral licks 4) Sedge – bluebell, fescue – sedge, fescue – willow and heath – lichen habitat types	terrain 2) Snow free, wind exposed plateaus and ridges, timberline and other areas with shallow snow 3) Mountain blocks orientated in an east-west direction 4) Heath – lichen habitat type
Over-wintering				See Winter Foraging habitats

Special Management Requirements and Ongoing Studies

Dall's sheep have not been assessed by COSEWIC, and therefore are not listed under the SARA. However, the *Wildlife Act* (Yukon) includes provisions to manage Dall's sheep populations, particularly harvest yields and harassment regulations.

A summary of appropriate special management requirements and known studies and monitoring programs for Dall's sheep within the study area is provided in Table 4.1.9-11.

TABLE 4.1.9-11 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES – DALL'S SHEEP			
SARA	*Wildlife Act* (Yukon)	Yukon Fish and Wildlife Co-Management	Ongoing Studies
Unlisted	1) Manages outfitting and hunting 2) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife.	Guidelines for allowable harvest yields	None known to date

4.1.9.6 Grizzly Bear (*Ursus arctos*)

CONSERVATION STATUS – GRIZZLY BEAR	
SARA	Unlisted
COSEWIC	Species of Special Concern
***Wildlife Act* (Yukon)**	Not listed.

Population Status and Regional Harvest Data

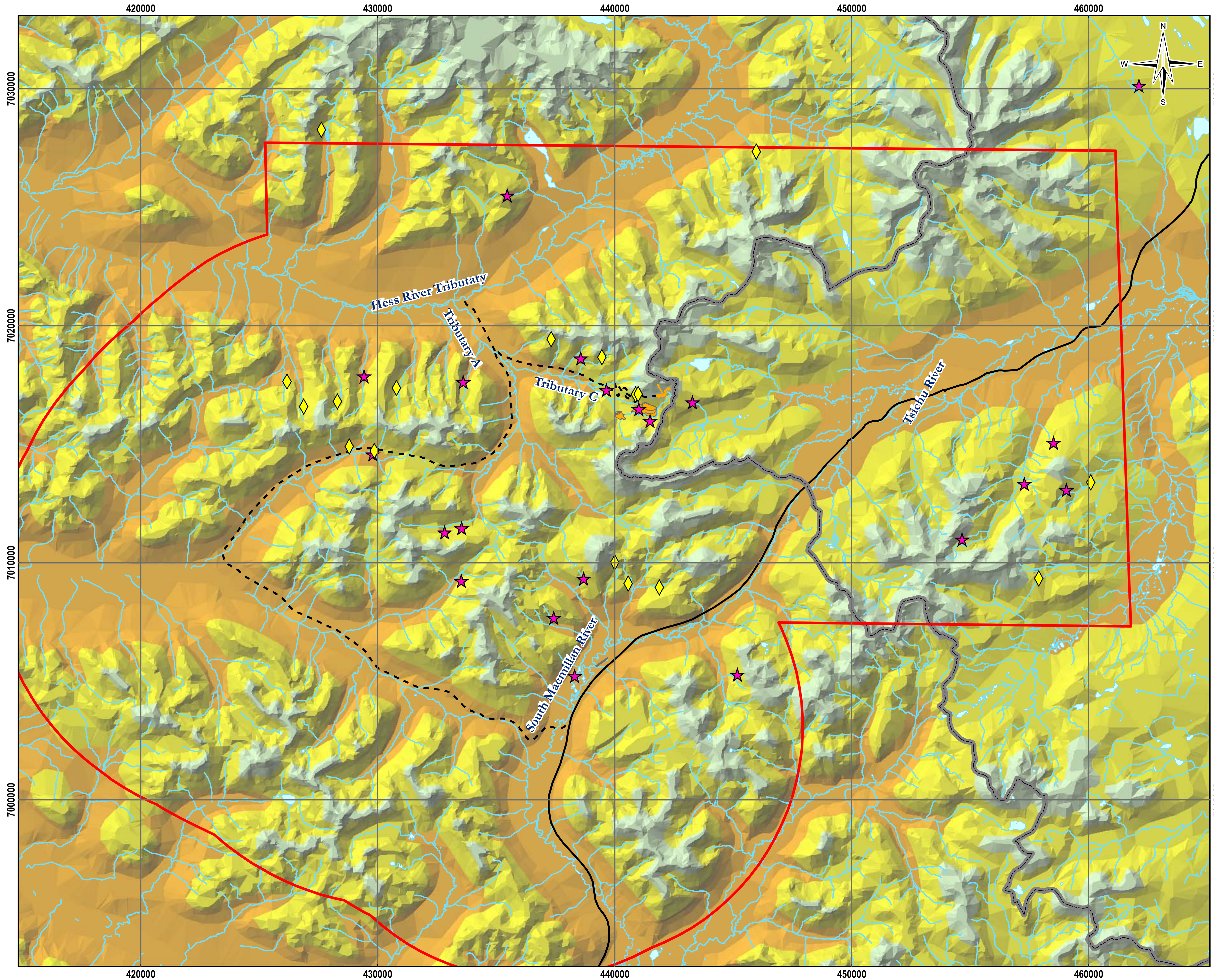
Nationally, grizzly bears are listed as a species of Special Concern (COSEWIC 2007), but are not listed under the federal *Species at Risk Act*.

An estimated 6,000 – 7,000 grizzly bears may occur in the Yukon (Bear Management Team 1997). Miller *et al.* (1982) estimated relative female grizzly bear densities in a 3,000 km^2 area (immediately east of the study area) as one per 289.16 km^2. Density estimates have not been reported within the study area. Based on the size of the total study area (approximately 1,200 km^2) and relative density estimates of female grizzlies (deduced from Miller et al. [1982] of one female every 289.16 km^2), the study area has the potential to support at least four female home territories and a small transient population. Information on grizzly bears within the study area has been deduced from numerous incidental grizzly bear observations and literature reviews. Grizzly bear harvest data was unavailable from the Yukon Fish and Wildlife Branch at the time of preparing this report.

General Life History and Habitat Requirements

The average female grizzly bear in the Mackenzie Mountains has a minimum home range of approximately 265 km^2; however, the home range of each individual varies in size from year to year (Miller et al. 1982). Grizzly bear habitat use outside of the denning season is complex and a function of many factors including plant phenology and the availability of mammalian prey. Grizzly bears are omnivorous. In spring and summer their diet consists primarily of over-wintered berries, roots, emergent grasses, horsetail and sedges, and by late summer and fall their diet consists primarily of berries and roots (Gill 1978). Small mammals, such as marmots and ground squirrels, which they excavate from burrows, are also eaten outside the denning season. Bears are opportunistic predators and will kill caribou, moose, sheep, and their young if opportunity arises. In the Mackenzie Mountains, meat was found to constitute 3 % of grizzly bear diets, whereas horsetail and alpine hedysarum comprised 60 % of grizzly bears' diet (Miller et al. 1982).

Grizzly bears occupy a variety of habitat types that are found throughout the study area from low elevation valleys to high alpine tundra. A general seasonal elevational shift in habitat occupancy has been documented in response to available food resources. In early summer (June and July), grizzly bears commonly occupy alpine areas, and begin to move down slope to subalpine areas by August when berries begin to ripen (Gill 1978; Miller *et al.* 1982). In September, subalpine and alpine habitats are used equally, and as the denning season approaches, grizzly bears commonly move higher in elevation until den emergence (Miller *et al.* 1982).



LEGEND

- Grizzly Bear Observations (Visual or Sign) 2005-2008
- Potential Bear Den
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Regional Wildlife Study Area
- North Canol Rd
- NWT - Yukon Territory Border
- Macmillan Pass Aerodrome
- Watercourse
- Waterbody

Habitat Interpretations - Potential Use

- High Use Denning and Foraging Habitat (1400-1800m Elevation)
- Moderate Use Foraging Habitat(<1400m Elevation)

ISSUED FOR USE

NOTES

Base data source: NTDB 1:50,000, 1:250,000,
Site Plan adapted from original provided by Wardrop

MACTUNG

Distribution of Grizzly Bear Observations within the Wildlife Regional Study Area

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:160,000

4 2 0 4

Kilometers

FILE NO.
W23101110_001_WL_Grizzly_Annual.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KL	1

OFFICE	DATE
EBA-VANC	December 4, 2008

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Figure 4.1.9-9

Miller *et al.* (1982) reported grizzly bears in the Mackenzie Mountains den predominantly on southeast facing slopes ranging from 31º to 38 º, and between 1,402 to 1,829 m in elevation. Seventeen of the 22 dens observed by Miller *et al.* (1982) occurred in alpine habitat, three in subalpine habitat, and two in white spruce forest habitats. Grizzly bears begin to enter dens in October and emerge in late March (males) to late April (females). While hibernating, pregnant females give birth to cubs in February.

Local Distribution and Habitat Use

Key spring, summer and fall areas within the Yukon have been delineated by the Yukon Environment (Government of Yukon 2006); however, no key grizzly bear areas were identified within the study area or neighbouring properties.

Grizzly bear, Mactung property, 2007

For a six-year period in the mid 1970's, AMAX personnel continually reported a sow grizzly with cubs in the east-central portion of the study area (Gill 1978). This particular sow produced two cubs every three to four years in that six-year observation time (Gill 1978). In addition, several observations of a single bear were recorded. These single bear observations were explained as part of a transient population.

Since 2005, EBA (Appendices G1 to G4) reported a total of 67 grizzly bear observations including visuals, dens, tracks, and digs within the study area (Figure 4.1.9-9). Of the 67 grizzly bear observations, a total of 14 grizzly bears were observed in 2006, seven in 2007 and 13 in 2008 (Figure 4.1.9-9). Several of these observations included a sow with cubs.

In particular, a sow with three cubs was detected approximately 2.5 km east of Mactung camp in 2006, and an additional observation of a sow with three cubs was recorded approximately 3.8 km northwest of camp in 2007. It is assumed these observations included the same sow and represent a productive territory near the Mactung camp. In general, observations of sows and cubs were within subalpine valley habitats.

Winter – Denning

Past surveys did not observe grizzly dens within the study area, but reported denning habitat exists within the study area (Gill 1978; AMAX 1983). A total of 17 den sites were recorded during contemporary surveys (Appendices G1 to G3), eight of which were within a 10 km radius of Mactung camp (Figure 4.1.9-9). All dens were situated on steep slopes between 1,400 - 1,800 m elevations and commonly occurred in the Yukon portion of the study area (Appendices G1 to G3). Most of the dens displayed a southerly aspect, but two dens were located with an easterly aspect and two west (Appendices G1 to G3). Fescue – willow and epilithic - lichen habitats, that have appropriate soil conditions, are considered important denning habitat. Typical den site characteristics in the Mackenzie Mountains include steep southeasterly slopes in alpine habitat; however, subalpine and forest dens have been documented (Miller *et al.* 1982).

Spring, Summer and Fall

Sedge – bluebell habitat types, which occur in gentle sloping sheltered valleys (particularly Cirque Lake and upper Tsichu River area) ranging in elevation between 1,370 m to 1,620 m, were considered by Gill (1978) as an important habitat type. Several other habitat types provide appropriate forage for grizzly bears at some point in the year. Willow – sedge habitats occur in stream and river floodplains and include an abundance of horsetail for early summer forage. Fescue – willow habitats (particularly those with a high abundance of alpine Hedysarum), located on moist alpine meadows, also provide favourable summer grizzly bear habitat. Heath – lichen habitats in exposed well drained alpine sites also support a variety of berry producing plants which begin to ripen in mid-August. These important habitat types exist throughout the entire study area wherever appropriate site conditions occur.

Summary

A summary of key grizzly bear habitats and their seasons of use is provided in Table 4.1.9-12. Habitats identified herein are considered important to fulfill grizzly bear life requisites; however, grizzly bears can be expected to occur in additional habitat types throughout the study area.

TABLE 4.1.9-12 SUMMARY OF KEY GRIZZLY BEAR HABITAT (IN THE STUDY AREA) AND SEASONS OF USE

Life Requisites	Seasonal Use of Key Habitats			
	Spring (April - May)	Summer (June – August)	Fall (September - October)	Winter (November - March)
Denning (first week of October – late April)	1) Generally steep alpine slopes between 1,402 - 1,829 m most favoured; however subalpine and forest dens have also been reported 2) Slopes with southeasterly aspects most favoured 3) Fescue – willow and epilithic – lichen habitats with appropriate soil conditions for denning	-	1) Generally steep alpine slopes between 1,402 - 1,829 m most favoured; however subalpine and forest dens have also been reported 2) Slopes with southeasterly aspects most favoured 3) Fescue – willow and epilithic – lichen habitats with appropriate soil conditions for denning	1) Generally steep alpine slopes between 1,402 - 1,829 m most favoured; however subalpine and forest dens have also been reported 2) Slopes with southeasterly aspects most favoured 3) Fescue – willow and epilithic – lichen habitats with appropriate soil conditions for denning
Foraging (during all non-denning periods)	1) All habitats with available food resources, including plants, small mammals and other opportunistic prey 2) Generally occupy alpine habitat 3) Sedge – bluebell and willow – sedge habitat types	1) All habitats with available food resources, including plants, small mammals and other opportunistic prey 2) Generally, occupy alpine areas in June and July, and subalpine areas in August following plant phenology 3) Fescue – willow, sedge – bluebell, willow – bluebell, sedge – cinquefoil, willow – sedge and heath – lichen habitat types	1) Habitats including berries and roots 2) Generally occupy subalpine and alpine habitats equally 3) Fescue – willow, sedge – bluebell, willow – bluebell and heath – lichen habitat types	-

Special Management Requirements and Ongoing Studies

Grizzly bears are listed as a species of Special Concern by COSEWIC; however, they are not listed under the SARA nor are they listed as Specially Protected under the Wildlife Act (Yukon). However, the *Wildlife Act* (Yukon) manages the harvest of species and prohibits harassment and the encouragement or attraction of nuisance or dangerous wildlife, including grizzly bears. A summary of special management requirements and known studies and monitoring programs for grizzly bears within the study area is provided in Table 4.1.9-13.

TABLE 4.1.9-13 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES – GRIZZLY BEAR

SARA	*Wildlife Act* (Yukon)	Yukon Fish and Wildlife Co-Management	Ongoing Studies
Unlisted	1) Manages outfitting and hunting 2) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife. 3) Prohibits attracting or encouraging dangerous or nuisance wildlife. No person shall leaving garbage or other attracting substances in a place accessible by wildlife, and must take reasonable precaution to prevent wildlife access or being attracted to a site.	Guidelines for allowable harvest yields	None known to date

4.1.9.7 Wolf (*Canis lupus*)

CONSERVATION STATUS – WOLF	
SARA	Unlisted
COSEWIC	Not Evaluated
***Wildlife Act* (Yukon)**	Not listed

Population Status and Regional Harvest Data

No current estimates of wolf populations for the region exist, either in the Yukon or the Northwest Territories. In addition, no known wolf studies have been conducted within the study area.

Harvest data are not an accurate indication of population size but rather an indicator of effort (H. Slama, pers. comm.). In the Yukon, harvest data from the Ross River area (registered trapping concession #405) from 1980 to 2006 indicated a total of 380 wolves were harvested from the Ross River area (Government of Yukon unpublished data). Forty nine percent of the wolves were harvested in the 1980's, 16% in the 1990's and 35% in the 2000's (Government of Yukon unpublished data).

General Life History and Habitat Requirements

The northern grey wolf is known to occupy a variety of habitat types. Wolf packs occupy a defended territory that varies in size, and may occasionally overlap a neighbouring territory. Lone wolves travel across much larger areas.

Wolves are habitat generalists and their distribution across a landscape corresponds to prey distribution and abundance. Large mammals, such as moose, caribou, and Dall's sheep comprise the majority of wolf diets, although diets also include beaver, other small mammals and birds. Wolves that rely on moose as their primary food source tend to occupy low valley systems and subalpine habitats more often, than compared to wolves that rely on Dall's sheep.

In the spring, when the pups are born (late May or early June), the female usually remains near the den while the remaining pack members hunt and bring back food. In the summer, the pack remains relatively near the den site; however, in winter the pack can travel long distances in search of food. Dens are commonly constructed in the ground usually in sandy soil, within a rock crevice, or overturned stump, and may be re-used year after year (Mech 1974). Dens are commonly constructed on sites higher than the surrounding area (used as a look-out), sites with a southerly aspect and near water. Appropriate denning habitat occurs in valley forests and subalpine habitats throughout the study area.

Local Distribution and Habitat Use

Key wildlife areas within the Yukon have been delineated by the Yukon Environment (Government of Yukon 2006); however, no key wolf areas were identified within or neighbouring the study area.

Grey wolves are expected to occur in all habitat types throughout the study area. In 2005, a pack of five wolves were observed in a forested habitat along the South Macmillan River near the Canol Road, immediately south of the study area (Appendix G1). Two additional wolves were observed in 2008; including a single wolf near the Mactung camp and one along an alpine ridge near the proposed mine access road. Four observations of wolf sign, including scat and tracks were also recorded in the study area during the 2005 – 2008 field programs (Appendices G1, G2, G5). Wolf sign was recorded in low valley habitats (particularly the Tsichu River valley) and subalpine valleys.

Both Kershaw and Kershaw (1983) and Gill (1978) reported an absence of wolves or wolf sign in high elevations during summer aerial surveys. Based on the lack of observations, Kershaw and Kershaw (1983) suggested wolves occupied low elevation habitats during the summer, particularly during denning. Outside aerial surveys, Kershaw and Kershaw (1983) observed a solitary wolf on two separate occasions following the mine site road and Canol road, respectively. In the fall, a pack of four wolves were observed in alpine heath – lichen habitat.

A summary of key wolf habitats and seasons of use within the study area is provided in Table 4.1.9-14.

TABLE 4.1.9-14 SUMMARY OF KEY GREY WOLF HABITAT WITHIN THE STUDY AREA AND SEASONS OF USE

Life Requisites	Seasonal Use of Key Habitats			
	Spring (April – May)	Summer (June – August)	Fall (September – October)	Winter (November – March)
Denning	1) Valley forests and subalpine habitats 2) Dens constructed in the ground, within a rock crevice, or overturned stump	-	-	-
Foraging (all year)	1) Wherever appropriate prey exist 2) Pack remains relatively close to den site 3) Game trails, ridges, roads and other linear features as travel corridors	1) Wherever appropriate prey exist 2) Game trails, ridges, roads and other linear features as travel corridors	1) Wherever appropriate prey exists, including habitats further away from the den site 2) Game trails, ridges, roads and other linear features as travel corridors	1) Wherever appropriate prey exists, including habitats far away from the den site 2) Game trails, frozen waterways, roads and other linear features for travel corridors

Special Management Requirements and Ongoing Studies

Grey wolves have not been assessed by COSEWIC, nor are they listed as Specially Protected under the *Wildlife Act* (Yukon). However, the *Wildlife Act* (Yukon) manages the harvest of species and prohibits harassment and the encouragement or attraction of nuisance or dangerous wildlife, including wolves.

In the Yukon, specific wolf populations have been managed by the Yukon Government to protect local caribou herds. To date, the Yukon Government has not managed wolves within the study area.

A summary of special management requirements and known studies and monitoring programs for grey wolves within the study area is provided in Table 4.1.9-15.

TABLE 4.1.9-15 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES – GREY WOLF			
SARA	*Wildlife Act* (Yukon)	Yukon Fish and Wildlife Co-Management	Ongoing Studies
Unlisted	1) Manages outfitting, hunting and trapping 2) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife. 3) Prohibits attracting or encouraging dangerous or nuisance wildlife. No person shall leaving garbage or other attracting substances in a place accessible by wildlife, and must take reasonable precaution to prevent wildlife access or being attracted to a site.	None known	None known to date

4.1.9.8 Wolverine (*Gulo gulo*)

CONSERVATION STATUS – WOLVERINE	
SARA	Unlisted
COSEWIC	Not Evaluated
***Wildlife Act* (Yukon)**	Not listed

Population Status and Regional Harvest Data

Nationally, the wolverine is listed as a species of Special Concern by COSEWIC (2007), but is not listed under the federal SARA. Wolverines are distributed throughout all habitat types in the Yukon. (Government of Yukon 2007d).

In the Yukon, population estimates for wolverines are unknown; however, wolverines are considered common (Government of Yukon 2007d). The Government of Yukon considers wolverines as abundant in mountainous regions, particularly those that comprise a variety of habitats and a diversity of prey. The southwest Yukon, considered the best wolverine habitat in the Yukon, supports approximately one wolverine per 180 km^2 (Government of Yukon 2007d). Golden et al. (2007) estimated wolverine population densities in the Old Crow Flats area of northern Yukon at 9.7 wolverines per 1,000 km^2, and in the upper Turnigan arm and Kenai Mountains of South-central Alaska at 3 wolverines per 1,000 km^2.

To date, studies targeting the study of wolverines within the study area have not been conducted. Information on wolverines within the study area has been deduced from a few incidental observations and literature reviews.

Harvest data from the Ross River area (registered trapping concession #405) from 1980 to 2006 indicated a total of 420 wolverines were harvested from the Ross River area, of which 44% were harvested from the 1980's and 17% from the 2000's (Government of Yukon unpublished data).

General Life History and Habitat Requirements

Wolverines are mainly solitary and have large home ranges in response to food availability, and live at naturally low population densities. Wolverines occupy all habitat types within the study area, particularly wherever food resources occur. Wolverines' diet is diverse and incorporates scavenged items, small mammals, birds and their eggs, vegetable matter (berries, roots) and insects. Wolverines also prey on caribou, moose and Dall's sheep young. Gill (1978) observed a wolverine prey upon and kill an 11 month old Dall's sheep which was already in a weakened state.

Wolverine distribution commonly follows a seasonal elevation trend in response to food availability and abundance. Based on telemetry data, wolverines commonly occupy higher elevations in the summer and lower elevations in the winter (Pasitschniak-Arts and Lariviere 1995). In the spring and summer, eggs, insects, berries and small mammals make up much of the wolverines diet. Whereas in winter, the wolverines light weight-to-foot surface ratio allows larger mammals to be preyed upon more readily (Gill 1978; Pasitschniak-Arts and Lariviere 1995). Excess food is cached in shallow snow and soil dens, commonly near the kill site or near parturition dens (Pasitschniak-Arts and Lariviere 1995).

Females dig shallow soil pits prior to parturition and lactation. Females give birth from January through April, with most birthing sometime before late March (Pasitschniak-Arts and Lariviere 1995). Like grizzly bears, wolverines commonly construct dens in alpine or subalpine habitats (although forest habitats are occasionally used) with southerly exposures (Pasitschniak-Arts and Lariviere 1995).

Local Distribution and Habitat Use

Key wildlife areas within the Yukon have been delineated by the Yukon Environment (Government of Yukon 2006); however, no key wolverine areas were identified within or neighbouring the study area.

Wolverines are year-round residents and are distributed throughout the study area. In the study area, wolverines may occupy a range of habitats, including forested valleys to alpine tundra.

EBA (Appendices G1 to G3) observed two wolverines (female and kit) approximately 9.5 km southwest of camp in the subalpine, as well as wolverine tracks along the Tsichu River in 2006. In March 2008, five observations of wolverine tracks were made along alpine ridge tops and one track was noted in riparian valley habitat. These wolverine tracks were long ranging, often traveling over several ridgelines. In surveys conducted at the Mactung site by AMAX (1976), wolverine tracks were also observed during every survey (October 1976 – March 1976).

A summary of key wolverine habitats and seasons of use within the study area are provided in Table 4.1.9-16.

TABLE 4.1.9-16 SUMMARY OF KEY WOLVERINE HABITAT WITHIN THE STUDY AREA AND SEASONS OF USE

Life Requisites	Seasonal Use of Key Habitats			
	Spring (April – May)	Summer (June – August)	Fall (September – October)	Winter (November – March)
Denning (parturition dens) (January to April)	1) Commonly den on slopes with southerly exposures in alpine or subalpine habitats	-	-	1) Commonly den on slopes with southerly exposures in alpine or subalpine habitats
Foraging (all year)	1) Wherever appropriate prey exist 2) Generally occupy subalpine and alpine habitats	1) Wherever appropriate prey exist 2) Generally occupy subalpine and alpine habitats	1) Wherever appropriate prey exist 2) Generally occupy low valley and subalpine habitats	1) Wherever appropriate prey exist 2) Generally occupy low valley and subalpine habitats

Special Management Requirements and Ongoing Studies

Wolverines have been listed as a species of Special Concern by COSEWIC; however, they are not listed under the SARA, nor are they listed as Specially Protected under the *Wildlife Act* (Yukon). However, the *Wildlife Act* (Yukon) manages the harvest of species and prohibits harassment and the encouragement or attraction of nuisance or dangerous wildlife.

A summary of special management requirements and known studies and monitoring programs for wolverines within the study area is provided in Table 4.1.9-17 below.

TABLE 4.1.9-17 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES – WOLVERINE

SARA	*Wildlife Act* (Yukon)	Yukon Fish and Wildlife Co-Management	Ongoing Studies
Unlisted	1) Manages hunting and trapping 2) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife. 3) Prohibits attracting or encouraging dangerous or nuisance wildlife. No person shall leaving garbage or other attracting substances in a place accessible by wildlife, and must take reasonable precaution to prevent wildlife access or being attracted to a site.	None known	None known to date

4.1.9.9 Small Mammals

Included in the small mammal category are commercial furbearing species such as the beaver, muskrat, fox and marten, as well as other less well known non-game species such as bats, shrews, voles and ground squirrels. Small mammals, as a species category or assemblage, are a large and diverse group of species, with varying life histories and habitat requirements, making generalization difficult.

Population Status and Regional Harvest Data

The population densities of small mammals in the Yukon are relatively unknown. Table 4.1.9-18 lists the small mammals potentially occurring in the study area, along with their conservation status and whether their presence was confirmed during baseline studies. A total of 36 small mammal species occur, or potentially occur, within the study area, of which nine were identified during baseline studies.

TABLE 4.1.9-18 SMALL MAMMAL SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE STUDY AREA

Common Name	Scientific Name	Conservation Status (SARA / COSEWIC)
River Otter	*Lutra canadensis yukonensis*	Not Assessed
American Marten	*Martes americana*	Not Assessed
Red Fox*	*Vulpes vulpes*	Not Assessed
Canada Lynx	*Lynx Canadensis*	Not At Risk
Ermine	*Mustela erminea*	Not Assessed
Least Weasel	*Mustela nivalis*	Not Assessed
Fisher	*Martes pennanti*	Not Assessed
American Mink	*Mustela vison*	Not Assessed
Little Brown Myotis	*Myotis lucifugus*	Not Assessed
Pygmy Shrew	*Microsorex hoyi*	Not Assessed
Arctic Shrew	*Sorex arcticus tundrensis*	Not Assessed
Masked Shrew	*Sorex cinereus*	Not Assessed
Dusky Shrew	*Sorex obscurus*	Not Assessed
Water Shrew	*Sorex palustris*	Not Assessed
Snowshoe Hare*	*Lepus americanus*	Not Assessed
Collared Pika*	*Ochotona collaris*	Not Assessed
Beaver*	*Castor canadensis*	Not Assessed
Muskrat	*Ondatra zibethicus*	Not Assessed
Meadow Jumping Mouse	*Zapus hudsonius*	Not Assessed
Deer Mouse	*Peromyscus maniculatus*	Not Assessed
American Porcupine	*Erethizon dorsatum*	Not Assessed
Northern Bog Lemming	*Synaptomys borealis*	Not Assessed
Brown Lemming*	*Lemmus trimucronatus*	Not Assessed

TABLE 4.1.9-18 SMALL MAMMAL SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE STUDY AREA		
Common Name	Scientific Name	Conservation Status (SARA / COSEWIC)
Northern Red-backed Vole*	*Clethrionomys rutilus*	Not Assessed
Long-tailed Vole	*Microtus longicaudus*	Not Assessed
Singing Vole	*Microtus miurus*	Not Assessed
Taiga Vole	*Microtus xanthognathus*	Not Assessed
Tundra Vole	*Microtus oeconomus*	Not Assessed
Meadow Vole	*Microtus pennsylvanicus*	Not Assessed
Northern Flying Squirrel	*Glaucomys sabrinus*	Not Assessed
Hoary Marmot*	*Marmota caligata*	Not Assessed
Woodchuck	*Marmota monax*	Not Assessed
Arctic Ground Squirrel*	*Spermophilus parryii*	Not Assessed
Least Chipmunk*	*Eutamias minimus*	Not Assessed
Red Squirrel	*Tamiasciurus hudsonicus*	Not Assessed
Bushy-tailed Woodrat	*Neotoma cinerea*	Not Assessed

* species observed within the study area (AMAX 1982; Appendices G2 and G5)

AMAX (1983) conducted small mammal surveys in the study area between 1977 and 1981. Contemporary small mammal information is limited to incidental observations during the 2005 – 2008 baseline studies.

Several species of small mammals are harvested in the Yukon; however, specific harvest levels within the study area are relatively unknown. Harvest data from the Ross River area (registered trapping concession #405) indicated over 15,000 small mammals were harvested from the Ross River area from 1980 to 2006 (Government of Yukon unpublished data). Table 4.1.9-19 summarizes this small mammal harvest data.

TABLE 4.1.9-19 SUMMARY OF SMALL MAMMAL HARVEST DATA, ROSS RIVER AREA (1980 – 2006)[1]			
Harvested Species	Total Number Harvested (1980 – 2006)	Harvested Species	Total Number Harvested (1980 – 2006)
Beaver	1,397	American Mink	582
Fisher	5	Muskrat	2,879
Lynx	2,552	River Otter	35
American Marten	13,173	Red Fox	816
Red Squirrel	13,647	Weasel	938

1. Government of Yukon unpublished data

General Life History and Habitat Requirements

Small mammals are likely to occur in all habitat types within the study area including the alpine, subalpine and valleys. Species occupancy of these areas depends on a number of abiotic and biotic factors including food availability, protective cover, climate and permafrost.

Small mammals are a vital component in the health of natural ecological systems. Small mammals such as voles, lemmings, snowshoe hares, ground squirrels and hoary marmots are important prey species for a number of larger predators such as grizzly bears, lynx and raptors as well as other smaller carnivores such as weasels and martens. Fluctuations of small mammal populations are echoed in predator populations; for example the well documented lynx and snowshoe hare cycles.

In addition, furbearers such as beaver, muskrat, marten and snowshoe hare are harvested and considered important economic species. These commercial species are expected to occur throughout most of the forested valleys within the study area.

Local Distribution and Habitat Use

The Government of Yukon (2006) has not mapped any key small mammal areas within or neighbouring the study area; and little to no information exists on the local distribution and habitat use within the study area.

A small mammal survey was conducted in the Mactung mine area by AMAX between 1977 and 1981 (AMAX 1983). During this study, small mammal traplines were set within ten plant communities. Twenty seven individual animals representing four different species were trapped, including 22 red-backed voles (*Clethrionomys rutilus*), two brown lemmings (*Lemnus sibiricus*), one least chipmunk (*Eutamus minimus*) and two red shrews (*Sorex sp.*). Sedge - bluebell and birch-moss habitats were found to have the largest rodent populations. The sedge - bluebell, sedge – cinquefoil, birch-moss, birch-lichen, fescue - willow and willow - sedge plant communities represented 99% of the small mammal biomass sampled during the study.

Special Management Requirements and Ongoing Studies

COSEWIC has not assessed the conservation status of any small mammal present within the study area. In addition, the *Wildlife Act* (Yukon) does not list any as Specially Protected. However, the *Wildlife Act* (Yukon) manages the harvest of species and prohibits harassment and the encouragement or attraction of nuisance or dangerous wildlife, including red foxes.

A summary of special management requirements and known studies and monitoring programs for small mammals within the study area is provided in Table 4.1.9-20.

TABLE 4.1.9-20 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES – SMALL MAMMALS[1]			
Harvested Species	Total Number Harvested (1980 – 2006)	Harvested Species	Total Number Harvested (1980 – 2006)
Beaver	1,397	American Mink	582
Fisher	5	Muskrat	2,879
Lynx	2,552	River Otter	35
American Marten	13,173	Red Fox	816
Red Squirrel	13,647	Weasel	938

4.1.9.10 Waterfowl

For the purpose of this report, all loons, grebes, ducks, swans and geese are considered waterfowl species.

CONSERVATION STATUS – WATERFOWL	
SARA	Various
COSEWIC	Various
***Wildlife Act* (Yukon)**	No species within the study area are listed under the *Act*. Various other waterfowl species in the Yukon are listed as both Secure and Sensitive by the Canadian Endangered Species Conservation Council (CESCC) (2006)

Population Status and Regional Harvest Data

The Yukon Territory supports large numbers of migrating, breeding and moulting waterfowl during spring, summer and fall. A primary route for these migrant birds traveling from their wintering to breeding ranges is through the Tintina Trench, which diagonally bisects the Yukon Territory.

Upon arrival, waterfowl breed throughout the Yukon at varying densities, wherever appropriate life requisites are met. Waterfowl densities within the Yukon are relatively unknown, but are characteristically lower than compared to southern Canada's boreal forests and prairie potholes. To date, the collection of long-term waterfowl data in the Yukon has been minimal, and subsequently, significant waterfowl population trends can not been determined (Government of Yukon 2002).

Twenty four waterfowl species occur or potentially occur within the study area, all of which potentially breed in the area (Table 4.1.9-21). Of these 24 waterfowl species, seven are listed as Sensitive within the Yukon and the remaining species are considered Secure (Table 4.1.9-21) (CESCC 2006). At a national level, COSEWIC assessed one of the 24 waterfowl species as Not At Risk, the remaining 23 species remain unevaluated by COSEWIC.

TABLE 4.1.9-21 WATERFOWL SPECIES OCCURRING OR POTENTIALLY OCCURRING WITHIN THE STUDY AREA[1]

Common Name	Scientific Name	National Conservation Status (SARA and COSEWIC)[2]	Yukon Conservation Status[3]
Canada Goose[B*]	*Branta canadensis*	Not Evaluated	Secure
American Wigeon[B*]	*Anas americana*	Not Evaluated	Sensitive
Mallard[B*]	*Anas platyrhynchos*	Not Evaluated	Secure
Blue-winged Teal[B*]	*Anas discors*	Not Evaluated	Secure
Northern Shoveler[B*]	*Anas clypeata*	Not Evaluated	Secure
Northern Pintail[B*]	*Anas acuta*	Not Evaluated	Sensitive
Green-winged Teal[B*]	*Anas crecca*	Not Evaluated	Secure
Canvasback[B]	*Aythya valisineria*	Not Evaluated	Secure
Ring-necked Duck[B*]	*Aythya collaris*	Not Evaluated	Secure
Greater Scaup[B]	*Aythya marila*	Not Evaluated	Secure
Lesser Scaup[B*]	*Aythya affinis*	Not Evaluated	Sensitive
Harlequin Duck[B*]	*Histrionicus histrionicus*	Not Evaluated	Sensitive
Surf Scoter[B*]	*Melanitta perspicillata*	Not Evaluated	Sensitive
White-winged Scoter[B*]	*Melanitta fusca*	Not Evaluated	Sensitive
Long-tailed Duck[B*]	*Clangula hyemalis*	Not Evaluated	Sensitive
Bufflehead[B*]	*Bucephala albeola*	Not Evaluated	Secure
Common Goldeneye[B*]	*Bucephala clangula*	Not Evaluated	Secure
Barrow's Goldeneye[B]	*Bucephala islandica*	Not Evaluated	Secure
Common Merganser[B*]	*Mergus merganser*	Not Evaluated	Secure
Red-breasted Merganser[B*]	*Mergus serrator*	Not Evaluated	Secure
Red-throated Loon[B]	*Gavia stellata*	Not Evaluated	Secure
Pacific Loon[B*]	*Gavia pacifica*	Not Evaluated	Secure
Horned Grebe[B*]	*Podiceps auritus*	Not Evaluated	Secure
Red-necked Grebe[B*]	*Podiceps grisegena*	Not At Risk	Secure

1. (Sibley 2003; Alexander et al. 2003).
2. (Species at Risk Act (SARA) 2008; Committee on the Status of Endangered Wildlife in Canada (COSEWIC) 2007)
3. (Canadian Endangered Species Conservation Council (CESCC) 2006; *Wildlife Act* (Yukon) 2002)

B = possible breeder
M = spring/fall migrant
* species observed within the study area (AMAX 1982; Appendices G3 and G5)

Aerial and ground based waterfowl surveys were conducted at a number of streams, lakes, wetlands and ponds within the study area on August 6 and 7, 2006, July 10 and September 5, 2007, and July 8, 2008. Field surveys were conducted at a time to coincide with brood rearing and moulting periods (Appendices G1 and G5). Twenty waterfowl species were observed during the 2006 - 2008 field programs. No waterfowl species observed within the study area are listed under the SARA; however, seven species (American Wigeon, Lesser Scaup, Northern Pintail, Harlequin Duck, Surf Scoter, White-winged Scoter and Long-tailed Duck) are listed as Sensitive in the Yukon (Table 4.1.9-22) (CESCC 2006).

General Life History and Habitat Requirements

In spring and fall, large numbers of waterfowl and other migratory birds travel through the Yukon as they make their way to nesting and wintering grounds, respectively. The timing of these annual migrations is influenced by weather (Terres 1982). Species advance northward as the weather warms and ice recedes from wetlands, rivers and lake shores. The departure time and speed of migration varies among species and is subject to the prevailing weather patterns. For example, migrants bound for the Arctic Ocean typically leave their wintering grounds later than other migrants and overtake ones that have departed earlier.

Although the Tintina Trench is a primary migration route for many species, less concentrated migrations occur throughout the entire Yukon Territory (Alexander *et al.* 2003). Traditional migration corridors between wintering and breeding grounds are used annually. By the time waterfowl reach the Yukon, the large flocks associated with more southerly locations disband as they begin to disperse across nesting territories.

Waterfowl begin to return to the Yukon in late March and early April and migration continues until late May (Alexander *et al.* 2003). Waterfowl return to areas that support successful feeding, nesting, brood rearing and moulting. In general, the majority of waterfowl exploit food resources, such as emergent and submergent vegetation found in shallow water of lakes, ponds, marshes and wetlands. A few species, such as scoters and mergansers, favour open expanses of water found in larger lakes and streams. Approximately three-quarters of waterfowl diets are composed of aquatic vegetation, with aquatic invertebrates and minnows providing the balance. In particular, pondweeds comprise the largest single food resource, followed by bulrushes and smartweeds (Lamoureux 1970).

In addition to adequate food supply, other important requirements of waterfowl habitat include secure nest locations and safe areas for rearing young and molting adults. Shallow wetlands, beaver ponds, lakes, rivers and streams principally in the low valley systems support these local nesting populations. Specific nesting requirements vary for each waterfowl species from quick flowing streams and rivers required by Harlequin Ducks to ponds with forested edges for Ring-necked Ducks and goldeneyes. Nesting generalists, for example the American Wigeon, Mallard, Northern Pintail and Green-winged Teal favour a variety of aquatic habitats. Most waterfowl will return to the same wetland/waterbody where they hatched, and in many cases, adults return to the same nest site (Terres 1982). Most nests are situated on the ground surrounded by vegetation such as grasses or sedges; however, other species nest in tree cavities, on floating mats of vegetation, or on islands. Following hatching, females typically remain on the nest for about a day. Within the next 48 hours, hatchlings will leave the nest site with the female and spend their time feeding in shallow bays, often using emergent vegetation for cover (Terres 1982).

Following breeding, male ducks undergo moult; whereas, females moult after brood rearing. During moult, male birds often move off their breeding ground and commonly congregate (moulting rafts) in deeper expanses of water or hide in emergent vegetation. Moulting birds select habitats rich in food and/or those with sufficient cover from predators.

Local Distribution and Habitat Use

Key waterfowl areas across the Yukon have been delineated by Yukon Environment (Government of Yukon 2006). Sheldon Lakes wetlands, approximately 60 km southwest of the study area is the nearest key waterfowl area identified (Government of Yukon 2006).

A total of 462 waterfowl observations were recorded within the study area during the 2006, 2007 and 2008 waterfowl surveys and an additional 18 waterfowl observations were recorded outside the specified waterfowl surveys. Lesser Scaup, Green–winged Teal, American Wigeon, Surf Scoter and Northern Pintail were the most commonly observed waterfowl during this time (Appendices G2 to G4). In 1982, former avifauna surveys completed in the study area reported observing eight waterfowl species, of which Lesser Scaup, Green-winged Teal, Blue-winged Teal and Harlequin Ducks were most common (AMAX 1983).

Waterfowl can be expected to occupy habitats wherever their key life requirements are met. Within the study area, large valley systems with a mosaic of wetlands, streams, beaver ponds, and to a lesser extent mid to high alpine aquatic habitats (both lakes and streams) support waterfowl during key life periods.

Five habitat types within the study area were categorized: beaver ponds, wetlands, mid- to large-sized ponds, rivers and streams, and mid-to high alpine lakes. Wetland habitat types were further described based on their association with the Tsichu, Hess River tributaries and South Macmillan rivers. These habitat types were described based on the number of waterfowl observations, number of species and the number of broods observed during the 2006 – 2008 field programs (Table 4.1.9-22).

TABLE 4.1.9-22 SUMMARY OF WATERFOWL OBSERVATIONS PER HABITAT TYPE, 2006 - 2008

General Habitat Types	Number of Waterfowl Observations	Number of Species	Number of Broods Observed (total # of young)	Occupying Species
Beaver Ponds along Hess tributaries, Tsichu and South Macmillan rivers	140	9*	10 (52)	Green-winged Teal, Harlequin Duck, Blue-winged Teal, Green-winged Teal, Northern Pintail, Northern Shoveler, American Wigeon, Canada Goose, Lesser Scaup and an unknown duck.
Wetlands and oxbows along the South South Macmillan River	55	8***	0	American Wigeon, Blue-winged Teal, Green-winged Teal, Mallard, Northern Shoveler, Northern Pintail, Ringed-necked Duck, Lesser Scaup, and three unknown ducks.

TABLE 4.1.9-22 SUMMARY OF WATERFOWL OBSERVATIONS PER HABITAT TYPE, 2006 - 2008

General Habitat Types	Number of Waterfowl Observations	Number of Species	Number of Broods Observed (total # of young)	Occupying Species
Wetlands and ponds along Hess River Tributaries	46	8*	0	Pacific Loon, Ring-necked Duck, Canada Goose, Common Merganser, Horned Grebe, Green – winged Teal, Northern Pintail, Northern Shoveler and unidentified teal species
Wetlands along Tsichu River	31	6	3 (10)	Green-winged Teal, American Wigeon, Northern Pintail, Northern Shoveler, Red-breasted Merganser and Lesser Scaup
Mid- to Large-sized ponds along Tsichu River system	125	10	2(9)	Green-winged Teal, American Wigeon, Bufflehead, Blue-winged Teal, Horned Grebe, Northern Pintail, Northern Shoveler, Red-necked Grebe, Ring-necked Duck, and Lesser Scaup
Rivers and Streams	2	1	0	Harlequin Duck
Mid to High Alpine Lakes	76	4	0	Surf Scoter, Ring-necked Duck, Lesser Scaup and Green-winged Teal
Total	**337**		**13(63)**	

* plus one unidentified duck species
*** plus three unidentified duck species

Beaver ponds along the Hess tributaries, Tsichu and South Macmillan rivers supported the highest number of waterfowl during the 2006 – 2008 field programs, followed by medium to large sized ponds along the Tsichu River, mid to high alpine lakes, wetlands and oxbows along the South Macmillan River, wetlands and ponds along Hess River tributaries, wetlands along the Tsichu River, and rivers and streams (Table 4.1.9-22) (Appendices G2, G3 and G5). Similarly, the greatest numbers of species were detected in the mid- to large-sized ponds and beaver ponds (Table 4.1.9-22) (Appendices G2, G3 and G5).

Mid to high alpine lakes are less productive than other aquatic habitats within the study area and are unlikely breeding ponds. During the surveys, these mid to high alpine lakes were occupied by a large number of non-breeders and moulting birds; no evidence of breeding was documented (Appendices G2, G3 and G5).

More productive waterfowl habitats within the study area are largely within the low valley systems. In general, aquatic habitats within the low valley systems provide adequate food resources and greater security for nests and rearing young than compared to mid to high alpine lakes. These productive habitats are favoured during nesting and rearing periods. Waterfowl broods were observed in three separate habitat types: beaver ponds, wetlands and mid- to large-sized ponds along the Tsichu River (Table 4.1.9-23). Beaver ponds are considered productive habitats and were observed to have the highest number of broods.

Spring

Early spring migrants including Common Goldeneye, Mallard and Northern Pintail, begin arriving in the Yukon as early as late March to the beginning of April (Alexander *et al.* 2003). Unlike the Tintina Trench, the study area is not considered an important waterfowl migration corridor. In the study area, waterfowl are expected to arrive late April to mid-July, and by May, many of the waterfowl species disband to their nesting sites.

Summer

General hatching dates vary across species, but in the study area hatching dates are expected to range from mid-June to late July (Alexander *et al.* 2003). American Wigeon and Northern Pintail ducklings were observed during the July, 2007 and 2008 waterfowl surveys (Appendix G5). Whereas, Green-winged Teal, Harlequin Duck, Northern Pintail and Lesser Scaup ducklings were observed during the August 6 – 7, 2006 waterfowl surveys (Appendix G2).

By July, males leave their nesting grounds to moult at lakes with appropriate food resources and security cover. During the July and August field studies (2006 – 2008), mid to high elevation lakes such as Cirque and Emerald lakes, as well as large ponds in the valley systems were occupied by molting rafts of male and non-breeding waterfowl (Appendices G2, G3 and G5). The largest raft observed included a total of 44 birds of mixed species at a large pond along the Tsichu River (July, 2007).

Species with special conservation status and their habitats were documented during the 2006, 2007 and 2008 field surveys. During these field programs, American Wigeons were observed occupying beaver ponds, small wetlands within the upper Tsichu and South Macmillan rivers, and mid to large sized ponds along the Tsichu River (Appendices G2, G3 and G5). A total of six American Wigeon broods were observed; five of which were observed occupying beaver ponds and one brood in wetlands in the upper Tsichu River (Appendices G2, G3 and G5). A total of 29 ducklings were detected within these six broods. Two American Wigeon breeding pairs were also observed without ducklings during the July 2007 survey event (Appendix G3).

Lesser Scaups were observed in beaver ponds, wetlands along the Tsichu River, wetlands and oxbows along the South Macmillan River, and a mid alpine lake during the 2006, 2007 and 2008 field programs. A total of four Lesser Scaup broods were detected in beaver ponds and other mid to large sized ponds along the upper Tsichu River (Appendices G2, G3 and G5). In addition, a pair was observed occupying a beaver pond and two pairs were at a mid alpine lake in July 2007. No ducklings were observed with these breeding pairs. Groups of males and non-breeders occupied a mid alpine lake (Cirque Lake) as well as at a large pond and wetland along the Tsichu River during the July and August surveys.

Surf Scoters were only observed within the study area during the August 2006 field survey. All observations included rafts of males and non-breeders occupying mid to high alpine lakes. Surf Scoters may breed within the study area; however, no evidence of breeding was observed during the 2006 and 2007 field programs.

Northern Pintails were observed at beaver ponds along the Tsichu and South Macmillan rivers as well as wetlands and mid- to large-sized ponds along the upper Tsichu River, wetlands and oxbows along the South Macmillan River. A total of four broods were detected. A single brood with three ducklings occupied a beaver pond, and two broods with a total of five ducklings occupied small wetlands. An additional three pairs were recorded without ducklings; two in small wetlands and one at a beaver pond.

Harlequin Ducks were detected along the Tsichu River and a tributary of the Hess River tributary (a third-order stream of the Hess River tributary) and at beaver ponds. A single brood with five ducklings was observed occupying a beaver pond along the third-order Hess River tributary stream. A breeding pair was also detected in a beaver pond along the South Macmillan River in June 2007.

Although Long-tailed Ducks and White-winged Scoters were not observed during the field programs, AMAX (1982) has documented them in the study area. These species are expected to occur wherever their life requirements are met. Long-tailed Ducks commonly nest near the arctic coast; however nesting occasionally occurs on tundra-like habitats at higher altitudes (Robertson and Savard 2002). During migration, Long-tailed Ducks occupy a variety of habitat types including streams, wetlands, ponds and lakes; however, they favour shallow wetlands and braided streams during breeding (Robertson and Savard 2002). White-winged Scoters favour medium to large lakes during migration and may use smaller lakes and forest ponds for nesting (Alexander *et al.* 2003).

Fall

Fall migration ranges from mid August to late September. During the September 5, 2007 waterfowl surveys, a total of seven waterfowl species (totalling 36 observations) were detected (Appendix G5). Waterfowl occupied mid and large size ponds and wetlands along the Tsichu River and beaver ponds.

Summary

Key habitats for waterfowl nesting, staging and feeding within the study area are summarized in Table 4.1.9-23. Habitats described herein are considered important to fulfill waterfowl life requisites.

TABLE 4.1.9-23 SUMMARY OF KEY WATERFOWL HABITAT WITHIN THE STUDY AREA AND SEASONS OF USE			
Life Requisites	Seasonal Use of Key Habitats		
	Spring (April - May)	Summer (June - August)	Fall (September - October)
Nesting and incubating (late May – mid June)	1) Low valley aquatic habitats, including beaver ponds, wetlands and mid- to large-sized ponds	1) Low valley aquatic habitats, including beaver ponds, wetlands and mid- to large-sized ponds	-
Staging	-	1) Mid- to high elevation lakes, such as Cirque and Emerald lakes 2) Large ponds along the Hess Tributary and Tsichu rivers	1) Mid- to high elevation lakes, such as Cirque and Emerald lakes 2) Large ponds along the Hess Tributary and Tsichu rivers
Feeding	1) Low valley aquatic habitats, including beaver ponds, wetlands, streams, rivers and mid- to large-sized ponds 2) Mid to high elevation lakes and stream	1) Low valley aquatic habitats, including beaver ponds, wetlands, streams, rivers and mid- to large-sized ponds 2) Mid to high elevation lakes and stream	1) Low valley aquatic habitats, including beaver ponds, wetlands, streams, rivers and mid- to large-sized ponds 2) Mid to high elevation lakes and stream

Special Management Requirements and Ongoing Studies

The conservation status of the majority of waterfowl species within the study area has not been assessed at a national scale. Those that have been assessed are considered Not At Risk nationally. Some of the common species within the study area (American Wigeon, Lesser Scaup, Surf Scoter, Northern Pintail and Harlequin Duck) are considered Sensitive in the Yukon. Other species less commonly observed within the study area and also listed as Sensitive include, Long-tailed Duck and White-winged Scoter. Waterfowl occupying the study area are not protected under the SARA, but are protected under the *Migratory Birds Convention Act* (MBCA). In the Yukon, waterfowl and their eggs and nests are protected under the MBCA.

A summary of special management requirements and known studies and monitoring programs for waterfowl within the study area is provided in Table 4.1.9-24 below.

TABLE 4.1.9-24 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES - WATERFOWL			
SARA	*Wildlife Act* (Yukon)	*Migratory Birds Convention Act*	Ongoing Studies
Unlisted	1) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife.	1) Prohibits the possession of a migratory bird (including waterfowl), its eggs or nest 2) No person shall disturb or destroy a nest or egg of a migratory bird 3) Prohibits the deposition of harmful substances to areas frequented by a migratory bird	

4.1.9.11 Raptors

Three species of raptor observed during baseline study work for the Mactung project have special conservation status; the Peregrine Falcon, Gyrfalcon and the Short-eared Owl.

CONSERVATION STATUS OF LISTED RAPTOR SPECIES OCCURRING WITHIN THE STUDY AREA	
Peregrine Falcon (Falco peregrinus)	
SARA	Threatened – Inactive Status[1]
COSEWIC	Special Concern
***Wildlife Act* (Yukon)**	Specially Protected
Gyrfalcon (Falco rusticolus)	
SARA	Unlisted
COSEWIC	Not at Risk
***Wildlife Act* (Yukon)**	Specially Protected
Short-eared Owl (Asio flammeus)	
SARA	Listed under Schedule 3
COSEWIC	Special Concern
***Wildlife Act* (Yukon)**	Specially Protected

1. The Peregrine Falcon subspecies (*anatum* and *tundrius*) populations have recently been down listed by COSEWIC from Threatened to Special Concern. SARA has yet to assess the new COSEWIC Peregrine Falcon evaluation, but has identified the former Threatened designation of the Peregrine Falcon as Inactive.

Population Status and Regional Harvest Data

The Yukon supports a number of raptor species, particularly during spring, summer and fall. Raptor densities vary throughout their range in response to prey abundance. For example, Gyrfalcon studies along the Yukon Coast Range Ecosystem from 1982 to 2002 have revealed the number of young Gyrfalcons in the population had significantly declined in 2001 and 2002 as a result of low prey numbers (Yukon Environment 2002). In years with high prey densities, some raptor species may over-winter in the Yukon.

Seventeen raptor species occur or potentially occur within the study area as migrants, immature residents or breeders (Table 4.1.9-25) Twelve of which potentially breed in the area, and the remaining five species may occupy the study area for short periods of time during migration or return to the area as a non-breeding resident (immature birds) (Table 4.1.9-25). Two raptor species, the Short-eared Owl and the Peregrine Falcon which occur within the study area are nationally listed as Special Concern by either COSEWIC or SARA.

The Peregrine Falcon subspecies (*anatum* and *tundrius*) populations have recently been combined and subsequently down listed by COSEWIC from Threatened to Special Concern. SARA has yet to assess the new COSEWIC Peregrine Falcon evaluation, but has listed the former Threatened designation of the Peregrine Falcon (both *anatum* and *tundrius*) as inactive. COSEWIC considers the remaining raptor species Not at Risk or Not Evaluated. At the territorial level, the Peregrine Falcon and Gyrfalcon are Specially Protected under the *Wildlife Act* (Yukon) and are considered by the Canadian Endangered Species Conservation Council (2006) as sensitive and secure, respectively. Similarly, the American Kestrel is considered at risk. Five additional species (Snowy Owl, Great Grey Owl, Short-eared Owl, Swainson's hawk and Golden Eagle) are listed as sensitive and the remaining are listed as secure in the Yukon Territory (CESCC 2006).

TABLE 4.1.9-25 RAPTOR SPECIES OCCURRING OR POTENTIALLY[1] OCCURRING WITHIN THE STUDY AREA

Common Name	Scientific Name	National Conservation Status (SARA[2] and COSEWIC)	Yukon Conservation Status[3]	Observed*
Great Horned Owl[B]	*Bubo virginianus*	Not Evaluated	Secure	
Snowy Owl[M]	*Bubo scandiacus*	Not At Risk	Sensitive	✓
Northern Hawk Owl[B]	*Surnia ulula*	Not At Risk	Secure	✓
Great Gray Owl[B]	*Strix nebulosa*	Not At Risk	Sensitive	✓
Short-eared Owl[B]	*Asio flammeus*	Special Concern (COSEWIC)	Sensitive	✓
Boreal Owl[B]	*Aegolius funereus*	Not At Risk	Secure	
Bald Eagle[M]	*Haliaeetus leucocephalus*	Not At Risk	Secure	✓
Northern Harrier[B]	*Circus cyaneus*	Not At Risk	Secure	✓
Sharp-shinned Hawk[B]	*Accipiter striatus*	Not At Risk	Secure	
Northern Goshawk[M]	*Accipiter gentilis*	Not At Risk	Secure	
Swainson's Hawk[M]	*Buteo swainsoni*	Not Evaluated	Sensitive	
Rough-legged Hawk[M]	*Buteo lagopus*	Not At Risk	Secure	✓
Golden Eagle[B]	*Aquila chrysaetos*	Not At Risk	Sensitive	✓
American Kestrel[B]	*Falco sparverius*	Not Evaluated	May Be At Risk	
Merlin[B]	*Falco columbarius*	Not At Risk	Secure	✓

TABLE 4.1.9-25 RAPTOR SPECIES OCCURRING OR POTENTIALLY[1] OCCURRING WITHIN THE STUDY AREA

Common Name	Scientific Name	National Conservation Status (SARA[2] and COSEWIC)	Yukon Conservation Status[3]	Observed*
Gyrfalcon[B]	*Falco rusticolus*	Not At Risk	Secure, but is Specially Protected under the *Wildlife Act* (Yukon)	✓
Peregrine Falcon (Anatum) [M]	*Falco peregrinus anatum*	Special Concern (COSEWIC)	Sensitive, but is Specially Protected under the *Wildlife Act* (Yukon)	✓

1. Species that have the potential to occur in the study area based on known distributions (Sibley 2003; Alexander et al. 2003)
2. (Species at Risk Act (SARA) 2008)
3. (Canadian Endangered Species Conservation Council (CESCC) 2006; Yukon Wildlife Act 2002)

B = possible breeder
M = spring/fall migrant
* species observed within the study area (AMAX 1982; Appendix G2 and G5)

Aerial raptor surveys were flown on June 14, 2006, June 18, July 11, and August 17, 2007 and July 8, 2008 to document raptor presence and breeding territories. Raptors observed outside these aerial surveys were also documented. Objectives of the raptor surveys were to document species presence and breeding territories of cliff nesting raptors such as Peregrine Falcons, Gyrfalcons, Golden Eagles, and Rough-legged Hawks. The raptor survey route was planned prior to the field program, using a 1:50,000 map base to determine possible raptor nesting habitat and previously known territories. Steep mountainous terrain and cliffs of known, suspected or potential nest sites were flown during these raptor surveys using a Bell 206 or a Robinson R-44 helicopter.

A total of 59 raptors were observed within the study area during the 2006, 2007 and 2008 field programs (including raptors observed outside the raptor surveys). During which, nine raptor species were recorded within the study area including: Golden Eagle, Bald Eagle, Peregrine Falcon, Gyrfalcon, Northern Harrier, Rough-legged Hawk, Merlin, Northern Hawk Owl, and Short-eared Owl. Golden Eagles were the most common raptor species observed, followed by Northern Harriers (see Table 4.1.9-26). During the surveys, raptors were observed occupying a variety of habitat types in forested valleys, alpine tundra and steep mountain cliffs.

General Life History and Habitat Requirements

Raptors are a diverse group of birds making generalization difficult. Species differ in their basic daily cycles (diurnal and nocturnal), food selection (small mammals, fish, other birds and scavenged food), nest site selection (tree, ground and/or cliff nesters) and breeding periods (egg-laying as early as March while others not until May). However the differences, the majority of raptors are migrants and occupy the study area only during breeding season. Only a select few species may over-winter during periods of high prey abundance.

TABLE 4.1.9-26 SUMMARY OF RAPTOR OBSERVATIONS				
Species	Conservation	# Observations 2006	# Observations 2007	# Observations 2008
American Kestrel (Falco suparverius)	Not Evaluated			
Bald Eagle (*Haliaeetus leucophalus*)	Not at Risk	1	1	1
Golden Eagle (*Aquila chrysaetos*)	Not at Risk	9	18	8
Gyrfalcon (*Falco rusticolus*)	Not at Risk / Yukon Wildlife Act		2	Nesting signs
Merlin (*Falco columbarius*)	Not at Risk		2	
Northern Goshawk (*Accipiter gentilis*)	Not at Risk			
Northern Harrier (*Circus cyaneus*)	Not at Risk	2	5	1
Northern Hawk owl (*Surnia ulula*)	Not at Risk			1
Peregrine falcon (*Falco peregrinus anatum*)	Threatened (SARA Schedule 1)[1] / Yukon Wildlife Act		2	
Rough-legged Hawk (*Buteo lagopus*)	Not at Risk	1		
Sharp-shinned Hawk (*Accipiter stiatus*)	Not at Risk			
Short-eared owl (*Asio flammeus*)	Special Concern (SARA Schedule 3)		1	4
Swainson's Hawk (*Buteo swaisoni*)	Not Evaluated			

Prey species commonly include fish, waterfowl, ptarmigan, muskrats, hares, squirrels (including ground squirrels), and other small mammals and birds (Blood and Anweiler 1994; Terres 1982). Scavengers, such as Bald Eagles also feed on carcasses. Prey availability varies throughout the year, as many prey species migrate, hibernate or are less available during winter. Other prey species that remain during the winter such as hares, voles and ptarmigan, undergo population cycles. Hare and ptarmigan populations follow a ten year cycle, whereas, vole populations have a four year cycle (Yukon Environment 2002). Clearly, raptor populations are closely linked to prey availability and their population cycles. For example, Gyrfalcons will not breed or may abandon nests during years of low ptarmigan numbers (Yukon Environment 2002).

Occurrence and breeding success of raptors in an area are governed by prey abundance and availability of suitable nesting habitat (Blood & Anweiler 1994; Campbell *et al.* 1990). Nesting habitat varies for each raptor species. Gyrfalcons nest on ledges (typically with a protected overhang above) on precipitous cliff faces, and also occupy nests abandoned by Common Ravens, Golden Eagles, and Rough-legged Hawks (Alexander *et al* 2003; Clum and Cade 1994). For tree nesting raptors, tree structure may be more important than the tree species in determining nest site selection (Gerrard *et al.* 1975; Anthony *et al.* 1982). Short-eared Owls, for example, are ground nesters and favour open wetland areas and tundra habitats for nesting. Boreal Owls and American Kestrels favour tree cavities as nesting substrates.

During nesting, brood rearing and fledging periods, adult pairs remain within a selected home range (including both nesting and hunting territories). Home range size varies each year and is determined by prey abundance. Nesting territories are generally defended, whereas, hunting territories may overlap with other raptor species.

Local Distribution and Habitat Use

Appropriate nesting sites and prey distribution are principal factors influencing raptor distribution within the study area. Since each raptor species select different nesting sites and prey items, raptor distribution and habitat use within the study area also varies.

Rand (1946) published bird species that were recorded along the Canol Trail from unpublished field data collected by the National Museum in 1944, as well as information from the Parks Branch. Based on this information, raptors considered commonly occurring within forest habitats in the summer were Goshawk, Great Horned Owl, and Northern Hawk Owl (Rand 1946). Raptors observed within or near the study area include Goshawk, Sharp-shinned Hawk, Golden Eagle, Northern Harrier and Peregrine Falcon (Rand 1946).

Yukon Environment (2006) prepared maps of key raptor habitats within the study area and neighbouring properties. Both Golden Eagle and Gyrfalcon key summer nesting areas have been identified within the study area and neighbouring properties. In fact, the majority of the study area, outside the Hess tributary and Tsichu river valleys were identified as key Golden Eagle and Gyrfalcon nesting areas (Yukon Environment 2006). The nearest Peregrine Falcon key nesting area was delineated well outside the study area, approximately 150 km to the northwest (Yukon Environment 2006). Whereas, the nearest key Bald Eagle nesting habitat was delineated approximately 15 km south of the study area along the South Macmillan River (Yukon Environment 2006). Key nesting Osprey habitat is also approximately 60 km southwest of the study area at Sheldon lakes wetlands (Yukon Environment 2006).

Late Winter - Spring

Spring arrival times may vary with species. In the Yukon, unpaired Gyrfalcons have been detected on nesting territories as early as January (Clum and Cade 1994). Whereas, others, such as Golden Eagles arrive by late March and Rough-legged Hawks arrive in April and May (Alexander *et al.* 2003). Spring arrival period is expected to be similar in the study area. Upon arrival to the breeding site, pair bonding and nest site selection begins wherever appropriate nesting habitat occurs.

During spring and summer, raptors are engaged in nesting and brood rearing. Owls are generally considered early nesters, whereas, other raptor species nest later. In general, most breeding owls lay eggs by early May. However, laying dates for Great Horned Owls in the Yukon range from the end of February to early April (Alexander *et al.* 2003). Other raptor species, including Gyrfalcons, American Kestrels, Golden Eagles and Rough-legged Hawks complete egg laying between April to June (Alexander *et al.* 2003; Clum and Cade 1994).

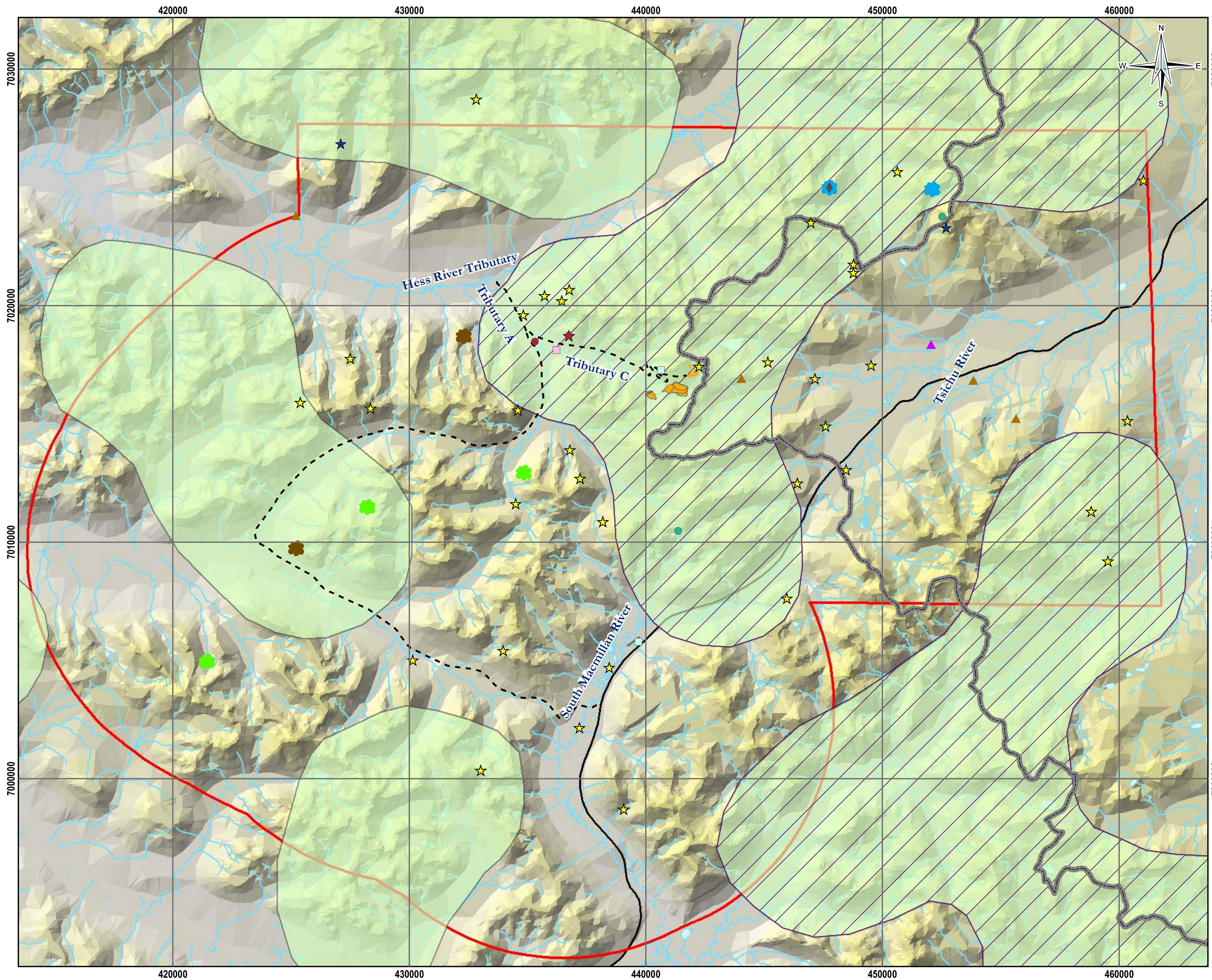
Summer

During the raptor surveys, most Golden Eagles were observed flying/soaring in mid to high alpine habitats; however, a few were recorded in large river valleys. All Northern Harrier, Bald Eagle, Rough-legged Hawk, Merlin, and Short-eared Owl observations were along major valleys in low to mid elevational habitats (Appendices G2, G3 and G5). The two Peregrine Falcon observations were reported at approximately 1,800 m elevation near major river valleys (Appendices G2, G3 and G5). All Gyrfalcons were recorded in high elevations, at or near their breeding territory. Raptor observations, including nests, are provided in Figure 4.1.9-10.

A single Gyrfalcon breeding territory was detected within the study area during the June 2007 survey, approximately 9 km northeast of the Mactung camp. The territory included a scrape and a number of perch sites, located at approximately 2,000 m elevation on a cliff face with a south southeast aspect. This occupied territory was previously documented in 1981 during the Yukon Raptor Inventory Program (Hayes and Mossop 1981). This was the only active Gyrfalcon nest site identified by Hayes and Mossop (1981) within the study area. They also observed an additional active nest site along the NWT/Yukon border to the south. An abandoned Gyrfalcon breeding territory approximately 11 km southeast of camp was observed during the July 2008 raptor survey, which included a scrape and perch sites.

A total of three Golden Eagle nests were observed within the study area; however, all nests were abandoned at the time of the site investigation. In addition, based on visual observations of adult Golden Eagles throughout the field programs, two additional breeding territories may occur within the study area (Appendices G2, G3 and G5). As part of the Yukon Raptor Inventory Program in 1981, Hayes and Mossop (1981) documented four active and three abandoned Golden Eagle nests within the study area, and several others in the neighbouring areas. One of the nest sites identified by Hayes and Mossop (1981) corroborates a probable territory postulated from adult visuals during the 2006 and 2007 surveys (Appendices G2, G3 and G5).

Based on field observations from 2006 to 2008, one Merlin, two Northern Harrier and two Short-eared Owl breeding territories are probable (total of five additional breeding territories). A probable Merlin territory is located approximately 5 km east of Mactung camp along an upper tributary of the Hess River. The two probable Northern Harrier territories are located in large river valleys (both the Hess River tributary and Tsichu River valleys), and two probable Short-eared Owl breeding territories are located in the Tsichu River valley.



LEGEND

Raptor Observations (Visual) 2005-2008

- Bald Eagle
- Golden Eagle
- Gyrfalcon
- Merlin
- Northern Harrier
- Northern Hawk Owl
- Peregrine Falcon
- Rough-legged Hawk
- Short-eared Owl

Raptor Nest Observations 2005-2008

- Common Raven
- Golden Eagle
- Gyrfalcon
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Regional Wildlife Study Area
- Gyrfalcon Summer Nesting Wildlife Key Area (Yukon Government, 2006)
- Golden Eagle Summer Nesting Wildlife Key Area (Yukon Government, 2006)
- North Canol Rd
- NWT - Yukon Territory Border
- Macmillan Pass Aerodrome
- Watercourse
- Waterbody

ISSUED FOR USE

NOTES

Since each raptor species select different nesting sites and prey items, raptor distribution and habitat use within the study area varies
Base data source: NTDB 1:50,000, 1:250,000,
Site Plan adapted from original provided by Wardrop

MACTUNG

Raptor and Raptor Nest Distribution within the Wildlife Regional Study Area

PROJECTION		DATUM	
UTM Zone 9		NAD83	
Scale: 1:160,000 (4 2 0 4 Kilometers)			
FILE NO. W23101110_001_WL_Raptor_Nest.mxd			
PROJECT NO. W23101110.001	DWN MEZ	CKD KL	REV 1
OFFICE EBA-VANC	DATE December 4, 2008		

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

Figure 4.1.9-10

Q:\Vancouver\GIS\ENVIRONMENTAL\W231\W23101110_MacTung_AP\Maps\001_YESAA_Prep\Wildlife\W23101110_001_WL_Raptor_Nest.mxd

The two Peregrine Falcons, two immature Bald Eagles, and two Rough-legged Hawks observed within the wildlife study area were considered transients and are not expected breeders. Observations were recorded during the June, July, August and September surveys.

Fall

Most individual migratory raptors depart central Yukon by late September or October; however, some individuals may remain until November and December (Alexander *et al* 2003). Similar departure dates are expected within the study area. Raptor fall migration generally coincides with the availability of their main prey species. Merlins, Sharp-shinned Hawk and Northern Harriers fall migration occurs in September, which is slightly delayed from the peak migration of small birds (main prey).

Winter

Some raptor species, such as the Golden Eagle, Gyrfalcon, Northern Goshawk, Great Horned Owl, Great Grey Owl, Northern Hawk Owl, Snowy Owl and Boreal Owl may over-winter within the study area, whenever appropriate food resources are available. Gyrfalcons may occupy their nesting territory all year round (Clum and Cade 1994).

Special Management Requirements and Ongoing Studies

All raptor species present within the study area are protected under the *Wildlife Act* (Yukon). It also lists several species as Specially Protected. Although several raptor species have been listed as Special Concern by COSEWIC, they receive no legal protection under the SARA.

The COSEWIC considers the Peregrine Falcon as Special Concern within Canada, but is currently not listed under the SARA. If the Peregrine Falcon is listed as Special Concern under SARA Schedule 1 a Management Plan must be developed. Once this management plan is developed, developers are encouraged to follow these management guidelines to prevent the species from becoming at risk. To date, no management requirements have been ascribed for the preservation of Peregrine Falcon populations in the Yukon. In addition, Peregrine Falcons are Specially Protected under the *Wildlife Act* (Yukon), which prohibits the hunting and possession of Peregrine Falcon(s) and their parts.

Short-eared Owls are listed under the SARA Schedule 3 as Special Concern and do not benefit from full legal protection under the Act. Re-evaluation of Short-eared Owl population status is still required under the SARA.

In addition, Gyrfalcons are Specially Protected under the *Wildlife Act* (Yukon), and therefore, it is unlawful to hunt or be in possession of Gyrfalcon(s) and/or their parts.

The Canadian Endangered Species Conservation Council (CESCC) (2006) also lists the American Kestrel as May be at Risk in the Yukon; however, there are no special management requirements for this species.

A summary of special management requirements and ongoing studies/monitoring programs within the study area is provided in Table 4.1.9-27.

TABLE 4.1.9-27 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES - RAPTORS		
SARA	*Wildlife Act* (Yukon)	Ongoing Studies
Not protected	1) No person shall destroy or be in possession of raptor eggs or nests 2) No person shall hunt or be in possession of a Specially Protected species 3) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife.	None known to date

Other Upland Birds

For the purposes of this report, all other birds, excluding waterfowl and raptors are considered "other upland birds". Species groups included in "other upland birds" are perching birds, woodpeckers, grouse/ptarmigan, shorebirds, waterbirds and gulls.

CONSERVATION STATUS – OTHER UPLAND BIRDS	
SARA	Not Evaluated
COSEWIC	Not Evaluated, except for the Common Nighthawk, Olive-sided Flycatcher and Rusty Blackbird. The Common Nighthawk and Olive-sided Flycatchers are listed as Threatened, and the Rusty Blackbird is listed as Special Concern.
Wildlife Act (Yukon)	No species listed under the *Act*. However, the Canadian Endangered Species Conservation Council (CESCC) (2006), lists the Short-billed Dowitcher as May Be At Risk and various other upland bird species in the Yukon as both Secure and Sensitive

Population Status and Regional Harvest Data

A total of 83 other upland bird species occur or potentially occur within the study area (Table 4.1.9-28). Few species are year-round residents while the majority are summer residents and are present only during their breeding periods. Of the 83 species occurring or potentially occurring, 77 species may breed within the study area and 10 species may remain over winter (Table 4.1.9-28).

COSEWIC considers the Common Nighthawk and Olive-sided Flycatchers as Threatened within Canada, but in the Yukon their populations are considered Secure and Sensitive, respectively (Table 4.1.9-28). Rusty Blackbird populations are listed as Special Concern on a national scale and Sensitive in the Yukon. The Short-billed Dowitcher has not been evaluated on a national scale, but populations in the Yukon are considered May Be At Risk.

TABLE 4.1.9-28 OTHER UPLAND BIRD SPECIES OCCURING OR POTENTIALLY[1] OCCURING WITHIN THE STUDY AREA

Common Name	Scientific Name	National Conservation Status (SARA[2] and COSEWIC)	Yukon Conservation Status[3]	Observed *
Spruce Grouse[B]	*Falcipennis canadensis*	Not Evaluated	Secure	
Willow Ptarmigan[B]*	*Lagopus lagopus*	Not Evaluated	Secure	✓
Rock Ptarmigan[B]*	*Lagopus mutus*	Not Evaluated	Secure	✓
White-tailed Ptarmigan[B]	*Lagopus leucura*	Not Evaluated	Secure	
Blue Grouse[B]	*Dendragapus obscurus*	Not Evaluated	Secure	
Sora[B]*	*Porzana carolina*	Not Evaluated	Secure	✓
Sandhill Crane[B]	*Grus canadensis canadensis*	Not Evaluated	Secure	
American Golden Plover[M]	*Pluvialis dominica*	Not Evaluated	Sensitive	
Semipalmated Plover[B]*	*Charadrius semipalmatus*	Not Evaluated	Secure	✓
Killdeer[B]	*Charadrius vociferus*	Not Evaluated	Secure	
Lesser Yellowlegs[B]*	*Tringa flavipes*	Not Evaluated	Sensitive	✓
Solitary Sandpiper[B]*	*Tringa solitaria*	Not Evaluated	Secure	✓
Wandering Tattler[B]*	*Heteroscelus incanus*	Not Evaluated	Sensitive	✓
Spotted Sandpiper[B]*	*Actitis macularius*	Not Evaluated	Secure	✓
Upland Sandpiper[B]*	*Bartramia longicauda*	Not Evaluated	Secure	✓
Semipalmated Sandpiper[M]	*Calidris pusilla*	Not Evaluated	Sensitive	
Least Sandpiper[B]*	*Calidris minutilla*	Not Evaluated	Secure	✓
Baird's Sandpiper[B]*	*Calidris bairdii*	Not Evaluated	Secure	✓
Short-billed Dowitcher[B]*	*Limnodromus griseus*	Not Evaluated	May Be At Risk	
Long-billed Dowitcher[M]	*Limnodromus scolopaceus*	Not Evaluated	Sensitive	
Wilson's Snipe[B]*	*Gallinago delicata*	Not Evaluated	Secure	✓
Red-necked Phalarope[B]*	*Phalaropus lobatus*	Not Evaluated	Sensitive	✓
Long-tailed Jaeger[M]	*Stercorarius longicaudus*	Not Evaluated	Secure	
Bonaparte's Gull[B]*	*Larus philadelphia*	Not Evaluated	Secure	✓
Mew Gull[B]*	*Larus canus*	Not Evaluated	Secure	✓
Herring Gull[B]*	*Larus argentatus*	Not Evaluated	Secure	
Arctic Tern[B]*	*Sterna paradisaea*	Not Evaluated	Secure	✓
Common Nighthawk[B]	*Chordeiles minor*	Threatened	Secure	
Belted Kingfisher[B]	*Ceryle alcyon*	Not Evaluated	Secure	
Hairy Woodpecker[B]	*Picoides villosus*	Not Evaluated	Secure	

TABLE 4.1.9-28 OTHER UPLAND BIRD SPECIES OCCURING OR POTENTIALLY[1] OCCURING WITHIN THE STUDY AREA

Common Name	Scientific Name	National Conservation Status (SARA[2] and COSEWIC)	Yukon Conservation Status[3]	Observed *
Three-toed Woodpecker[B]*	*Picoides dorsalis*	Not Evaluated	Secure	✓
Northern Flicker[B]*	*Colaptes auratus*	Not Evaluated	Secure	✓
Olive-sided Flycatcher[B]*	*Contopus cooperi*	Threatened	Sensitive	✓
Yellow-bellied Flycatcher[B]	*Empidonax flaviventris*	Not Evaluated	Secure	
Alder Flycatcher[B]*	*Empidonax alnorum*	Not Evaluated	Secure	✓
Say's Phoebe[B]*	*Sayornis saya*	Not Evaluated	Secure	✓
Northern Shrike[B]*	*Lanius excubitor*	Not Evaluated	Sensitive	✓
Gray Jay[B]*	*Perisoreus canadensis*	Not Evaluated	Secure	✓
Common Raven[B]*	*Corvus corax*	Not Evaluated	Secure	✓
Horned Lark[B]*	*Eremophila alpestris*	Not Evaluated	Secure	✓
Tree Swallow[B]*	*Tachycineta bicolor*	Not Evaluated	Secure	✓
Violet-green Swallow[B]	*Tachycineta thalassina*	Not Evaluated	Secure	
Bank Swallow[B]	*Riparia riparia*	Not Evaluated	Secure	
Cliff Swallow[B]*	*Petrochelidon pyrrhonota*	Not Evaluated	Secure	✓
Barn Swallow[B]	*Hirundo rustica*	Not Evaluated	Secure	
Boreal Chickadee[B]*	*Poecile hudsonica*	Not Evaluated	Secure	✓
American Dipper[B]*	*Cinclus mexicanus*	Not Evaluated	Secure	✓
Ruby-crowned Kinglet[B]*	*Regulus calendula*	Not Evaluated	Secure	✓
Northern Wheatear[B]	*Oenanthe oenanthe*	Not Evaluated	Secure	
Townsend's Solitaire[B]*	*Myadestes townsendi*	Not Evaluated	Secure	✓
Gray-cheeked Thrush[B]*	*Catharus minimus*	Not Evaluated	Secure	✓
Swainson's Thrush[B]*	*Catharus ustulatus*	Not Evaluated	Secure	✓
Hermit Thrush[B]*	*Catharus guttatus*	Not Evaluated	Secure	✓
American Robin[B]*	*Turdus migratorius*	Not Evaluated	Secure	✓
Varied Thrush[B]	*Ixoreus naevius*	Not Evaluated	Secure	
American Pipit[B]*	*Anthus rubescens*	Not Evaluated	Secure	✓
Bohemian Waxwing[B]	*Bombycilla garrulus*	Not Evaluated	Secure	
Tennessee Warbler[B]	*Vermivora peregrina*	Not Evaluated	Secure	
Orange-crowned Warbler[B]*	*Vermivora celata*	Not Evaluated	Secure	✓
Yellow Warbler[B]*	*Dendroica petechia*	Not Evaluated	Secure	✓
Yellow-rumped Warbler[B]*	*Dendroica coronata*	Not Evaluated	Secure	✓

TABLE 4.1.9-28 OTHER UPLAND BIRD SPECIES OCCURING OR POTENTIALLY[1] OCCURING WITHIN THE STUDY AREA				
Common Name	Scientific Name	National Conservation Status (SARA[2] and COSEWIC)	Yukon Conservation Status[3]	Observed *
Blackpoll Warbler[B]*	*Dendroica striata*	Not Evaluated	Secure	✓
Northern Waterthrush[B]*	*Seiurus noveboracensis*	Not Evaluated	Secure	✓
Common Yellowthroat[B]*	*Geothlypis trichas*	Not Evaluated	Secure	✓
Wilson's Warbler[B]*	*Wilsonia pusilla*	Not Evaluated	Secure	✓
American Tree Sparrow[B]*	*Spizella arborea*	Not Evaluated	Secure	✓
Chipping Sparrow[B]*	*Spizella passerina*	Not Evaluated	Secure	✓
Savannah Sparrow[B]*	*Passerculus sandwichensis*	Not Evaluated	Secure	✓
Fox Sparrow[B]*	*Passerella iliaca*	Not Evaluated	Secure	✓
Lincoln's Sparrow[B]*	*Melospiza lincolnii*	Not Evaluated	Secure	✓
White-crowned Sparrow[B]*	*Zonotrichia albicollis*	Not Evaluated	Secure	✓
Golden-crowned Sparrow[B]*	*Zonotrichia atricapilla*	Not Evaluated	Secure	✓
Dark-eyed Junco[B]*	*Junco hyemalis*	Not Evaluated	Secure	✓
Lapland Longspur[M]*	*Calcarius lapponicus*	Not Evaluated	Secure	✓
Smith's Longspur[B]	*Calcarius pictus*	Not Evaluated	Sensitive	
Snow Bunting[B]*	*Plectrophenax nivalis*	Not Evaluated	Secure	✓
Rusty Blackbird[B]*	*Euphagus carolinus*	Special Concern	Sensitive	✓
Gray-crowned Rosy Finch[B]*	*Leucosticte tephrocotis*	Not Evaluated	Secure	✓
Pine Grosbeak[B]*	*Pinicola enucleator*	Not Evaluated	Secure	✓
White-winged Crossbill[B]*	*Loxia leucoptera*	Not Evaluated	Secure	✓
Common Redpoll[B]*	*Carduelis flammea*	Not Evaluated	Secure	✓
Hoary Redpoll[M]*	*Carduelis hornemanni*	Not Evaluated	Secure	✓
Pine Siskin[B]	*Carduelis pinus*	Not Evaluated	Secure	

1 Species that have the potential to occur in the study area based on known distributions (Sibley 2003; Alexander et al. 2003)
2. (Species at Risk Act (SARA) 2008)
3. (Canadian Endangered Species Conservation Council (CESCC) 2006; *Wildlife Act* (Yukon), 2002. B = possible breeder. M = spring/fall migrant
* species observed within the study area (AMAX 1982; Appendices G2 and G5)

Breeding upland birds were surveyed within the study area in June 2006 and 2007 using fixed radius point count stations. During this time, a total of 102 breeding bird stations were surveyed in various habitat types. Objectives of the breeding bird survey were to document species presence and breeding territories within available habitat types. To promote proportional sampling among available habitats, ecosystem types previously classified in the study area were used. Stations that included two different habitat types were reported as a habitat complex.

A total of 440 "other upland birds" were recorded during the 2005 – 2008 field surveys, including those detected during the breeding bird surveys and incidentals. Of which, 49 upland bird species were observed (including incidentals or those observed outside the breeding bird stations) (Appendices G2, G3 and G5). American Tree Sparrow, Wilson's Warbler, White-crowned Sparrow, American Pipit, Yellow-rumped Warbler, Golden-crowned Sparrow, Common Redpoll, Savannah Sparrow and Ruby-crowned Kinglet were the most common species throughout the study area (Appendix G2, G3 and G5).

Ptarmigan

General Life History and Habitat Requirements

Upland birds occur throughout all habitat types within the study area. Some species are year-round residents while the majority are migratory and are present only during their reproductive phase. These upland birds breed at varying densities, wherever appropriate life requisites are met.

Passerines represent a large and diverse group of birds and, consequently, their life requirements vary. Upland nesting birds eat a variety of food such as wild fruits, seeds, and insects. Food items may shift as the availability of food resources changes with the seasons. Foraging occurs in all habitat types and may include aerial feeding by swallows and Common Nighthawks over water, and ground and canopy feeding by sparrows and warblers, respectively.

In addition to adequate food resources, another important life requirement of upland birds is secure nest locations. Although it is not possible to generalize the nesting habits of 77 different species of upland birds that may breed within the study area, nesting occurs in all terrestrial habitat types including coniferous stands, shrub stands, different vegetated seral stages, dry uplands to wet lowlands, and vegetated to sparsely vegetated alpine sites. Nests may be built in tall trees and shrubs, tree cavities, grass/sedges, ledges and rocky cliffs, sandy banks and on the ground. The majority are commonly well concealed from predators. A few other upland birds may utilize man-made structures, such as bridges and buildings as nesting substrates.

Local Distribution and Habitat Use

Early reports from along the Canol road indicated avifauna were relatively scarce, with limited species richness and diversity. These comments were later doubted and the perceived lack of birdlife was attributed to the timing of observations outside the breeding season (Rand 1946; Alexander *et al.* 2003). Upland nesting birds occur within the study area during spring, summer and fall; however, their abundance diminishes outside the summer breeding season.

In the Mackenzie Mountains, Rand (1946) commonly reported Olive-sided Flycatcher, Boreal Chickadee, Swainson's Thrush, Ruby-crowned Kinglet, Bohemian Waxwing, Yellow-rumped Warbler and Dark-eyed Junco in forested habitats. At the treeline, American Tree and Golden-crowned sparrows were common (Rand 1946). Whereas, in alpine habitats, Rand (1946) commonly observed Lapland Longspur, Snow Bunting, Wandering Tattler and Gray-crowned Rosy Finch.

Spring

Migrant upland birds return from their southern wintering grounds at various times during the spring. Early migrants, such as Northern Shrikes and Snow Buntings have been seen in the Yukon as early as February and March; however, peak migration for most species occurs in late April to late May. The American Tree and Golden-crowned sparrows, Dark-eyed Juncos and Rusty Blackbirds arrive in central Yukon mid to late April, whereas, others such as Lincoln's Sparrow, Lapland Longspur, Blackpoll Warbler, American Golden and Semipalmated plovers and gulls arrive mid to late May (Alexander *et al.* 2003). The Common Nighthawk is one of the latest migrants, and is expected within the study area by early June.

Summer

By June, most upland birds occupy and defend their breeding territories. It is this time when birds are most easily detected.

During the breeding bird surveys, habitats such as birch-lichen: willow-edge complex, birch-moss: water complex, fescue-willow, willow-bluebell and willow-sedge habitats had the highest average number of birds detected per survey station (Table 4.1.9-29) (Appendices

G2, G3 and G5). These habitat types largely occur in valley systems, except for fescue-willow habitats, which are located in moist alpine meadows (Table 4.1.9-29). Heath-lichen, fescue-sedge and fir-lichen habitats had the lowest number of birds observed (Appendices G2, G3 and G5). These sites occur in dry exposed high elevation sites, except for fir-lichen habitats. Fir-lichen habitats are located in warm exposed valley systems on the Yukon portion of the study area (Table 4.1.9-29).

In addition, species diversity amongst habitats surveyed differed. Using the Shannon-Wiener Index, habitat types with the highest species diversity included: birch-lichen, willow-sedge, spruce-moss, fir-moss, and fescue-willow (Table 4.1.9-29) (Appendices G2, G3 and G5). Most of these habitat types are located in both low and mid elevation valley habitats, except fescue-willow habitat types are located in the alpine. Whereas, fescue-sedge, fescue-willow: birch-moss complex, willow-bluebell and heath-lichen: fescue-sedge complex habitats had the lowest species diversity (Table 4.1.9-29) (Appendices G2, G3 and G5). These habitats commonly occur in alpine and at the transition zone between high and mid alpine.

Fall

In the fall, the majority of upland nesters migrate south. This migration period is highly variable and species dependent. Peak fall migration of many upland birds occurs from late July to mid August. However, migration of Wilson's Warblers, Chipping Sparrows and Semipalmated Sandpipers may begin as early as July (Alexander *et al.* 2003). Most species, including the Common Nighthawk have departed by the end of August. However, some species, such as the Rusty Blackbird may remain until September and the American Tree Sparrow may rarely remain until November (Alexander *et al.* 2003). Most migrant upland birds leave the study area by early October.

Winter

Those species remaining over winter may adapt to winter conditions by caching food, roosting under the snow and roosting in tree cavities (individual and/or group roosting). Ten species may over-winter within the study area provided adequate food resources are available. Those species include Spruce Grouse, Willow and Rock ptarmigans, Hairy and Three-toed woodpeckers, Gray Jay, Common Raven, Boreal Chickadee, White-winged Crossbill and Hoary Redpoll. Low valley habitats, such as fir-moss, spruce-moss and fir-lichen habitats are important for over-wintering birds.

Special Management Requirements and Ongoing Studies

Intermittent breeding bird surveys were conducted along the Macmillan Pass in the late 1980s and early 1990s. To date, no other studies within the study area or vicinity are known (Table 4.1.9-30).

TABLE 4.1.9-29: SUMMARY OF BREEDING BIRD SURVEY RESULTS, 2006 AND 2007

Habitat Type	General Habitat Description	No. Surveyed (2006 and 2007)	Ave. No. of Birds Detected[1] per Station (2006 and 2007)	No. of Bird Species Detected (2006 and 2007)	Shannon-Wiener Species Diversity[2] Index
Alpine[2]					
Fescue-Sedge	These areas are dry alpine meadows. Habitat unit dominated by fescue and lichen species, although, sedge and grass species may occur in high abundance on moister soils. These sites are generally on exposed, well drained soils, convex micro-topography and/or warm aspects.	4	2.75	4	0.10
Fescue-Willow	Occur on moist alpine meadows. Habitat unit dominated by fescue and moss species, although, sedge, hairgrass, and rush species may occur in high abundance. These sites are characterized by the occurrence of dwarf willow species, and occur on well drained soils, concave micro-topography and cool aspects.	12	8.17	12	0.21
Heath-Lichen	These areas are dwarf shrub communities observed in the alpine. Habitat unit dominated by dwarf shrub species mountain heather, crowberry, lingonberry, and lichen species. Few plants grow taller than 20 cm high. These sites are generally on exposed and well drained soils.	14	2.57	7	0.15
Shrub Taiga[3]					
Birch-Lichen	Occurs on upland terraces. Habitat dominated by scrub birch and lichen species. These sites are generally on exposed well drained soils, convex micro-topography and/or warm aspects.	12	5.75	20	0.27
Birch-Moss	Habitat unit dominated by scrub birch and a moss understory. Birch-Moss is generally occurs on sheltered, moist, well drained soils, concave micro-topography and/or cool aspects.	5	5.00	8	0.16
Willow-Bluebell	Occurs in sheltered valleys, adjacent to streams and seepage. Dense canopy is dominated by medium to tall willow species, and the understory is a diverse mix of forbs including bluebell. These sites are moderately drained, with moist to wet soils.	2	8.00	6	0.13
Willow-Slope	Occurs on steep slopes and avalanche chutes. Dense canopy is dominated by medium to tall willow species and may have an understory of alpine fir, sedge species, and/ or a mix of forbs. These sites have steep slopes, with well drained submesic to xeric soils.	3	4.67	8	0.16
Wooded Taiga[4]					
Fir-Lichen	Habitat unit dominated by alpine fir and lichen species. The canopy is usually open and may a have scrub birch layer. These sites are generally on exposed, well drained soils, convex micro-topography and/or warm aspects.	4	3.75	7	0.15
Fir-Moss	Habitat dominated by alpine fir and a moss understory. Percent canopy cover is higher than in the Fir-Lichen vegetation unit. Fir-Moss generally occurs on sheltered, moist, well drained soils, concave micro-topography and/or cool aspects. This community also occurs adjacent to seeps streams.	8	4.13	13	0.22
Spruce-Moss	Habitat unit dominated by white spruce and a moss understory. Percent canopy cover low. High shrub layer dominated by scrub birch and/or willow species. Generally occurs on moist, well drained soils, and/or cool aspects.	5	6.60	14	0.23
Wetland and Riparian					
Willow-Sedge	Occurs adjacent to streams and rivers in floodplains. Dense canopy is dominated by medium to tall willow species and the understory is characterized by sedge species, horsetail species, and moss species. These sites are generally flat, moderately to well drained with submesic to mesic soils.	10	7.40	18	0.26

TABLE 4.1.9-29: SUMMARY OF BREEDING BIRD SURVEY RESULTS, 2006 AND 2007					
Habitat Type	General Habitat Description	No. Surveyed (2006 and 2007)	Ave. No. of Birds Detected[1] per Station (2006 and 2007)	No. of Bird Species Detected (2006 and 2007)	Shannon-Wiener Species Diversity[2] Index
Complex Habitats					
Complex: Heath-Lichen: Fescue-Sedge	See Heath-Lichen and Fescue-Sedge	4	4.25	6	0.13
Complex: Fescue-Willow: Birch-Moss	See Fescue-Willow and Birch-Moss	2	6.50	5	0.12
Complex: Birch-Lichen: Willow-Sedge	See Birch-Lichen and Willow-Sedge	2	10.5	8	0.16

1. Analysis does not include incidental birds.
2. Alpine is defined as high elevation mountain regions unvegetated or vegetated by dwarf shrubs, herbs and krummholtz trees.
3. Shrub Taiga (subalpine) is defined as mid elevation mountain regions vegetated by tall or low shrubs and sparse tree cover.
4. Wooded Taiga is defined as lower mountain slopes and valley bottoms vegetated primarily by coniferous forests.

TABLE 4.1.9-30 SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES – OTHER UPLAND BIRDS			
SARA	*Wildlife Act* (Yukon)	*Migratory Birds Convention Act*	Ongoing Studies
Not protected	1) No person shall destroy or be in possession of bird eggs or nests 2) Prohibits harassing wildlife. No person shall capture, handle or attempt to do so, interfere with the movement of an animal across a road or watercourse and operate a vehicle or boat in a manner considered harassment towards any wildlife.	1) Prohibits the possession of a migratory bird, its eggs or nest 2) No person shall disturb or destroy a nest or egg of a migratory bird 3) Prohibits the deposition of harmful substances to areas frequented by a migratory bird	None known to date

Three species, Common Nighthawk, Olive-sided Flycatcher and Rusty Blackbird have been ascribed special conservation status in Canada by COSEWIC; however, their populations are not protected under the SARA. Once a species is evaluated and listed as Threatened under SARA Schedule 1 (such as the Common Nighthawk and Olive-sided Flycatcher), a Recovery Plan will be developed within one to two years. Following the release of the Recovery Plan, proposed developments must support species at risk recovery efforts. If a species, such as the Rusty Blackbird is listed as Special Concern under SARA Schedule 1, they do not benefit from full legal protection under the Act; however under SARA, a Management Plan will be developed. Once this management plan is developed, developers are encouraged to follow these management guidelines to prevent species from becoming at risk. To date, no special recovery and or management requirements have been ascribed for the preservation of any upland bird species with special conservation status.

The Short-billed Dowitcher has not been evaluated on a national scale, but populations in the Yukon are considered May Be At Risk. To date, there is no territorial protection for the Short-billed Dowitcher.

Although there are no special management requirements for species with special conservation status as of yet, all migratory birds and their nests (including cranes, shorebirds and other migratory insectivorous birds such as chickadees, woodpeckers, nighthawks, warblers and flycatchers) are protected under the federal MBCA..

4.1.9.12 Amphibians

The Yukon lies in the extreme northern limit of amphibian species ranges. Northern distributions are limited by winter temperatures and species cold tolerance. Only one amphibian species, the wood frog, may occur within the study area.

CONSERVATION STATUS – WOOD FROG	
SARA	Unlisted
COSEWIC	Not Evaluated
Wildlife Act Yukon)	Not listed.

Population Status and Regional Harvest Data

Wood frogs are considered common in the Yukon, and have not been evaluated by COSEWIC. However, studies have shown recent world-wide declines in amphibian populations. Unlike other frog species in Canada, wood frogs are highly adaptive to cold temperatures and are able to tolerate freezing during winter hibernation.

General Life History and Habitat Requirements

Wood frogs occupy various habitat types throughout their life cycle including forests, meadows and wetlands. In October, as winter progresses, wood frogs move into forests to over-winter under leaf litter. After hibernating for up to six months, wood frogs emerge as soon as daily air temperatures are above freezing and before all ice has melted off wetlands. Breeding begins shortly after emergence from hibernation (April through June) at clear, shallow ponds, wetlands, and other slow-moving or stagnant waters. Their eggs are laid in globular masses, which are submerged and often attached to sticks or plants. After hatching, tadpoles remain in their birthing aquatic habitats feeding predominantly on algae. After 6-12 weeks, the tadpoles transform to adults.

As adults, wood frogs may disperse into terrestrial habitats, such as fir - moss, spruce - moss, birch – moss and willow – bluebell habitat types. Others remain in aquatic habitats prior to hibernation. Like all amphibians, wood frogs prey on insects; however, wood frogs may also cannibalize prior to hibernation when insects become unavailable.

Local Distribution and Habitat Use

No frogs were observed (or heard) within the study area during the 2005 – 2008 field surveys, including during the ground based waterfowl and breeding bird surveys. These ground based waterfowl and breeding bird surveys, were conducted at a time when breeding frogs are audible and reasonably detected.

Wood frogs may occur throughout most low valley aquatic and terrestrial habitats, particularly in the Hess River tributary and the South Macmillan and Tsichu rivers.

Special Management Requirements and Ongoing Studies

There are no special management requirements to protect wood frog populations in the study area. In addition, no known ongoing studies or monitoring programs exist within the study area.

4.1.10 Water Resources

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

4.1.10.1 Hydrological Setting

The Mactung property is located on the watershed divide that also delineates the border between the Yukon and the Northwest Territories (see Figure 4.1.10-1). Creeks generally flow west on the Yukon side of the border.

Runoff from the Mactung site within the Yukon is conveyed by unnamed creeks that are headwaters of the Hess River, which flows 200 km west to join the Stewart River, which in turn joins the Yukon River another 250 km to the west. For the purposes of this proposal, the local watercourses are referred to as Tributaries A, B, C and Hess River South Tributary, the locations of which are indicated on Figure 4.1.10-1. Tributary A drains the southern part of the study area outlined on Figure 4.1.10-1 and flows into the watercourse designated South Tributary of Hess River. This creek flows from elevation 1800 m to elevation 1100 m at the confluence with the South Tributary. Tributary B has its headwater at elevation 1929 m. It flows northeast for roughly 8.5 km before it joins Tributary A at elevation 1200m. Tributary C originates just west of the camp site at about elevation 1700 m and joins Tributary A at about elevation 1150 m roughly 4 km downstream of the Tributary B confluence. The tributaries are discussed in more detail in the following sections.

Local Monitoring Program

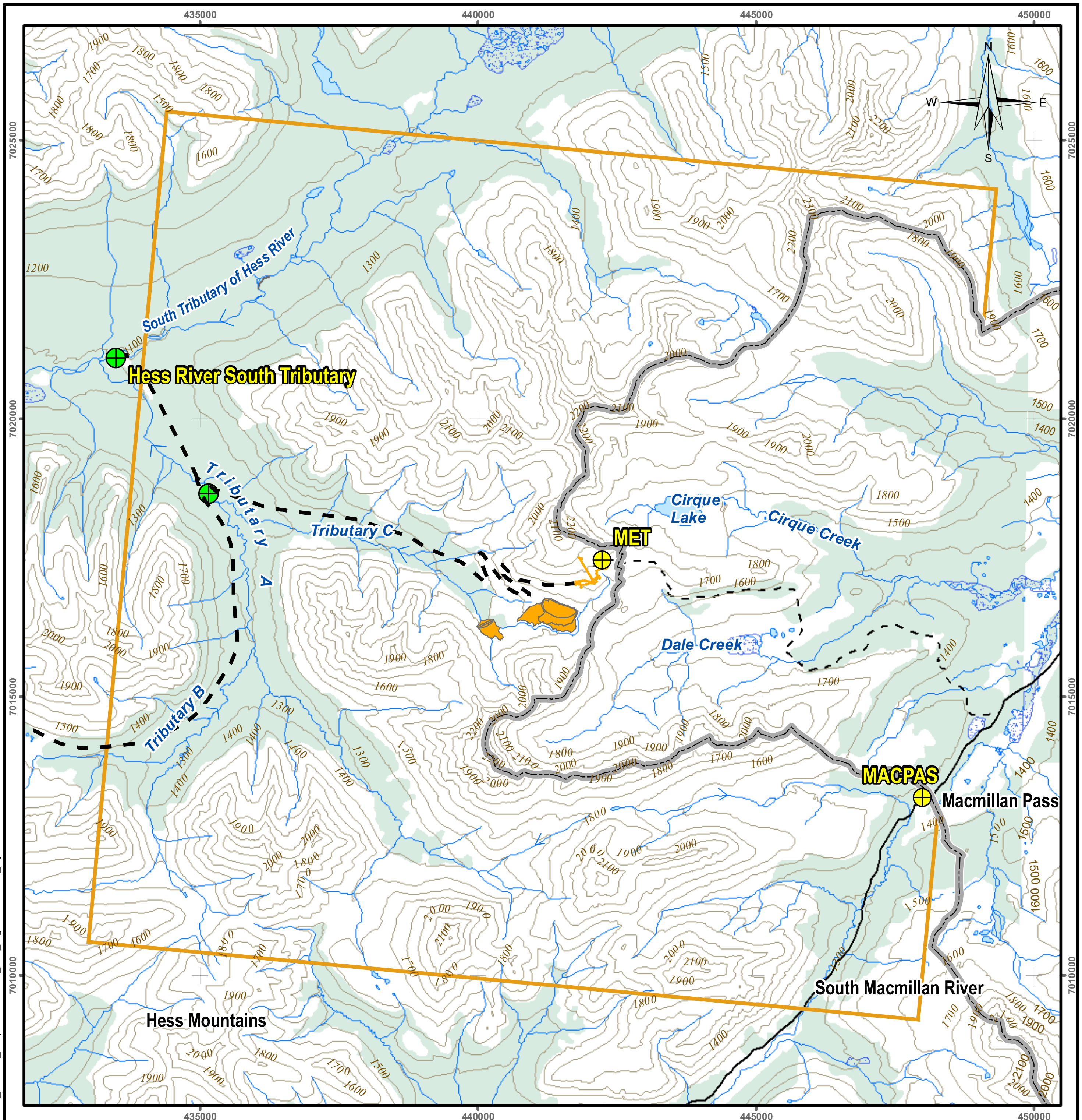
Tributary A

A hydrometric station was installed on Tributary A during the summer of 2006, about 7 km west of the Mactung camp, at latitude 63° 17' 22.6" N, longitude 130° 17' 19.0 " W. The station, which is at an elevation of 1133 m, monitors discharge and water temperature. The drainage area above this station is 79.1 square km and the basin has approximate dimensions of 12 km by 10 km. The station is located about 50 m downstream of the confluence with Tributary C and so includes the drainage areas of Tributaries B and C and part of the Tributary A basin. The highest elevation within the basin is over 2000 m.

At the location of the hydrometric station on Tributary A the river is approximately 11 m wide with a maximum water depth of 0.5 m. These dimensions vary with the creek discharge. The creek bed consists mostly of cobbles ranging from 10 to 200 cm in size. There is also some sand and gravel.

Flow hydrographs and water temperature records were developed from data recorded every 15 minutes at the hydrometric station over the periods from July 9 to September 20, 2006, July 10 to September 5, 2007 and June 18 to September 3, 2008. The flow hydrographs are presented in Figure 4.1.10-2.

The average recorded flow for Tributary A for the period of record was 3.0 m3/s for 2006, 2.6 m3/s for 2007 and 3.6 for 2008. The short duration increases in flow that occurred during the summer months were in response to heavy rainstorms. The maximum recorded flow of 8.12 m3/s occurred on June 23, 2008. Average monthly discharges for Tributary A, are presented in Table 4.1.10-1.



LEGEND

- Proposed Access Road
- NWT - Yukon Border
- Proposed Mine Site Infrastructure
- Local Study Area
- Road
- Trail
- Contour (100m)
- Watercourse
- Waterbody
- Wetland
- Vegetation
- Hydrometric Station
- Meteorological Station

TRIB A	Tributary A Hydrometric Station
MET	Mactung Camp Meteorological Station
MACPAS	MSC Macmillan Pass Meteorological Station

NOTES Base data source: NTS 1:50,000

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MACTUNG

Hydrometeorological Station Location Map

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:100,000

0 0.5 1 2 3 4

Kilometres

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FILE NO.
W23101110_001_Figure-4-1-10-1_HydroMeteo.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	KMW	EL	1

OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 4.1.10-1

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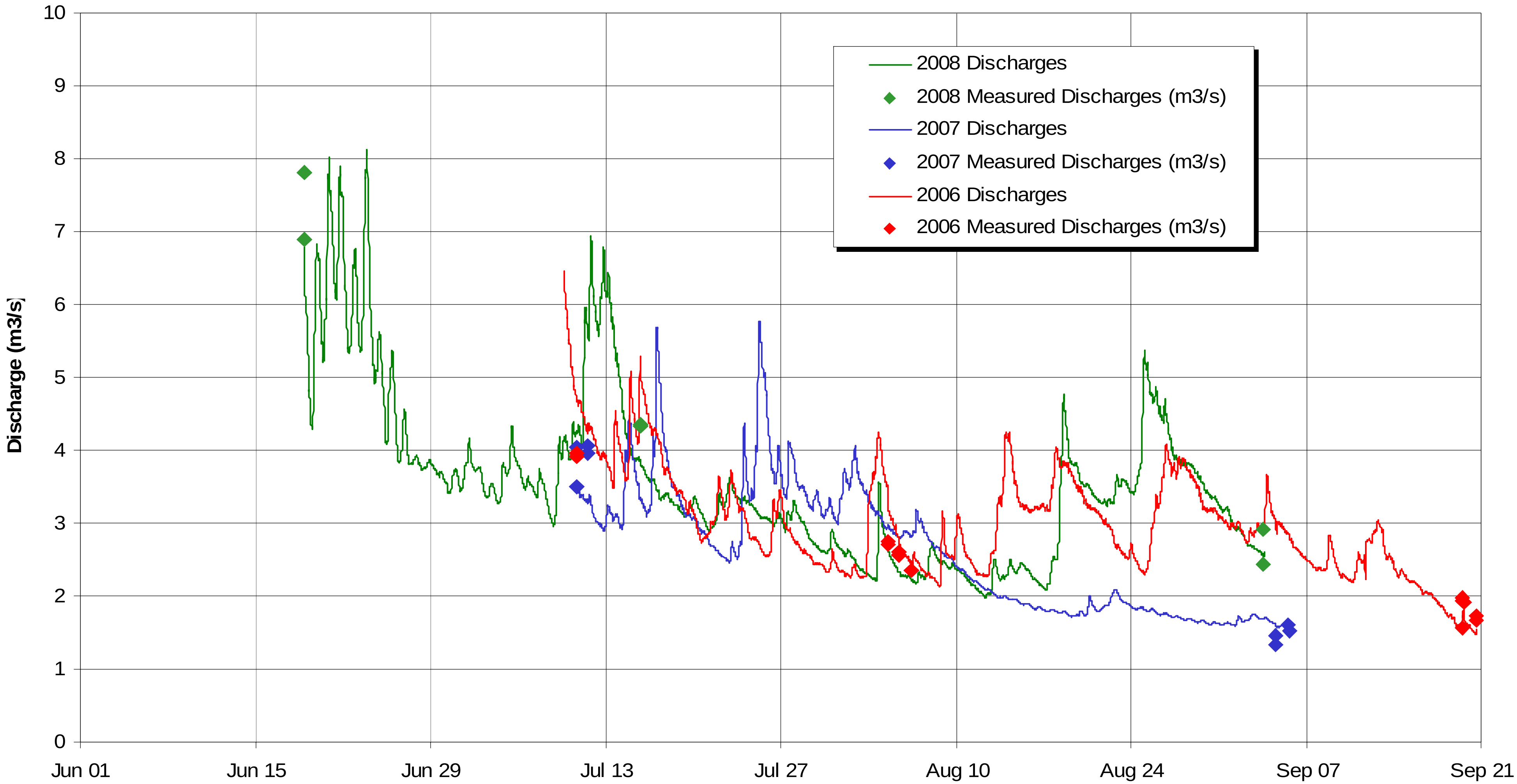

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NOTES

A discharge of 0.23 m^3/s was measured on May 8, 2008 @ 14:00 hours.

CLIENT

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MACTUNG

Tributary A
2006-2008
Discharge Hydrograph

PROJECT NO.	DWN	CKD	REV
W23101110.001	RED	JAS	0
OFFICE	DATE		
EBA-VANC	October, 2008		

Figure 4.1.10-2

Winter flows were not recorded, but are assumed to be near zero as the creeks freeze under sub-zero temperatures. Since instrumentation was not installed prior to the snowmelt, maximum freshet flows have likely not been recorded.

The water temperature records are plotted in Figure 4.1.10-3. The maximum water temperature recorded was 10.8 ºC on the evening of July 29, 2006, and the lowest, 0.8 ºC, occurred on the morning of September 14, 2006.

A diurnal temperature cycle is evident, with maximum daily water temperatures occurring each evening around 5:00 to 6:00 PM and minimum temperatures occurring in the mornings from 7:30 to 9:00 AM. The typical daily maximum to minimum temperature variation is approximately 3°C.

Hydrometric station at Tributary A

Tributary C

Spot manual discharge measurements were carried out on Tributaries A and C at similar times on five days throughout the course of the study in order to determine a relationship between the flows in the two creeks. The average ratio of Tributary C to Tributary A flows was determined to be 0.3384. The ratio of the catchment areas is 0.302, which is consistent with this approach.

Using the flow ratio of 0.3384 and flow data recorded by the hydrometric station on Tributary A, discharge hydrographs for Tributary C were generated, as presented in Figure 4.1.10-4.

The average flow on Tributary C over the period of record from three years was 0.85 m^3/s. The maximum estimated summer flow on Tributary C was 2.6 m^3/s. Estimated average monthly discharges for Tributary C are presented in Table 4.1.10-1.

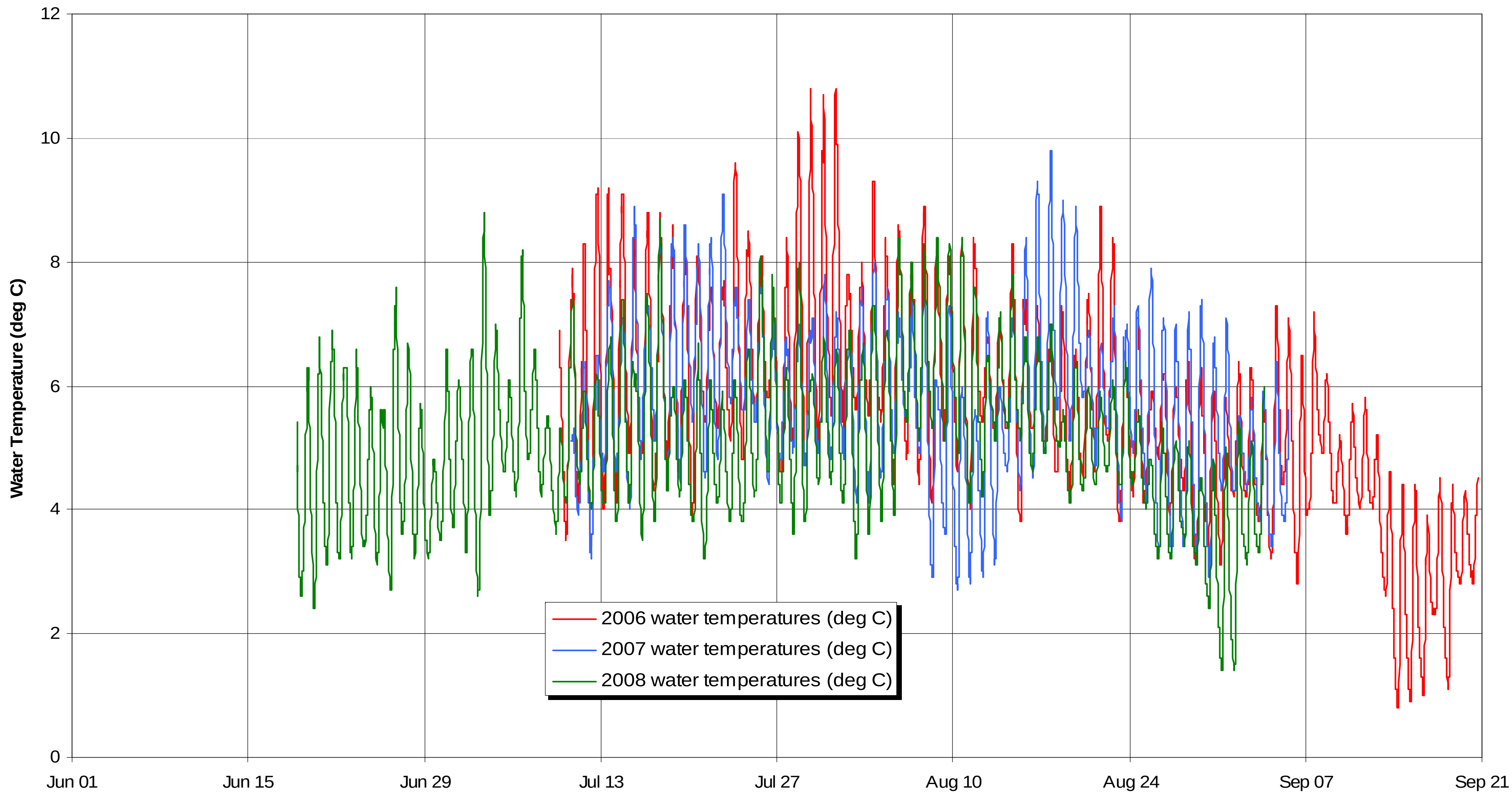
Hess River South Tributary

A hydrometric station was installed on Hess River south tributary during the early summer of 2008. The station, which is located at approximate latitude 63° 18' 44.9" N, longitude 130° 19' 38.5 " W, monitors discharge and water temperature. The drainage area above this station is 340 square km. The station is located about 150 m downstream of the confluence with Tributary A and so includes the drainage areas of Tributaries A, B and C.

The Hess tributary in this reach is approximately 23 m in width and there is bedrock outcropping on the left bank. The right bank consists of vegetated surficial materials and is approximately 2 m in height. The bedrock on the left bank is highly fractured and easily dislodged. As a result the stream bed extending downstream from the bedrock is primarily gravel sized angular clasts with some cobbles and boulders. The covering of angular gravel sized clasts extends downstream approximately 50 m before the stream becomes predominantly a cobble and boulder bed system. The stream gradient in the area of the discharge monitoring location is approximately 0.5% and this increases to almost 1% downstream of this location. Erosion of the fractured bedrock has resulted in deep pools on the left bank, upstream of the gauging section, where the stream turns a right corner. These pools are in the area proposed for the fresh water intake.

Flow hydrographs and water temperature records were developed from data recorded every 15 minutes at the hydrometric station over the periods from June 18 to September 3, 2008. The flow hydrographs are presented in Figure 4.1.10-5.

The average recorded flow for Hess River South Tributary for the period of record was 14.1 m^3/s. The maximum recorded flow of 31.5 m3/s occurred on July 13, 2008. The water temperature records are plotted in Figure 4.1.10-6. The maximum water temperature recorded was 11.9 ºC on Aug 09, 2008, and the lowest, 0.8 ºC, occurred on the morning of August 31, 2008.



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NOTES

Water Temperatures collected at the same depth as the transducer.

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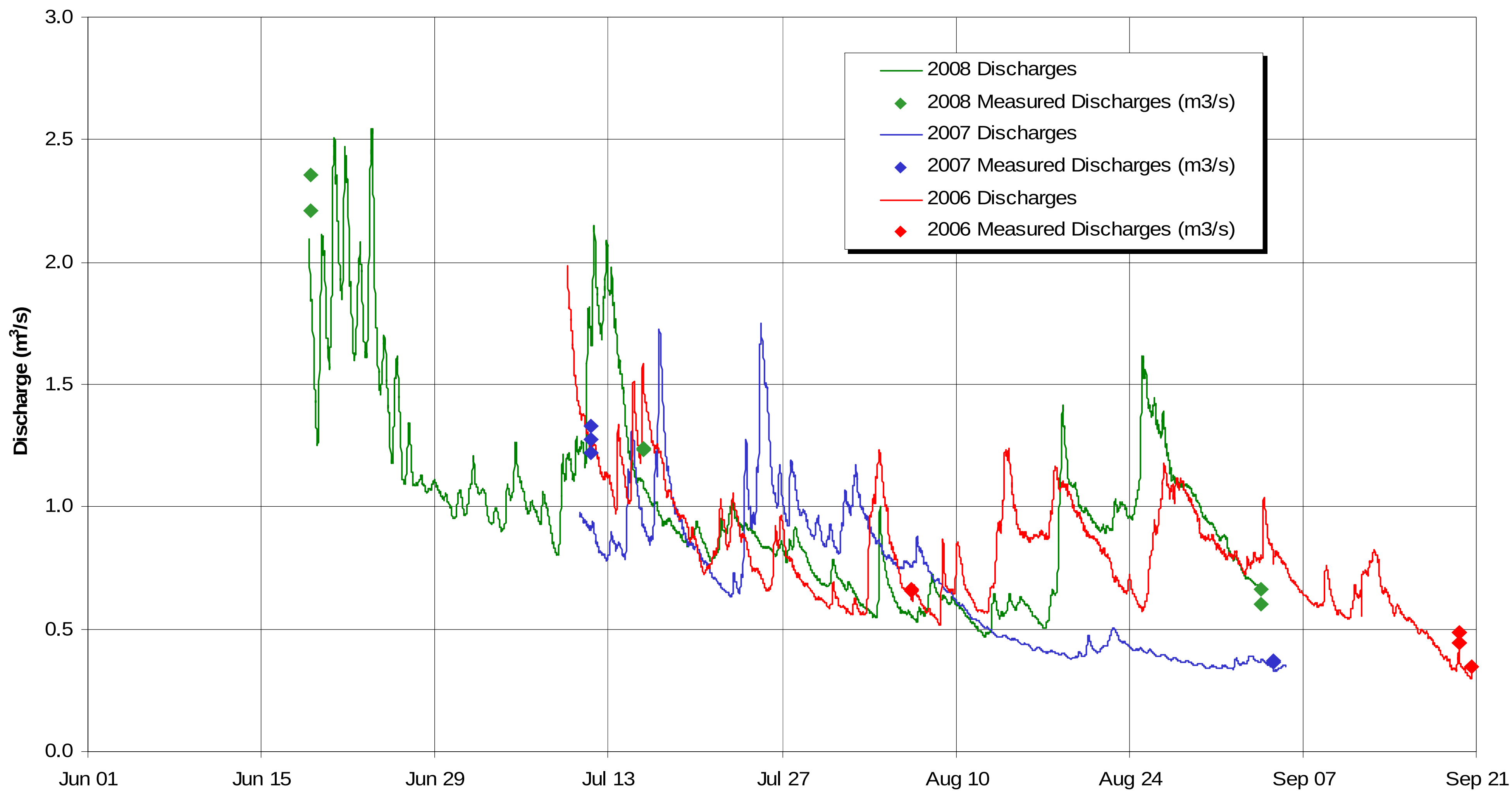
MACTUNG

Tributary A
2006 - 2008
Water Temperatures

PROJECT NO.	DWN	CKD	REV
W23101110.001	RED	JAS	0
OFFICE	DATE		
EBA-VANC	October, 2008		

Figure 4.1.10-3



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NOTES

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MACTUNG

Tributary C
2006-2008
Discharge Hydrograph

PROJECT NO.	DWN	CKD	REV
W23101110.001	RED	JAS	0
OFFICE	DATE		
EBA-VANC	October, 2008		

Figure 4.1.10-4

TABLE 4.1.10-1 AVERAGE MONTHLY DISCHARGES

Year	Period of Record		Average Monthly Discharge (m3/s)			
	Start	End	June	July	August	September
Tributary A - Basin Area = 79.1 km²						
2006	Jul 9 16:38	Sep 20 16:38	No data	3.45	3.03	2.43
2007	Jul 10 15:59	Sep 05 15:59	No data	3.41	2.20	1.66
2008	Jun 18 20:49	Sep 3 17:04	5.10	3.63	2.98	2.76
Tributary C - Basin Area = 24.2 km2						
2006	Jul 9 16:38	Sep 20 16:38	No data	0.97	0.82	0.62
2007	Jul 10 15:59	Sep 05 15:59	No data	0.95	0.54	0.36
2008	Jun 18 20:49	Sep 3 17:04	1.52	1.03	0.81	0.73
Hess River South Tributary – Basin Area 340 km2						
2008	Jun 18 15:32	Sep 3 13:17	16.59	14.96	12.81	6.11

Note: The discharge data presented for Tributary C is derived from Tributary A discharges as determined by the hydrometric station located on that creek. Tributary C discharges are calculated by adjusting Tributary A discharges by the ratio of discrete discharge measurements collected at similar times from both creeks. This discharge ratio agrees well with the basin area ratio.

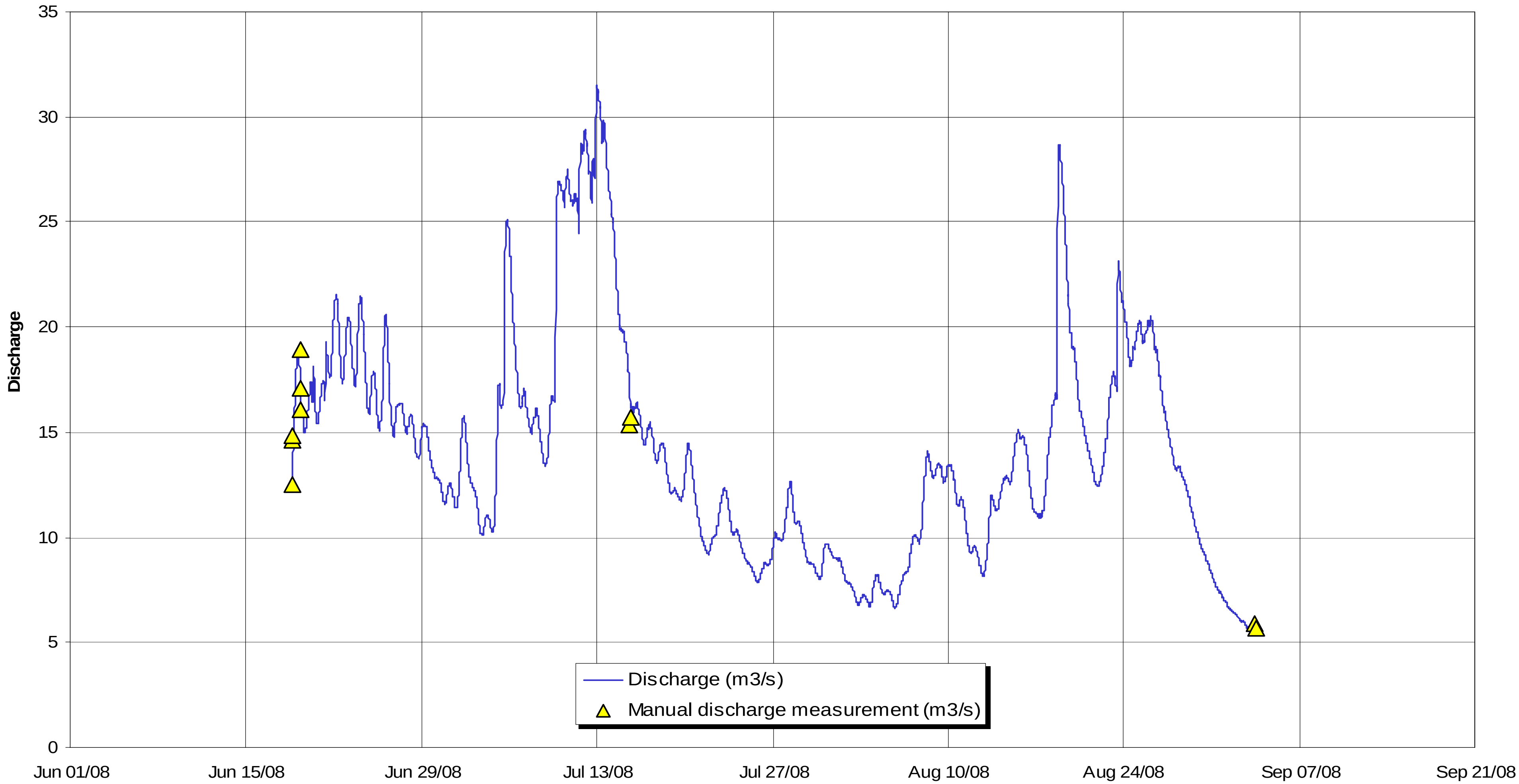
Estimated Hydrological Regime

In the absence of year round records of flow in any of the local watercourses, the annual hydrological regime was estimated making use of regional stations and the short duration records obtained on site. Three regional stations were identified as potentially useful in characterizing the site hydrology as listed in Table 4.1.10-2 (Water Survey of Canada, 2008). The locations of these stations are indicated on Figure 4.1.10-7.

TABLE 4.1.10-2 REGIONAL HYDROMETRIC STATIONS

Station No.	Name	Lat	Long	Drainage Area (km²)	Record Period
09DA001	Hess River above Emerald Creek	63o 20’ 10”	131o 30’ 00”	4840	1976-1996
09BB001	South Macmillan River at km 407 Canol Road	62o 55’ 30”	130o 32’ 30”	997	1974-1996
29BB001	Boulder Creek at km 387 Canol Highway	62o 51’ 50”	130o 49’ 55”	84.1	1976-1991

Source: Water Survey of Canada, Archived Hydrometric Data. Website: http://www.wsc.ec.gc.ca/hydat/H2O/index_e.cfm?cname=main_e.cfm



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NOTES

A winter flow of 0.141 m^3/s was measured on March 28, 2008 @ 13:00 hours on the South Tributary of the Hess River

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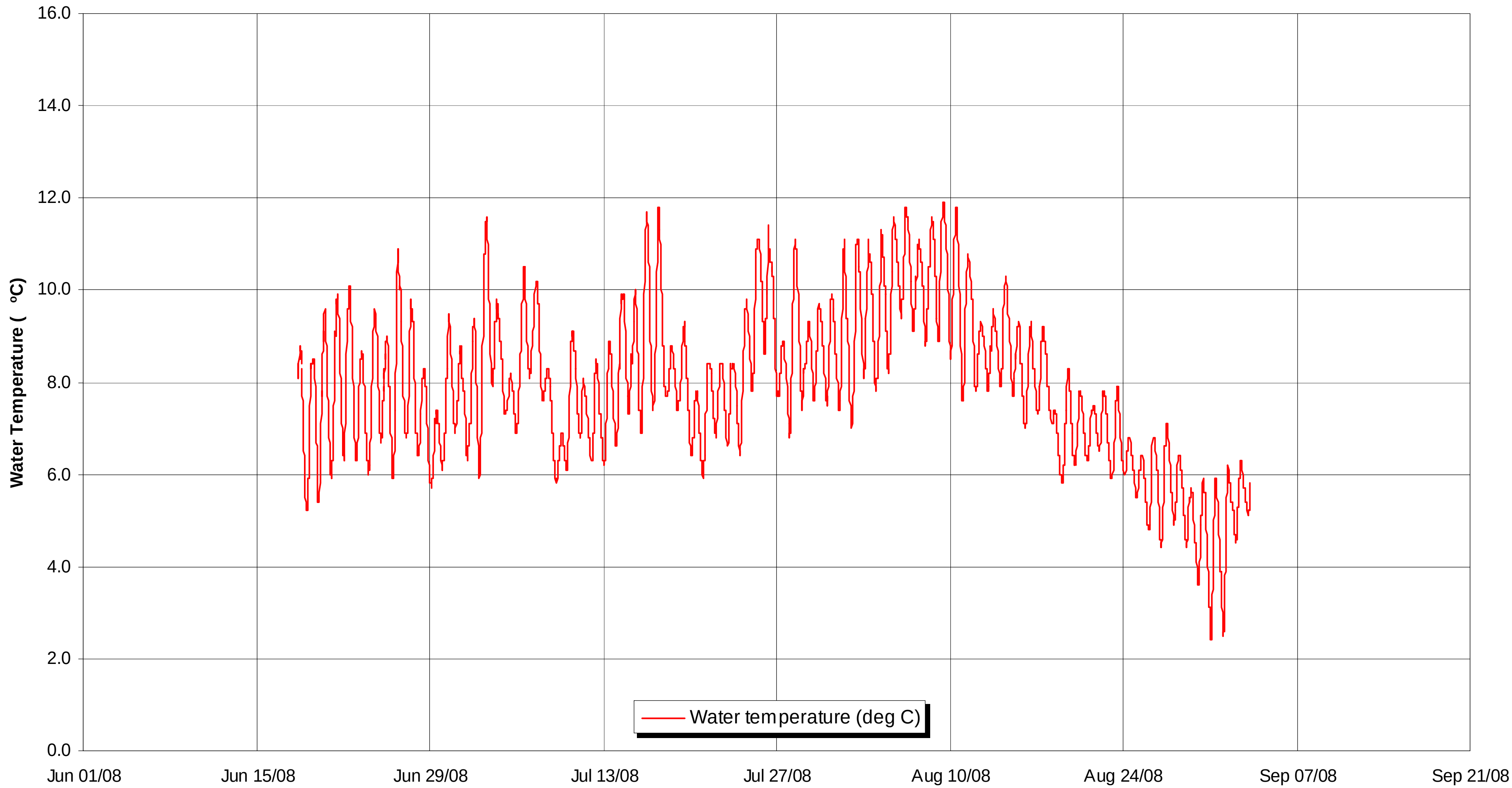
Hess River
SouthTributary
2008 Discharge Hydrograph

PROJECT NO.	DWN	CKD	REV
W23101110.001	RED	JAS	0
OFFICE	DATE		
EBA-VANC	October, 2008		

Figure 4.1-10-5



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NOTES

Water temperatures are collected ath the same depth as the transducer.

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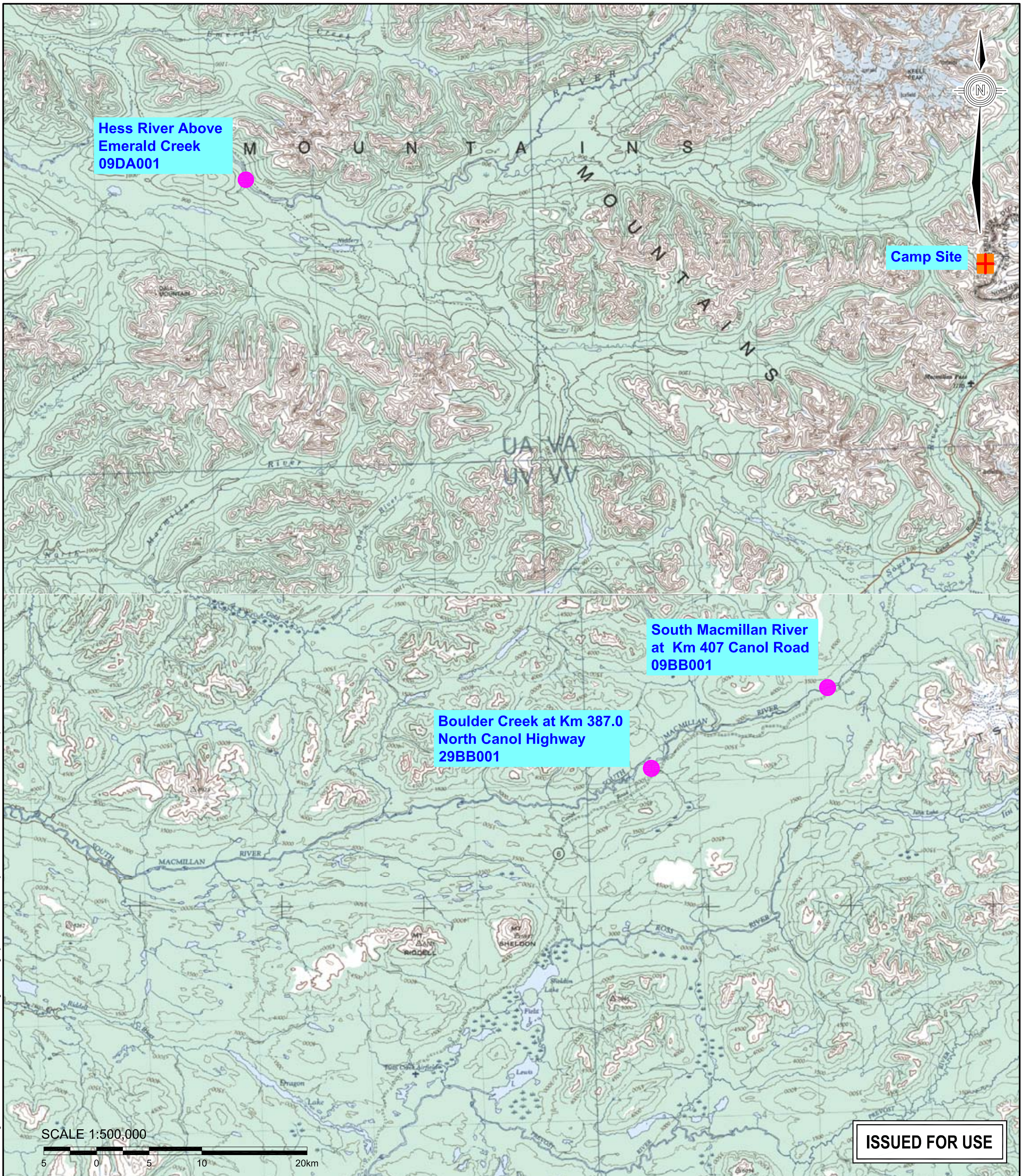
MACTUNG				
Hess River SouthTributary 2008 Water Temperatures				
PROJECT NO. W23101110.001	DWN RED	CKD JAS	REV 0	Figure 4.1-10-6
OFFICE EBA-VANC	DATE October, 2008			



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Location of Regional Hydrometric Stations

PROJECT NO.	DWN	CKD	REV
W23101110.001	EL	AC	2
OFFICE	DATE		
VANC	December 4, 2008		

Figure 4.1.10-7

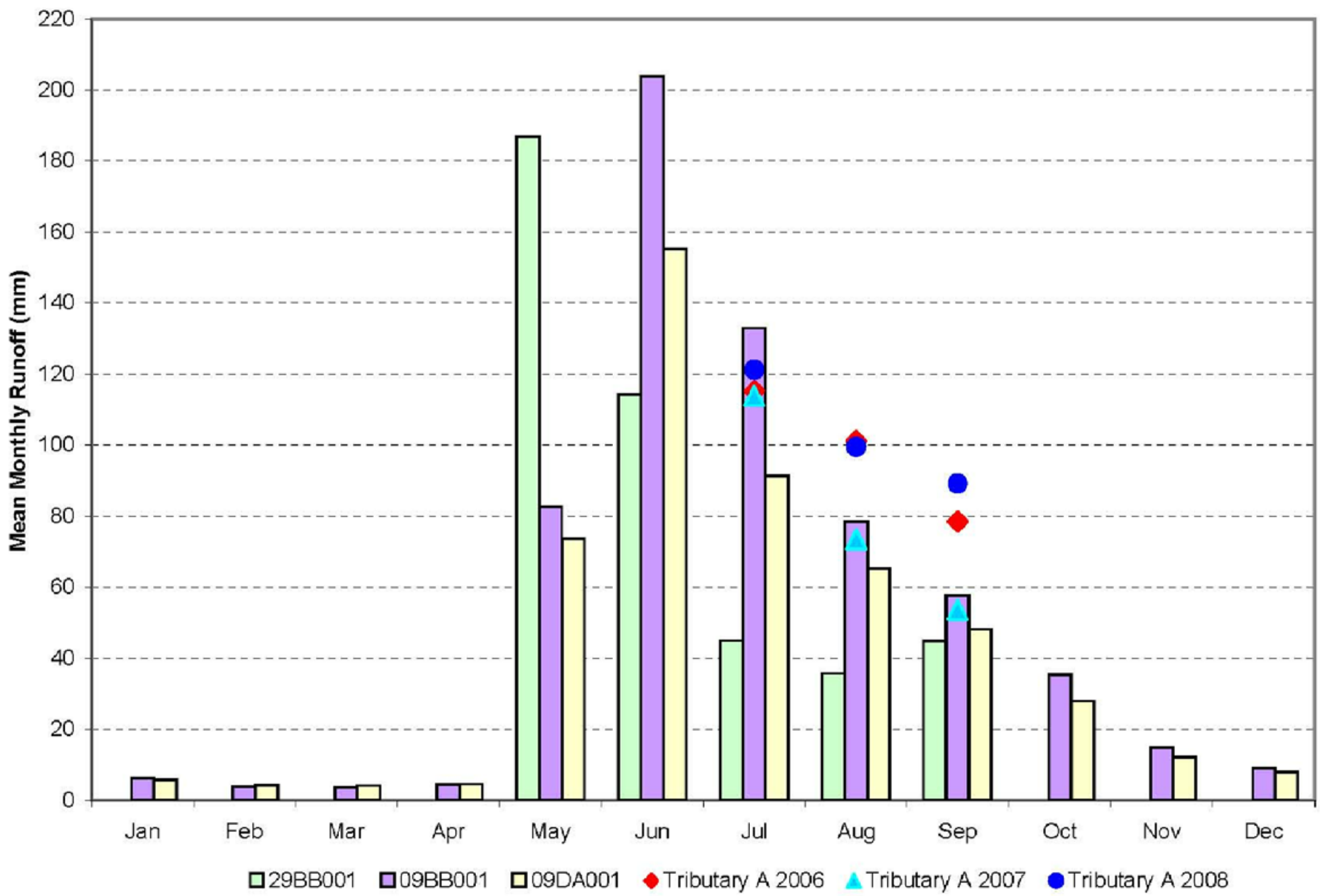
Q:\Vancouver\Engineering\V132\Projects\W23101110.001 Mactung, YESAA Assessment\Clerical\Figures.dwg [FIGURE 4.1.10-7] December 04, 2008 - 9:49:04 am (BY: EVA LI)

The rationale for selection of the three stations is as follows:

- The Hess River station is in the drainage basin that receives runoff from the mine area, but has a very large drainage area by comparison;
- The South Macmillan station is the closest hydrometric station to the site with a 22-year, year-round record. It has a smaller drainage area than the Hess River station;
- The Boulder Creek station is also closer to the site than the Hess River station and has a much smaller drainage area that is more representative of the local drainages at the site.

Mean monthly runoff from the three stations has been normalized by converting each flow to depth of runoff over the catchment and the results are plotted on Figure 4.1.10-8. This plot indicates a regime that is likely reflected in the upper reaches of the Hess River basin with the exception that lower winter flows and later snowmelt hydrogaphs may be expected near the site due to the higher elevations and prolonged freezing temperatures.

The mean annual runoff calculated for the three reference hydrometric stations is plotted against median basin elevation in Figure 4.1.10-9. The annual runoff at Tributary A station is determined by extrapolating the correlation using an estimated median basin elevation of 1620 m. As listed in Table 4.1.10-3, the mean annual runoff at Tributary A is calculated to be 695 mm, which is 10% higher than the South Macmillan River at km 407 Canol Road hydrometric station. Frequency analysis was undertaken using Hydrological Frequency Analysis Software package (HYFRAN 1.1.) to determine the extreme runoffs, namely 10-year wet and 10-year dry, at the South Macmillan River at km 407 Canol Road hydrometric station. The extreme runoffs at the Tributary A station were scaled up by 10% as shown in Table 4.1.10-3.



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LEGEND:
Hydrometric Stations:
- Boulder Creek at Km 387.0 North Canol Highway, 29BB001
- South Macmillan River at Km 407 Canol Road, 09BB001
- Hess River above Emerald Creek, 09DA001

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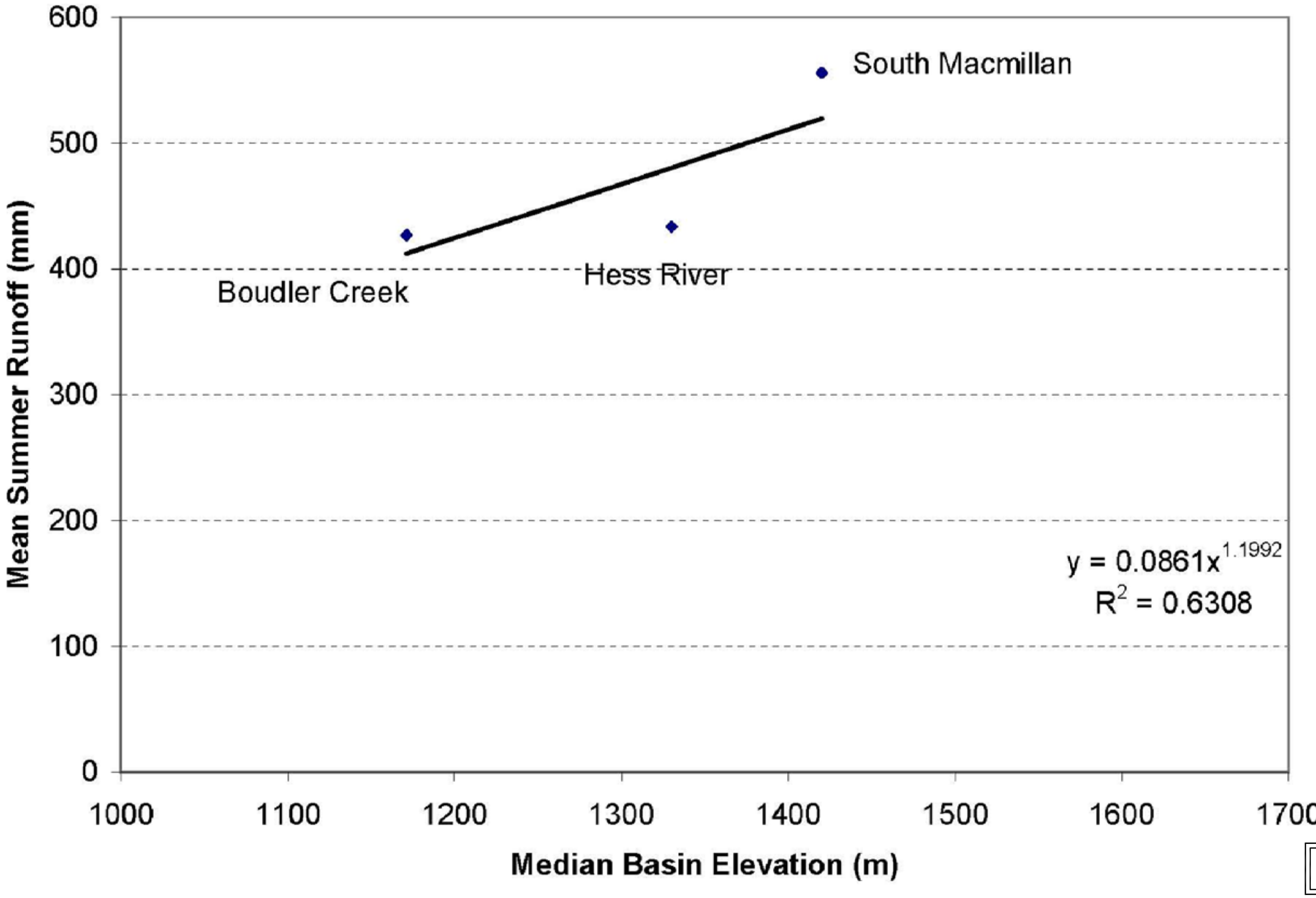
Mean Monthly Runoff Distributions

PROJECT NO.	DWN	CKD	REV
W23101110.001	EL	AC	2
OFFICE	DATE		
VANC	December 04, 2008		

Figure 4.1.10-8



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NOTE

Based on 3 regional hydrometric stations:

- Boulder Creek at Km 387.0 North Canol Highway, 29BB001
- South Macmillan River at Lm 407 Canol Road, 09BB001
- Hess River above Emerald Creek, 09DA001

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Annual Runoff vs. Median Basin Elevation

PROJECT NO.	DWN	CKD	REV
W23101110.001	EL	AC	2
OFFICE	DATE		
VANC	December 4, 2008		

Figure 4.1.10-9

TABLE 4.1.10-3 MEAN AND EXTREME RUNOFF AT THE MACMILLAN RIVER HYDROMETRIC STATION AND TRIBUTARY A		
	Macmillan River Km 407 Station	Tributary A
Mean Annual Runoff (mm)	633	695
10 Year Wet Runoff (mm)	747	820
10 Year Dry Runoff (mm)	532	584

Observations in the field suggest that Tributary A flows year round. The monthly runoff at the Tributary A station was estimated using the annual runoff distribution of the South Macmillan River at km 407 Canol Road hydrometric station, which has discharge records from 1975 to 1996. A summary of the mean and extreme monthly runoffs and the monthly percentage runoff distribution in Tributary A is given in Table 4.1.10-4.

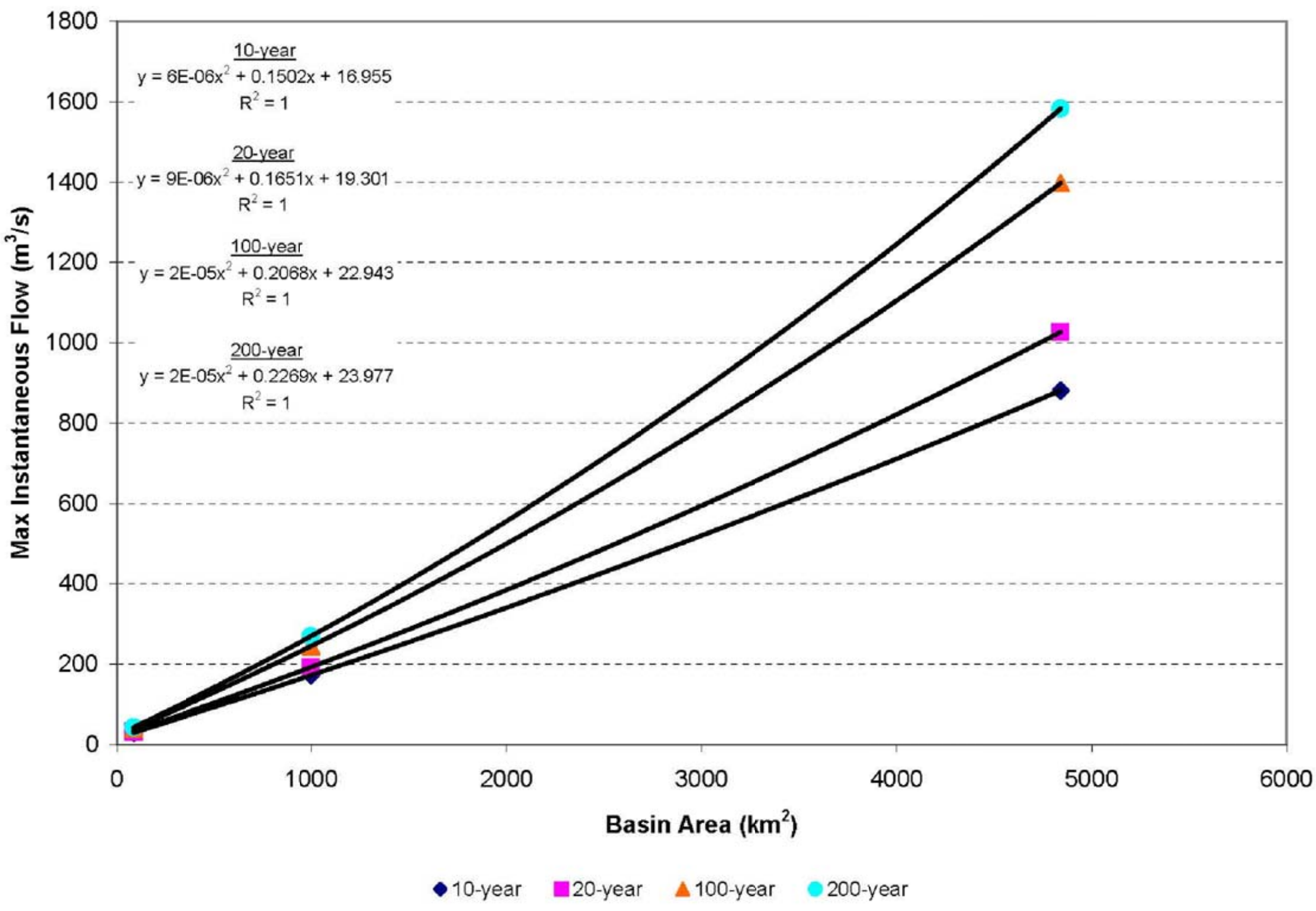
TABLE 4.1.10-4 MEAN AND EXTREME MONTHLY RUNOFF AND PERCENTAGE DISTRIBUTION IN TRIBUTARY A

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Mean Monthly Runoff (mm)	6.8	4.3	4.0	4.9	90.7	223.8	146.1	86.1	63.3	38.7	16.3	10.0	695
10-Year Wet Runoff (mm)	8.1	5.0	4.7	5.8	107.1	264.0	172.4	101.6	74.7	45.6	19.2	11.8	820
10-Year Dry Runoff (mm)	5.7	3.6	3.4	4.1	76.2	188.0	122.8	72.4	53.2	32.5	13.7	8.4	584
Distribution (%)	1.0	0.6	0.6	0.7	13.1	32.2	21.0	12.4	9.1	5.6	2.3	1.4	100

In general terms, peak runoff rates are expected to occur during June, followed by a steady decline in mean monthly flow until April in the Mactung area. It should be noted that, the winter (October to April) runoff is possibly over-estimated due to the use of a lower elevation regional station. The mean and extreme runoffs at Tributaries B and C can be estimated by scaling from Tributary A using the aforementioned basin runoff ratios.

Flood Flow Estimation

Frequency analysis was carried out on the annual maximum instantaneous flows for three hydrometric stations identified in the previous section. This was done using Environment Canada's Consolidated Frequency Analysis program (CFA 3.1). Peak flows of various return periods were determined by taking the average of the results from four frequency distributions. Regional peak flows are plotted against drainage area in Figure 4.1.10-10. In the absence of long term records for the small drainage areas at the site, the equations on Figure 4.1.10-10 may be used to predict return period snowmelt discharges as a function of drainage area. Rainfall-generated peak discharges were also calculated using 4- and 24-hour rainfall distributions and the HEC-HMS hydrologic model. Rainfall-generated peaks were found to be smaller than snowmelt-generated peak flows of the same return period.



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NOTE

Based on 3 regional hydrometric stations:

- Boulder Creek at Km 387.0 North Canol Highway, 29BB001
- South Macmillan River at Lm 407 Canol Road, 09BB001
- Hess River above Emerald Creek, 09DA001

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Regional Peak Flow vs. Drainage Area

PROJECT NO.	DWN	CKD	REV
W23101110.001	EL	AC	2
OFFICE	DATE		
VANC	December 4, 2008		

Figure 4.1.10-10

Tributaries A, B and C are located along the proposed access road to the Mactung property. The peak flow within these drainage basins can be used to develop design floods for the road crossings. The drainage areas of Tributaries A, B and C were estimated from topographic mapping. Figure 4.1.10-10 was used to determine the 10-, 20, 100- and 200-year peak flows at points on each tributary. Another potential stream crossing was identified on the South Macmillan River about 500 m from the junction with the North Canol Road (62° 9' 3" N; 130° 14' 20" W). Peak flow estimates for these locations are given in Table 4.1.10-5.

TABLE 4.1.10-5 MAXIMUM INSTANTANEOUS FLOW ESTIMATES

Basin	Catchment Area (km^2)	Maximum Instantaneous Flow (m^3/s)			
		10- year	20-year	100-year	200-year
Tributary A gauge	79.1	28.9	32.4	39.4	42.0
Tributary B mouth	22.2	20.3	23.0	27.5	29.0
Tributary C mouth	24.2	20.6	23.3	28.0	29.5
S. Macmillan River Crossing	160.1	41.2	46.0	56.6	60.8

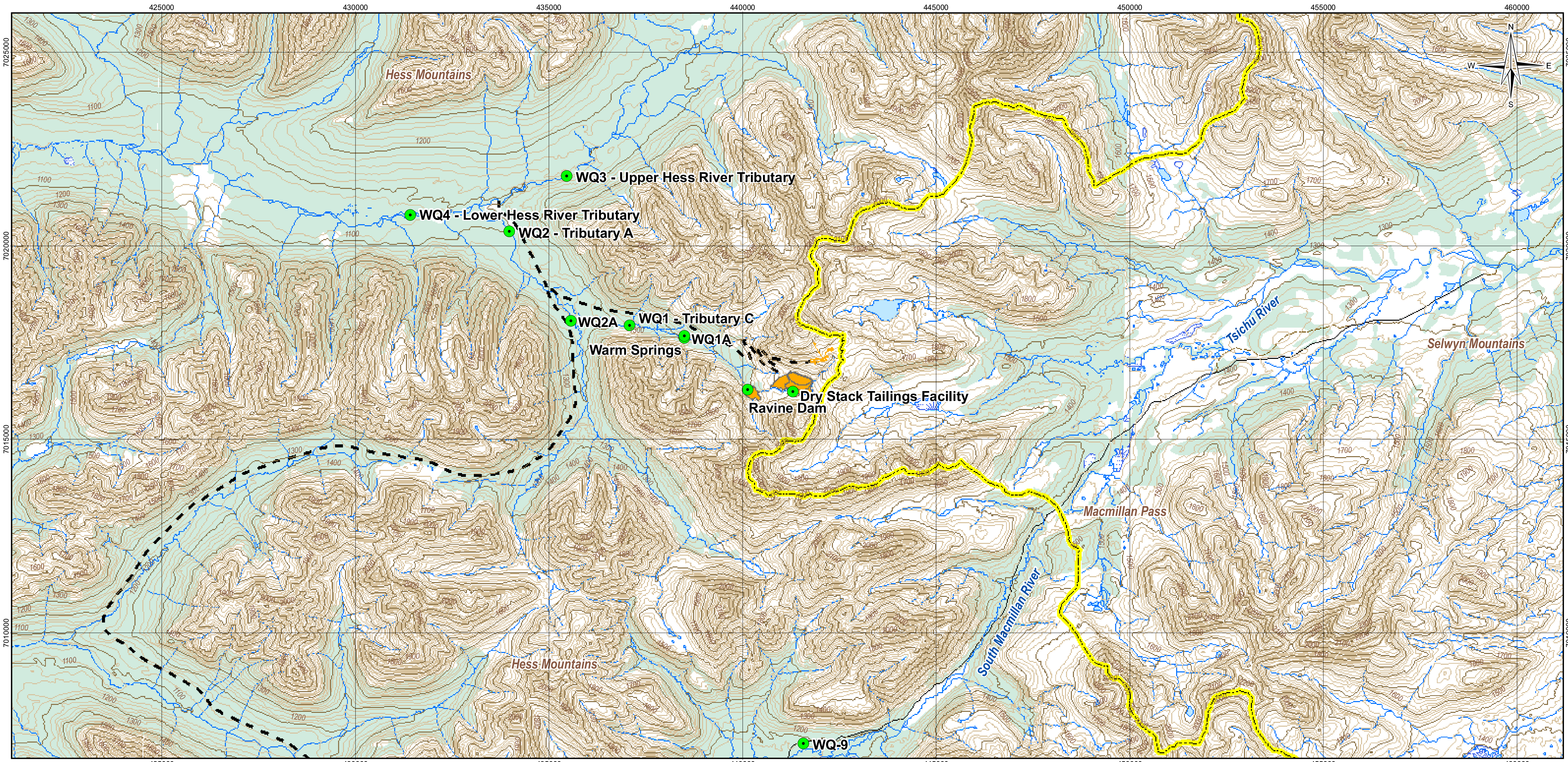
4.1.10.2 Water Quality

In June, July, August and September of 2006 and 2007, and May 2008 EBA conducted water quality sampling at watercourses within the Mactung project area including tributaries of the Hess River in the Yukon (Appendix H4; H5; and, H6). Water quality samples were collected on nine occasions from four water quality (WQ) stations in the Yukon (WQ1 through WQ4). Sample location WQ1 is located on Tributary C. Site WQ2 is located on Tributary A. Both tributaries A and C flow into the Hess River tributary that is monitored by sites WQ3 and WQ4. Sample location WQ4 on the Hess River tributary provides a site for the collective contributions of tributaries A and C, while WQ3 provides background water quality. In 2006, a ninth station (WQ9), on the South Macmillan River in the Yukon, was sampled twice. In May 2008, two additional sites were added; WQ1A farther up Tributary C and WQ2A farther up Tributary A (Figure 4.1.10-11; Photograph 4.1.10-1 through Photograph 4.1.10-7). In August 2008, additional surface water samples were collected from the locations of the proposed Ravine Dam, the proposed Dry Stack Tailings Facility and at a third site adjacent to station WQ1A (Warm Springs) (Figure 4.1.10-11). These August 2008 water samples were collected as part of the hydrogeology program to characterize surface water flows that were being used for the drilling. All water quality samples were collected and shipped to an accredited laboratory for analysis of standard physical and chemical parameters.

Physical parameters such total suspended solids (TSS), turbidity, pH and electrical conductivity (EC), nutrients (ammonia – N, nitrate, and total phosphorus), major ions (calcium, potassium, magnesium, sodium and iron - extractable) and total organic carbon (TOC) and are described in this report. These parameters typically demonstrate early signs of anthropogenic disturbances.

pH Values

All water quality stations within the Mactung study area during 2006 and 2007, with the exception of WQ9, had similar pH values, ranging from 6.9 to 8.0 for the Yukon watersheds (Table 4.1.10-6). The pH at WQ9 was below 4.5 for the two events that the site was sampled which is indicative of natural acid rock drainage occurring within that drainage. May 2008 sampling yielded similar results to 2006 and 2007, with pH ranging from 6.11 (WQ2A) (below the CCME guideline) to 7.87. The pH values for the Ravine Dam location and the Dry Stack Tailings Facility location are similar to those of the rest of the water quality stations within the Mactung study area. The pH of the Warm Spring near WQ1A exceeded the CCME guideline with a value of 9.31, considerably higher than the May value returned for the adjacent WQ1A.



LEGEND

- Sampling Locations
- NWT-Yukon Territory Border
- Proposed Mine Site Infrastructure
- Proposed Access Road
- Index Contours
- Road
- Trail
- Watercourse
- Waterbody
- Wetland
- Vegetation

NOTES
Base data source: 1:50,000 NTS

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2006, 2007, and May 2008 Water Quality Sampling Locations

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:100,000
1 0.5 0 1 2
Kilometers

FILE NO.
W23101110-001_Map004_1-1WaterQuality.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KA	1

OFFICE	DATE
EBA-VANC	December 10, 2008

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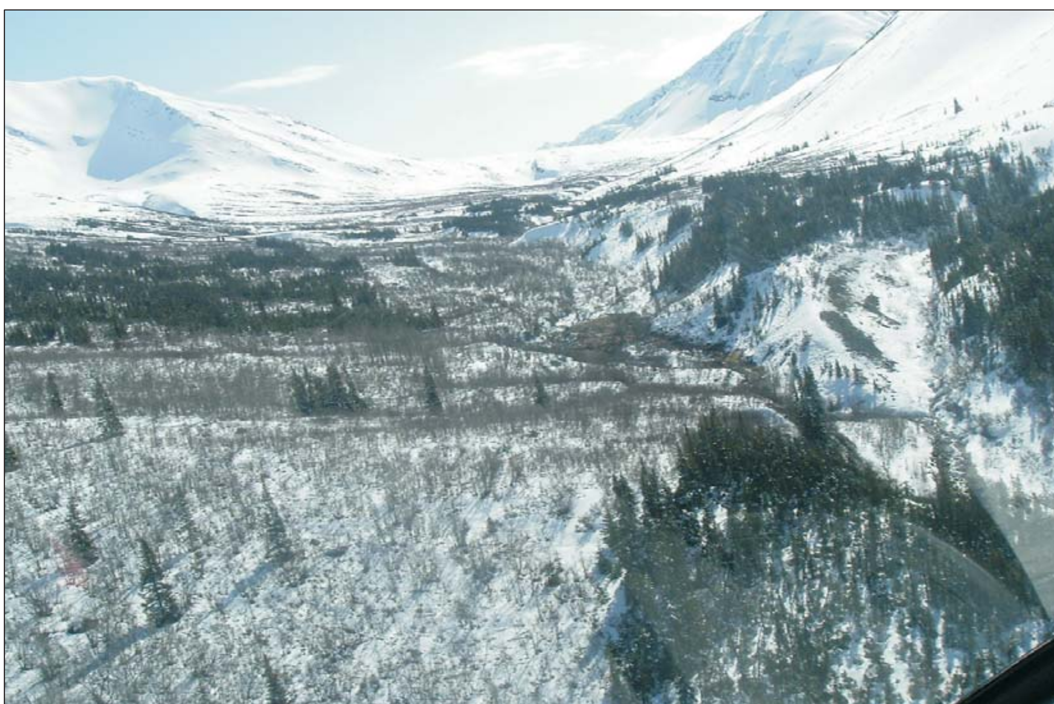
Figure 4.1.10-11

Q:\Vancouver\GIS\ENVIRONMENTAL\W231\W23101110_MacTung_AP\Maps\001_YESAA_Prep\WaterQuality\W23101110-001_Map004_1-1WaterQuality.mxd

Photograph 4.1.10-1
WQ 1 - Tributary C of the Hess River, Yukon.



Photograph 4.1.10-2
WQ 1A - Tributary C of the Hess River, Yukon.

Photograph 4.1.10-3
WQ 2 - Tributary A of the Hess River, Yukon.

Photograph 4.1.10-4
WQ 2A - Tributary A of the Hess River, Yukon.

Photograph 4.1.10-5
WQ 3 - Tributary of Hess River Upstream of Confluence with Tributary A, Yukon.

Photograph 4.1.10-6
WQ 4 - Tributary of Hess River Downstream of Confluence with Tributary A, Yukon.

Photograph 4.1.10-7
WQ 9 - South Macmillan River, Yukon.

TABLE 4.1.10-6 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT pH RESULTS

Water Quality Stations	pH Values during 2006 Sampling Events				2006 Water Quality Station Average	pH Values during 2007 Sampling Events				2007 Water Quality Station Average	pH Values during 2008		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	7.8	7.7	8	8	*7.9*	7.4	7.9	7.8	7.8	*7.7*	7.86	na	7.86	*8.8*	*7.4*	*8*
WQ 1A	na	na	na	na	---	na	na	na	na	---	7.87	na	7.87	*7.9*	*7.87*	*7.87*
WQ 2	7.5	7.3	7.3	7.3	*7.4*	7	7.5	6.9	6.9	*7.1*	7.37	na	7.37	*8.1*	*6.9*	*7.5*
WQ 2A	na	na	na	na	---	na	na	na	na	---	6.11	na	*6.11*	*6.1*	*6.11*	*6.11*
WQ 3	7.5	7.3	7.5	7.7	*7.5*	7.1	7.6	7.4	7.6	*7.4*	7.32	na	7.32	*8.4*	*7.1*	*7.7*
WQ 4	7.5	7.4	7.5	7.7	*7.5*	7.2	7.5	7.5	7.5	*7.4*	7.36	na	7.36	*8.4*	*7.2*	*7.7*
WQ 9	na	na	4.4	4.3	*4.4*	na	na	na	na	---	na	na	---	*4.4*	*4.3*	*4.4*
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	7.72	7.72	*7.72*	*7.72*	*7.72*
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	7.81	7.81	*7.81*	*7.81*	*7.81*
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	9.31	9.31	*9.31*	*9.31*	*9.31*
Event Average	*7.6*	*7.4*	*6.9*	*7.0*	*7.2*	*7.2*	*7.6*	*7.4*	*7.5*	*7.4*	*7.3*	*8.3*	*7.6*			

na = not applicable, not analyzed or not sampled

Outside CCME Guidelines of 6.5 - 9.0

TABLE 4.1.10-7 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT ELECTRICAL CONDUCTIVITY RESULTS

Water Quality Stations	EC Values during 2006 Sampling Events (µS/cm)				2006 Water Quality Station Average	EC Values during 2007 Sampling Events (µS/cm)				2007 Water Quality Station Average	EC Values during 2008		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	156	174	314	414	*264.5*	220	266	345	379	*302.5*	395	na	395	*332.9*	*156*	*414*
WQ 1A	na	na	na	na	---	na	na	na	na	---	606	na	606	*606.0*	*606*	*606*
WQ 2	173	206	275	334	*247.0*	218	256	294	328	*274*	302	na	302	*298.3*	*173*	*334*
WQ 2A	na	na	na	na	---	na	na	na	na	---	275	na	*275*	*275.0*	*275*	*275*
WQ 3	83.8	92	84.6	171	*107.9*	95.7	92.1	80.5	135	*100.825*	150	na	150	*123.1*	*80.5*	*171*
WQ 4	115	114	134	234	*149.3*	135	126	166	200	*156.75*	165	na	165	*173.6*	*114*	*234*
WQ 9	na	na	313	400	*356.5*	na	na	na	na	---	na	na	---	*356.5*	*313*	*400*
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	238	238	*238*	*238*	*238*
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	242	242	*242*	*242*	*242*
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	366	366	*366*	*366*	*366*
Event Average	*132.0*	*146.5*	*224.1*	*310.6*	*210.4*	*167.2*	*185.0*	*221.4*	*260.5*	*208.5*	*315.5*	*282.0*	*304.3*			

na = not applicable, not analyzed or not sampled

TABLE 4.1.10-8 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL SUSPENDED SOLIDS RESULTS

Water Quality Stations	TSS Values during 2006 Sampling Events (mg/L)				2006 Water Quality Station Average	TSS Values during 2007 Sampling Events (mg/L)				2007 Water Quality Station Average	TSS Values during 2008		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	na	na	na	na	---	3	3	3	9	*4.5*	**3**	na	3	*2.6*	*3*	*9*
WQ 1A	na	na	na	na	---	na	na	na	na	*na*	8.9	na	8.9	*8.9*	*8.9*	*8.9*
WQ 2	na	na	na	na	---	19	14	22	24	*19.75*	23.9	na	23.9	*12.9*	*14*	*24*
WQ 2A	na	na	na	na	---	na	na	na	na	*na*	20.4	na	*20.4*	*20.4*	*20.4*	*20.4*
WQ 3	na	na	na	na	---	4	8	17	4	*8.25*	6.4	na	6.4	*4.9*	*4*	*17*
WQ 4	na	na	na	na	---	10	10	5	5	*7.5*	29.9	na	29.9	*7.5*	*5*	*29.9*
WQ 9	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	na	na	---	---	---
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	na	na	---	---	---
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	na	na	---	---	---
Event Average	---	---	---	---	---	*9.0*	*8.8*	*11.8*	*10.5*	*10.0*	*15.4*	*na*	*15.4*			

na = not applicable, not analyzed or not sampled

Bolded figures indicate that the detection limit value was used (or included) to calculate the average value as the analytical value was not detected

Electrical Conductivity (EC)

Electrical conductivity ranged from 80.5 microsiemens per centimetre (µS/cm) to 606 µS/cm (Table 4.1.10-7). WQ1A exhibited the highest EC for a single event, while WQ9 had the highest average EC and WQ3 exhibited the lowest EC. Values returned for Ravine Dam, Dry Stack Tailings Facility and the Warm Spring during August 2008 fall within the above range of electrical conductivity for the Mactung study area.

Total Suspended Solids (TSS)

Total suspended solids[3] (TSS) ranged from below 3 milligrams per litre (mg/L) to 29.9 mg/L (Table 4.1.10-8). WQ4 exhibited the highest TSS for a single event, while WQ2 exhibited the highest average TSS concentrations. The TSS concentrations at WQ1 were typically below detection (3 mg/L). TSS was not analyzed for the August 2008 samples.

Turbidity

Turbidity[4] ranged from 0.1 Nephelometric Turbidity Units (NTU) to 16.9 NTU (Table 4.1.10-9). WQ4 exhibited the highest average turbidity, while turbidity at WQ1 was the lowest. The results for turbidity for Ravine Dam, Dry Stack Tailings Facility and the Warm Spring in August 2008 fall within the lower end of the above range for the Mactung study area and are most comparable to turbidity at WQ1 and WQ1A.

Ammonia – N

Ammonia - N concentrations ranged from below detection (0.005 mg/L) to 0.041 mg/L (Table 4.1.10-10). WQ9 showed the highest average ammonia - N concentrations and all stations, except WQ1A and WQ9, were below the detection limit for at least one event. Ammonia-N concentrations for Ravine Dam, Dry Stack Tailings Facility and the Warm Spring in August 2008 fall within the lower end of the above range for the Mactung study area and are most comparable to ammonia - N concentrations at WQ1 and WQ1A.

Nitrate

Nitrate concentrations ranged from below detection (0.006 mg/L) to 0.1 mg/L[5] (Table 4.1.10-11). Excluding the August 2006 results for reasons mentioned in footnote #3, WQ9 showed the highest average nitrate concentrations. Nitrate concentrations for Ravine Dam and Dry Stack Tailings Facility in August 2008 fall within the above range for the Mactung study area and are most comparable to nitrate concentrations at WQ1. Nitrate concentrations returned for the Warm Spring were below detection.

---

[3] Total suspended solids were not analyzed in 2006

[4] Turbidity was not analyzed in 2006

[5] An analysis with a higher detection limit of 0.1 mg/L was conducted on the August 2006 samples; consequently all results were below detection.

Table 4.1.10-9 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TURBIDITY RESULTS

Water Quality Stations	Turbidity Values during 2006 Sampling Events (NTU)				2006 Water Quality Station Average	Turbidity Values during 2007 Sampling Events (NTU)				2007 Water Quality Station Average	Turbidity Values during 2008 Sampling Events		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	na	na	na	na	---	1.20	0.40	0.70	4.20	1.63	0.14	na	0.14	0.83	0.14	4.2
WQ 1A	na	na	na	na	---	na	na	na	na	na	0.1	na	0.1	0.10	0.1	0.1
WQ 2	na	na	na	na	---	1.80	6.20	0.80	11.00	4.95	15	na	15	4.35	0.8	15
WQ 2A	na	na	na	na	---	na	na	na	na	na	16.9	na	16.9	16.90	16.9	16.9
WQ 3	na	na	na	na	---	4.90	6.40	10.00	6.00	6.83	2.31	na	2.31	3.70	2.31	10
WQ 4	na	na	na	na	---	6.40	11.00	3.40	7.60	7.10	7.92	na	7.92	4.54	3.4	11
WQ 9	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	**0.1**	0.1	0.1	0.1	0.1
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	**0.1**	0.1	0.1	0.1	0.1
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	0.9	0.9	0.9	0.9	0.9
Event Average	---	---	---	---	---	3.58	6.00	3.73	7.20	5.13	7.1	0.4	4.8			

na = not applicable, not analyzed or not sampled

Table 4.1.10-10 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT AMMONIA - N RESULTS

Water Quality Stations	Ammonia - N Concentrations during 2006 Sampling Events				2006 Water Quality Station Average	Ammonia - N Concentrations during 2007 Sampling Events				2007 Water Quality Station Average	Ammonia - N Concentrations during 2008 Sampling		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	0.006	**0.005**	0.005	**0.005**	0.005	**0.005**	**0.005**	**0.005**	**0.005**	0.005	**0.005**	na	0.005	0.006	0.005	0.006
WQ 1A	na	na	na	na	na	na	na	na	na	na	0.0052	na	0.0052	0.005	0.0052	0.0052
WQ 2	**0.005**	**0.005**	0.016	**0.005**	0.008	**0.005**	0.009	0.007	0.011	0.008	**0.005**	na	0.005	0.009	0.005	0.016
WQ 2A	na	na	na	na	na	na	na	na	na	na	**0.005**	na	0.005	0.005	0.005	0.005
WQ 3	**0.005**	**0.005**	0.006	**0.005**	0.005	**0.005**	**0.005**	**0.005**	0.011	0.007	0.0105	na	0.0105	0.007	0.005	0.011
WQ 4	**0.005**	**0.005**	0.007	**0.005**	0.006	**0.005**	0.006	0.007	**0.005**	0.006	0.0085	na	0.0085	0.007	0.005	0.0085
WQ 9	na	na	0.034	0.041	0.038	na	na	na	na	---	na	na	---	0.038	0.034	0.041
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	**0.005**	0.005	0.005	0.005	0.005
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	**0.005**	0.005	0.005	0.005	0.005
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	0.047	0.047	0.047	0.047	0.047
Event Average	0.005	0.005	0.014	0.012	0.009	0.005	0.006	0.006	0.008	0.006	0.007	0.019	0.011			

na = not applicable, not analyzed or not sampled

Bolded figures indicate that the detection limit value was used (or included) to calculate the average value as the analytical value was not detected

Table 4.1.10-11 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT NITRATE RESULTS

Water Quality Stations	Nitrate Concentrations during 2006 Sampling Events (mg/L)				2006 Water Quality Station Average	Nitrate Concentrations during 2007 Sampling Events (mg/L)				2007 Water Quality Station Average	Nitrate Concentrations during 2008 Sampling		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August*	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	0.060	0.050	**0.100**	0.026	0.06	0.071	0.037	0.031	0.048	0.047	0.0218	na	0.0218	0.056	0.0218	0.1
WQ 1A	na	na	na	na	na	na	na	na	na	na	0.0658	na	0.0658	0.066	0.0658	0.0658
WQ 2	0.072	0.053	**0.100**	0.042	0.07	0.072	0.049	0.046	0.053	0.055	0.0555	na	0.0555	0.068	0.042	0.1
WQ 2A	na	na	na	na	na	na	na	na	na	na	0.056	na	0.056	0.056	0.056	0.056
WQ 3	0.027	0.023	**0.100**	0.006	0.04	0.029	0.015	**0.006**	0.008	0.015	0.0087	na	0.0087	0.028	0.006	0.1
WQ 4	0.041	0.028	**0.100**	0.020	0.05	0.041	0.028	0.017	0.021	0.027	0.0135	na	0.0135	0.039	0.0135	0.1
WQ 9	na	na	**0.100**	0.053	0.08	na	na	na	na	---	na	na	---	0.077	0.053	0.1
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	0.03	0.03	0.03	0.03	0.03
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	0.03	0.03	0.03	0.03	0.03
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	**0.01**	**0.01**	**0.01**	0.01	0.01
Event Average	0.05	0.04	0.10	0.03	0.06	0.053	0.032	0.025	0.033	0.036	0.037	0.02	0.032			

na = not applicable, not analyzed or not sampled

Bolded figures indicate that the detection limit value was used (or included) to calculate the average value as the analytical value was not detected

*An analysis with a higher detection limit of 0.1 mg/L was conducted on the August 2006 samples; consequently all results were below detection.

Phosphorus

Phosphorus concentrations ranged from 0.003 mg/L to 0.052 mg/L (Table 4.1.10-12). WQ2A had the highest average phosphorus concentrations and WQ1 had the lowest. Phosphorus concentrations for Ravine Dam, Dry Stack Tailings Facility and the Warm Spring in August 2008 fall within the higher end of the above range for the Mactung study area.

Calcium

Calcium concentrations ranged from 8.3 mg/L to 75.6 mg/L (Table 4.1.10-13). WQ1 had the highest average calcium concentration and WQ3 had the lowest. Calcium as a major ion was not analyzed in May or August 2008.

Potassium

Potassium concentrations ranged from 0.1 mg/L to 1.3 mg/L (Table 4.1.10-14). WQ1 had the highest average potassium concentration and WQ4 had the lowest. Potassium as a major ion was not analyzed in May or August 2008.

Magnesium

Magnesium concentrations ranged from 2.1 mg/L to 17.5 mg/L (Table 4.1.10-15). WQ9 had the highest average magnesium concentration and WQ1 had the lowest. Magnesium as a major ion was not analyzed in May or August 2008.

Sodium

Sodium concentrations were either at or below detection (1.0 mg/L) for all stations, except WQ1 and WQ4 (Table 4.1.10-16). WQ1 had sodium concentrations of 2.0 mg/L in August and September 2006 and 2007 and WQ4 had a sodium concentration of 2.0 mg/L in September 2006. Sodium as a major ion was not analyzed in May or August 2008.

Iron – Extractable

Iron - extractable concentrations ranged from 0.014 mg/L to 0.617 mg/L (Table 4.1.10-17). WQ2 had the highest average iron - extractable concentration and WQ1 had the lowest. Iron - extractable was not analyzed in May or August 2008.

Total Organic Carbon (TOC)

Total organic carbon (TOC) concentrations ranged from 0.7 mg/L to 2.0 mg/L (Table 4.1.10-18). WQ4 had the highest average TOC concentration and WQ1 and WQ2 had the lowest. TOC was not analyzed in May or August 2008.

Table 4.1.10-12 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT PHOSPHORUS RESULTS

Water Quality Stations	Phosphorus Concentrations during 2006 Sampling Event (mg/L)				2006 Water Quality Station Average	Phosphorus Concentrations during 2007 Sampling Event (mg/L)				2007 Water Quality Station Average	Phosphorus Concentrations during 2008 Sampling		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	0.04	0.02	na	na	*0.03*	0.007	0.003	0.003	0.004	*0.004*	0.0091	na	0.0091	*0.012*	*0.003*	*0.043*
WQ 1A	na	na	na	na	---	na	na	na	na	---	0.0034	na	0.0034	*0.003*	*0.0034*	*0.0034*
WQ 2	0.05	0.01	na	na	*0.03*	0.020	0.012	0.018	0.021	*0.018*	0.029	na	0.029	*0.021*	*0.012*	*0.052*
WQ 2A	na	na	na	na	---	na	na	na	na	---	0.0246	na	0.0246	*0.025*	*0.0246*	*0.0246*
WQ 3	0.03	0.02	na	na	*0.03*	0.013	0.010	0.014	0.007	*0.011*	0.026	na	0.026	*0.015*	*0.007*	*0.026*
WQ 4	0.04	0.02	na	na	*0.03*	0.015	0.013	0.010	0.009	*0.012*	0.029	na	0.029	*0.018*	*0.009*	*0.04*
WQ 9	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	0.02	0.02	0.02	*0.02*	*0.02*
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	0.01	0.01	0.01	*0.01*	*0.01*
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	0.03	0.03	0.03	*0.03*	*0.03*
Event Average	*0.04*	*0.02*	---	---	*0.03*	*0.014*	*0.010*	*0.011*	*0.010*	*0.011*	*0.020*	*0.02*	*0.020*			

na = not applicable, not analyzed or not sampled

*A different analysis was conducted on the June 2006 phosphorus sample at Station 6, yielding an incomparably higher result

Table 4.1.10-13 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT CALCIUM RESULTS

Water Quality Stations	Calcium Concentrations during 2006 Sampling Events (mg/L)				2006 Water Quality Station Average	Calcium Concentrations during 2007 Sampling Events (mg/L)				2007 Water Quality Station Average	Calcium Concentrations during 2008 Sampling		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	25.1	27.6	56.7	75.6	*46.3*	33.7	45.8	59.4	60.4	*49.8*	na	na	---	*48.0*	*25.1*	*75.6*
WQ 1A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 2	22.8	28	39.4	47	*34.3*	27.2	35.1	38.6	41.6	*35.6*	na	na	---	*35.0*	*22.8*	*47*
WQ 2A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 3	9.2	8.3	9.3	18.8	*11.4*	9.4	9.9	8.3	13.5	*10.3*	na	na	---	*10.8*	*8.3*	*18.8*
WQ 4	13.8	13	16.4	28	*17.8*	14.7	14.9	18.9	22.5	*17.8*	na	na	---	*17.8*	*13*	*28*
WQ 9	na	na	28.5	32.9	*30.7*	na	na	na	na	---	na	na	---	*7.7*	*28.5*	*32.9*
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Event Average	*17.7*	*19.2*	*30.1*	*40.5*	*27.8*	*21.3*	*26.4*	*31.3*	*34.5*	*28.4*	---	---	---			

na = not applicable, not analyzed or not sampled

Table 4.1.10-14 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT POTASSIUM RESULTS

Water Quality Stations	Potassium Concentrations during 2006 Sampling Events (mg/L)				2006 Water Quality Station Average	Potassium Concentrations during 2007 Sampling Events (mg/L)				2007 Water Quality Station Average	Potassium Concentrations during 2008 Sampling		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	0.6	0.6	1.1	1.3	*0.9*	0.5	0.9	1	1.2	*0.9*	na	na	---	*0.9*	*0.5*	*1.3*
WQ 1A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 2	0.4	0.5	0.9	0.8	*0.7*	0.4	0.7	0.5	0.6	*0.6*	na	na	---	*0.6*	*0.4*	*0.9*
WQ 2A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 3	0.4	0.5	0.5	0.5	*0.5*	0.3	0.6	0.6	0.5	*0.5*	na	na	---	*0.5*	*0.3*	*0.6*
WQ 4	0.5	0.5	0.7	0.1	*0.5*	0.4	0.4	0.5	0.5	*0.5*	na	na	---	*0.5*	*0.1*	*0.7*
WQ 9	na	na	0.8	1	*0.9*	na	na	na	na	---	na	na	---	*0.2*	*0.8*	*1*
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Event Average	*0.5*	*0.5*	*0.8*	*0.7*	*0.7*	*0.4*	*0.7*	*0.7*	*0.7*	*0.6*	---	---	---			

na = not applicable, not analyzed or not sampled

Table 4.1.10-15 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT MAGNESIUM RESULTS

Water Quality Stations	Magnesium Concentrations during 2006 Sampling Events (mg/L)				2006 Water Quality Station Average	Magnesium Concentrations during 2007 Sampling Events (mg/L)				2007 Water Quality Station Average	Magnesium Concentrations during 2008 Sampling		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	2.1	2.1	5.2	6.3	3.9	3.3	3.8	4.8	6.5	4.6	na	na	---	4.3	2.1	6.5
WQ 1A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 2	5.4	6.6	10	11.9	8.5	7	8.6	9.6	11.3	9.1	na	na	---	8.8	5.4	11.9
WQ 2A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 3	3.8	3.2	4.2	8.8	5.0	4.2	4.3	3.2	6.5	4.6	na	na	---	4.8	3.2	8.8
WQ 4	4.5	4	5.8	10.1	6.1	5.2	5.1	6	8.1	6.1	na	na	---	6.1	4	10.1
WQ 9	na	na	14.1	17.5	15.8	na	na	na	na	---	na	na	---	4.0	14.1	17.5
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Event Average	4.0	4.0	7.9	10.9	7.0	4.9	5.5	5.9	8.1	6.1	---	---	---			

na = not applicable, not analyzed or not sampled

Table 4.1.10-16 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT SODIUM RESULTS

Water Quality Stations	Sodium Concentrations during 2006 Sampling Events (mg/L)				2006 Water Quality Station Average	Sodium Concentrations during 2007 Sampling Events (mg/L)				2007 Water Quality Station Average	Sodium Concentrations during 2008 Sampling		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	**1.0**	**1.0**	2.0	2.0	1.5	1	1	2	2	1.5	na	na	---	1.5	1	2
WQ 1A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 2	**1.0**	**1.0**	1.0	1.0	1.0	**1**	**1**	**1**	**1**	1.0	na	na	---	1.0	1	1
WQ 2A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 3	**1.0**	**1.0**	**1.0**	**1.0**	1.0	**1**	**1**	**1**	**1**	1.0	na	na	---	1.0	1	1
WQ 4	**1.0**	**1.0**	**1.0**	2.0	1.3	**1**	**1**	**1**	**1**	1.0	na	na	---	1.1	1	2
WQ 9	na	na	**1.0**	**1.0**	1.0	na	na	na	na	---	na	na	---	0.3	1	1
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Event Average	1.0	1.0	1.2	1.4	1.2	1.0	1.0	1.3	1.3	1.1	---	---	---			

na = not applicable, not analyzed or not sampled

Bolded figures indicate that the detection limit value was used (or included) to calculate the average value as the analytical value was not detected

Table 4.1.10-17 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT IRON - EXTRACTABLE RESULTS

Water Quality Stations	Iron - Extractable Concentrations during 2006 Sampling Events				2006 Water Quality Station Average	Iron - Extractable Concentrations during 2007 Sampling Events				2007 Water Quality Station Average	Iron - Extractable Concentrations during 2008		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	na	0.01	na	na	0.0	**0.05**	**0.05**	**0.05**	0.26	0.10	na	na	---	0.05	0.014	0.26
WQ 1A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 2	na	0.62	na	na	0.6	0.44	0.42	0.32	**0.05**	0.31	na	na	---	0.23	0.05	0.617
WQ 2A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 3	na	0.52	na	na	0.5	**0.05**	**0.05**	**0.05**	**0.05**	0.05	na	na	---	0.09	0.05	0.516
WQ 4	na	0.54	na	na	0.5	0.10	0.10	0.17	**0.05**	0.11	na	na	---	0.12	0.05	0.542
WQ 9	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Event Average	---	0.4	---	---	0.4	0.16	0.16	0.15	0.10	0.14	---	---	---			

na = not applicable, not analyzed or not sampled

Bolded figures indicate that the detection limit value was used (or included) to calculate the average value as the analytical value was not detected

Table 4.1.10-18 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL ORGANIC CARBON RESULTS

Water Quality Stations	TOC Concentrations during 2006 Sampling Events (mg/L)				2006 Water Quality Station Average	TOC Concentrations during 2007 Sampling Events (mg/L)				2007 Water Quality Station Average	TOC Concentrations during 2008 Sampling Events		2008 Water Quality Station Average	Water Quality Station Summary		
	June	July	August	September		June	July	August	September		May	August		Average	Minimum	Maximum
WQ 1	1.0	0.8	**1.0**	**1.0**	*1.0*	**1**	1	**1**	**1**	*1.0*	na	na	---	*1.0*	*0.8*	*1*
WQ 1A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 2	1.0	0.7	**1.0**	**1.0**	*0.9*	**1**	1	**1**	1	*1.0*	na	na	---	*1.0*	*0.7*	*1*
WQ 2A	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
WQ 3	1.0	1.2	1.0	1.0	*1.1*	**1**	2	1	1	*1.3*	na	na	---	*1.2*	*1*	*2*
WQ 4	2.0	1.2	1.0	1.0	*1.3*	**1**	2	1	1	*1.3*	na	na	---	*1.3*	*1*	*2*
WQ 9	na	na	**1.0**	**1.0**	*1.0*	na	na	na	na	---	na	na	---	*0.3*	*1*	*1*
Dry Stack Tailings Facility	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Ravine Dam	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Warm Spring	na	na	na	na	---	na	na	na	na	---	na	na	---	---	---	---
Event Average	*1.3*	*1.0*	*1.0*	*1.0*	*1.1*	*1.0*	*1.5*	*1.0*	*1.0*	*1.1*	---	---	---			

na = not applicable, not analyzed or not sampled

Bolded figures indicate that the detection limit value was used (or included) to calculate the average value as the analytical value was not detected

Dissolved Oxygen and Temperature

Dissolved oxygen (DO) and temperature were not measured during water quality sampling; however, these parameters were measured during the Mactung fisheries and aquatics resources program in August 2006 and 2007. The sampling sites were at slightly different locations than the water quality sites (Figure 4.1.10-12); however, these values should be representative of dissolved oxygen concentrations and temperature at the water quality sampling sites due their close proximity. Dissolved oxygen concentrations were high at all stations. The lowest concentration of dissolved oxygen was 9.01 mg/L at fish station 10 (FS10) in upper Tributary C. Average August water temperatures ranged from 6.95 degrees Celsius (°C) at FS7 to 9.05°C at FS8.

Dissolved oxygen and temperature were also measured during the August 2008 sampling at Ravine Dam, Dry Stack Tailings Facility and the Warm Spring. DO concentrations were high at Ravine Dam (11.3 mg/L) and Dry Stack Tailings Facility (10.6 mg/L), and low at the Warm Spring (0.5 mg/L). Temperatures measured at Ravine Dam, Dry Stack Tailings Facility and the Warm Spring were 2.8 °C, 5.3 °C and 32.9 °C, respectively. The low DO for the warm spring reflects the groundwater discharge source of this sampling location.

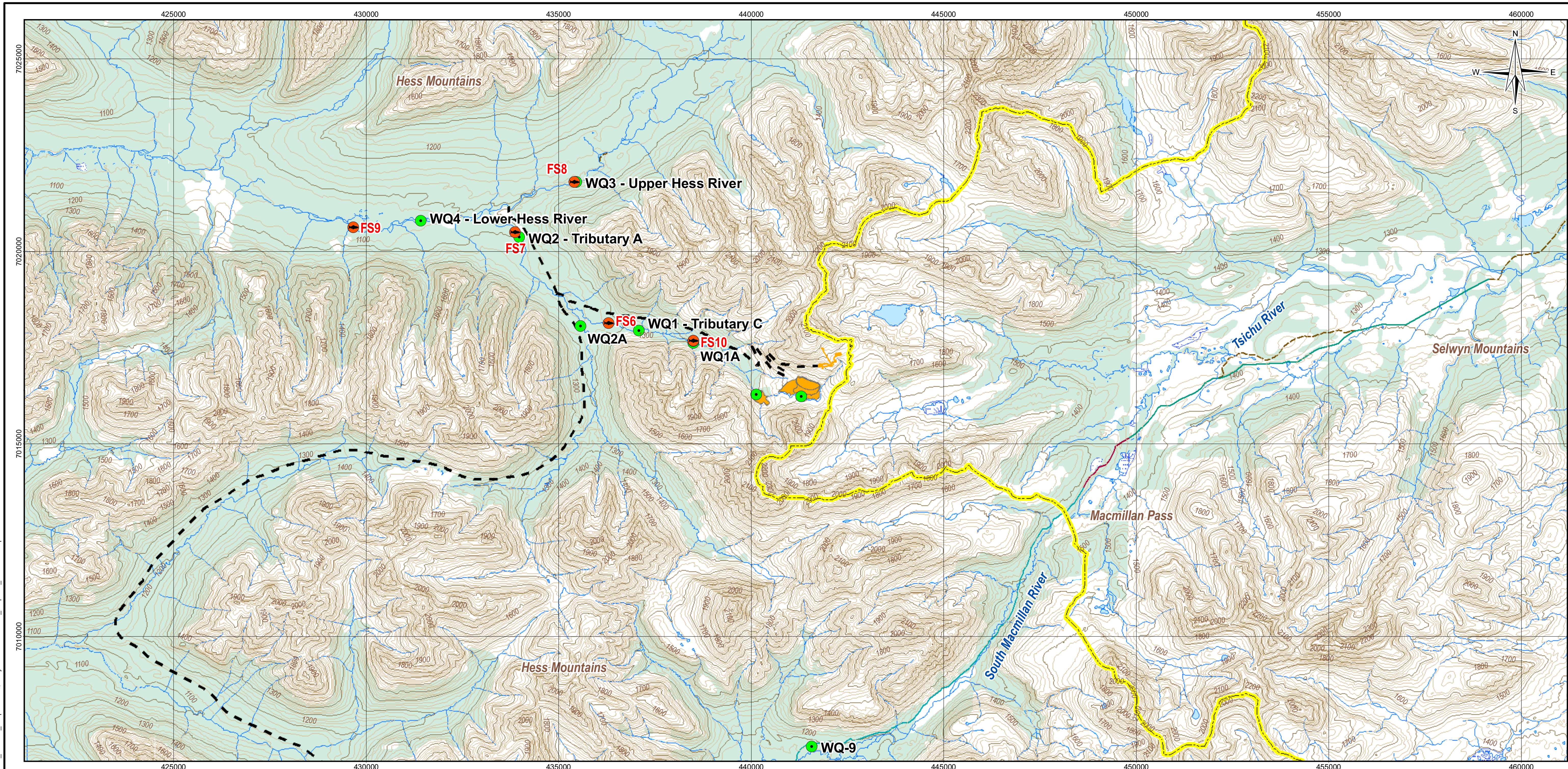
Metals Concentrations

Metals included in this report are those that have exhibited concentrations consistently found to be above the Canadian Council of Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life. The metals which were consistently found to be above CCME guidelines are aluminum, cadmium, copper, iron, nickel, selenium and zinc (Tables 4.1.10-19 to 4.1.10-25). These elevated concentrations of metals do appear to be a natural phenomenon based on the limited level of development within the watersheds and also the mineralized nature of the project area.

Aluminum

Aluminum concentrations ranged[6] from 0.0187 mg/L to 8.08 mg/L (Table 4.1.10-19). WQ1 had the lowest aluminum concentration while WQ9 had the highest. Aluminum concentrations from Ravine Dam and Dry Stack Tailings Facility in August 2008 did not exceed the CCME guideline of 0.1 mg/L, while aluminum concentrations for the Warm Spring exceeded the CCME guidelines marginally at 0.123 mg/L.

[6] All ranges for total metals reported in the text include results of ultra-low and low level analyses and therefore should be interpreted with caution. It is advised to refer to the respective tables for actual values.



LEGEND

- 2007 Fisheries and Aquatic Resources Sample Locations
- Water Quality Sample Locations
- Proposed Mine Site Infrastructure
- Proposed Access Road
- NWT-Yukon Territory Boundary
- Index Contours
- Trail
- Road
- Watercourse
- Waterbody
- Wetland
- Vegetation

NOTES

Base data source: 1:50,000 NTS

ISSUED FOR USE

MACTUNG

Fisheries and Aquatic Resources Sampling Locations

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:100,000
1 0.5 0 1 2
Kilometers

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EBA Engineering Consultants Ltd.

FILE NO.
W23101110-001_Map004_1-2FishSamples.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	KA	0

OFFICE	DATE
EBA-VANC	December 4, 2008

Figure 4.1.10-12

Q:\Vancouver\GIS\ENVIRONMENTAL\W231\W23101110_MacTung_AP\Maps\001_YESAA_Prep\WaterQuality\W23101110-001_Map004_1-2FishSamples.mxd

TABLE 4.1.10-19 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL ALUMINUM CONCENTRATION

Water Quality Stations	Total Aluminum Concentration during 2006 Sampling				Total Aluminum Concentration during 2007 Sampling				Total Aluminum Concentration during 2008 Sampling	
	June	July	August	September	June	July	August	September	May	August
WQ 1	1.24*	0.53*	0.351	0.299	0.318	0.252	0.729	1.42	0.0187	na
WQ 1A	na	na	na	na	na	na	na	na	0.014	na
WQ 2	2.42*	2.02	4.13	5.01	2.02*	2.68*	4.16	4.88	4.06	na
WQ 2A	na	na	na	na	na	na	na	na	3.5	na
WQ 3	1.00*	1.39*	1.00*	0.157	0.45*	0.67*	1.09*	0.327	0.232	na
WQ 4	1.51*	1.51*	1.46*	1.58	0.81*	1.18*	1.09	1.31	1.01	na
WQ 9	na	na	5.33	8.08	N/S	N/S	N/S	N/S	N/S	na
Dry Stack Tailings Facility	na	na	na	na	na	na	na	na	na	0.078
Ravine Dam	na	na	na	na	na	na	na	na	na	0.02
Warm Spring	na	na	na	na	na	na	na	na	na	0.123

N/S = not sampled

N/A = not analyzed

*Low-level metals analysis

Above CCME Guidelines of 0.1 mg/L. (CCME guideline for Aluminum is dependent on pH. The guideline presented here for Aluminum is specific to the pH of the water at this site.)

Please note that due to elevated concentrations of suspended solids in the samples, ultra-low level metal analysis was not always possible and low level metal analysis was conducted instead. The results from these analyses are not comparable and therefore cannot be averaged.

Table 4.1.10-20 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL CADMIUM CONCENTRATION

Water Quality Stations	Total Cadmium Concentration during 2006 Sampling Events				Total Cadmium Concentration during 2007 Sampling Events				Total Cadmium Concentration during 2008 Sampling	
	June	July	August	September	June	July	August	September	May	August
WQ 1	0.0011*	0.0006*	0.0013	0.00152	0.00078	0.00072	0.00144	0.00269	0.000735	na
WQ 1A	na	na	na	na	na	na	na	na	0.00109	na
WQ 2	0.0033*	0.00361	0.00623	0.0075	0.0033*	0.0044*	0.00622	0.00795	0.005	na
WQ 2A	na	na	na	na	na	na	na	na	0.0055	na
WQ 3	<0.0002*	<0.0002*	<0.0002*	<0.00005	<0.0002*	<0.0002*	<0.0002*	0.00005	0.000084	na
WQ 4	0.001*	0.0008*	0.0012*	0.00234	0.0009*	0.0008*	0.00139	0.00189	0.000824	na
WQ 9	na	na	0.0192	0.0307	N/S	N/S	N/S	N/S	N/S	na
Dry Stack Tailings Facility	na	na	na	na	na	na	na	na	na	0.00024
Ravine Dam	na	na	na	na	na	na	na	na	na	0.00015
Warm Spring	na	na	na	na	na	na	na	na	na	0.00007

N/S = not sampled

N/A = not analyzed

*Low-level metals analysis

Above CCME Guidelines of 0.00002 to 0.00003 mg/L. (CCME guideline for Cadmium is dependent on hardness of the water and is calculated using the formula: Cd guideline = 10 exp{0.86[log(hardness)]-3.2}. This range of CCME guideline for Cadmium is specific to the average hardness of the water at this site.)

Please note that due to elevated concentrations of suspended solids in the samples, ultra-low level metal analysis was not always possible and low level metal analysis was conducted instead. The results from these analyses are not comparable and therefore cannot be averaged.

Cadmium

Cadmium concentrations ranged from below detection (0.00005 mg/L) to 0.0307 mg/L (Table 4.1.10-20). WQ3 had the lowest cadmium concentration while WQ9 had the highest. Cadmium concentrations from Ravine Dam, Dry Stack Tailings Facility and the Warm Spring in August 2008 all exceeded the CCME guidelines for cadmium.

Copper

Copper concentration ranged from 0.001 mg/L to 0.0793 mg/L (Table 4.1.10-21). WQ3 had the lowest copper concentration while WQ9 had the highest. Copper concentrations from Ravine Dam, Dry Stack Tailings Facility and the warm springs in August 2008 all fell below the detection limit of 0.001 mg/L and therefore below the CCME guideline of 0.002 mg/L. Copper solubility increases dramatically with decreases in pH. This is the most likely reason for the naturally elevated copper concentrations in the Macmillan River which was measured to have a pH of approximately 4.5.

Iron

Iron concentration ranged from 0.008 mg/L to 5.53 mg/L (Table 4.1.10-22). WQ1 had the lowest iron concentration while WQ9 had the highest. Iron concentrations from Ravine Dam, Dry Stack Tailings Facility and the Warm Spring in August 2008 all fell below the CCME guideline of 0.3 mg/L.

Nickel

Nickel concentration ranged from 0.0023 mg/L to 0.271 mg/L (Table 4.1.10-23). WQ3 had the lowest nickel concentration while WQ9 had the highest. Nickel concentrations from Ravine Dam, Dry Stack Tailings Facility and the Warm Spring in August 2008 all fell below the CCME guideline of 0.025 to 0.065 mg/L.

Selenium

Selenium concentration ranged from 0.0002 mg/L to 0.0044 mg/L (Table 4.1.10-24). WQ3 had the lowest selenium concentration while WQ1 had the highest. Selenium concentrations from Ravine Dam, Dry Stack Tailings Facility and the Warm Spring in August 2008 all fell within the above range, with concentrations at Ravine Dam marginally exceeding the CCME guideline of 0.001 mg/L.

Zinc

Zinc concentration ranged from 0.0068 mg/L to 0.929 mg/L (Table 4.1.10-25). WQ3 had the lowest zinc concentration while WQ9 had the highest. Zinc concentrations from Ravine Dam, Dry Stack Tailings Facility and the Warm Spring in August 2008 all fell below the CCME guideline of 0.03 mg/L.

Table 4.1.10-21 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL COPPER CONCENTRATION

Water Quality Stations	Total Copper Concentration during 2006 Sampling Events				Total Copper Concentration during 2007 Sampling Events				Total Copper Concentration during 2008 Sampling Events	
	June	July	August	September	June	July	August	September	May	August
WQ 1	0.012*	0.006*	0.0038	0.0025	0.0046	0.0033	0.0089	0.0199	0.0014	na
WQ 1A	na	na	na	na	na	na	na	na	<0.0020	na
WQ 2	0.023*	0.0208	0.0359	0.0434	0.02*	0.024*	0.0378	0.0442	0.0164	na
WQ 2A	na	na	na	na	na	na	na	na	0.0079	na
WQ 3	0.003*	0.004*	0.002*	0.0011	0.001*	0.001*	0.001*	0.0016	0.0022	na
WQ 4	0.009*	0.009*	0.008*	0.0135	0.006*	0.006*	0.0089	0.0113	0.0052	na
WQ 9	na	na	0.0555	0.0793	N/S	N/S	N/S	N/S	N/S	na
Dry Stack Tailings Facility	na	na	na	na	na	na	na	na	na	<0.001
Ravine Dam	na	na	na	na	na	na	na	na	na	<0.001
Warm Spring	na	na	na	na	na	na	na	na	na	<0.001

N/S = not sampled
N/A = not analyzed
*Low-level metals analysis

Above CCME Guidelines of 0.002 mg/L. (CCME guideline for copper is dependent on hardness of the water and is specific to the average hardness of the water at this site.)

Please note that due to elevated concentrations of suspended solids in the samples, ultra-low level metal analysis was not always possible and low level metal analysis was conducted instead. The results from these analyses are not comparable and therefore cannot be averaged.

Table 4.1.10-22 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL IRON CONCENTRATION

Water Quality Stations	Total Iron Concentration during 2006 Sampling Events				Total Iron Concentration during 2007 Sampling Events				Total Iron Concentration during 2008 Sampling Events	
	June	July	August	September	June	July	August	September	May	August
WQ 1	0.846*	0.217*	0.008	0.009	0.039	0.029	0.075	0.262	0.097	na
WQ 1A	na	na	na	na	na	na	na	na	0.062	na
WQ 2	2*	0.78	1.37	1.73	0.704*	0.661*	1.22	1.44	1.23	na
WQ 2A	na	na	na	na	na	na	na	na	1.54	na
WQ 3	1.17*	1.42*	0.804*	0.241	0.607*	0.708*	1.38*	0.495	0.608	na
WQ 4	1.82*	1.36*	0.788*	0.666	0.637*	0.772*	0.678	0.653	0.654	na
WQ 9	na	na	3.35	5.53	N/S	N/S	N/S	N/S	N/S	na
Dry Stack Tailings Facility	na	na	na	na	na	na	na	na	na	0.051
Ravine Dam	na	na	na	na	na	na	na	na	na	0.02
Warm Spring	na	na	na	na	na	na	na	na	na	0.227

N/S = not sampled
N/A = not analyzed
*Low-level metals analysis

Above CCME Guidelines of 0.3 mg/L

Please note that due to elevated concentrations of suspended solids in the samples, ultra-low level metal analysis was not always possible and low level metal analysis was conducted instead. The results from these analyses are not comparable and therefore cannot be averaged.

Table 4.1.10-23 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL NICKEL CONCENTRATION

Water Quality Stations	Total Nickel Concentration during 2006 Sampling Events				Total Nickel Concentration during 2007 Sampling Events				Total Nickel Concentration during 2008 Sampling Events	
	June	July	August	September	June	July	August	September	May	August
WQ 1	0.0265*	0.0176*	0.028	0.0286	0.0251	0.0208	0.0325	0.0569	0.0074	na
WQ 1A	na	na	na	na	na	na	na	na	0.0106	na
WQ 2	0.0549*	0.0572	0.109	0.126	0.0686*	0.0773*	0.126	0.142	0.107	na
WQ 2A	na	na	na	na	na	na	na	na	0.132	na
WQ 3	0.005*	0.0052*	0.0038*	0.0054	0.0044*	0.0035*	0.0023*	0.00583	0.0055	na
WQ 4	0.0199*	0.0184*	0.0245*	0.0415	0.021*	0.0179*	0.03	0.0368	0.0206	na
WQ 9	---	---	0.194	0.271	---	---	---	---	N/S	na
Dry Stack Tailings Facility	na	na	na	na	na	na	na	na	na	0.009
Ravine Dam	na	na	na	na	na	na	na	na	na	0.004
Warm Spring	na	na	na	na	na	na	na	na	na	<0.001

N/S = not sampled
N/A = not analyzed
*Low-level metals analysis

Above CCME Guidelines of 0.025 to 0.065 mg/L. (CCME guideline for nickel is dependent on hardness of the water and this range of CCME guideline is specific to the average hardness of the water at this site.)

Please note that due to elevated concentrations of suspended solids in the samples, ultra-low level metal analysis was not always possible and low level metal analysis was conducted instead. The results from these analyses are not comparable and therefore cannot be averaged.

Table 4.1.10-24 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL SELENIUM CONCENTRATION

Water Quality Stations	Total Selenium Concentration during 2006 Sampling Events				Total Selenium Concentration during 2007 Sampling Events				Total Selenium Concentration during 2008 Sampling	
	June	July	August	September	June	July	August	September	May	August
WQ 1	0.0023*	0.0012*	0.0035	0.0044	0.0022	0.0029	0.0035	0.0027	0.0031	na
WQ 1A	na	na	na	na	na	na	na	na	0.0037	na
WQ 2	0.0024*	0.002	0.003	0.0035	0.0022*	0.0021*	0.0018	0.0017	0.0026	na
WQ 2A	na	na	na	na	na	na	na	na	0.0025	na
WQ 3	<0.0004*	<0.0004*	0.0007*	0.0002	<0.0004*	<0.0004*	<0.0004*	0.0002	<0.0010	na
WQ 4	0.0011*	0.0006*	0.001*	0.0013	0.0008*	0.0008*	0.0009	0.0009	<0.0010	na
WQ 9	---	---	0.0015	0.0022	---	---	---	---	N/S	na
Dry Stack Tailings Facility	na	na	na	na	na	na	na	na	na	0.0009
Ravine Dam	na	na	na	na	na	na	na	na	na	0.0013
Warm Spring	na	na	na	na	na	na	na	na	na	<0.0006

N/S = not sampled
N/A = not analyzed
*Low-level metals analysis
Above CCME Guidelines of 0.001 mg/L

Please note that due to elevated concentrations of suspended solids in the samples, ultra-low level metal analysis was not always possible and low level metal analysis was conducted instead. The results from these analyses are not comparable and therefore cannot be averaged.

Table 4.1.10-25 SUMMARY OF 2006, 2007 AND MAY 2008 MACTUNG PROJECT TOTAL ZINC CONCENTRATION

Water Quality Stations	Total Zinc Concentration during 2006 Sampling Events				Total Zinc Concentration during 2007 Sampling Events				Total Zinc Concentration during 2008 Sampling Events	
	June	July	August	September	June	July	August	September	May	August
WQ 1	0.129*	0.069*	0.111	0.0945	0.0856	0.0754	0.134	0.262	0.0254	na
WQ 1A	na	na	na	na	na	na	na	na	0.0371	na
WQ 2	0.189*	0.198	0.376	0.396	0.207*	0.241*	0.398	0.48	0.35	na
WQ 2A	na	na	na	na	na	na	na	na	0.441	na
WQ 3	0.011*	0.01*	0.007*	0.0068	0.01*	0.007*	0.012*	0.008	0.0079	na
WQ 4	0.061*	0.051*	0.063*	0.124	0.062*	0.052*	0.0933	0.125	0.0616	na
WQ 9	---	---	0.742	0.929	---	---	---	---	N/S	na
Dry Stack Tailings Facility	na	na	na	na	na	na	na	na	na	0.011
Ravine Dam	na	na	na	na	na	na	na	na	na	0.009
Warm Spring	na	na	na	na	na	na	na	na	na	0.005

N/S = not sampled

N/A = not analyzed

*Low-level metals analysis

Above CCME Guidelines of 0.03 mg/L

Please note that due to elevated concentrations of suspended solids in the samples, ultra-low level metal analysis was not always possible and low level metal analysis was conducted instead. The results from these analyses are not comparable and therefore cannot be averaged.

Discussion

All of the water quality stations described in this report are located within the Yukon. WQ1, WQ1A, WQ2 and WQ2A are small tributary streams in the upper watershed that receive direct runoff from the neighbouring mountains (first order tributaries). WQ3 and WQ4 are located in larger valley systems and are considered second order tributaries.

In general, WQ9, located on the South Macmillan River, had the highest electrical conductivity and total metal concentrations. WQ2, located on Tributary A (Figure 4.1.10-11), had the highest nutrient, major ion and total metal concentrations and therefore had the lowest baseline water quality. WQ3, on a tributary of the Hess River, had the lowest total metals concentration, while WQ1 on Tributary C generally had the lowest major ion concentrations and physical properties. Sampling at Stations WQ2A and WQ9 both had pH values that were below the CCME guidelines. These low pH values are attributed to natural acid rock drainage occurring within each of these drainages. The high metal concentrations within the Macmillan River support this assertion.

Water samples collected in August 2008 are not directly comparable to previous water sampling conducted in the Mactung study area. However, since the proposed Ravine Dam and Dry Stack Tailings Facility are in the project area, it is pertinent to include the results in this report and to compare the water quality of these two sites to stations WQ1 and WQ1A which are situated downstream. In general, there are no differences in the water quality between these two pairs of sites.

Water samples collected from the Warm Spring are most comparable to the adjacent station, WQ1A; however since both sites were not sampled during the same event and each site was sampled only once, limited conclusions can be drawn. Nevertheless, the most noteworthy differences between the Warm Spring and WQ1A are the pH and electrical conductivity values, and the ammonia-N, aluminum, cadmium, iron, nickel, selenium and zinc concentrations. The pH values, ammonia-N, aluminum and iron concentrations were considerably higher for the Warm Spring sample, while the electrical conductivity, cadmium, nickel, selenium and zinc concentrations were lower than for WQ1A. These results reflect the groundwater source for the Warm Spring as compared to WQ-1A.

AMAX Northwest Mining Company Limited (AMAX) (1974) in their initial environmental evaluation reported results similar to those contained in this report. In the Yukon, AMAX stated that generally the water quality of the various tributaries of the Hess River was typically good and clear, with low turbidity values. They also state that the water quality of the feeder tributaries is generally lower than that of the main tributary of the Hess River. Baseline water quality in the Mactung study area appears to have remained relatively constant since the 1970s studies performed by AMAX.

The Mactung property is located in an area of high natural mineralization with large mineral deposits below and at the surface, influencing natural water quality conditions. There are also natural mineralized underground springs seeping out at various locations, further influencing surface water quality. These phenomena naturally cause exceedance of the CCME guidelines for the protection of aquatic life.

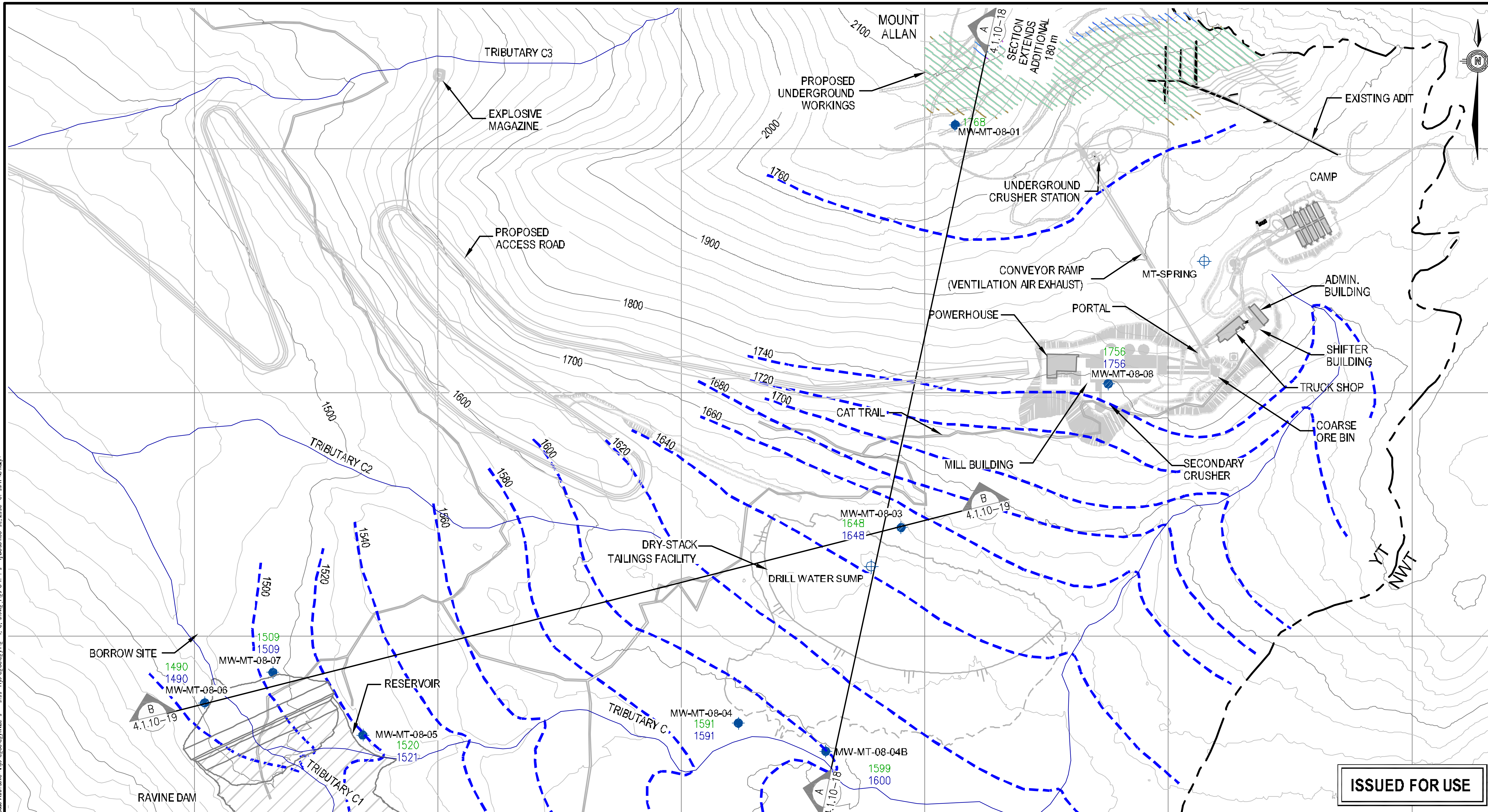
4.1.10.3 Hydrogeology

This section describes the hydrogeological baseline conditions in the Mactung project area (the project area). The hydrogeological regime includes the distribution, quantity and quality of groundwater flowing through the porous and/or fractured subsurface. This regime depends on several geological and environmental conditions, such as hydraulic and chemical properties of soils and rocks, precipitation, the presence and extent of permafrost, and groundwater/surface water interaction. The local hydraulic and hydrogeochemical conditions in the project area have been used to develop a conceptual hydrogeological model of the project area which describes the baseline groundwater conditions before potential alteration by proposed mining activities.

A Detailed Hydrogeological Assessment (DHA) was conducted by EBA for NATC to assess the groundwater conditions at the Mactung property. The purpose of the DHA was to provide enough background information for the description of the existing (baseline) hydrogeological conditions and to carry out a hydrogeological effects assessment for the purposes of an application within the YESAA process. The DHA report is attached to this document in Appendix H8.

The project area (for the purpose of detailed hydrogeological assessment) encompasses the area of the proposed mine including all major mine components (Figures 4.1.10-13 and 4.1.10-14) and areas downgradient of proposed mine infrastructure to the proposed ravine dam. The study area is comprised of the south slope of Mt. Allan and the adjacent valley of an unnamed creek (referred to here as Tributary C) to the south of Mt. Allan, including the ore deposit, the existing camp, and the areas of proposed mine facilities.

Figure 4.1.10-13: Aerial photograph of the project area showing approximate observation well locations.



LEGEND

- GROUNDWATER OBSERVATION WELL LOCATION
- SHALLOW GROUNDWATER SAMPLING LOCATION
- 1489 HYDRAULIC HEAD MEASUREMENT OBSERVED (AUG 2008) IN DEEP INSTALLATIONS (m-asl)
- 1490 HYDRAULIC HEAD MEASUREMENT OBSERVED (SEPT 2008) IN DEEP INSTALLATIONS (m-asl)
- INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR (m-asl)

NOTE:

20 m CONTOUR INTERVAL

0 250

Scale: 1: 7 500 (metres)

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Groundwater Observation Wells and Hydraulic Head Map

PROJECT NO.	DWN	CKD	REV
W23101110.001	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	NOVEMBER, 2008		

Figure 4.1.10-14

Hydrogeological Data for the Mactung Property

The DHA program involved the following baseline data collection: observations during the drilling of diamond drill holes (DDHs) at key locations in the project area, logging drill core, hydraulic testing (packer tests and pumping tests), observation well installations, instrumentation installations and monitoring, and groundwater sampling and chemical analysis.

A total of eight groundwater observation wells were installed in diamond drill holes (DDHs) in the project area to study the hydrogeological regime, and in particular, the groundwater conditions in areas of proposed mine infrastructure. Figure 4.1.10-14 shows the project area and locations of groundwater observation wells. At most of the observation well locations, nested standpipe piezometers were installed in the same DDH. The nested observation wells consist of deep and shallow PVC standpipe piezometers, tapping the shallow overburden and deep bedrock aquifers, with an impermeable bentonite seal between each installation. The deep installations vary in depth from about 30 to 350 metres below ground surface (m bgs) while shallow piezometers are installed within the overburden, typically at depths of 4-5 m bgs. Three wells were equipped with vibrating wire piezometers (VWP) to measure in situ pore water pressure and temperature. At two locations (MW-MT-08-01 and MW-MT-08-08) where the shallow piezometers could not be installed within the DDHs, standpipe piezometers were installed within overburden deposits beside the deeper installation. Table 4.1.10-26 provides details of the groundwater observation wells along with measured groundwater elevations.

Drill cores were retrieved from all DDHs and the core was logged for lithology and geotechnical properties, such as recovery, rock quality designation (RQD), and fracture frequency. Detailed well logs were prepared including lithology, geotechnical parameters, hydraulic test results, and well installation details. Figure 4.1.10-15 shows the well log for MW-MT-08-03 as an example (see Appendix B1 to B9 of the DHA report in Appendix H8 of this proposal for a complete set of well logs).

Hydraulic tests were conducted in all DDHs drilled as part of the DHA using an inflatable packer test assembly to determine the hydraulic conductivity of finite bedrock intervals. In addition to the packer tests, pumping tests were performed in selected observation wells to determine bulk hydraulic conductivities in the vicinity of the test wells. The hydraulic test results are summarized in Table 4.1.10-27.

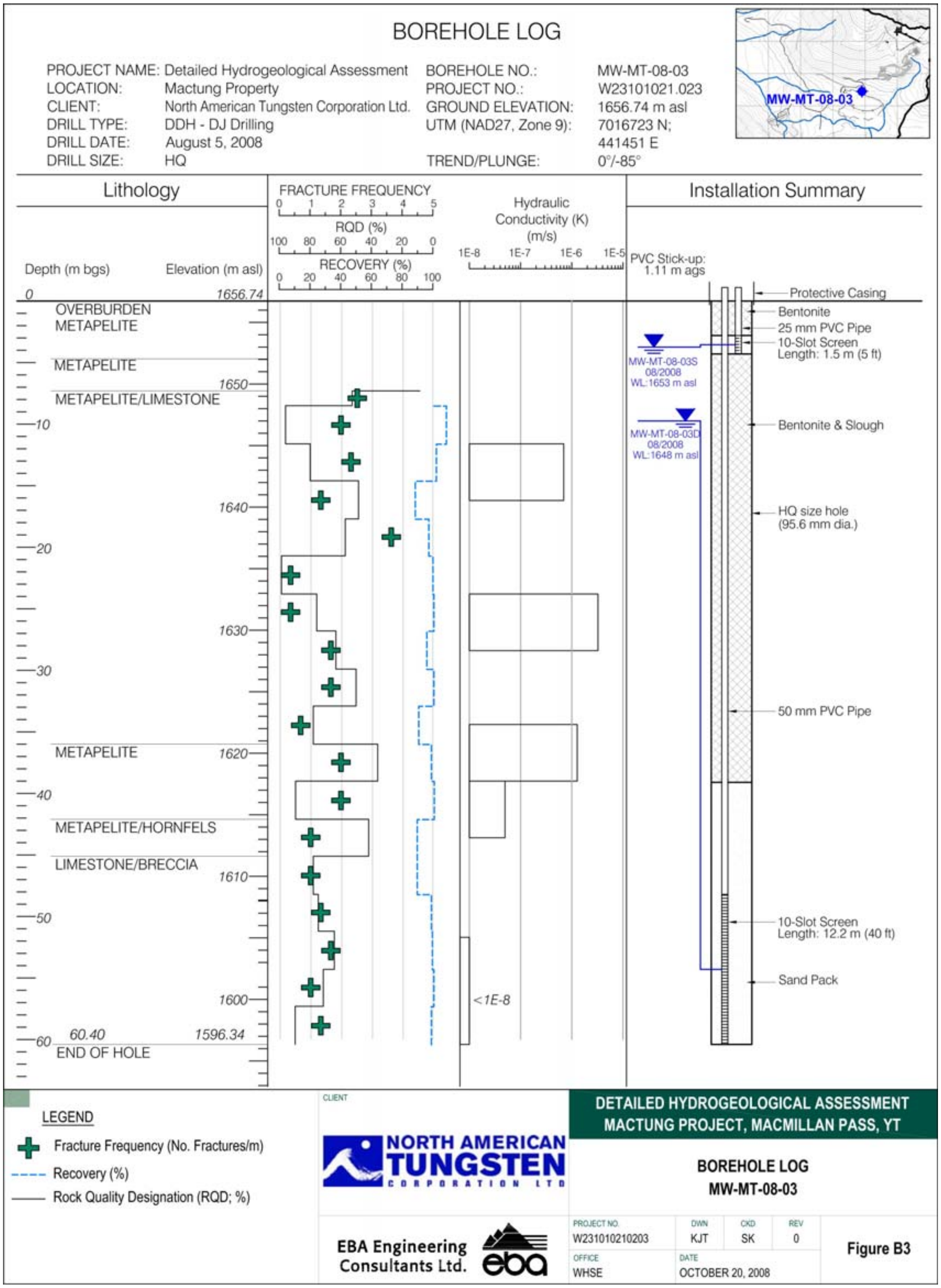


Figure 4.1.10-15: Example of borehole log from Detailed Hydrogeological Assessment.

TABLE 4.1.10-26 GROUNDWATER OBSERVATION WELL SUMMARY

Well	Grade Elevation	Well depth		Depth to Water [1,2]		Groundwater Elevation	
		Deep Aquifer	Shallow Aquifer	Deep Aquifer	Shallow Aquifer	Deep Aquifer	Shallow Aquifer
	m asl [3]	m bgs [4]		m bgs		m asl	
MW-MT-08-01 [5]	2064.61	351.4	2.4	296.2	--	1768.4	dry
MW-MT-08-03	1656.74	60.4	4.3	9.1	3.3	1647.7	1653.4
MW-MT-08-04	1591.39	42.1	4.3	0.2	0.3	1591.2	1591.1
MW-MT-08-04B	1599.29	39.6	4.6	-0.2	0.8	1599.4	1598.5
MW-MT-08-05	1520.04	36.0	4.9	0.0	1.5	1520.1	1518.5
MW-MT-08-06	1497.69	60.1	4.6	8.1	--	1489.5	dry
MW-MT-08-07	1495.86	30.2	--	-12.9	--	1508.8	--
MW-MT-08-08	1796.44	103.0	2.1	40.5	--	1755.9	dry

Notes: [1] Depths and elevations corrected for angle of inclined boreholes where applicable.
[2] Negative values indicate artesian conditions.
[3] m bgs = metres below ground surface
[4] m asl = metres above sea level
[5] Data from VWP installed below permafrost at 339 m bgs.

TABLE 4.1.10-27 SUMMARY OF HYDRAULIC TEST RESULTS

Well	Packer Test Results				Pumping Test Results
	Test Interval		Hydraulic Conductivity		Bulk Hydraulic Conductivity
	Midpoint	Length of Interval	Average	Geometric Mean	
	m bgs	m	m/s	m/s	m/s
MW-MT-08-01	31.4	6.1	2.9E-08	2.6E-08	n/a
	37.5	6.1	2.6E-08		
	43.6	6.1	2.3E-08		
	49.7	6.1	2.5E-08		
	55.8	6.1	2.9E-08		
	61.9	6.1	2.9E-08		
	68.0	6.1	2.6E-08		
	80.2	6.1	2.0E-08		
	86.3	6.1	2.5E-08		
	92.4	6.1	2.2E-08		

TABLE 4.1.10-27 SUMMARY OF HYDRAULIC TEST RESULTS

Well	Packer Test Results				Pumping Test Results
	Test Interval		Hydraulic Conductivity		Bulk Hydraulic Conductivity
	Midpoint	Length of Interval	Average	Geometric Mean	
	m bgs	m	m/s	m/s	m/s
	98.5	6.1	2.5E-08		
	104.6	6.1	2.6E-08		
	110.7	6.1	1.6E-07		
	116.8	6.1	2.5E-08		
	122.9	6.1	2.1E-08		
	129.0	6.1	2.3E-08		
	135.1	6.1	1.4E-08		
	141.2	6.1	1.4E-08		
MW-MT-08-02	228.0	9.2	1.5E-08	3.1E-08	n/a
	218.9	9.1	1.7E-08		
	209.7	9.2	1.5E-08		
	200.6	9.1	1.2E-08		
	191.4	9.2	1.2E-08		
	182.3	9.1	1.5E-08		
	87.8	9.2	3.8E-07		
	106.1	9.1	6.2E-08		
	121.3	9.2	1.8E-07		
	136.6	9.1	2.3E-08		
MW-MT-08-03	13.9	7.6	6.9E-07	6.2E-07	n/a
	26.1	7.6	3.3E-06		
	36.7	4.6	1.3E-06		
	41.3	7.6	5.0E-08		
	56.6	7.7	< 1E-08		
MW-MT-08-04	13.9	7.6	1.1E-07	3.8E-08	n/a
	23.0	7.6	1.7E-08		
	32.2	7.7	3.1E-08		
MW-MT-08-04B	14.2	7.6	1.7E-06	7.3E-07	1E-06
	23.3	7.6	1.5E-06		
	35.5	7.6	1.6E-07		
MW-MT-08-05	20.0	7.6	5.7E-08	1.1E-07	n/a
	32.2	7.7	1.0E-07		
	23.1	25.9	2.3E-07		

TABLE 4.1.10-27 SUMMARY OF HYDRAULIC TEST RESULTS					
Well	Packer Test Results				Pumping Test Results
	Test Interval		Hydraulic Conductivity		Bulk Hydraulic Conductivity
	Midpoint	Length of Interval	Average	Geometric Mean	
	m bgs	m	m/s	m/s	m/s
MW-MT-08-06	17.2	7.6	1.5E-06	8.8E-07	2E-07
	26.4	7.6	8.5E-07		
	38.6	7.7	1.8E-07		
	47.7	7.6	1.4E-06		
	56.9	7.7	1.6E-06		
MW-MT-08-07	14.2	7.6	3.8E-06	3.4E-06	n/a
	23.3	7.6	3.0E-06		
MW-MT-08-08	38.3	7.7	< 1E-08	1.9E-07	6E-07
	50.5	7.7	< 1E-08		
	62.6	7.6	7.8E-08		
	74.8	7.6	4.7E-07		
	87.0	7.6	3.6E-08		
	96.2	7.6	9.1E-07		
BH46	30.9	5.2	< 1E-08	< 1E-08	n/a
	27.9	11.3	< 1E-08		
BH49	9.6	4.6	2.6E-06	2.6E-06	n/a
	17.2	7.6	1.9E-06		
	26.4	7.6	3.5E-06		
BH50	18.7	4.6	8.0E-06	8.0E-06	n/a

Notes: [1] m bgs - metres below ground surface
Data for the DDHs BH46, BH49, and BH50 were collected as part of the geotechnical site investigations.

Groundwater level measurements in both shallow and deep aquifers provided the necessary information for EBA to interpret the groundwater flow regime (groundwater flow direction, hydraulic gradients). A map showing the hydraulic head contours deduced from observed groundwater elevations is provided in Figure 4.1.10-14.

Groundwater samples were collected from selected observation wells to assess baseline hydrogeochemistry. All samples were analyzed for a similar suite of chemical parameters, including field chemical parameters, major cations and anions, and total and dissolved metals. The hydrogeochemical results were then compared to applicable water quality standards and guidelines to identify any natural exceedances.

Temperature measurements by VWPs were used to assess the presence and the extent of permafrost at the project area.

Permafrost

Ground temperature data collected in observation well MW-MT-08-01 indicate the presence of permafrost in the upland areas of Mt. Allan. Figure 4.1.10-16 shows the ground temperature profile measured in well MW-MT-08-01, exhibiting subzero ground temperatures at 20 m bgs (-1.8°C) and 144 m bgs (-1.5°C) but a positive ground temperature at a depth of 339 m bgs (+1.2°C). Assuming a mean linear temperature increase with depth, permafrost seems to extend to about 200 m to 250 m bgs at the location of well MW-MT-08-01, which is situated at higher elevations in the northern part of the project area.

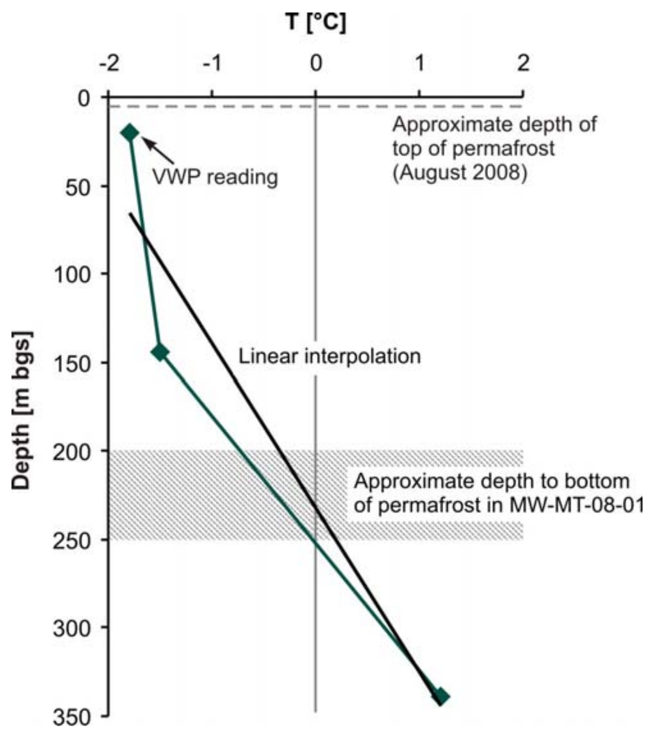


Figure 4.1.10-16: Ground temperature profile measured by VWPs installed in observation well MW-MT-08-01. The black line shows the linear interpolation of the temperature readings and represents the mean thermal gradient, indicating that permafrost extends to a depth of about 200-250 m bgs at the location of MW-MT-08-01.

The active layer is the shallow soil zone which freezes and thaws with the changing seasons. Field observations at the Mactung property in late summer of 2008 showed that existing exploration DDHs in the northern part of the project area were plugged by ice at a depth of about 2-4 m bgs. These ice plugs probably indicate the top of permafrost and the thickness of the active layer at higher elevation on Mt. Allan in late summer. Ground ice was also found from a depth of about a 1.5 to 2 m below the original ground surface in a test pit excavated next to observation well MW-MT-08-08.

There were no indications of permafrost conditions in the southern part of the project area south of Mt. Allan. Packer tests did not reveal any impermeable zones, and temperature measurements conducted as part of the geotechnical site assessment yielded no evidence for the presence of permafrost in the valley south of Mt. Allan.

Hydrogeochemistry

A total of seven groundwater samples were collected at the project area. Five were taken from deep well installations within the bedrock aquifer(s), one sample was taken from a spring about 100 m west of the existing camp representing shallow groundwater within the overburden in the upland areas of Mt. Allan, and one sample was taken from a drill water sump, representing shallow groundwater in the area of the proposed dry-stacked tailings facility.

A summary of groundwater chemistry at the Mactung property is provided in Table 4.1.10-28. Shallow and deep groundwater samples had low to moderate concentrations of total dissolved solids (TDS) ranging from 99 to 257 mg/L, and corresponding low to moderate electrical conductivities from 82 to 515 µS/cm. The pH values ranged from 7.0 to 9.4 and hardness ranged from 78 to 267 mg/L. Dissolved oxygen concentrations were generally very low between 0.0 and 0.3 mg/L suggesting reducing chemical conditions, except for the shallow groundwater samples, which had dissolved oxygen concentrations of about 11.5 g/L. The groundwater temperature varied between 1.2 and 3.1°C.

Major Ion Chemistry and Hydrochemical Facies

The chemical composition of groundwater strongly depends on the local and upgradient aquifer lithologies. As groundwater flows through the aquifer it assumes and continuously evolves a characteristic chemical composition due to interactions with the aquifer matrix. As such, a groundwater sample represents the local and upstream aquifer conditions, and its composition is a function of aquifer lithology, solution kinetics, water residence time, mixing, and groundwater flow patterns.

The groundwater samples can be classified based on their major ion chemical composition, taking into account all major anions and cations. Calcium is a dominating cation in all groundwater samples from the project area. Magnesium was only dominant in the sample from observation well MW-MT-08-05.

Bicarbonate and sulfate were the dominating anions in all samples, except for the sample collected from observation well MW-MT-08-08 in which sulfate was the only dominating anion. The bicarbonate concentration in the sample from well MW-MT-08-08, which is located on Mt. Allan and downgradient of the proposed underground workings, was significantly lower compared to the groundwater in the valley wells to the south and west (see Table 4.1.10-28). A Piper tri-linear diagram (see Figure 4.1.10-17) illustrates the major ion chemical composition of each sample collected. The difference in hydrogeochemistry between groundwater from observation well MW-MT-08-08 and all other groundwater samples taken in the valley is shown by the separation of this point from the cluster of other valley groundwater compositions.

TABLE 4.1.10-28: SUMMARY OF GROUNDWATER CHEMISTRY AT MACTUNG PROPERTY

		Sample Date	19-Aug-08	20-Aug-08	21-Aug-08	9-Aug-08	18-Aug-08	21-Jul-08	9-Aug-08	Yukon CSR	CCME Guideline [1,2]	CCME Guideline [1,2]
		Sample Name	MT-MW-08-04B	MT-MW-08-05	MT-MW-08-06	MW-MT-08-07	MT-MW-08-08	MT Spring	Drill Water #3			
		Sample Location	DDH	DDH	DDH	DDH	DDH	Spring	Sump			x10
		Relative Groundwater Depth	Deep	Deep	Deep	Deep	Deep	Shallow	Shallow	Aquatic Life	Aquatic Life	Aquatic Life
		Detection Limit	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**			
Ionic Balance	%		-3.01	-2.95	-1.40	-0.32	-5.66	-1.37	-1.22	-	-	-
Water type			Ca-HCO3-SO4	Ca-Mg-SO4-HCO3	Ca-HCO3-SO4	Ca-SO4-HCO3	Ca-SO4	Ca-HCO3-SO4	Ca-SO4-HCO3	-	-	-
Field Parameters												
Temperature	°C		2.8	2.4	2.5	2.9	3.1	1.2	7.0	-	-	-
pH	-		7.86	7.00	7.83	7.23	9.38	7.35	7.16	-	-	-
Dissolved O_2	mg/L		0.0	0.0	0.0	0.0	0.3	11.2	11.7		5.5-9.5	-
Electrical Conductivity	µS/cm		259	515	382	515	198	82	222	-	-	-
TDS	ppm		130	257	190	255	99	123	112	-	-	-
Routine Water Parameters												
pH			7.84	7.94	8.03	7.52	8.99	7.81	7.63	-	6.5 - 9	-
Electrical Conductivity	µS/cm at 25°C	1	240	469	351	497	184	176	216	-	-	-
Turbidity	NTU	0.1	15.0	6.6	0.2	15.0	30.0	0.7	0.5	-	-	-
Total Dissolved Solids	mg/L	1	162	337	245	334	136	120	138	-	-	-
Hardness	mg/L	1	118	264	196	267	78	86	103	-	-	-
Chloride	mg/L	0.02	0.07	0.04	0.04	0.03	0.10	0.08	0.04	-	-	-
Ammonia - N	mg/L	0.005	0.097	0.080	0.029	0.014	0.260	<0.005	<0.005	11.3	1.54	15.4
Nitrate - N	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	0.06	0.15	0.08	400	13	130
Nitrite - N	mg/L	0.01	0.03	0.06	0.04	0.04	<0.01	0.01	0.01	0.2	0.06	0.6
Sulfate (SO4)	mg/L	0.05	58.60	149.00	97.60	140.00	69.60	39.20	64.00	1000	-	-
Hydroxide	mg/L	5	<5	<5	<5	<5	<5	<5	<5	-	-	-
Carbonate	mg/L	6	<6	<6	<6	<6	7	<6	<6	-	-	-
Bicarbonate	mg/L	5	90	160	130	160	20	60	50	-	-	-
T-Alkalinity	mg/L	5	74	130	105	131	25	54	42	-	-	-
Acidity	mg/L as CaCO3	5	<5	6	<5	-	<5	-	-	-	-	-
Metals - Dissolved												
Mercury	mg/L	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.001	0.000026	0.00026
Aluminum	mg/L	0.005	0.021	0.008	0.019	<0.005	**0.572**	0.021	<0.005	-	0.1	1
Antimony	mg/L	0.0002	0.0024	0.0008	0.0032	0.0010	0.0108	0.0007	0.0005	0.2	-	-
Arsenic	mg/L	0.0002	0.0016	<0.0002	0.0016	0.0045	**0.0058**	<0.0002	<0.0002	0.05	0.005	0.05
Barium	mg/L	0.001	0.019	0.020	0.025	0.021	0.012	0.007	0.009	10	-	-
Beryllium	mg/L	0.00004	<0.00004	<0.00004	<0.00004	<0.00004	0.00006	<0.00004	<0.00004	0.053	-	-
Bismuth	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Boron	mg/L	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.005	-	-	-
Cadmium	mg/L	0.00001	0.00002	0.00001	0.00003	<0.00001	0.00015	0.00002	<0.00001	0.0005-0.0006	0.000017	0.00017
Calcium	mg/L	0.04	42.30	80.10	62.70	99.80	30.30	31.80	39.30	-	-	-
Chromium	mg/L	0.0004	<0.0004	0.0007	0.0006	0.0007	0.0009	<0.0004	<0.0004	0.01	0.001[3]	0.01
Cobalt	mg/L	0.00002	0.00006	0.00006	0.00012	0.00248	0.00009	0.00004	0.00002	0.009	-	-
Copper	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.05-0.09	0.002 - 0.004[4]	0.02-0.04

TABLE 4.1.10-28: SUMMARY OF GROUNDWATER CHEMISTRY AT MACTUNG PROPERTY

		Sample Date	19-Aug-08	20-Aug-08	21-Aug-08	9-Aug-08	18-Aug-08	21-Jul-08	9-Aug-08	Yukon CSR	CCME Guideline [1,2]	CCME Guideline [1,2]
		Sample Name	MT-MW-08-04B	MT-MW-08-05	MT-MW-08-06	MW-MT-08-07	MT-MW-08-08	MT Spring	Drill Water #3			
		Sample Location	DDH	DDH	DDH	DDH	DDH	Spring	Sump			x10
		Relative Groundwater Depth	Deep	Deep	Deep	Deep	Deep	Shallow	Shallow	Aquatic Life	Aquatic Life	Aquatic Life
		Detection Limit	Results	Results	Results	Results	Results	Results	Results			
Metals - Dissolved												
Iron	mg/L	0.01	**0.55**	<0.01	0.11	**3.24**	**0.31**	0.02	<0.01	-	0.3	3
Lead	mg/L	0.0001	<0.0001	0.0001	0.0002	<0.0001	0.0012	0.0002	<0.0001	0.06-0.16	0.007[5]	0.07
Lithium	mg/L	0.001	0.004	0.002	0.005	0.003	0.003	<0.001	<0.001	-	-	-
Magnesium	mg/L	0.04	3.07	15.70	9.59	4.29	0.51	1.60	1.14	-	-	-
Manganese	mg/L	0.0001	0.0881	0.0101	0.0179	0.1310	0.0050	0.0009	0.0004	-	-	-
Molybdenum	mg/L	0.00002	0.00188	0.00099	0.00768	0.00355	0.00842	0.00203	0.00095	10	0.073	0.73
Nickel	mg/L	0.001	0.002	<0.001	0.002	0.060	0.001	<0.001	<0.001	1.1-1.5	0.15[6]	1.5
Phosphorus	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	-	-	-
Potassium	mg/L	0.04	2.53	1.71	1.64	0.99	0.68	0.47	0.68	-	-	-
Selenium	mg/L	0.0006	<0.0006	<0.0006	<0.0006	<0.0006	**0.0024**	**0.0016**	**0.0026**	0.01	0.001	0.01
Silicon	mg/L	0.01	3.28	3.75	3.08	3.18	5.50	3.24	2.32	-	-	-
Silver	mg/L	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.0005-0.015	0.0001	0.001
Sodium	mg/L	0.04	2.11	1.50	1.95	0.66	4.94	0.50	0.66	-	-	-
Strontium	mg/L	0.001	0.114	1.000	0.209	0.213	0.042	0.047	0.083	-	-	-
Thallium	mg/L	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.003	-	-
Thorium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Tin	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Titanium	mg/L	0.0001	0.0010	0.0006	0.0008	0.0003	0.0092	0.0014	<0.0001	1	-	-
Tungsten	mg/L	0.0001	0.0036	0.0017	0.0038	0.0004	0.0219	0.0098	0.0005	-	-	-
Uranium	mg/L	0.0004	0.0035	0.0027	0.0117	0.0098	0.0006	0.0005	<0.0004	3	-	-
Vanadium	mg/L	0.00004	0.00021	0.00021	0.00033	0.00021	0.00480	0.00036	0.00026	-	-	-
Zinc	mg/L	0.001	0.003	0.002	0.003	**0.052**	0.004	0.003	<0.001	0.15-2.4	0.03	0.3
Zirconium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	-	-	-

Notes:
"<" indicates less than the laboratory detection limit
"-" indicates no guidelines or no standards established
Applicable Standard: Underline indicates exceeds Yukon CSR Standard (note: CSR Standard compared with total metals concentrations for surface water, and dissolved metals concentrations for groundwater).
Comparison Guidelines: **Bold Highlighting- indicates results exceed CCME Aquatic life guidelines**
Bold Highlighting and Borders- indicates results exceed CCME Aquatic life guidelines ×10

[1] Canadian Water Quality Guidelines for the Protection of Aquatic Life, Canadian Council of Ministers of the Environment ("CCME"), updated 6.0, July 2006
[2] Standard based on Canadian Trigger Ranges for ultra-oligotrophic, the most stringent of standards.
[3] Standard is for Chromium VI.
[4] Standard is based on hardness (CaCO3) where copper equals; 0.002 mg/L when hardness is 0 - 120 mg/l, 0.003 mg/L when hardness is 120-180 mg/L, 0.004 mg/L when hardness is >180 mg/L.
[5] Standard is based on hardness (CaCO3) where lead equals; 0.001 mg/L when hardness is 0 - 60 mg/l, 0.002 mg/L when hardness is 60-120 mg/L, 0.004 mg/L when hardness is 120 - 180 mg/L, 0.007 when hardness is >180 mg/L.
[6] Standard is based on hardness (CaCO3) where nickel equals; 0.025 mg/L when hardness is 0 - 60 mg/l, 0.065 mg/L when hardness is 60-120 mg/L, 0.110 mg/L when hardness is 120 - 180 mg/L, 0.150 when hardness is >180 mg/L.

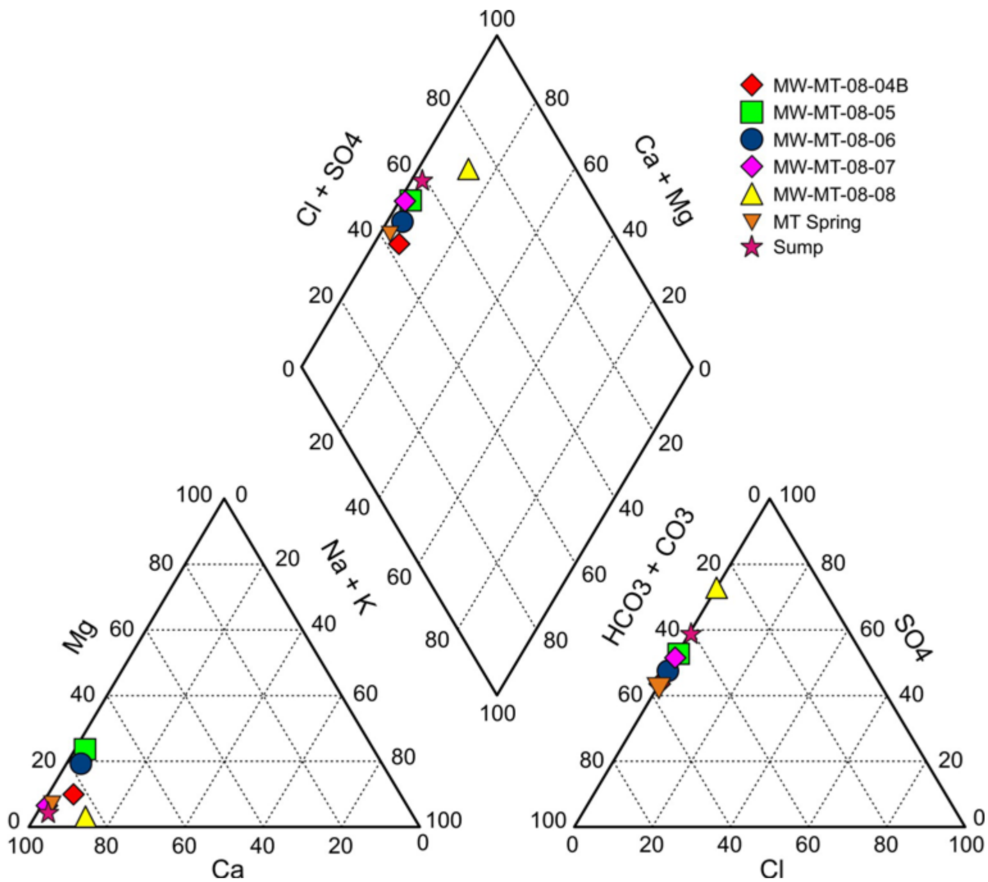


Figure 4.1.10-17: Piper diagram showing the major ion composition of the groundwater samples collected at the Mactung property.

The sample obtained from observation well MW-MT-08-08 contains significantly less bicarbonate and can therefore be characterized as calcium-sulfate type groundwater. Although this sample was taken from great depth (~90-100 m bgs) and most likely represents sub-permafrost groundwater, the water has low mineralization as indicated by the TDS concentration of about 100 mg/L.

The sample collected from the spring west of the existing camp ("MT Spring") represents shallow overburden groundwater and can be characterized as weakly mineralized calcium-bicarbonate-sulfate water. The shallow groundwater sample collected from a drill water sump in the area of the dry-stacked tailings facility ("Drill Water #3") can be typified as weakly mineralized calcium-sulfate-bicarbonate water.

Comparison of Project Area Hydrogeochemistry with Guidelines and Standards

All groundwater samples were analyzed for their concentrations of dissolved metals. The measured dissolved metals concentrations were compared to the Yukon's Contaminated Sites Regulation (CSR) and Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life). The CSR standards apply to groundwater and the CCME guidelines only apply to surface water. As groundwater ultimately discharges into surface water bodies, the CCME guideline values are included here for reference. One approach for using the CCME freshwater aquatic life guidelines for groundwater is to multiply them by 10, representing a dilution effect that might occur when groundwater discharges into surface water. While it is noteworthy to document where groundwater exceeds these adjusted "guideline" values, it is important to note that such exceedances do not compel action under the actual CCME guidelines.

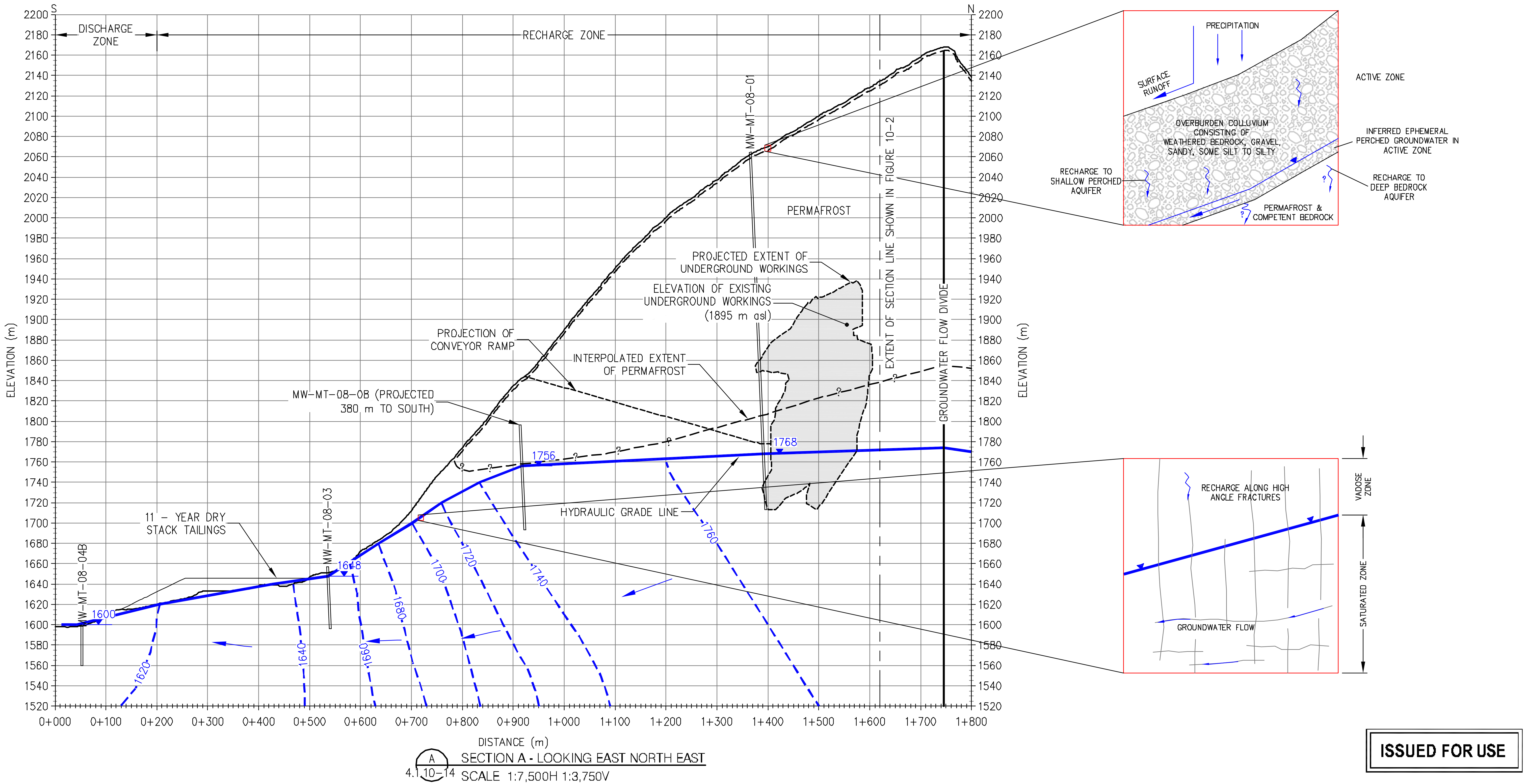
Some of the dissolved metals concentrations slightly exceeded the CCME guideline values for aluminum, cadmium, iron, selenium, and zinc. However, all dissolved metals concentrations also met the adjusted CCME guideline values, except for the dissolved iron concentration of 3.24 mg/L in the sample from observation well MW-MT-08-07. However, depending on the oxidation state of the dissolved iron (whether highly soluble ferrous iron (Fe^{2+}) or less soluble ferric iron (Fe^{3+})), this iron-rich groundwater may react with oxygen-rich surface water and iron(hydr)oxides may precipitate so that resulting iron concentrations in the surface water may fall below the CCME surface water guideline value.

Conceptual Baseline Hydrogeological Model

The conceptual baseline hydrogeological model is intended to conceptually describe the pre-mine local hydrogeological conditions at Mactung property with respect to groundwater flow and groundwater quality. The conceptual model is based upon all information gathered during the DHA fieldwork and data interpretation.

The local hydrogeological system at the project area consists of shallow and deep aquifers. The shallow aquifer is unconfined and comprises porous overburden sediments overlying bedrock and within the active zone (seasonally thawed zone) in areas where permafrost exists. The deep aquifer(s) consists of various metamorphic contact and sedimentary bedrock lithologies in which groundwater flow mainly occurs along fractures and other rock discontinuities.

The hydrogeological conditions for both shallow and deep aquifers at the project area are discussed in more detail in the following sections. Figures 4.1.10-18 and 4.1.10-19 present conceptual hydrogeological cross-sections through the project area (the cross-section lines are shown on Figure 4.1.10-14).



A 4.1.10-14 SECTION A - LOOKING EAST NORTH EAST
SCALE 1:7,500H 1:3,750V

ISSUED FOR USE

LEGEND

▼ 1490 HYDRAULIC HEAD MEASUREMENT OBSERVED (SEPT 2008) IN DEEP INSTALLATIONS (m asl)

– – – INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR (m asl)

NORTH AMERICAN TUNGSTEN CORPORATION LTD.

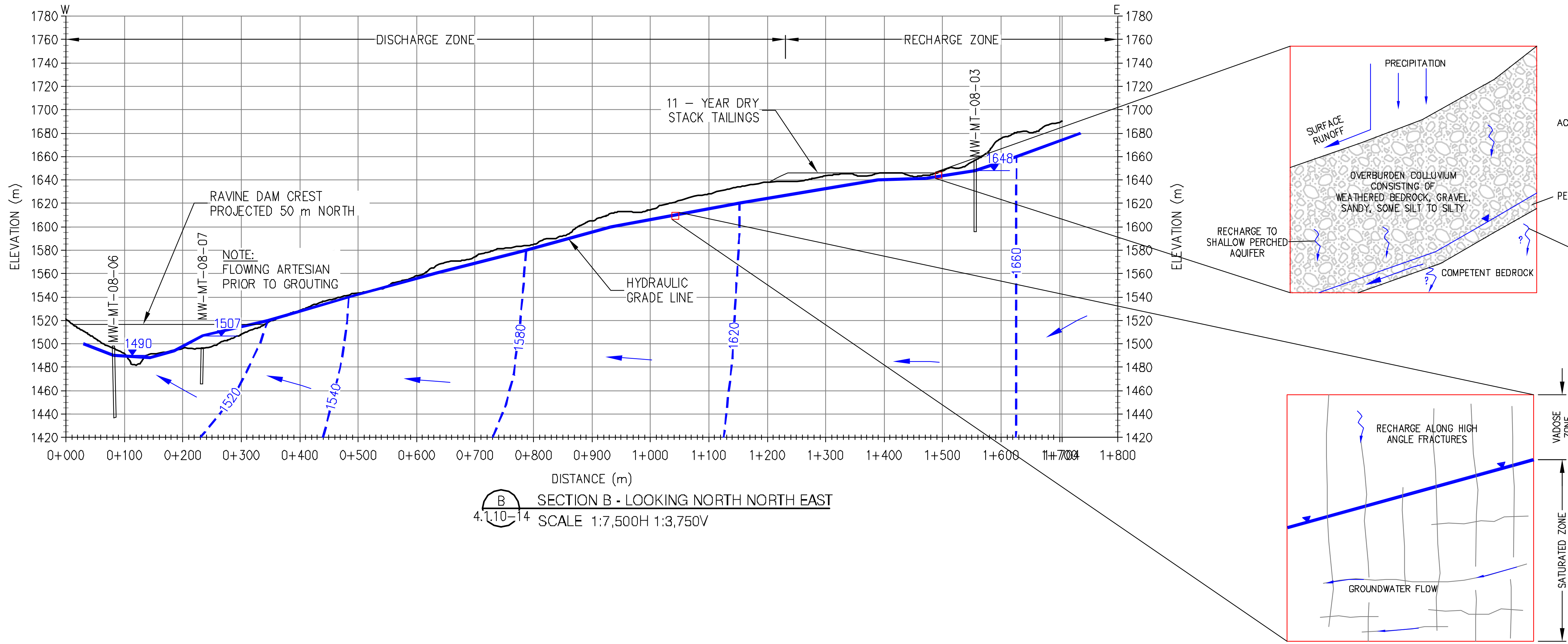
EBA Engineering Consultants Ltd.

MACTUNG

Conceptual Hydrogeology
Cross Section A

PROJECT NO.	DWN	CKD	REV
W23101110.001	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	NOVEMBER, 2008		

Figure 4.1.10-18



B 4.1.10-14 SECTION B - LOOKING NORTH NORTH EAST

SCALE 1:7,500H 1:3,750V

ISSUED FOR USE

LEGEND

▼ 1490 HYDRAULIC HEAD MEASUREMENT OBSERVED (SEPT 2008) IN DEEP INSTALLATIONS (m asl)

— — — GROUNDWATER EQUIPOTENTIAL CONTOUR (m asl)

CLIENT: NORTH AMERICAN TUNGSTEN CORPORATION LTD

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Conceptual Hydrogeology Cross Section B

PROJECT NO.	DWN	CKD	REV
W23101110.001	KJT	RMM	0

OFFICE	DATE
EBA-WHSE	NOVEMBER, 2008

Figure 4.1.10-19

Overburden Aquifer

In the upland areas of Mt. Allan, the overburden sediments comprising the shallow aquifer mainly consist of coarse blocky talus derived from ongoing erosion of upslope bedrock outcrops. An organic soil cover is lacking at higher elevations and steep slopes where erosion is most active. Colluvium at lower elevations in the valley floor is mainly composed of silt, silty sand, and silty, sandy gravel, and is typically covered by a thin organic horizon with ground vegetation. The thickness of the overburden sediments is about 1-3 m in the upland areas of Mt. Allan, and about 5-10 m at the valley floor.

Grain size distributions of 15 samples were obtained from test pits and shallow drill holes throughout the project area (EBA 2008). The grain size distributions show that the hydraulic conductivity of the overburden sediments were determined to have a large range of values from 2×10^{-7} to 3×10^{-3} m/s (Table 4.1.10-29). The hydraulic conductivity of the overburden sediments in the northern part of the site in the upland area of Mt. Allan (geometric mean: 3×10^{-5} m/s) is generally higher than in the valley south of Mt. Allan. The hydraulic conductivities in the areas of the dry-stacked tailings facility and the ravine dam are fairly constant with a mean value of about 5×10^{-6} m/s (see DHA report in Appendix H8 for more details).

TABLE 4.1.10-29 HYDRAULIC CONDUCTIVITIES OF THE SHALLOW AQUIFER (OVERBURDEN)

Location	Hydraulic Conductivity		
	Min	Max	Geomean
	m/s		
All	1.7E-07	2.5E-03	9.7E-06
Mt. Allan (incl. Mill, Camp)	1.7E-07	2.5E-03	3.1E-05
DSTF	1.5E-06	9.2E-06	4.7E-06
Ravine Dam	1.3E-06	1.7E-05	4.2E-06

Note: DSTF - Dry-stacked tailings facility

Groundwater flow within the shallow aquifer occurs in overburden deposits overlying bedrock, and in the active layer where permafrost exists (i.e., in the layer of seasonal thawing and freezing). The main groundwater flow with the highest groundwater levels is anticipated to occur during the snowmelt in late spring after thawing of the shallow sediments.

Along the southern slope of Mt. Allan, EBA considers the shallow groundwater as temporary or seasonal subsurface runoff (ephemeral throughflow) rather than permanent groundwater in a strict sense.

Bedrock Aquifers

The shallow unconfined overburden aquifer is underlain by fractured bedrock. The bedrock lithology mainly consists of hornfels, metapelite, skarn, and limestone in the northern part of the project area on Mt. Allan, and is dominated by metapelite in the southern and western part at the valley floor in the vicinity of the proposed dry-stacked tailings facility and the aging pond.

Groundwater flow in the bedrock aquifers predominantly occurs in fractures and fault zones and under confined or unconfined conditions. Groundwater flow in fractured media is complex and can vary greatly in direction and rate, depending on the local hydrogeological and structural geological conditions. Hydraulic conductivity values can change over several orders of magnitude within the same rock mass, and groundwater flow may be largely controlled by a few conductive fractures or other rock mass discontinuities. Bedrock hydraulic conductivity values determined for this study are summarized in Table 4.1.10-27 and ranged from $< 1\times10^{-8}$ to 5×10^{-6} m/s. These conductivity values are generally lower than the overburden hydraulic conductivities.

In the upland areas of Mt. Allan, groundwater within the bedrock aquifer occurs beneath the permafrost which extends to depths of up to about 250 m bgs (see Figures 4.1.10-16 and 4.1.10-18). There may be locations on Mt. Allan, where groundwater is confined by the base of the permafrost although there was no direct evidence of this in this study.

Groundwater – Surface Water Interaction

The main surface water body at the project area is Tributary C originating southwest of the existing camp and flowing through the southern part of the area (Figures 4.1.10-13 and 4.1.10-14). Tributary C1 joins Tributary C in the area of the proposed aging pond, and Tributaries C2 and C3 join Tributary C downstream of the aging pond and outside of the project area. Tributary C is the main receiving surface water body for groundwater discharging from shallow and deep aquifers at the project area, and we interpret that groundwater discharge from all areas of proposed mine infrastructure, including underground workings, camp and mill site, dry-stacked tailings facility, and reservoir will ultimately discharge to Tributary C. However, weakly artesian groundwater conditions at locations close to Tributary C in observation wells MW-MT-08-04B, MW-MT-08-05, and MW-MT-08-07 indicate that the hydraulic connection between the deep aquifer and Tributary C might be reduced in those areas, and that deep groundwater may discharge to Tributary C further downstream.

Tributary C2 may receive some discharge water form the westernmost area of the proposed underground workings. Tributary C3 most likely does not receive any discharging groundwater from the areas of proposed mine facilities.

Tributary C1 originates on the opposite side of the valley south of Mt. Allan, and is therefore not affected by groundwater discharge from the project area.

Groundwater Flow Regime Summary

The project area is bordered by surface water divides to the north, east, and south. The regional groundwater flow divide is assumed by EBA to coincide with surface water divides (i.e., groundwater from the project area discharges to the valley of Tributary C south of Mt. Allan).

The general groundwater flow direction – inferred by EBA from groundwater level measurements in the observation wells – generally mimics surface topography. Deep groundwater flows from the highest areas of Mt. Allan southwards, turning southwesterly or westerly in the valley of Tributary C (see Figure 4.1.10-14). Shallow groundwater flow within the overburden is characterized by local, small-scale flow cells, with its flow direction closely following local topography.

Groundwater recharge typically occurs at higher elevations with groundwater ultimately discharging to surface water bodies at lower elevations in valleys. The presence of permafrost in the upland areas tends to reduce infiltration to groundwater. In the Mactung project area, hydraulic heads increase from south to north beneath upland areas of Mt. Allan where permafrost exists, indicating that at least some recharge takes place into this rock mass beneath the permafrost zone. At lower elevations where permafrost is absent, we interpret groundwater recharge to occur at the lower valley slopes in areas where a hydraulic connection exists between the shallow overburden and deep bedrock aquifers. Overburden sediments in the valley are, however, often composed of moraine sediments mixed with talus and colluvium, having a low hydraulic conductivity. These fine grained sediments may also act as a barrier for infiltrating seepage water and as a (semi-)confining layer for deeper groundwater.

The horizontal hydraulic gradient in the bedrock aquifer ranges from about 0.02, i.e., the hydraulic head decreases by 2 m over a distance of 100 m in the direction of groundwater flow, in the upland areas of Mt. Allan to about 0.5 in locations south of the proposed mill site. The hydraulic gradient in the valley south of Mt. Allan appears to be fairly constant at 0.1-0.15. Based on the hydraulic conductivities obtained from hydraulic tests (see Table 4.10.1-27), the hydraulic gradients inferred by EBA from groundwater level measurements, and assuming a bedrock porosity of about 0.05-0.15 (Domenico and Schwartz 1998; Freeze and Cherry 1979), the mean flow velocity of the deep groundwater is estimated to range from about a few metres to several tens of metres per year.

4.1.11 Aquatic Ecosystems and Fisheries Resources

This section provides a summary of aquatic ecosystems and fisheries resources information for the proposed mine development and related areas of impact. For ease of reading and comprehension, this section has been subdivided into three major subject areas: existing information from historical studies; receiving environment baseline studies; and access road baseline studies. To orient the reader with the characteristics of the local area as they relate to fisheries resources, the following sections provide information related to the project, study areas, and baseline study scope.

Several project components as outlined in Section 5 of this proposal were considered in the design of baseline studies for the Mactung project area. The main study areas included:

- The footprint of the mine and associated infrastructure;
- The mine receiving environment;
- The proposed water pumping station;
- The Macmillan Pass Aerodrome expansion; and,
- The proposed new and upgraded access roads.

4.1.11.1 Regional Setting

As described in Section 4.1.10 (water resources), the Mactung project area lies within two regional-level watershed drainages, and is drained via two major river systems, the Hess River and the South Macmillan River. The majority of the project area, however, falls within the drainage of the Hess River (Figure 4.1.11-1).

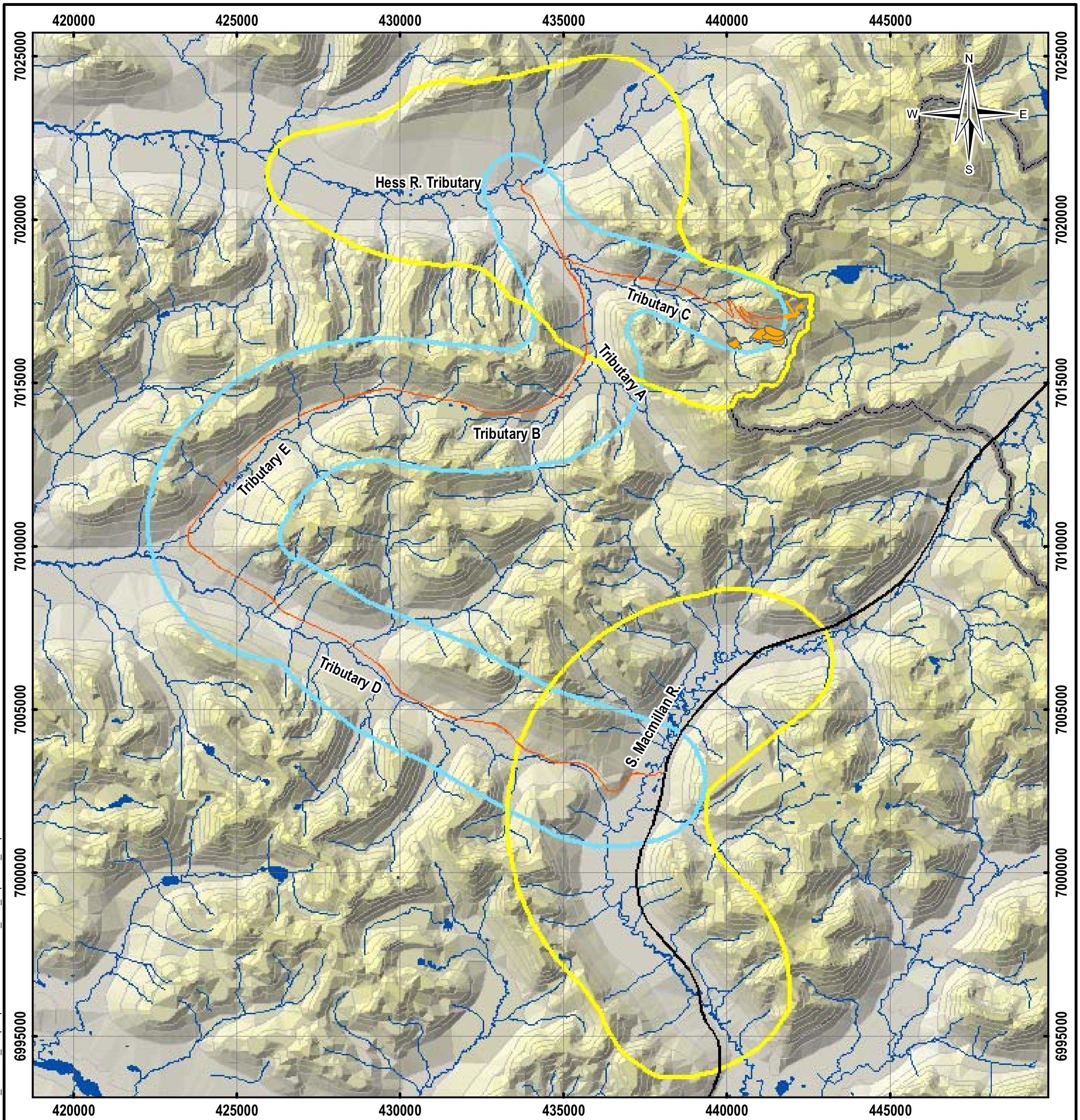
4.1.11.2 Definition of Study Areas and Study Program

The design of EBA's fisheries baseline study program was organized according to two primary study areas: the Project Aquatics Study Area (ASA^P) and the Road Aquatics Study Area (ASA^R).

ASA^P – The Project Aquatics Study Area includes all watercourses that may be influenced directly or indirectly by the project infrastructure (including the mine development, pumping station and transfer infrastructure, and the aerodrome expansion). This includes Tributaries A and C, the Hess River Tributary, the South Macmillan River, as well as several first order tributaries to Tributary C that are found within the mine footprint area (Figure 4.1.11-1, Table 4.1.11-1).

ASA^R – The Road Aquatics Study Area includes all watercourses that are crossed by the proposed mine access road, as well as those included within a defined downstream zone of impact[7]. This included Tributaries A through E (all tributaries to the Hess River), as well as the South Macmillan River (Figure 4.1.11-1, Table 4.1.11-1).

[7] For road developments, an accepted definition of the zone of impact is "the area of bed and banks of the water body that will be altered or disrupted as a result of the works and where 90% of the sediment discharged as a result of the works will be deposited" (Alberta Environment 2001).



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LEGEND

- Project Aquatic Study Area
- Road Aquatic Study Area
- Watercourses
- Waterbodies
- Access Road Route
- Proposed Mine Site Infrastructure
- North Canol Road
- NWT - Yukon Territory Border

NOTES

Base data source: 1:50K NTDB
Site Plan adapted from original provided by Wardrop

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Aquatics Study Areas

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:170,000
2 1 0 2
Kilometres

FILE NO.
W23101110_001_Aquatics_Map004.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	CJJ	1

OFFICE	DATE
EBA-VANC	December 8, 2008

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Figure 4.1.11-1

TABLE 4.1.11-1 DESCRIPTON OF WATERCOURSES WITHIN THE AQUATICS REGIONAL STUDY AREA				
Watercourse Identifier	Highest Local Stream Order/Parent Watercourse	Fish Bearing Status	Project Infrastructure Influences	Number of Watercourse Crossings (Direct/Indirect)
Hess River Tribuatary	5/Hess River	Fish Bearing	- Access Road - Mine and Dam Facilities - Pumping Station	0
Tributary A	4/Hess River	Unconfirmed, (migration potential)	- Access Road - Mine and Dam Facilities	1/2
Tributary B	3/Hess River	Non-Fish-Bearing	- Access Road	0/1
Tributary C	3/Hess River	Fish Bearing	- Access Road - Mine and Dam Facilities	0/5
Tributary D	4/Hess River	Fish Bearing	- Access Road	0/6
Tributary E	3/Hess River	Non Fish-Bearing	- Access Road	2/5
South MacMillan River	4/Pelly River	Unconfirmed	- Access Road - Airstrip Expansion	1/0

EBA's baseline study program took place between 2006 and 2008, and included the components outlined in Table 4.1.11-2.

TABLE 4.1.11-2 SUMMARY OF FISHERIES/AQUATICS BASELINE STUDY COMPONENTS		
Year	Watercourses	Study Program
Fisheries Baseline Studies		
2006	Tributary A, Tributary C, Hess River Tributary	- Receiving environment habitat assessment - Fish presence and composition assessment - Delineation of habitat availability, fish passage barriers.
2007	Tributary A, Tributary C, Hess River Tributary	- Refinement of receiving environment habitat assessments. - Second season of fish presence/composition/habitat use assessment. - Habitat assessment in upper Tributary C (receiving env't).
2008	Tributary C	- Intensive fish presence/absence assessment in upper Tributary C (mine footprint area).
2008	Hess River Tributary	- Habitat mapping and assessment of pump station location. - Detailed assessment of fish habitat usage in summer, fall, and winter (at ice-up). - Assessment of potential spawning habitat use by Dolly

TABLE 4.1.11-2 SUMMARY OF FISHERIES/AQUATICS BASELINE STUDY COMPONENTS		
Year	Watercourses	Study Program
		Varden.
2008	Tributaries A, B, C, D, E, and South MacMillan River	- Fish and fish habitat assessments for access road watercourse crossings.
Aquatic Environment Baseline Studies		
2006	Tributary A, Tributary C, Hess River Tributary	- Physical water quality assessment. - Benthic macroinvertebrate taxonomic analyses.
2007	Tributary A, Tributary C, Hess River Tributary	- Physical water quality assessment. - Benthic macroinvertebrate taxonomic analyses.
2008	Tributaries A, C, D, and E	- Stream sediment metal and grain size analyses. - Periphyton productivity and taxonomic analyses. - Minor macroinvertebrate taxonomic analyses.
2008	Tributaries A, B, C, D, E, and South MacMillan River	- Physical water quality assessments.

4.1.11.3 Fish and Fish Habitat

Historical Baseline Studies and Existing Information

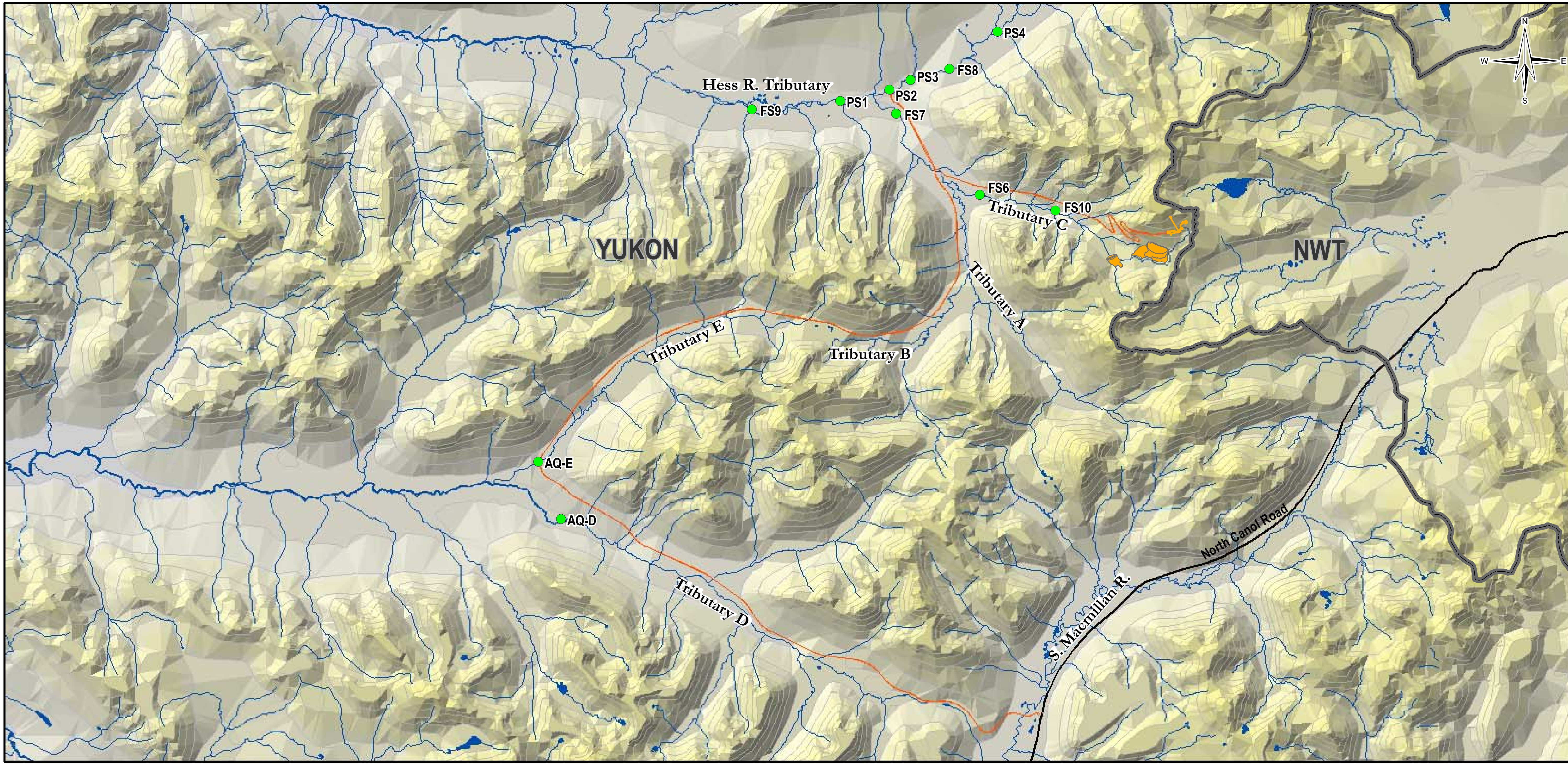
Historical information for fisheries distrubution and habitat composition for watercourses located within and around the project area is extremely limited. Following an extensive review of existing literature for this area, EBA found that no fisheries information was available on the Hess River Tributary or the smaller Tributaries (Tributaries A-E). Limited information was available for the South Macmillan River. Davies and Shepard (1981) found Arctic grayling (*Thymallus arcticus*) and slimy sculpin (*Cottus cognatus*) at kilometer 183 on the South Macmillan River. No fish were observed during sampling upstream of this point (i.e. there have been no fish observed upstream of the second water crossing). Jack and Osler (1983) and Soroka and Jack (1983) attempted to electrofish on the South Macmillan River but were unable to due environmental conditions (i.e. deep water and high flows). MPERG's (2007) aquatic assessment on the South Macmillan River did not contain a fisheries component.

Fish and Fish Habitat Assessments Methods (2006-2008)

Fish and fish habitat assessments were conducted on the three tributaries that comprise the project receiving environment (Tributaries A, C, and the Hess River tributaries) from August 4-8 2006, and August 14-18 2007. As part of these studies, stream channels were assessed by aerial reconnaissance to determine overall fish habitat potential, habitat characteristics, and to identify barriers to fish passage. Fish presence and habitat quality were then further assessed at a number of representative fisheries sample (FS) sites (Shown in Figure 4.1.11-2). At each site, habitat characteristics were assessed according to the Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures (RIC

2001) and the Guide to the Code of Practice for Watercourse Crossings (Alberta Environment 2001). This habitat assessment included:

- Stream channel characteristics (e.g. bankfull and wetted width, measures of depth, bank height, slope, and stability);
- Channel substrate composition and characteristics;
- Distribution of major habitat groups (e.g. Riffle, Run, and Pool);
- Riparian vegetation composition, instream cover abundance and composition; and,
- Basic water quality attributes (e.g. dissolved oxygen, conductivity, temperature, turbidity, pH).



LEGEND

- Sampling Locations
- Proposed Mine Site Infrastructure
- NWT - Yukon Territory Border
- Access Road Route
- North Canol Road
- Watercourses
- Waterbodies

Sample Type

- **FS** Fisheries Sample Site
- **PS** Pumping Station Sample Site
- **AQ** Aquatics Sample Site

NOTES

Base data source: 1:50K NTDB
Site Plan adapted from original provided by Wardrop

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Receiving Environment Aquatics Study Area Sampling Locations

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:115,000
2 1 0 2
Kilometers

FILE NO. W23101110_001_Aquatics_Map001.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	CJJ	1

OFFICE	DATE
EBA-VANC	December 8, 2008

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Figure 4.1.11-2

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At each sample site, fish presence and species diversity were assessed through backpack electrofishing, using a modified pole net to capture fish in fast currents. Methods used were consistent with the British Columbia Ministry of Environment (BC MOE) Fish and Fish Habitat Inventory and Information Program (1989), and by the BC Fish and Fish Habitat Inventory Standards and Procedures published by the Resource Inventory Committee (RIC 2001).

Detailed aerial reach mapping of Tributary A and Tributary C also conducted to catalogue the distribution of habitats occurring directly within the immediate receiving environment.

Electrofishing on Tributary A in 2007

Footprint Fish Presence Assessment (Tributary C)

A single day intensive assessment of fish presence/absence was conducted in upper Tributary C in July of 2008. This effort focused on corroborating previous evidence of non-fish bearing status in the upper reaches of Tributary C that fall within the area of footprint area (proposed). This assessment was conducted using backpack electrofishing of extended channel reaches.

Hess River Tributary Fisheries Studies

In 2008, several baseline study components were undertaken to provide detailed information on fish species composition and seasonal habitat use in the Hess River Tributary (HRT) in the vicinity of proposed water intake infrastructure for the project. These study components focussed on gathering information related to potential impacts of water withdrawal from the watercourse. Components of this program included:

Peak Flow/Early Summer Assessment

In early July of 2008, an intensive survey of fish habitat use was conducted in the Hess River Tributary in an attempt to determine fish species usage during early summer high flow periods. This program specifically targeted young-of-year or juvenile fish (primarily Arctic grayling and Dolly Varden), as well as adult fish of numerous species. This fish assessment employed backpack electrofishing, fine-mesh seine netting, as well as visual observations, and targeted four sites on the HRT that provided a good diversity of riffle, run, pool, and off-channel habitats.

Dolly Varden Spawning and Over-Winter Fish Presence Assessment

In September and October of 2008, a survey of fish presence and distribution was undertaken to determine the presence of fish in the HRT in fall. The purpose of this assessment was twofold:

- To gather evidence of spawning activity, pre-spawn staging, or post-spawn staging of fall spawning species (e.g. Dolly Varden or round whitefish) in the vicinity and downstream area of the proposed water withdrawal area. This work was undertaken to assess the potential impacts on redds, eggs, or larvae in relation to potential flow reductions resulting from proposed winter water withdrawal.
- To determine the presence of fish in areas identified as suitable over-wintering habitat immediately before ice-over as an indicator of local winter fish habitat use. This work was undertaken to assess the potential effects of reduced low-flows on local fish populations (resulting from proposed winter water withdrawal).

This survey was based on the same four sites established for the early summer assessment as noted above (due to suitable deep pool habitats), and employed a number of fish survey techniques to determine fish presence, including backpack electrofishing, fine-mesh seine netting, angling, visual surveys, and gill-netting.

The results of the above noted baseline study programs are outlined in the following sections and have been organized by watercourse from closest to furthest from the Mactung property.

Dolly Varden

Tributary C

<u>Results</u>

Three fish sampling locations were established on this third order tributary.

Lower Tributary C (FS-6)

Approximately 650 m of this watercourse was electrofished during an effort of 1962 seconds in the proximity of FS6 over two years (2006 and 2007), resulting in the capture of three dolly varden and observation of four others[8] (Table 4.1.11-3, Figure 4.1.11-2). Two additional Dolly Varden were captured through angling. Fish were primarily found within plunge pools associated with large woody debris, or beneath extensive undercut bank areas which were measured to extend for greater than one metre beneath the willow/moss root mat in some areas. Indications from the sampling suggested that this species occurs at low densities in Tributary C. Furthermore, some individuals sampled demonstrated reproductive coloration and gonadal maturity at a small size (272 mm), suggesting that these individuals are part of a local resident dwarf Dolly Varden population.

[8] The fish captured in Tributary C belong to complementary species pair, Dolly Varden and bull trout, for which the complete distributions are still being defined. Based on current information, it is understood that only Dolly Varden exists within the Yukon River drainage (Susan Thopmson, pers. comm.).

TABLE 4.1.11-3 SUMMARY OF 2006-2008 RECEIVING ENVIRONMENT BASELINE ELECTROFISHING CATCH RESULTS							
Watercourse	Site	Year	Effort (Seconds)	No. Fish Captured (No. Observed But Not Captured)			
				SaMa	*ThAr*	*PrCy*	*CoCo*
Tributary C	FS6	2006	620				
	FS6	2007	1342	3(4)			
	FS10	2007	514				
	Footprint Area	2008	2223				
	Tributary C Total		4699	3(4)			
Tributary A	FS7	2006	1129				
	FS7	2007	787				
	Tributary A Total		1916				
Upper Hess River Tributary	FS8	2006	1347				(8)
	FS8	2007	1723	3	4		17
	PS2	2008	1176		5		3
	PS3	2008	799				7
	PS4	2008	1317		4		3
	Upper Hess Trib. Total		6362	3	13		30(8)
Lower Hess River Tributary	FS9	2006	2056		(9)		(26)
	FS9	2007	1558		5		7
	PS1	2008	499				1
	Lower Hess Trib. Total		4113		5(9)		8(26)

FS6 was established approximately 1300 m upstream of the confluence of Tributary C and Tributary A (Figure 4.1.11-2). The high water channel width of this stream reach was found to range from 6.3 to 11.4 m, and the mean wetted width at the time of sampling ranged from 4.8 m to 7.0 m. The mean and maximum channel depths were 0.25 m and 0.31 m, with fast flow creating approximately 30% riffle habitat, 25% cascade, 25% pool, and 20% run habitats. Stream substrate composition was wide-ranging, and included components from boulder to small gravels, although cobbles were frequent. Stream banks were moderately vegetated (50-70% cover), ranging from 1.5 m to 1.7 m. Fish habitat cover was abundant (45% coverage), consisting of surface turbulence, overhanging stream bank vegetation, undercut banks, and deep water pools. Detailed descriptions of the habitat information are available in Appendix I1 and I2.

Based on EBA's investigations at the site, Tributary C provided suitable habitat features to satisfy all life history requirements of Dolly Varden, and potentially slimy sculpin (although none were observed). Considering the habitat availability in Tributary C, lack of captured fish in Tributary A (below), and evidence that the water quality in Tributary A is annually reduced with seasonal flow reductions, the population of Dolly Varden in Tributary C is considered to be seasonally restricted to that watercourse by poor downstream water quality (Appendix I2).

Given the average width of this stream reach and the presence of fish, the Forest Practices Code Act of British Columbia classification of this stream reach is S2.

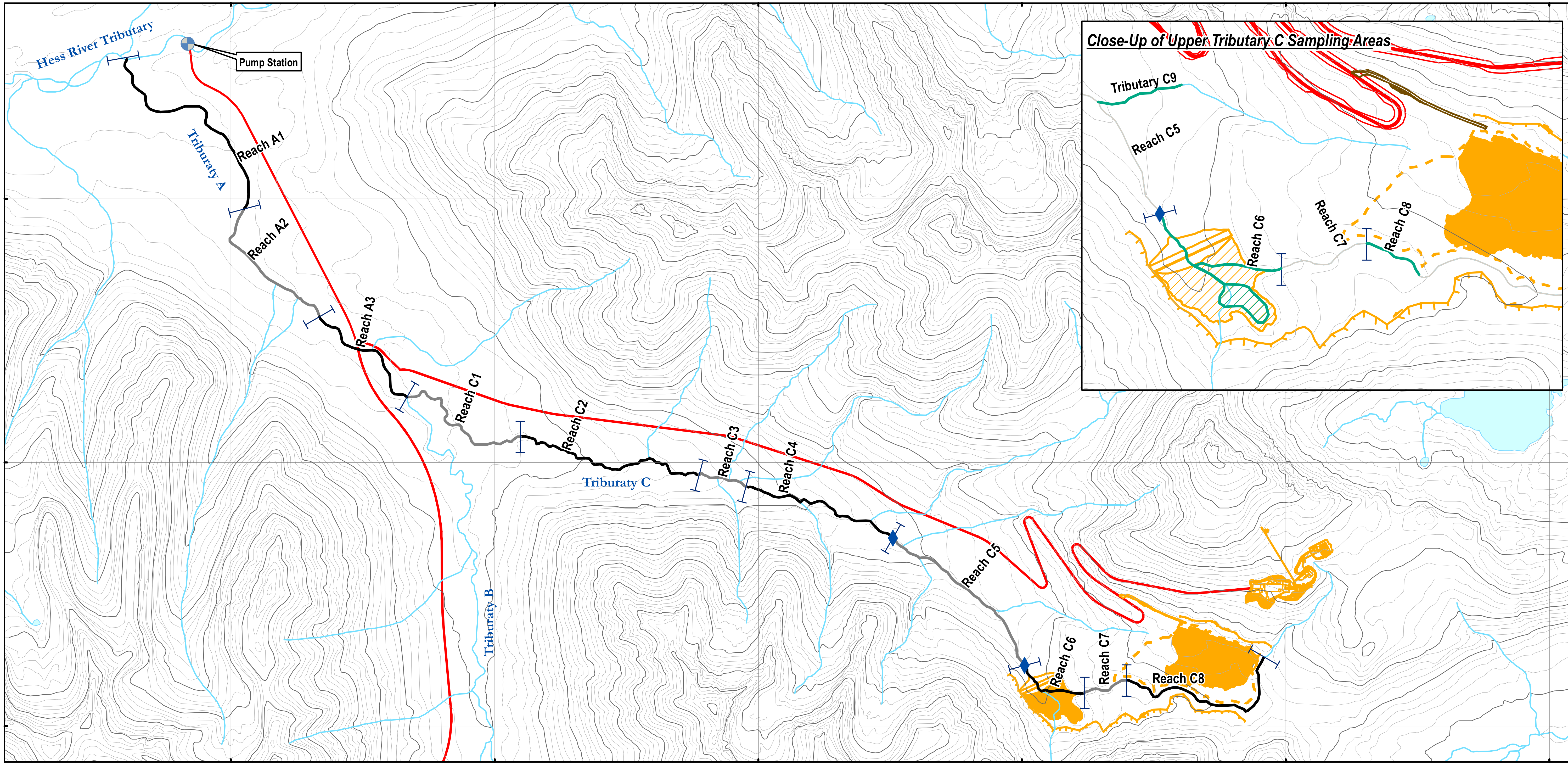
Upper Tributary C (FS-10)

Approximately 210 m of this watercourse was electrofished for a total of 514 seconds, and did not result in the capture of fish. In addition, no fish were observed during sampling efforts (Table 4.1.11-3).

The second fisheries sampling location, FS-10, was established at a point where the stream's morphology changed to primarily a cascade/rapid type, and the stream substrate was dominated by large cobbles and boulder. FS-10 was established approximately 2300 m upstream of FS-6 at the first accessible location to assess whether Dolly Varden were inhabiting the upper reaches of Tributary C (Figure 4.1.11-2). A distinct reach break was located approximately 600m upstream from FS10 at a point where a barrier to fish passage was situated (Figure 4.1.11-3). The high water channel width of this stream reach was 2.1 m and the wetted width at the time of sampling was 1.8 m. The channel gradients upstream of FS10 were substantially steeper than those found in the lower reaches, resulting in 60% cascade habitat, with 25% riffle, 10% pool, and 5% run morphologies.

Stream substrate was dominated by boulder and larger cobble (70% aggregate), with smaller components of other cobbles and gravel. Stream banks were well vegetated (70%-75% cover), ranging from 0.35 m to 1.5 m. Fish habitat cover was good (40% coverage), consisting of surface turbulence, overhanging stream bank vegetation, deep water pools, and small woody debris. The frequently confined channel provided potentially suitable migration and feeding habitats, but several potential (small) barriers to fish passage were apparent in a reconnaissance between FS6 and FS10. The general stream gradient of Tributary C slowly increased upstream of FS6. More detailed habitat information for FS-10 is available in Appendix I2.

Given the average width of this stream reach and the potential presence of fish, the Forest Practices Code Act of British Columbia classification of this stream reach is a S3. All stream reaches above the identified barriers that exist upstream of FS10 are considered to be non fish bearing, and are consequently classified as S6 (Figure 4.1.11-4).



LEGEND

- Reach Breaks
- Barrier
- Reach
- Reach
- Sampled Area
- Contours (100m)
- Contours (20m)
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Watercourse
- Waterbody

NOTES

Base data source: NTDB 1:50,000, QuickBird,
Site Plan adapted from original provided by Wardrop

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MACTUNG

Stream Reaches and Upper Sampling Locations Tributary A and Tributary C

PROJECTION: UTM Zone 9	DATUM: NAD83

Scale: 1:30,000
0.5 0.25 0 0.5
Kilometres

FILE NO.: W23101110_001_Aquatics_Map003.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	CJ	2

OFFICE	DATE
EBA-VANC	December 8, 2008

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Figure 4.1.11-3

Tributary C Mine Footprint Area

Three areas of upper Tributary C (upstream of the uppermost barrier near the proposed ravine dam site) and lower reaches of Tributary C9 were electrofished in order to confirm the non-fish bearing status of areas within direct impact of proposed mine infrastructure (Figure 4.1.11-3). A total electrofishing effort of 2223 seconds resulted in no fish captures or observations. Based on these data and the identification of a large barrier immediately downstream of the mine footprint area, all areas of this watercourse upstream from local barriers (shown in Figure 4.1.11-3) are considered to be non-fish bearing (according to the *Forest Practices Code Act* of British Columbia).

Description of Stream Classifications

As noted, classification of Tributary C according to the Forest Practices Code Act of British Columbia denotes lower reaches as S2, mid-reaches as S3, and upper non-fish bearing reaches as S6.

Aerial reach mapping performed as part of EBA's 2008 baseline studies identified 8 distinct stream reaches throughout the mainstem of Tributary C, as outlined in Table 4.1.11-4 and Figure 4.1.11-3. Reaches 1 through 3 provided the highest overall habitat quality, as lower gradients, higher cobble composition and higher occurrences of functional large woody debris provided useful cover. Reaches 4 and 5 were characterized by steeper gradients, a step pool channel pattern, and reduced cover, all of which proved less useable fish cover. Reaches 6 through 8 are considered non-fish bearing.

TABLE 4.1.11-4 SUMMARY OF REACH MAPPING DATA FOR TRIBUTARIES A AND C

Water-course	Reach		Channel Type	Habitat Description
	Number	Length (m)		
Tributary C	1		RP_b	Channel dominated by boulder riffles with irregular pools. Consistent slope and irregular meander. Riparian vegetation is a mixture of small shrub and conifer.
	2		RP_b-w/ SP_r	Slope increases, riffle pool with a moderate LWD component (forming plunge pools). Channel narrows overall under tall shrub (willow) with high canopy closure. Several bedrock outcrops were noted, and add confinement areas.
	3		RP_c	Dominant substrate shifts from boulder to cobble, stream channel slightly wider, shallower. Irregular meander with tall shrub (willow) cover.
	4		SP_b	Noticeable slope increase, substrate 60-70% boulder, forming a narrower step pool pattern. Several potential barriers to fish passage noted. Low to tall shrub cover continues.
	5		SP_b	Slope consistent above barrier, although channel

TABLE 4.1.11-4 SUMMARY OF REACH MAPPING DATA FOR TRIBUTARIES A AND C				
Water-course	Reach		Channel Type	Habitat Description
	Number	Length (m)		
				width narrows. Boulder dominated step-pool distribution continues. Vegetation cover thins noticeably as elevation reaches the extent of the treeline.
	6		SP_b/RP_c	Area of tributary within footprint. Slope remains consistently steep, largely dominated by boulder step pool, although some more level areas have cobble riffles. This reach is above the treeline extent, and cover is reduced to a minimum (small to medium height shrubs only).
	7		SP_r/ Canyon	Bedrock controlled canyon with large cascades, high energy flow. Considered another barrier to fish passage. No vegetation cover.
	8		Riffle-Run	Stream generally level or low-slope across alpine plateau. Deep channel dominated by fines and gravel, confined by deep vegetated banks. Little overhead cover, although overhanging banks are frequent. Many small tributary feeders form a network of streams.
Tributary A	1		RP_c	Cobble dominated channel with low gradient. Braided frequently with side bars and eroding outer banks indicating mobile channel. Deep pools relatively frequent at base of riffles. Low canopy cover, riparian vegetation consists of birch shrub and conifer (mature).
	2		CP_b	More boulder cascades with several bedrock outcrops. Overall gradient is increased, with riffles still cobble dominated. Deep pools relatively frequent at base of riffles. Low canopy cover, riparian vegetation consists of birch shrub and conifer (mature).
	3		RP_c	Gradient reduced from reach 2, and braided riffle-dominated channel resumes. Channel appears mobile, with frequent side bars of gravel/cobble. Reach extends to the junction of Tributary C.

Channel Habitat descriptors: RP_b = riffle-pool, boulder dominated; RP_c = riffle-pool, cobble dominated; SP_r = step-pool, rock based; SP_b = step-pool, boulder based; CP_b = cascade-pool, boulder dominated. The –w modifier indicated functional large woody debris.

Tributary A Results

Fish Presence, Abundance, and Distribution

One fish sampling station (FS7) was established on this fourth order tributary approximately 1200m upstream with the confluence of the Hess River Tributary (Figure 4.1.11-2).

In 2006, approximately 300 m of the channel were electrofished with an effort of 1129 seconds, and in 2007 approximately 280 m of the channel were electrofished for 787 seconds. In both years, no fish were observed or caught (Table 4.1.11-3). It is apparent that upstream acid rock drainage had a negative effect on habitat within this watercourse, as indicated by the moderate turbidity caused by precipitate in the water column (8.8 NTU), presence of precipitate on the substrate, and the lowest measured benthic productivity of all sites in 2007 baseline studies. Water quality characteristics, in particular metals concentrations such as copper and zinc, increased substantially throughout the summer season, presumably as a shift from surface runoff to groundwater sources occurred (Data available in Appendix H8). It is for this reason Tributary A is considered to have low overall habitat quality, and likely lacks significant over-wintering, nursery, and feeding habitats. Despite this, the presence of fish in Tributary C suggests that Dolly Varden, at a minimum, migrate through Tributary A on a seasonal basis, likely during freshet.

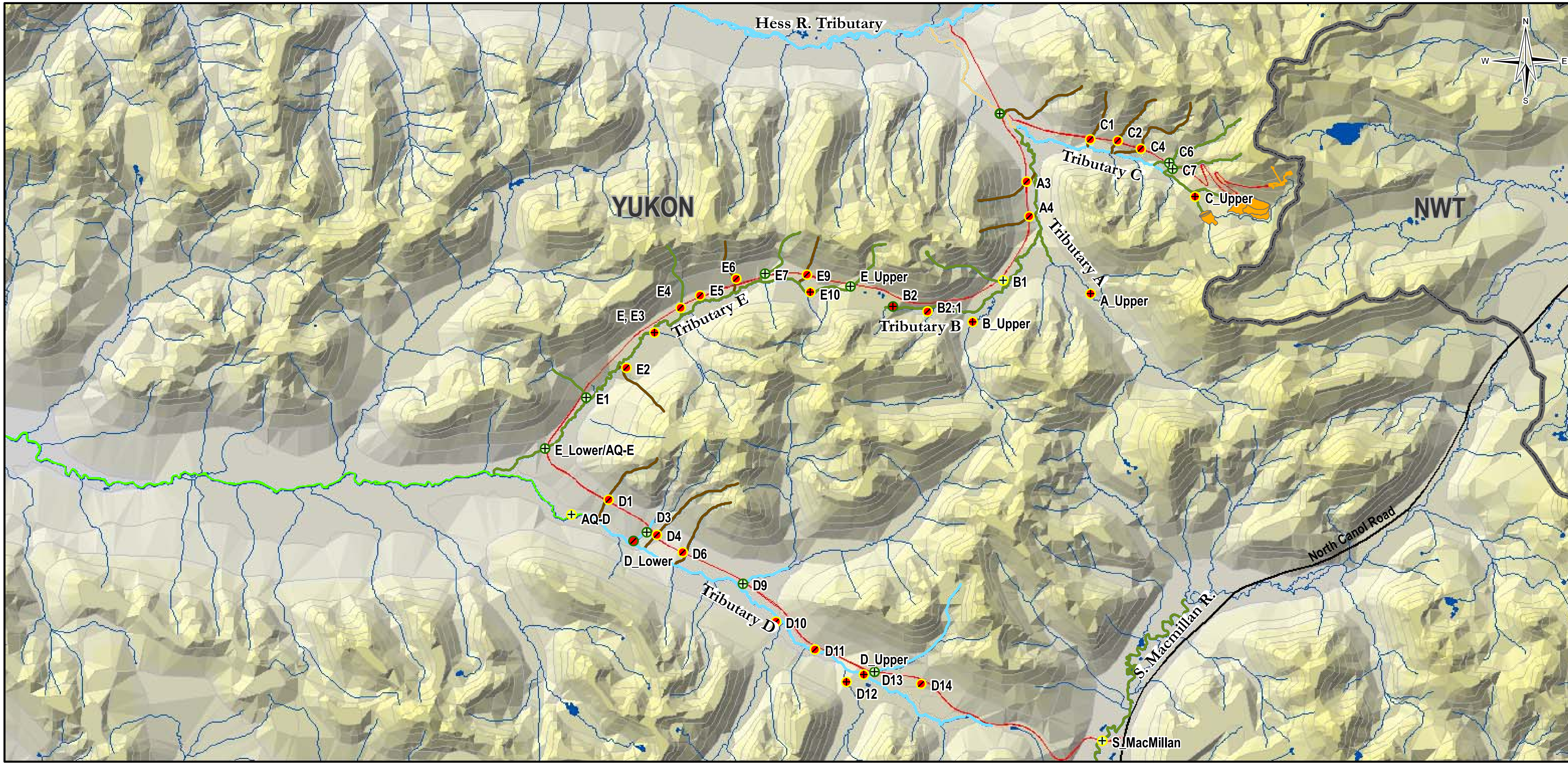
The maximum high water channel width of this Tributary A stream reach was 17.1 m and the wetted width at the time of sampling was measured at 12.6 m. Mean residual pool depth was 75 cm, while mean riffle depth was 35 cm. Habitat distributions in the reach sampled consisted of primarily riffle (75%), along with run, pool and cascade habitats. Generally, the channel in Tributary A appeared to be quite mobile and consisted of primarily cobble and gravel substrates. Consequently, depositional or eroding banks, point bars, and deep scour pools were relatively common. Cover for fish totalled approximately 40% and consisted of deep pools, undercut banks and large organic debris. Functionally, however, the actual habitat value of Tributary A appeared restricted by apparent precipitate in both the water column and substrate and by low benthic productivity that is likely linked to this condition. A summary of habitat characteristics for this stream reach is located in Appendices I1 and I2.

Description of Stream Classification

As it is not possible to rule out the occasional use or occupancy by fish in Tributary A, it is classified as an S2 stream, consistent with the Forest Practices Code Act of British Columbia.

During the classification of Tributary A all reaches mapped between the HRT and Tributary C were classified as class S2.

Aerial reach mapping performed as part of EBA's 2008 baseline studies identified 3 distinct stream reaches from the confluence with the Hess River Tributary to its junction with Tributary C, as outlined in Table 4.1.11-4 and Figure 4.1.11-3. Reaches 1 and 3 were characterized by cobble dominated riffle-pool segments, with a braided and moderately mobile channel (depositional bars with some eroding banks). Reach 2 consisted of a section of higher gradient channel controlled more by boulder and bedrock with a mainly cascade-pool pattern. Cover and crown closure were relatively low throughout these reaches, with little overhead cover and riparian vegetation, consisting of medium height shrubs and mature conifer, being set relatively far back from the active channel.



LEGEND

- NWT - Yukon Territory Border
- Access Road Route
- Proposed Mine Site Infrastructure
- Existing Road
- Waterbody
- Unassessed Watercourses

Streams

- Fish Bearing
- Mapped, but no Channel
- Marginal or Unconfirmed
- Non-Fish Bearing

Sampled for Water Quality

- / No
- + Yes

Sampled for Full Habitat

- No
- Yes

Sampled for Fish

- No
- Yes

NOTES

Base data source: 1:50K NTDB
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

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Road Aquatics Study Area
Fish Presence and Sample Locations

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:100,000

2 1 0 2

Kilometers

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

FILE NO.
W23101110_001_Aquatics_Map002.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	CJJ	1

OFFICE	DATE
EBA-VANC	December 8, 2008

Figure 4.1.11-4

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Hess River Tributary Results

Fish Presence, Abundance, and Distribution

During 2006 and 2007 baseline study efforts, two sample stations were established on the HRT: FS8 located approximately 2.5 km upstream from the inflow of Tributary A, and FS9, located approximately 4 km downstream from the inflow of Tributary A (Appendices I1 and I2).

Over these two years at FS8, approximately 658 m of channel was electrofished with a total effort of 3070 seconds. Dolly Varden, Arctic grayling and slimy sculpin were all captured in close proximity to this station during sampling efforts. The capture of one juvenile Dolly Varden provided initial evidence that HRT likely provides suitable juvenile nursery habitat, and suitable spawning habitat (potentially further upstream). Various size- and age-classes of slimy sculpin were also captured, as expected with this restricted home range species. During 2006 and 2007 studies at FS9, roughly 1100 m of channel were electrofished with a total effort of 3614 seconds. Arctic grayling and slimy sculpin were both captured during this effort, however in lower abundance compared to that in the upper HRT (FS8).

During the summer/fall of 2008, an expanded baseline study program on the HRT further assessed seasonal fish presence and distribution. These studies focussed on the vicinity of three sites in the upper HRT (Figure 4.1.11-2): the location of the proposed pumping station (PS2), site FS8 as noted above (denoted as PS3), and a reference area selected as having diverse pool, riffle, and off channel habitats located roughly three km upstream (PS4). During the July studies, numerous fish were captured in both in- and off-channel habitats using seine netting and electrofishing in the upper HRT (Tables 4.1.11-3 and 4.1.11-5). Between PS2 and PS4, 26 Arctic grayling were captured, ranging in size from 29 mm to 364 mm (which included one young of year (YOY), several yearlings, and subadults/adults). Subadults were confirmed to be using small side pool habitats in the mainstem of the river, while the sole YOY was in an extensive off-channel network. 11 slimy sculpin were captured (16 mm – 83 mm), as well as one round whitefish (257 mm). No Dolly Varden were captured at these sites in July.

July sampling in the lower HRT was similar in effort to that noted above; however, no Arctic grayling or Dolly Varden were captured (Tables 4.1.11-3 and 4.1.11-5). One round whitefish (158 mm) and numerous slimy sculpin (37 mm – 106 mm) were captured.

Fall sampling was initiated in early September both to observe the distribution of fish leading to winter conditions, as well as to monitor the presence or potential local spawning of Dolly Varden. These sampling efforts focussed on deep pool staging areas, although shallow/riffle habitats were also assessed. In early September (4th, 5th), a marked reduction in fish presence was noted in upper HRT. Among three upper HRT sample sites, 24 adult Arctic grayling were captured (230 mm to 327 mm), but no YOY, yearlings, or subadults. A range of sizes of slimy sculpin were captured, but no other species including Dolly Varden and round whitefish. At this same time (early September), no fish were observed or captured in the lower HRT.

TABLE 4.1.11-5 SUMMARY OF 2008 HESS RIVER TRIBUTARY SEINE NETTING DATA								
Site	Month	No. Sites	No. Efforts (Pulls)	Total Effort (m^2)	Number of Fish Captured			
					SaMa	*ThAr*	*PrCy*	*CoCo*
PS-1	July	2	3	72			1	4
	September	3	3	38				
	Total	5	6	110			1	4
PS-2	July	5	10	265		11	1	3
	September	4	5	108		2		1
	October	2	4	110				
	Total	11	19	483		13	1	4
PS-3	October	2	4	160				
	Total	2	4	160				
PS-4	July	3	7	190		5		1
	October	2	3	120				
	Total	5	10	310		5		1

Species codes: *SaMa* – Dolly Varden (*Salvelinus malma*), *ThAr* – Arctic grayling (*Thymallus arcticus*), *PrCy* – Round Whitefish (*Prosopium cylindraceum*), *CoCo* – slimy sculpin (*Cottus cognatus*).

During all late September and October sampling efforts, no fish of any species were captured in the upper or lower HRT.

These combined baseline observations indicate overall that that fish presence and habitat use in the HRT appears to be seasonal in nature and differs between the upper and lower HRT. Although the collection methods did not provide a direct comparison, an indication of higher abundance of fish in the upper HRT versus the lower suggests that the poorer water quality and resulting lower productivity (e.g. benthic macroinvertebrates, periphyton, etc.) limits the capacity of fish to use the lower HRT. This habitat quality reduction is assumed to be minimized further downstream as other tributary influences mitigate the poor water quality effects.

In the upper HRT, early season habitat usage appears to be moderate. While baseline studies suggest that grayling use the study area for feeding, the low abundance of YOY Arctic grayling suggest that spawning is rare, or is occurring only in reaches far upstream of the project area. Later in the season, however, these early life stages were absent from the study area, as individuals had likely reatreated to downstream mainstem areas with lower velocity/energy or better water quality. The late season occurrence of many adult Arctic grayling suggests the availability of a late season food resource, but no overwintering by Arctic grayling is expected as suggested by fall capture data. The capture of several juvenile Dolly Varden indicates that spawning is occurring in the watershed, but their low density and the absence of adults indicates that primary habitat for this species is restricted to small upper tributaries, as observed in Tributaries C, D, D9, and D13 (outlined above and below). Based on baseline study data, slimy sculpin are likely to occur in the study area in all seasons. Round whitefish (and potentially mountain whitefish) are also not expected to overwinter or reproduce in the project area.

Habitat condition and quality varied between the upper and lower HRT, as it did with fish abundance. At FS8 (upper HRT), the channel consisted of primarily boulder based cascade-pool (CPb) morphology, interspersed with boulder riffles and larger cascades. Channel width and wetted width were variable, ranging from 15 m - 22.5 m and 14 m – 19 m, respectively. Mean riffle depth was estimated at 20 cm, while pool depths were too deep to measure (but noted to be frequently deeper than 1.5 m). In general terms, this tributary was fast flowing with a high discharge, and was a moderate to high energy system. Numerous very large and deep pools were present in relation to bedrock outcrops, and numerous smaller/shallower side channels and calm backwater areas provided good rearing habitat. Overall, the upper HRT provided a good diversity of habitats and suitable water quality/benthic resources, but was still a high energy system (limiting fish to those adapted for these conditions).

In comparison, the lower HRT had a lower gradient, and a channel of primarily cobble based riffle-pool morphology (RPc). Channel and wetted widths were 17 m – 19 m and 9.5 m – 15.5 m, respectively. Neither riffle depths nor pool depths could be measured accurately due to high flows in the system. In general terms, the lower HRT was characterized by fast flows and high discharge, with a moderately braided, irregularly meandering channel based in large cobble and boulder. Consequently, more bars, islands, and side channels were present in the lower HRT compared to the upper. Deep pools occurred regularly in this system, and comprised a major fish habitat component (as did surface turbulence). The lower HRT provided suitable feeding, migration, and nursery habitat for various species, but as noted earlier, was restricted by poor water quality.

Description of Stream Classifications

Given the average width of this stream reach and the presence of fish, the Forest Practices Code Act of British Columbia classification of the entire HRT in the study area is S2. Detailed reach mapping of this tributary was not conducted, as the watercourse was determined to be largely homogenous at a large scale (roughly between the upper and lower HRT). Detailed habitat mapping of the areas adjacent to the proposed pumphouse location were conducted as part of EBA's 2008 baseline studies, and are described in Appendix I3.

Access Road Baseline Studies

In late summer 2008, a total of 23 watercourses were assessed to provide baseline information for the access road route within the ASA^{R} (Tables 4.1.11-2 and 4.1.11-6, Figure 4.1.11-4). These studies spanned the entire access road route (approximately 45 km), and included tributaries to all project-related watercourses as noted in Table 4.1.11-1. These studies had the primary objective of providing information regarding the fish bearing status, basic physical attributes, as well as fish habitat features in those watercourses and watercourses systems influenced by the access road development.

TABLE 4.1.11-6 SUMMARY OF WATERCOURSE CROSSING FISHERIES ASSESSMENT EFFORT

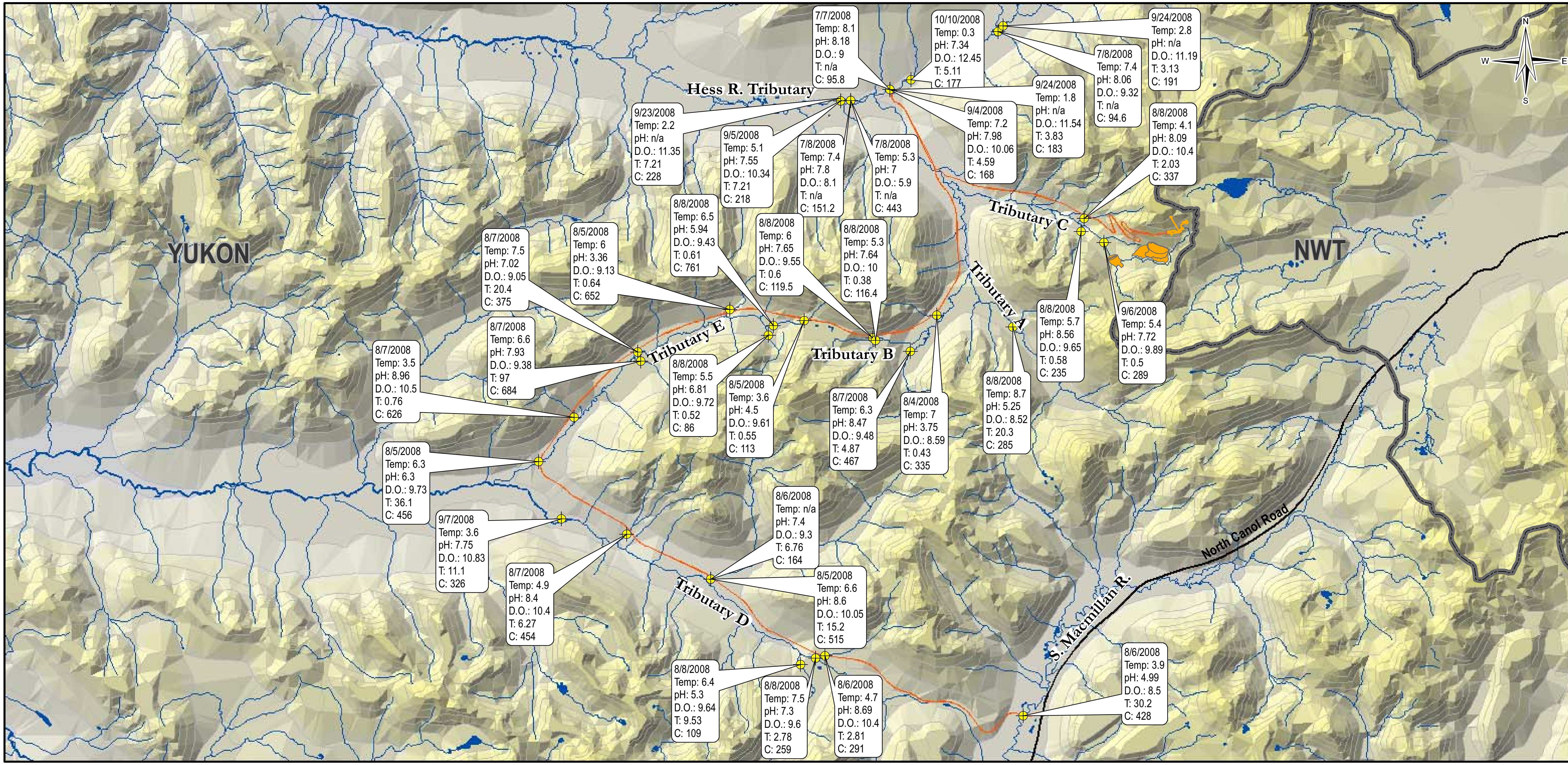
Watercourse	Crossings On Proposed Road Route			No. Other Adjacent Sites Assessed	No. Sites Assessed For:		
	Total No. of Access Road Intersections (Mapped)	No. Crossing Sites Assessed	No. Mapped Sites w. No Distinct Channel		Fish Presence/ Absence	Habitat	Water Quality
Tributary A	3	1	2	1	1	1	2
Tributary B	1	1	0	3	1	1	4
Tributary C	5	2	3	0	2	2	3
Tributary D	6	3	3	7	4	3	5
Tributary E	7	4	3	3	4	4	6
South MacMillan River	1	1	0	0	0	1	1

Habitat assessments for the access road assessments were conducted according to the Reconaissance (1:20,000) Fish and Fish Habitat Assessment Inventory: Standards and Procedures (2001). At each watercourse, a length of channel ranging from 100 to 400 m was assessed (according to channel width), and included the following habitat data:

- Local stream channel characteristics (Wetted width and bankfull width, residual pool depth, depth at bankfull, and channel gradient).
- Channel substrate composition and characteristics (dominant and subdominant substrates, substrate size classes).
- Distribution of major habitat groups (e.g. Riffle, Run, and Pool).
- Bank stability, height, and vegetation cover.
- Riparian vegetation composition, instream cover abundance and composition.
- Large scale channel reach characteristics (disturbances, confinement, stream pattern, etc.)
- Basic water quality attributes (e.g. dissolved oxygen, conductivity, temperature, turbidity, pH).

Where the presence of fish was deemed possible (e.g. no downstream barriers, suitable water quality), fish presence and species diversity was assessed through backpack electrofishing. Methods used were consistent with the BC MOE Fish and Fish Habitat Inventory and Information Program (1989), and by the BC Fish and Fish Habitat Inventory Standards and Procedures published by the Resource Inventory Committee (RIC 2001).

Figure 4.1.11-5 identifies the sampling water quality results at each station.



LEGEND

- Sampling Locations
- Proposed Mine Site Infrastructure
- NWT - Yukon Territory Border
- Access Road Route
- North Canol Road
- Watercourses
- Waterbodies

Water Quality Parameters

Temp = Temperature (ºC)
D.O. = Dissolved Oxygen (mg/L)
T = Turbidity (NTU)
C = Conductivity (µs•cm^{-1})

NOTES

Base data source: 1:50K NTDB
Site Plan adapted from original provided by Wardrop

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Aquatics Sampling Water Quality Results

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:115,000
2 1 0 2
Kilometers

FILE NO.
W23101110_001_Aquatics_Map005.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	CJJ	1

OFFICE	DATE
EBA-VANC	December 8, 2008

NORTH AMERICAN TUNGSTEN CORPORATION LTD
EBA Engineering Consultants Ltd.

Figure 4.1.11-5

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Additionally, sample points on mainstems or other tributaries along the road route were assessed (habitat, fish presence/absence, or water quality) to allow further determination of potential indirect (downstream) effects, or to refine the fish bearing status of a particular tributary.

Access Road Results

The results of the access road fisheries baseline studies are outlined in the following sections, organized according to tributary group starting from the North Canol Road and leading to the proposed mine site. Detailed baseline study information for this program is also included in Appendix I3.

South Macmillan River

The proposed access road only crosses the mainstream of the South Macmillan River (no tributaries) adjacent to the existing but deteriorated crossing (Figure 4.1.11-4). At this location, the river consists of a wide and deep channel carved through gravels and fines, with minimal larger substrate composition. The channel in the greater crossing area is moderately mobile, showing signs of ongoing migration (eroding banks, depositional areas), and forms numerous point bars and deep pools/channel segments. Despite the presence of deep run and pool habitats, the upper reaches of this river are heavily affected by local geological features and prior mining projects (e.g. Sekie Creek #2 from the Jason Project, pH = 2.9; MPERG 2007).Consequently, the area local to the crossing lacks suitable water quality to support fish, and shows visible signs of negatively impacted physical and water quality (e.g. visible siderite precipite, local pH of 4.99, and turbidity of 30.2 NTU). Consequently, local areas of the South Macmillan River do not provide suitable fish habitat. Detailed information regarding this crossing is available in Appendix I3 and Table 4.1.11-5.

Tributary D

Tributary D (which feeds the Hess River) flows adjacent to the proposed access road from roughly km 3.5 through km 17, and six tributaries to this watercourse are crossed within this span (three of which are channelized). All three channelized tributary crossings were assessed, as well as a total of seven additional sites on the mainstem or tributaries opposite to the access road that were used to determine the overall fish habitat value of the system (Tables 4.1.11-6 and 4.1.11-7, Figure 4.1.11-4).

Overall, this system was found to provide moderate quality fisheries habitat and to support populations of Dolly Varden. Each of the three individual tributaries crossed (D3, D9, and D13) were high energy cascade-pool watercourses with predominantly boulder based substrates, and gradients ranging from 7% to 12.5% (Table 4.1.11-7). Basic water quality attributes of all three were suitable to support fish, and cover/habitat distributions were favourable to support feeding, potential spawning, and potential over-wintering habitat for Dolly Varden (areas studied were below the treeline).

TABLE 4.1.11-7: SUMMARY OF WATERCOURSE CROSSING STREAM CHANNEL HABITAT CHARACTERISTICS

Watercourse	Site Type	Channel Characteristics (Avg.)				Gradient (%)	Channel Type	Substrate (Dom./ Subdom)	Fish Habitat Cover		Fish Status	General Habitat Attributes
		Residual Pool Depth (cm)	Bankfull Depth (cm)	Channel Width (m)	Wetted Width (m)				%	Dominant Types		
South Macmillan River	Road	N/A	N/A	14.7	23.05	<1	RP_g	Gravel / Fines	45	Deep Water / Surface Turbulence	NB (Water Quality)	Upper reaches heavily impacted by ARD, low productivity documented in the area. Simple channel/habitat structure.
D13	Road	12	61	3.73	2.44	9	CP_b	Boulder / Cobble	70	Overstream Veg. / Surface Turbulence	CF - *SaMa*	Excellent pool habitat structure supported by overhead cover and limited large woody debris (LWD).
D9	Road	27	97	3.95	3.53	7	CP_b	Boulder / Gravel	33	Surface Turbulence/ Undercut Bank	CF - *SaMa*	High discharge stream with good pool habitat availability. Overwintering and spawning potential if water quality allows.
D6	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
D4	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
D3	Road	20	38	1.67	1.19	12.5	CP_b-w	Gravel / Boulder	70	Overstream Veg. / LWD	CF - *SaMa*	Small channel confined by vegetation and LWD. Network of many small drainages join the mainstem at various locations.
D1	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
E (Lower)	Road	13	99	3.92	3.80	1	RP_b	Boulder / Gravel	40	Surface Turbulence/ Small Woody Debris	NB	Fast, deep channel has good habitat attributes, but water quality is limited (upstream ARD).
E1	Road	12	42	1.43	0.83	18	CP_b	Fines / Boulder	40	Undercut Bank / Overstream Veg.	NB	Good summer fish habitat, but lacks over-wintering habitat. Fish access to site limited by poor water quality of Tributary E.
E4	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
E6	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
E7	Road	12	39	1.7	1.21	3.5	RP_g	Gravel / Cobble	45	Overstream Veg. / Surface Turbulence	NB	Low energy, low slope stream near the proposed crossing. Habitat and water quality suitable, but lacks over-wintering hab.
E9	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
E (Upper)	Road	21	42	3.03	2.1	13.5	CP_b	Boulder / Cobble	20	Surface Turbulence/ Overstream Veg.	NB	High energy, steep slope stream with little fish habitat value.
B1	Road	18	77	14.9	2.06	N/A	CP_c	Cobble / Boulder	35	Surface Turbulence / Overstream Veg.	NB	High energy, steep slope stream with little fish habitat value. Water quality unsuitable.
A4	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
A3	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
A	Road	75	35*	14.8	7.2	N/A	RPc	Cobble / Fines	25	Surface Turbulence/ Deep Water	NB†	Fast flowing channel offering migration and feeding habitat, but restricted by water quality. No fish captured or observed.
C1	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
C2	Road	--	--	--	--	--	--	--	--	--	--	Mapped watercourse, but no distinct channel found.
C4	Road	--	--	--	--	--	--	--	--	--	NB	Channelized in upper reaches, but channel sub-ground prior to junction with Tributary C. No overwintering habitat observed.
C6	Road	19	56	3.99	2.72	8	CP_b	Boulder / Gravel	46	Surface Turbulence/ Overstream Veg.	NB	Water quality and habitat suitable for feeding, but passage downstream is unlikely. Stream likely fish bearing nearer to mainstem of Tributary C (*SaMa*), but unconfirmed.
C7	Road	8	41	1.18	0.84	10.5	RP_c	Cobble	15	Undercut Bank/ Overstream Veg.	NB	Small meandering channel confined by vegetated banks. Habitat seasonally suitable. Size and low cover lower habitat suitability.

* Mean riffle depth

† Seasonal early summer fish usage or migration suspected, but unconfirmed.

Channel Habitat descriptors: RP_b = riffle-pool, boulder dominated; RP_c = riffle-pool, cobble dominated; SP_r = step-pool, rock based; SP_b = step-pool, boulder based; CP_b = cascade-pool, boulder dominated. The –w modifier indicated functional large woody debris.

Species codes: *SaMa* – Dolly Varden (*Salvelinus malma*), *ThAr* – Arctic grayling (*Thymallus arcticus*), *PrCy* – Round Whitefish (*Prosopium cylindraceum*), *CoCo* – slimy sculpin (*Cottus cognatus*).

Several assessment sites in the mainstem of Tributary D also confirmed suitable fish habitat conditions, as well as the presence of Dolly Varden. Water quality attributes in this tributary were suitable to support fish (e.g. pH ranging from 7.4 – 7.75). The channel was dominated by cobbles, consisting of riffle-pool sequences interspersed by boulder cascade areas. Cover in this watercourse was not abundant or of high quality (little canopy closure or vegetation / wood), but characteristic of other area main tributaries in the form of pools and turbulent water.

In total, an electrofishing effort of 1923 seconds across fish sample sites resulted in the capture of 15 Dolly Varden ranging in fork length from 83 mm to 215 mm. No Arctic grayling or slimy sculpin were captured or observed in Tributary D, despite the expectation of their presence.

Tributary E

Tributary E (which feeds Tributary D) is crossed by the proposed access road twice (kms 17.5 and 27), between which it flows adjacent to the proposed road route, crossing 5 mapped tributaries to that watercourse along its route (Figure 4.1.11-4). Of these five tributaries, three were found to have no distinct channel, or a channel that did not connect with the mainstem. The two channelized tributaries, as well as two mainstem sites were fully assessed for habitat, fish presence, and water quality (Table 4.1.11-6). Six additional sites on the mainstream or tributaries opposite to the access road were used to determine the overall fish habitat value of the system (Table 4.1.11-6).

Overall, this watercourse system was found to provide low fisheries habitat value, and was not found to support any fish. The uppermost reach of Tributary E, as well as site E1 that crossed the road route, were high energy, fast flowing, streams with cobble or boulder dominated substrates and gradients of 13.5 and 18%, respectively (Table 4.1.11-7). E1 was the only site found to have suitable water quality and habitat distribution (e.g. pH of 8.96, good cover). In contrast, the suitability of Site E7 and Upper Tributary E (both of which cross the road route) were limited by acidic characteristics (pH of 3.36 and 4.5, respectively). This trend was also observed in other tributaries that feed the system from the South, which were found to have very poor water quality attributes, and overall habitat characteristics that were not suitable to fish (pH ranging from 5.94 to 7.93, and precipitate in E3 resulting in turbidity of 97 NTU).

Consequently, the lower mainstem of Tributary E was found to provide low quality habitat, primarily as a result of poor water quality conditions (pH of 6.3 and a heavy precipitate load resulting in turbidity of 36 NTU at the lowest sample site and crossing). These attributes were of primary importance in determining the ability of this watercourse system to support fish. From a physical habitat perspective, Tributary E was found to be a high energy/high discharge watercourse with channel characteristics dominated by a boulder substrate (riffle-pool with some cascade). Cover in Tributary E was also not abundant or of high quality (little canopy closure or vegetation/wood), but characteristic of other area main tributaries in the form of pools and turbulent water.

Despite poor overall habitat quality, fish presence was assessed through a total of 667 seconds of electrofishing effort (across four sites: Upper and Lower E, E1, and E7), which resulted in no fish captures or observations.

Tributary B

Tributary B (which feeds Tributary A) flows adjacent to the proposed access road from roughly km 28 to km 32.5, and one tributary to this watercourse is crossed at Tributary B1 (Tables 4.1.11-6 and 4.1.11-7, Figure 4.1.11-4). This single crossing site was assessed, along with four additional sites on the mainstream or tributaries opposite to the access road that were used to determine the overall fish habitat value of the system (Table 4.1.11-6).

The crossing site B1 was not found to support fish, nor did it provide suitable fish habitat. Despite being a steep, disturbance channel dominated by cobble and boulder cascades (with little cover), the pH of this watercourse was measured at only 3.75 (Table 4.1.11-7).

Despite the poor quality of Tributary B1, the mainstem of Tributary B was found to have suitable water quality characteristics, with pH ranging between 7.64 and 8.47. This watercourse was cobble dominated with a riffle-pool pattern and moderate amounts of instream and overstream cover that appeared suitable for fish. However, Tributary B and B2 were noted to be shallow with no observed overwintering habitat, and as earlier noted the Tributary A system (into which B flows), does not support fish, suggesting that seasonal fish presence in Tributary B is not likely to occur. No fish were captured or observed in 450 seconds of electrofishing effort in Tributary B, further supporting the non-fish bearing status.

Tributary A

Tributary A (which feeds the Hess River Tributary) flows adjacent to the proposed access road from roughly km 32.5 through km 35.5, as well as along the pumping station spur road. The proposed access road crosses two small non-channelized tributaries to Tributary A, and crosses the mainstem of Tributary A just downstream from its junction with Tributary C (Figure 4.1.11-4). Only this crossing location was assessed as part of the baseline program.

Overall, this system has been found to provide only low quality fisheries habitat, and has not been found to support any fish. Tributary A near the proposed crossing is representative of the greater watercourse, consisting of a mid-energy riffle-pool channel dominated by cobbles and gravels, with isolated boulder cascades. Deep pools were the primary habitat cover available, and water quality appeared generally suitable to support fish (pH of 6.7, turbidity of 8.8 NTU, 9.7 mg/l of dissolved oxygen) (Table 4.1.11-7). However, both the suspended precipitate and benthic deposits/staining are suggestive of upstream ARD and elevated metals levels (confirmed at a pH of 5.25 in upstream areas). As noted earlier, EBA's baseline water quality data for this tributary has shown a trend of increasing metals concentrations with the progression of the season (Appendix H5). While this is believed to restrict fish presence in Tributary A throughout much of the open water season, the presence of fish in Tributary C confirms that fish are able to at least migrate through the area, likely during spring freshet.

In total, a combined electrofishing effort of 1916 seconds in 2006 and 2007 resulted in the no fish captures or observations (Table 4.1.11-3)

Tributary C

Tributary C (which feeds Tributary A) flows adjacent to the proposed access road from roughly km 35.5 to the mine site, and five mapped tributaries to this watercourse are crossed within this span (only two of which are channelized)(Figure 4.1.11-4). The two channelized tributary crossings (C6 and C7) were assessed (Table 4.1.11-7), in addition to information on Tributary C collected as part of the receiving environment baseline studies.

As noted earlier, the mainstream of Tributary C was found to provide good quality fisheries habitat, with the potential to support populations of Dolly Varden year-round. While both C6 and C7 were found to offer moderate to good quality fish habitat value, neither was found to support fish during baseline studies (403 and 470 seconds of electrofishing effort, respectively).

Tributary C6 was a steep, high energy stream with 8% gradient, and the study area was moderately confined by bedrock and boulder (Table 4.1.11-7). As a result, numerous large cascades presented possible to likely barriers to fish passage. Consequently, areas upstream from the sampling location are considered to be non-fish bearing. However, it is likely that areas closer to the mainstem of Tributary C support fish populations. Habitat characteristics, such as water quality, cover, and general habitat distributions were suitable for supporting fish (with the exception of barriers).

Tributary C7 was a much shallower watercourse with a predominantly cobble substrate channelized by tall vegetated banks (Table 4.1.11-7). Despite being shallow and having little overhead cover, the water quality and availability of undercut bank cover in this tributary were conducive to supporting fish. However, as noted above, no fish were captured.

4.1.11.4 Aquatic Environment

Stream Sediment Metals and Particle Size

Historical Studies and Existing Information

Historical information regarding aquatic studies for streams located directly within the ASAR and ASAP is limited. However, some information is available for the South Macmillan River (YT) and for Dale Creek (NTW). Although the proposed mine site is neither within close proximity nor does surface runoff from the mine site flow into the South Macmillan River, the proposed access road crosses the river west of the aerodrome. Dale Creek flows into the Tsichu River and although Dale Creek is part of the Mackenzie drainage, not the Yukon River drainage, the headwaters are located within close proximity to Tributary C and would therefore likely have similar sediment chemical characteristics.

In the South Macmillan River, Soroka and Jack (1983) and Jack and Osler (1983) reported that high levels of arsenic, barium, cadmium, copper, nickel, lead and zinc were found during baseline studies conducted for the Tom and Jason Properties. Both of these properties are located in the Macmillan Pass area, in the vicinity of the proposed access road.

More recently, studies conducted by MPERG (2007) on the South Macmillan River in 2006 indicate that many sediment samples exceeded the Interim Standard Quality Guidelines (ISQG) for arsenic, cadmium, copper, lead and zinc. Although the South Macmillan system does not directly form part of the receiving environment, results for this study are noted as they also recognize that metal concentrations in regional sediments often exceed guideline levels, and such baseline levels must be taken into account.

Notably, sites M13 (located on a South Macmillan Tributary), M15 and M25 (both located on the South Macmillan mainstem) are located downstream of the proposed bridge crossing over the South Macmillan River. The arsenic and cadmium levels at all three sites were higher than the ISQG Guidelines. The levels for copper at sites M15 and M25, both located on the South Macmillan mainstem, exceeded the guideline levels as did lead concentrations at M25. The regional geology, namely the Tom Sequence geologic formation, has resulted in naturally high concentrations of dissolved metals such as arsenic, cadmium, copper and zinc (MPERG 2007). This study also noted that ambient water quality characteristics should be considered when treating waste water from mining exploration and development activities as the majority of metal concentrations in the sediment exceed CCME and ISQG guideline levels. Treating water to meet the guidelines would result in different water chemistry than that which occurs naturally in the local systems.

Closer to the proposed development area, studies conducted by AMAX (1983) found that the levels for arsenic, cadmium, copper, lead, mercury, nickel and zinc for Dale Creek and the Tsichu River all exceeded the current guideline levels.

Baseline Study Program

The results described below have been adapted from the Mactung 2008 Fisheries and Aquatic Resources Report (Appendix I3).

Field Sampling

Sampling for stream sediment particle size and metals was conducted as part of EBA's 2008 aquatics baseline study program. EBA collected sediment samples from seven sites across five streams within the ASAP and ASAR. At each station, samples were collected from three separate depositional areas within the active channel. Each sample was collected using an aluminium scoop, by a collector wearing latex gloves. Samples were directly placed into labelled 125 mL glass jars and kept refrigerated until being placed on ice in coolers for transport under chain of custody to Maxxam Analytics Ltd. for analysis. All samples were collected on September 6, 2008.

Laboratory and Data Analysis

At the laboratory, samples were dried and screened using sieves at ASTM mesh numbers 16, 30, 50, 100, 140, 200, 270 and 400. The percentage of total sample retained by sieve was recorded. Results of the particle size distribution were assessed for consistency between replicate samples at a given site by calculating the coefficient of variation (CV) between sample replicates for each sieve class.

Following physical particle size separation, a sub-sample of sediments from the #100 sieve was analysed by Maxxam Analytics for metals concentrations using ICPMS analysis, as well the loss on ignition (LOI) at 550°C. Results of the ICPMS analysis were compared to Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life. To provide a reference for those metals where no CCME standard exists, samples were compared to the British Columbia Water Quality Guidelines (BCWQ) for the protection of aquatic life.

Grain Size Distribution

Generally, the results of the grain size distribution were consistent with those of high energy/high slope stream systems. Samples from all sites consisted largely of fine to coarse sand with little silt deposition (Table 4.1.11-8). Low order streams (sites FS10, FS6, AQ-E) contained the highest composition of very coarse sand. Sediment samples taken from the Hess River Tributary (sites FS8 and FS9), a fifth order stream, were comprised largely of medium to coarse sand. Overall, sediment samples contained only minute amounts of silt. However, silt and fine sand levels were substantially elevated in the sediment samples collected at site FS10. This site is located on the upper portion of Tributary C, approximately 2 km downstream of the mine site (Figure 4.1.11-2).

A moderate degree of grain size variability occurred in the replicate samples taken from the same location, as indicated by the coefficient of variation (CV) (Table 4.1.11-9). High variability (CV > 1.00) occurred in seven of the sample replicates (or 10% of replicates), six of which were at site FS8. Moderate variability (CV between 0.75 and 1.00) occurred in eleven sample replicates (16% of replicates), seven of which were taken from sites on the Hess River Tributary (sites FS8 and FS9).

Sediment Metals

Table 4.1.11-10 presents the detailed results of the metals concentrations from the sediment samples taken at each site. Samples were compared against various standards as mentioned above, however these standards only exist for arsenic, cadmium, chromium, copper, lead, mercury, selenium, strontium and zinc. All metal parameters were below comparable standards except for those listed below:

TABLE 4.1.11-8: PHYSICAL SEDIMENT ANALYSIS RESULTS									
Stream	**Tributary C**						**Tributary A**		
Sample ID	**FS10**			**FS6**			**FS7**		
	S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
Sampling Date	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08
Physical Properties (% weight fraction)									
Loss on Ignition	4	6	8	3	5	4	6	5	14
Sieve - #16 (>1.18mm)	43.0	7.6	2.7	30.1	25.0	5.6	15.0	4.1	3.2
Sieve - #30 (>0.60mm)	30.0	11.5	6.0	40.9	33.8	36.7	25.7	33.1	13.8
Sieve - #50 (>0.300 mm)	10.9	11.8	12.3	16.8	23.8	46.4	16.3	48.9	34.2
Sieve - #100 Mesh (>.15 mm)	4.7	17.4	24.4	7.0	11.6	9.8	15.3	9.0	20.5
Sieve - #140 (>0.106mm)	2.8	16.8	16.3	2.2	2.5	0.6	11.0	1.8	8.4
Sieve - #200 (>0.075mm)	2.5	11.3	10.3	1.2	1.5	0.3	6.6	1.1	6.4
Sieve - #270 (>0.053mm)	2.1	10.3	10.5	1.0	0.8	0.3	5.0	0.9	6.6
Sieve - #400 (>0.030 mm)	1.5	5.5	6.8	0.3	0.3	<0.1	2.5	0.5	4.1
Sieve - Pan	2.6	7.7	10.8	0.4	0.7	0.3	2.6	0.6	2.8

TABLE 4.1.11-8: PHYSICAL SEDIMENT ANALYSIS RESULTS (CON'T)												
Stream	**Hess River Tributary**						**Tributary E**			**Tributary D**		
Sample ID	**FS8**			**FS9**			**AQ-E**			**AQ-D**		
	S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
Sampling Date	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08
Physical Properties (% weight fraction)												
Loss on Ignition	2	3	2	2	2	2	4	5	5	4	3	4
Sieve - #16 (>1.18mm)	10.4	0.7	9.6	1.5	12.7	6.3	27.1	7.3	9.1	4.9	4.8	2.4
Sieve - #30 (>0.60mm)	66.2	1.7	35.1	24.8	43.8	38.9	50.0	35.6	28.7	40.2	42.6	30.5
Sieve - #50 (>0.300 mm)	18.8	8.5	46.4	66.5	27.0	39.3	16.0	31.8	30.6	47.6	44.8	45.2
Sieve - 100 Mesh (>.15 mm)	3.7	31.5	7.8	6.9	12.2	13.3	4.6	12.9	17.8	4.8	5.2	14.8
Sieve - #140 (>0.106mm)	0.5	20.3	0.5	<0.1	2.2	1.4	1.1	4.3	5.7	1.0	1.0	3.3
Sieve - #200 (>0.075mm)	0.2	11.3	0.1	<0.1	1.0	0.4	0.5	2.7	3.1	0.7	0.7	1.5
Sieve - #270 (>0.053mm)	0.1	11.2	0.2	<0.1	0.6	0.2	0.3	2.3	2.6	0.3	0.3	1.1
Sieve - #400 (>0.030 mm)	<0.1	6.6	<0.1	<0.1	0.2	<0.1	0.2	1.6	1.4	0.3	0.3	0.6
Sieve - Pan	0.1	8.2	0.2	0.1	0.3	0.1	0.2	1.4	1.1	0.3	0.3	0.6

TABLE 4.1.11-9: COEFFICIENT OF VARIATION VALUES FROM GRAIN SIZE ANALYSIS RESULTS							
Stream	**Tributary C**		**Tributary A**	**Hess River Tributary**		**Tributary E**	**Tributary D**
Site	**FS10**	**FS6**	**FS7**	**FS8**	**FS9**	**AQ-E**	**AQ-D**
Sieve - #16 (>1.18mm)	1.24	0.64	0.88	0.78	0.82	0.76	0.35
Sieve - #30 (>0.60mm)	0.79	0.10	0.40	0.94	0.28	0.29	0.17
Sieve - #30 (>0.60mm)	0.06	0.53	0.49	0.80	0.46	0.34	0.03
Sieve - #50 (>0.300 mm)	0.64	0.24	0.39	1.05	0.32	0.57	0.68
Sieve - #100 (>.15 mm)	0.66	0.58	0.67	1.61	0.86	0.64	0.75
Sieve - #140 (>0.106mm)	0.60	0.62	0.66	1.66	0.92	0.67	0.48
Sieve - #200 (>0.075mm)	0.63	0.52	0.71	1.66	0.88	0.72	0.82
Sieve - #270 (>0.053mm)	0.60	0.49	0.76	1.66	0.43	0.71	0.43
Sieve - #400 (>0.030 mm)	0.59	0.45	0.61	1.64	0.69	0.69	0.43
Sieve - Pan	0.33	0.25	0.59	0.25	0.00	0.12	0.16

(orange) Coefficient of Variation > 1.0 (grey) Coefficient of Variation >0.75, <1.0

TABLE 4.1.11-10: STREAM SEDIMENT METALS RESULTS

Stream	Tributary E			Tributary D			Tributary C			Tributary A			BCWQG [1]	CCME [2]	
Sample ID	AQE-S1	AQE-S2	AQE-S3	AQD-S1	AQD-S2	AQD-S3	FS6-S1	FS6-S2	FS6-S3	FS7-S1	FS7-S2	FS7-S3			
Sampling Date	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08		ISQG[3]	PEL[4]
Misc. Inorganics															
Soluble (2:1) pH	7.50	7.63	7.52	7.60	7.39	7.40	7.64	7.87	7.93	6.90	6.97	7.06			
Total Metals by ICPMS (mg/kg)															
Total Aluminum (Al)	7050	8140	9330	7540	6560	10600	15600	16200	15800	21000	14300	28900	-	-	-
Total Antimony (Sb)	5.0	5.5	6.1	4.8	4.5	5.1	4.0	5.1	4.3	5.4	4.2	4.9	-	-	-
Total Arsenic (As)	**52.3**	**51.6**	**51.6**	**30.8**	**33.4**	**38.8**	**26.6**	**31.4**	**27.8**	**36.0**	**32.3**	**52.9**	5.9	5.9	17
Total Barium (Ba)	429	589	708	566	271	471	384	400	468	426	327	388	-	-	-
Total Beryllium (Be)	0.6	0.8	0.9	0.7	0.8	0.9	1.3	1.4	1.5	1.7	1.2	2.4	-	-	-
Total Bismuth (Bi)	0.2	0.3	0.3	0.2	0.2	0.2	1.7	0.3	0.6	0.3	0.3	0.5	-	-	-
Total Cadmium (Cd)	**7.97**	**9.64**	**10.7**	**8.31**	**13.1**	**15.5**	**11.3**	**14.6**	**8.33**	**14.4**	**8.37**	**20.4**	0.6	0.6	3.5
Total Calcium (Ca)	3240	3680	3200	6200	5430	6210	12200	10200	16300	4500	3990	9730	-	-	-
Total Chromium (Cr)	10	12	13	10	8	11	29	29	29	21	22	25	37.3	37.3	90
Total Cobalt (Co)	31.4	40.2	38.9	62.2	101	117	70.0	89.0	43.6	75.9	53.2	73.6	-	-	-
Total Copper (Cu)	**193**	**209**	**223**	**75.9**	**88.0**	**93.8**	**114**	**130**	**104**	**206**	**131**	**261**	35.7	35.7	197
Total Iron (Fe)	33400	34200	39000	31900	31000	44100	20700	20700	22400	46800	32900	51900	-	-	-
Total Lead (Pb)	19.2	19.7	20.8	22.7	21.8	23.5	11.2	11.3	12.1	15.3	13.9	18.1	35	35	91.3
Total Magnesium (Mg)	528	759	893	2020	1830	2470	6690	6530	6880	4530	4060	4860	-	-	-
Total Manganese (Mn)	496	590	607	964	1700	1790	1510	1970	942	1160	858	1270	-	-	-
Total Mercury (Hg)	**0.28**	**0.99**	**0.24**	0.07	<0.05	0.08	0.06	0.09	<0.05	**0.17**	0.10	0.16	0.17	0.17	0.486
Total Molybdenum (Mo)	15.8	13.5	16.9	14.5	15.0	17.6	26.7	26.6	21.4	25.0	19.5	21.2	-	-	-
Total Nickel (Ni)	**99.9**	**118**	**120**	**144**	**215**	**235**	**215**	**242**	**171**	**200**	**154**	**267**	75	-	-
Total Phosphorus (P)	1590	1730	1340	2160	1980	1890	2280	2350	3650	1660	1570	1500	-	-	-
Total Potassium (K)	770	512	650	621	499	660	3120	2860	3180	1490	1570	1290	-	-	-
Total Selenium (Se)	5.1	2.8	4.0	2.9	3.3	3.3	3.7	3.2	2.2	2.8	2.2	6.3	5	-	-
Total Silver (Ag)	0.48	**0.51**	**0.55**	0.47	0.45	**0.51**	**0.60**	**0.64**	**0.59**	**0.77**	**0.52**	**1.15**	0.5	-	-
Total Sodium (Na)	<100	<100	<100	<100	<100	<100	185	177	204	<100	<100	<100	-	-	-
Total Strontium (Sr)	71.9	78.4	57.8	37.0	30.2	38.3	60.2	56.6	73.3	57.7	47.8	63.6	-	-	-
Total Thallium (Tl)	0.71	0.74	0.81	0.52	0.59	0.70	1.06	1.15	0.81	0.64	0.71	0.59	-	-	-
Total Tin (Sn)	0.3	0.2	0.3	0.3	0.2	0.4	0.3	0.4	0.4	0.3	0.3	0.3	-	-	-
Total Titanium (Ti)	125	54	67	125	87	202	243	234	255	194	154	217	-	-	-
Total Vanadium (V)	66	53	65	62	47	66	281	353	267	138	151	139	-	-	-
Total Zinc (Zn)	**482**	**564**	**625**	**700**	**921**	**1190**	**1260**	**1420**	**957**	**1150**	**673**	**1090**	123	123	315
Total Zirconium (Zr)	2.1	2.4	2.6	1.9	2.0	2.4	2.4	2.5	2.6	3.3	2.7	6.2	-	-	-

[1]British Columbia Water Quality Guidelines (BCWQG) for the Protection of Freshwater Aquatic Life, 2001

[2]Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life, 2003

[3]ISQG = Interim Sediment Quality Guideline

[4]PEL = Probable Effect Level

"-" Indicates no analysis conducted or no applicable standard available.

BOLD indicates parameter exceeds BC Water Quality Guidelines

(grey) indicates parameter exceeds ISQG Guideline

(orange) Indicates parameter exceeds PEL and ISQG Guidelines

TABLE 4.1.11-10: STREAM SEDIMENT METALS RESULTS (CONTINUED)

Stream	Hess River Tributary			Hess River Tributary			Tributary C			BCWQG [1]	CCME [2]	
Sample ID	FS8-S1	FS8-S2	FS8-S3	FS9-S1	FS9-S2	FS9-S3	FS10-S1	FS10-S2	FS10-S3			
Sampling Date	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08	9/6/08		ISQG[3]	PEL[4]
Misc. Inorganics												
Soluble (2:1) pH	7.20	6.86	6.91	6.95	6.83	7.10	7.33	7.43	7.49			
Total Metals by ICPMS (mg/kg)												
Total Aluminum (Al)	7420	11800	9750	7630	8800	8700	13300	18600	19300	-	-	-
Total Antimony (Sb)	0.9	0.9	0.7	1.3	1.8	1.5	2.0	2.9	3.6	-	-	-
Total Arsenic (As)	**13.8**	**17.9**	**12.1**	**15.4**	**17.5**	**18.1**	**40.2**	**74.9**	**64.1**	5.9	5.9	17
Total Barium (Ba)	71.8	120	91.4	138	158	126	161	289	430	-	-	-
Total Beryllium (Be)	0.4	0.5	0.3	0.5	0.5	0.5	0.9	1.7	1.5	-	-	-
Total Bismuth (Bi)	0.2	0.5	0.3	0.3	0.3	0.2	0.7	2.6	2.1	-	-	-
Total Cadmium (Cd)	**0.76**	0.58	0.47	**3.27**	**3.39**	**4.50**	**3.24**	**4.19**	**4.62**	0.6	0.6	3.5
Total Calcium (Ca)	2040	2440	1880	2920	3510	2560	17000	10700	8440	-	-	-
Total Chromium (Cr)	10	16	13	10	13	12	25	26	29	37.3	37.3	90
Total Cobalt (Co)	29.5	20.2	24.4	24.4	24.0	36.2	11.5	17.7	14.5	-	-	-
Total Copper (Cu)	**55.6**	26.8	23.9	**39.9**	**43.3**	**52.2**	**117**	**114**	**98.1**	35.7	35.7	197
Total Iron (Fe)	26400	31000	32300	20400	23200	23700	25700	32900	30600	-	-	-
Total Lead (Pb)	18.0	16.2	17.7	9.1	10.7	10.9	18.9	26.8	23.3	35	35	91.3
Total Magnesium (Mg)	3080	4630	3610	2630	3080	3190	7570	9020	9440	-	-	-
Total Manganese (Mn)	1100	670	841	537	538	780	343	466	364	-	-	-
Total Mercury (Hg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.17	0.17	0.486
Total Molybdenum (Mo)	2.2	1.5	1.2	4.7	5.6	5.6	8.9	8.7	12.4	-	-	-
Total Nickel (Ni)	55.8	38.3	40.8	61.5	68.4	**82.7**	72.7	**112**	**110**	75	-	-
Total Phosphorus (P)	676	684	638	1110	1400	910	4880	3220	1980	-	-	-
Total Potassium (K)	381	881	333	616	844	688	3410	2780	2470	-	-	-
Total Selenium (Se)	<0.5	<0.5	<0.5	1.0	0.7	<0.5	1.8	1.4	1.2	5	-	-
Total Silver (Ag)	0.07	0.10	0.05	0.17	0.19	0.16	**0.78**	**0.64**	**0.68**	0.5	-	-
Total Sodium (Na)	<100	<100	<100	<100	<100	<100	111	157	157	-	-	-
Total Strontium (Sr)	14.3	17.1	12.9	30.1	33.0	23.9	48.5	62.6	79.9	-	-	-
Total Thallium (Tl)	0.13	0.15	0.07	0.21	0.22	0.23	0.33	0.37	0.52	-	-	-
Total Tin (Sn)	0.2	0.4	0.2	0.1	0.2	0.2	0.3	0.8	0.7	-	-	-
Total Titanium (Ti)	79	367	85	91	153	143	200	417	442	-	-	-
Total Vanadium (V)	23	25	16	38	47	46	99	92	143	-	-	-
Total Zinc (Zn)	**142**	**144**	122	**239**	**279**	**318**	**293**	**444**	**521**	123	123	315
Total Zirconium (Zr)	1.1	1.2	1.1	1.0	1.3	1.5	2.3	1.4	1.4	-	-	-

[1]British Columbia Water Quality Guidelines (BCWQG) for the Protection of Freshwater Aquatic Life, 2001

[2]Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life, 2003

[3]ISQG = Interim Sediment Quality Guideline

[4]PEL = Probable Effect Level

"-" Indicates no analysis conducted or no applicable standard available.

BOLD indicates parameter exceeds BC Water Quality Guidelines

(grey) indicates parameter exceeds ISQG Guideline

(orange) Indicates parameter exceeds PEL and ISQG Guidelines

FS6 (Lower Tributary C)

- Concentrations of arsenic, cadmium, copper, nickel, silver and zinc were above the comparable standards in all three samples that were collected at FS6.
- Concentrations of arsenic, cadmium and zinc also exceeded the Predicted Effects Level (PEL) in all three samples.

FS10 (Upper Tributary C)

- Concentrations of arsenic, cadmium, copper, silver and zinc were above the comparable standards in all three samples that were collected at FS10.
- Nickel concentrations in Samples 2 and 3 were higher that the comparable standards.
- The PEL was exceeded for arsenic in all three samples for arsenic and in two samples for both cadmium and zinc.

FS7 (Lower Tributary A)

- Concentrations for arsenic, cadmium, copper, nickel, silver and zinc were above the comparable standards in all three samples that were collected at FS7.
- The mercury concentration in one of the samples collected at FS7 exceeded the acceptable guidelines.
- Concentrations for arsenic, cadmium and zinc exceeded the PEL in all three samples and the concentrations for copper exceeded the PEL in Samples 2 and 3.

FS8 (Upper Hess River Tributary)

- Concentrations for arsenic were above the comparable standards in all three samples that were collected at FS8.
- The concentration of zinc was above the comparable standards in two of the samples that were collected at FS8.
- The concentrations for cadmium and copper exceeded the standards in Sample 1.
- The PEL for arsenic concentrations was exceeded in one of the samples.

FS9 (Lower Hess River Tributary)

- Arsenic, cadmium, copper and zinc concentrations exceeded the acceptable standards in all three samples collected at sample site FS9.
- The nickel concentration in Sample 3 was above the comparable standards.
- The PEL for arsenic concentrations were exceeded in two samples and cadmium concentration was exceeded in one sample.

AQ-D (Tributary D)

- Concentrations of arsenic, cadmium, copper, nickel, and zinc were above the comparable standards in all three samples that were collected at sample site AQ-D.
- The concentration of silver in Sample 3 was higher than the guideline standards.
- Concentrations of arsenic and cadmium exceeded the PEL in all three samples. The zinc concentrations exceeded the PEL in two samples.

AQ-E (Tributary E)

- Concentrations of arsenic, cadmium, copper, mercury, nickel, and zinc were above the comparable standards in all three samples that were collected at sample site AQ-E.
- Silver concentrations in Samples 2 and 3 were higher than the guideline standards.
- Concentrations of arsenic and cadmium exceeded the PEL in all three samples. The copper and zinc concentrations exceeded the PEL in two samples and the mercury concentration exceeded the PEL in one sample.

Stream Periphyton Analysis

Historical Studies and Existing Information

Periphyton are comprised of benthic algae, bacteria, fungi, microinvertebrates and detritus that grow attached to substrate, such as rocks and larger plants, in the aquatic ecosystem. Periphyton serve as an important food source for invertebrates and fish, and are often used as indicator of primary productivity and water quality (US EPA, 2007). Because they are sensitive to environmental change and the tolerance and sensitivity to changes in environmental conditions for some species are known, periphyton composition and abundance can be used to assess the health of aquatic ecosystems.

Historical information on periphyton and primary productivity in the study area was very limited. EBA was unable to locate any studies conducted within either ASA. However, AMAX (1978) conducted work in Macmillan Pass within the NWT. This report states that benthic algae and bacteria samples were collected but not analyzed for inclusion in that report.

Baseline Study Program

The results described below have been adapted from the Mactung 2008 Fisheries and Aquatic Baseline Studies Report (Appendix I3).

Periphyton samples were collected at each of the seven sample sites in conjunction with other sampling, as shown in Figure 4.1.11-2. At each site, three separate rocks were randomly retrieved from riffle habitat (at least 1 m apart from each other). Two standard size circles (5.5 cm diameter) were etched into the surface of each rock, following which the periphyton was scraped from inside once circle on each rock using a knife and small brush. A first composite sample was collected, chilled, kept dark, and sent for analysis of

Chlorophyll A,B,C, and Phaeophytin to assess levels of primary productivity. A second composite sample was preserved with Lugol's solution, and sent for laboratory taxonomic analysis.

This section presents the results of the periphyton community surveys completed during the 2008 Mactung Fisheries and Aquatics baseline assessment. Sample locations are consistent with the fisheries stations shown in Figure 4.1.11-2. At the time of preparation of this proposal, only the chlorophyll and phaeophyton results were available, which are presented in Table 4.1.11-11. The remainder of the periphyton taxonomic data will be provided in an appendix when it becomes available. All results are presented in $\mu g/cm^2$.

Primary productivity, which is the biomass of periphyton (reported as the concentration of chlorophyll A), was highly variable throughout the sites ranging from < 0.03 to 0.65 $\mu g/cm^2$. The Chlorophyll A concentrations at all sample sites were below the BCWQG (10 $\mu g/cm^2$), indicating generally low productivity (oligotrophy) in all watercourses.

Levels of primary productivity at sites FS6 and FS10 on the Tributary C were the highest, with Chlorophyll A levels of 0.65 $\mu g/cm^2$. The primary productivity on the upper HRT (site FS8) was moderately high with 0.36 ug/cm^2 of chlorophyll A. In contrast, the primary productivity at sites FS7 (Tributary A), FS9 (lower HRT), AQ-E (Tributary E), and AQ-D (Tributary D) were all very low with levels of 0.06 $\mu g/cm^2$ or lower.

Stream Benthic Macroinvertebrate Analysis

Historical Studies and Existing Information

The abundance and diversity of benthos can be used as indicators of changing environmental conditions. The distribution and abundance of benthic invertebrate species can be influenced by a wide variety of physical parameters such as hydrology, substrate composition, metal concentrations (both in sediment and in the water column), water temperature, dissolved oxygen, pH, salinity, and sediment C/N ratios. Many types of benthos are sensitive to pollutants, such as metals and organic wastes, and the presence and/or composition of certain feeding groups (such as scrapers and filterers) are often used as an indicator of aquatic health. Historic information for streams located near the study area and within the Yukon was not available. Information for streams located in the Northwest Territories (AMAX 1983, EBA 2007a and EBA 2007b) that originate near the study area was available and this information has been included in the baseline reports (Appendices I1 and I2). This information has not been included in the Baseline Study Program section as these sites are located outside of the Yukon River watershed, and consequently outside of the ASA[P].

TABLE 4.1.11-11. PERIPHYTON PRODUCTIVITY†							
Stream	**Lower Tributary C**	**Upper Tributary C**	**Tributary A**	**Upper Hess River Tributary**	**Lower Hess River Tributary**	**Tributary E**	**Tributary D**
Sampling Station	**FS-6**	**FS-10**	**FS-7**	**FS-8**	**FS-9**	**AQ-E**	**AQ-D**
Sampling Date	9/6/2008	9/6/2008	9/6/2008	9/6/2008	9/6/2008	9/6/2008	9/6/2008
Chlorophyll a‡	0.65	0.65	<0.03	0.36	<0.03	0.06	0.12
Chlorophyll b	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Chlorophyll c	0.06	0.09	<0.03	0.04	<0.03	<0.03	<0.03
Phaeophytin A	<0.03	0.06	<0.03	<0.03	<0.03	<0.03	<0.03

†Chlorophyll levels are given in µg/cm²

‡ BC Water Quality Aquatic Life Guideline (BCWQG) for periphyton is 100 mg/m² (Equivalent to 10 µg/cm²)

Baseline Study Program

The majority of sampling for benthic macroinvertebrates was conducted during the 2006 and 2007 Fisheries and Aquatics Program at Mactung. In 2008, additional samples were collected from Tributaries D and E. The results described below have been adapted from the Mactung 2006, 2007 and 2008 Fisheries and Aquatic Resources Reports (Appendices I1, I2, and I3). The taxonomic composition of benthic macroinvertebrates has previously been presented and discussed in the baseline reports as outlined above.

Benthic sampling was conducted at all sites using a Hess substrate invertebrate sampler with an area of 0.086 m^2 and 363 µm mesh size. The sampler was inserted into the substrate to a depth of ~ 10 cm, and the substrate was washed for 5 minutes (RIC 1997). Contents were preserved on site in 80% ethanol solution for taxonomic analysis. At each site, 3 replicate stations with similar flow, depth and substrate characteristics were sampled moving in an upstream direction (each spaced a minimum of 2 m from the previous).

Preserved samples were all identified and enumerated by Sue P. Salter, R.P.Bio. of Cordillera Consulting. The guidelines used for taxonomic analysis were those provided in the MMER Guidance Document for Aquatic Environmental Effects Monitoring (Environment Canada 2002). Re-sorts were conducted of the sub-samples, thus effectively achieving a Quality Control check on approximately 10% of the samples, as specified in the MMER Guidance Document.

Simpson's Diversity Index was used as a measure of taxonomic diversity in the samples. This index takes into account both the richness and abundance of the invertebrate community, by determining the relative mean contribution of individuals to the site total. The index ranges from 0 to 1, representing low to high diversity, respectively.

A summary of the benthic macroinvertebrate community composition and metrics for the Hess River Tributary and Tributaries A and C are provided in Table 4.1.11-12. The majority of invertebrates were keyed to the family classification level. Major benthic invertebrate families that were found on site include Plecoptera, Ephemeroptera, Diptera, Oligochaeta, Trichoptera, Copepoda, Arachnica, Collembola, Odonata, Coleoptera, Hydracarina, Haplotaxida, Lumbiculida and Oribatei.

TABLE 4.1.11-12 . BENTHIC MACROINVERTEBRATE ABUNDANCE, DENSITY AND SPECIES RICHNESS								
Stream	**Tributary C**		**Tributary A**		**Upper Hess River Tributary**		**Lower Hess River Tributary**	
Site	**FS6**		**FS7**		**FS8**		**FS9**	
Sample Year	2006	2007	2006	2007	2006	2007	2006	2007
Calculated Mean Density (#/m²)	601	1252	23	47	570	764	58	116
Mean Species Richness Per Replicate	8	7	2	3	13	10	4	6
Number of orders present	5	5	2	3	7	5	6	3
Total Abundance (# of individuals)	155	323	6	12	147	197	15	31
Simpson's Index	0.757	0.532	0.389	0.440	0.872	0.283	0.660	0.205

Tributary C (FS6)

Sample results for Tributary C indicated that this site contained both the highest diversity and density for benthic invertebrates of all baseline locations. A mean total abundance of 239 individuals was recorded. This relates to a calculated density of 601 organisms/m^2 in 2006 and 1252 organisms/m^2 in 2007 samples. Total species richnesses of the samples collected in 2006 were 8 species and 7 species for sanples collected in 2007.

Tributary A (FS7)

Tributary A contained the lowest benthic invertebrate abundance and species richness among the sample sites within the study area. Sediment results indicate that high levels of metals are present in Tributary A which may be a factor in low diversity and abundance. The calculated Simpson's index was low in both 2006 and 2007 with values of 0.389 and 0.440 respectively.

Upper Hess River Tributary (FS8)

The Upper Hess Tributary contained a relatively high number of individual benthic invertebrates with a mean of 172 individuals per replicate observed over the two year period. Density was consistently moderate over the two years with 570 and 764 individuals/m^2 observed in 2006 and 2007 respectively. In 2006, the highest diversity of any site was recorded with a Simpson's Index of 0.872.

Lower Hess River Tributary (FS9)

Macroinvertebrate abundance at site FS9, on Lower Hess River Tributary, was low. Only 15 and 31 individual organisms per sample were present on average in the samples taken in 2006 and 2007. Despite the low average density (58 individuals/m^2), the diversity was still moderate with a mean species richness of four and Simpson's Index of 0.660 in 2006. It should be noted that Tributary A flows into the Hess River Tributary upstream from this site. As a result, decreased water quality, invertebrate abundance and invertebrate density has been observed. This supports the evidence that the water quality in Tributary A is greatly influenced by upstream ARD.

Tributaries D and E

Macroinvertebrate samples for Tributaries D and E were sampled in the late summer of 2008. At the time of preparation of this proposal, the results from the taxonomic analysis were not yet available. The results of this analysis will be provided in an appendix when it becomes available.

4.1.12 Archaeology

4.1.12.1 Introduction

Archaeological assessment studies have been conducted for the Mactung project by Points West Heritage Consulting Ltd. (Points West). Archaeological sites are locations that contain physical evidence (artifacts or features) of past human activity and are integral to understanding the cultural history of the Mactung area. These sites are a non-renewable resource and as such are susceptible to damage from any land altering activity.

4.1.12.2 Archaeological Site Protection

In the Yukon, Archaeological sites are considered a historic resource and legislatively protected under the Yukon Historic Resources Act (RSY 2002, Chap. 109). Historic resources are broadly defined as "any work or assembly of works of nature or of human endeavor that is of value for its archaeological, palaeontological, pre-historic, historic, scientific or aesthetic features". The protective provisions of the Act (25(1)) prohibit any alteration of a historic resource without the authority of a historic resources permit. In the case of archaeological sites, such permits are issued pursuant to the Yukon Archaeological Sites Regulations (OIC. 2003/73).

The Yukon Archaeological Sites Regulations (YASR) define an archaeological site as; "a site where an archaeological object has been found". In the Mactung project area, archaeological sites are likely prehistoric and consist of the remains of camps, stone tools and stone tool making debris.

The three archaeological studies conducted by Points West for the Mactung project in 2006, 2007 and 2008 were authorized by appropriate YASR permits. Additionally, each year, Points West was assisted by a Kaska representative recommended by the Ross River Dena Council Economic Development Department.

4.1.12.3 Study Methods

Two levels of study were undertaken for the Mactung project, the first being an overview of previous archaeological research in the region, coupled with a terrain analysis and preliminary field assessment using a low and slow helicopter fly-over of the proposed development areas. This was done to determine specific areas of potential for the presence of archaeological sites. Factors used in making this determination are described the report of the 2006 investigations (Appendix K1).

The second level of study used intensive ground reconnaissance. Any landforms determined through the overview as having moderate or higher potential for archaeological sites, were plotted on 1:50,000 scale field maps, and investigated on the ground. The ground reconnaissance involved foot traverses of the landforms where surface exposures were examined for evidence of archaeological material. Foot traverse were generally spaced 5 to 10 m apart. In areas where surface exposure is considered to be insufficient for adequate assessment, small shovel pits (ca. 50 cm2) were excavated at judgmentally determined locations. Testing was undertaken in rough 5 cm to 10 cm levels and rarely exceeded 20 cms. Excavation of the pits was undertaken by shovel and trowel. Subsurface deposits were sorted by hand and trowel and then the pits were backfilled (Photograph 4.1.12-1).

Photograph 4.1.12-1
Typical subsurface testing at one location in the Mactung project area

4.1.12.4 Results of Studies

Three key aspects of the background research are summarized below. A detailed discussion of the cultural background of the Mactung area can be found in the 2006 report (Appendix K1).

Ethnographic Background

Ethnographically, the areas around Macmillan Pass were used by the Upper Pelly Indians (Yukon), associated with the Kaska and the Mountain Indians (NWT). This area would have only been used periodically by either group. The Mountain Indians originally inhabited the eastern slopes of the east side of the Mackenzie Mountains to the west side of the Mackenzie River. The territory of the Upper Pelly Indians extended into the western side of the Mackenzie Mountains including the drainages of the Ross River and Upper Hess River.

Most of the Upper Pelly groups were massacred by the Mountain Indians around 1886, likely prompted by competition for furs. By the 1900s, the Mountain Indians were hunting, trapping and fishing in the upper Hess, North and South Macmillan and Ross rivers. They used a number of trails to access Yukon posts for trade, one of which later became the Canol Road.

Historical Background

The term historic is often used to define the period post-dating the first contact with indigenous peoples in North America. In the south and central Yukon, Robert Campbell explored the Liard and Pelly rivers in 1840. However, initial contact in the Macmillan Pass area likely occurred after the Klondike gold discoveries of 1898.

Non-aboriginal interest in the area was sporadic until the construction of the Canol Road for and pipeline in 1942 resulted in an influx of people and money. The Canol Road runs from Norman Wells to Whitehorse via Ross River. The Canol Road was responsible for opening up the area to increased use and continues to provide access. Current activities in the Macmillan Pass area include subsistence and recreational hunting (individually and with guide outfitters), mineral exploration and recreation.

Previous Archaeological Investigations

Prior to the 2006 Mactung archaeological investigations, only three previous studies had been undertaken in the area: a 1981 assessment of the North Canol Road; a 1981regional archaeological inventory of the Yukon Macmillan Pass area; and a 1983 archaeological inventory of the Mactung Project. Those studies indicated archaeological sites are sparsely distributed in the mountains around the Mactung Project. Further, sites that are likely present will primarily be small, short term occupancy lookouts or camps of low visibility and limited in archaeological content.

Areas Examined in 2006 and 2007

Both the investigations in 2006 and 2007 focused on the Mine site and adjacent facilities on the upper slopes of Mt. Allen. The 2006 investigations primarily involved identifying areas of archaeological potential. More intensive investigations including subsurface testing were completed in 2007. The landforms investigated are shown in Figure 4.1.12-1, were primarily a series of ridges and knolls, and a relatively broad bench in the area of the proposed mill site. See Appendix K1 (2006), and K2 (2007) for more detailed information.

No archaeological sites were discovered in the vicinity of the mine site or associated development facilities. No further work is recommended for that area.

Areas Examined in 2008

The 2008 investigations focused on the proposed access road alignment from Macmillan Pass to the mine site; the proposed water pumping station on a southern tributary of the Hess River and connecting road/pipeline alignment to the mine site access road; and a proposed extension to the northeast end of the Macmillan Pass Aerodrome. The full report related to these investigations is appended to this proposal (Appendix K3).

The majority of the access road alignment is situated on poorly drained side-slope and was considered to be of low archaeological potential. Specific areas of moderate potential investigated included gravel knolls near the aerodrome extension and between the North Canol Road and South Macmillan River, the terraces backing the pumping station locality, as well as several gravel knolls, ridges and remnant terraces along the road alignment in the Hess drainage side of the divide. Those areas were investigated on the ground (Figures 4.1.12-2, 4.1.12-3).

One small archaeological site, KgTg-3 was located on a knoll in Macmillan Pass (Photo 3). It is adjacent to an existing exploration road, which will likely be used as part of the Mactung access. A detailed assessment of the site produced only a single retouched chert flake. KgTg-3 is considered unlikely to yield additional information that would significantly add to our understanding of the prehistory of the area. No further work is recommended.

Aside from KgTg-3, no further archaeological material was observed along the road alignment, thus no further work is recommended. However, three areas of moderate archaeological potential were observed outside the proposed road alignment.

Photograph 4.1.12-2
View west showing KgTg-3 (where people are standing)

4.1.12.5 Conclusion

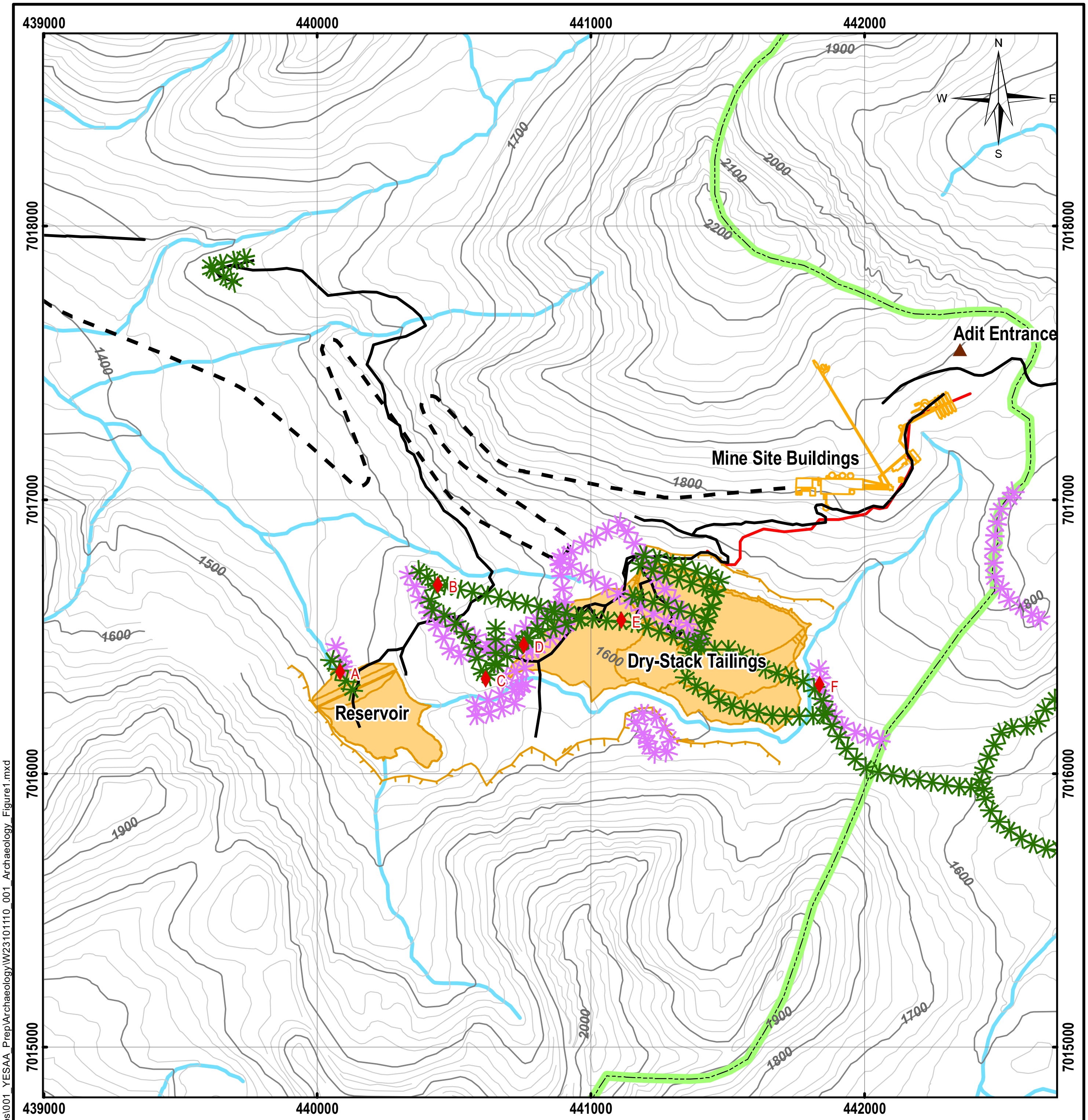
No new archaeological sites were encountered during the 2006 and 2007 studies. The proposed mine site area is considered to be generally of low archaeological potential and no further archaeological work is recommended.

During the 2008 investigations one small archaeological site, KgTg-3 was located on a knoll in Macmillan Pass. That site is unlikely to yield additional information that would significantly add to our understanding of the prehistory of the area, and no further work is recommended.

The proposed access road alignment, aerodrome extension and pumping station locality were similarly found to have low archaeological potential and no further archaeological investigations are considered necessary for the project as proposed.

Three areas of moderate archaeological potential were observed outside the proposed access road alignment. It is recommended that those areas be re-assessed by an archaeologist if the alignment is altered in the future.

Although it cannot be stated with total certainty that no additional archaeological sites are in the proposed development areas, the potential for such an occurrence is considered low.



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LEGEND

- Archaeology Shovel Test (ST) Locations
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Existing Road
- Existing Trail
- Contours (100m)
- Contours (20m)
- NWT-Yukon Territory Border
- Watercourse
- Waterbody
- 2006 Area of Archaeological Ground Reconnaissance
- 2007 Area of Arcaeological Ground Reconnaissance

ST	NOTES
A	2 ST 20m apart
B	3 ST 50cm apart and 2 ST 20m and 40m south from B
C	1 ST
D	1 ST
E	5 ST at 20m intervals running east from E
F	3 ST 10m apart running south

ST=Shovel Test

ISSUED FOR USE

NOTES:
Base Data Source: NTS 1:50,000,
Site Plan Design adapted from original provided by Wardrop

MACTUNG

Areas of Archaeological Assessment 2006 & 2007

PROJECTION: UTM Zone 9
DATUM: NAD83

Scale: 1:20,273

390 195 0 390
Meters

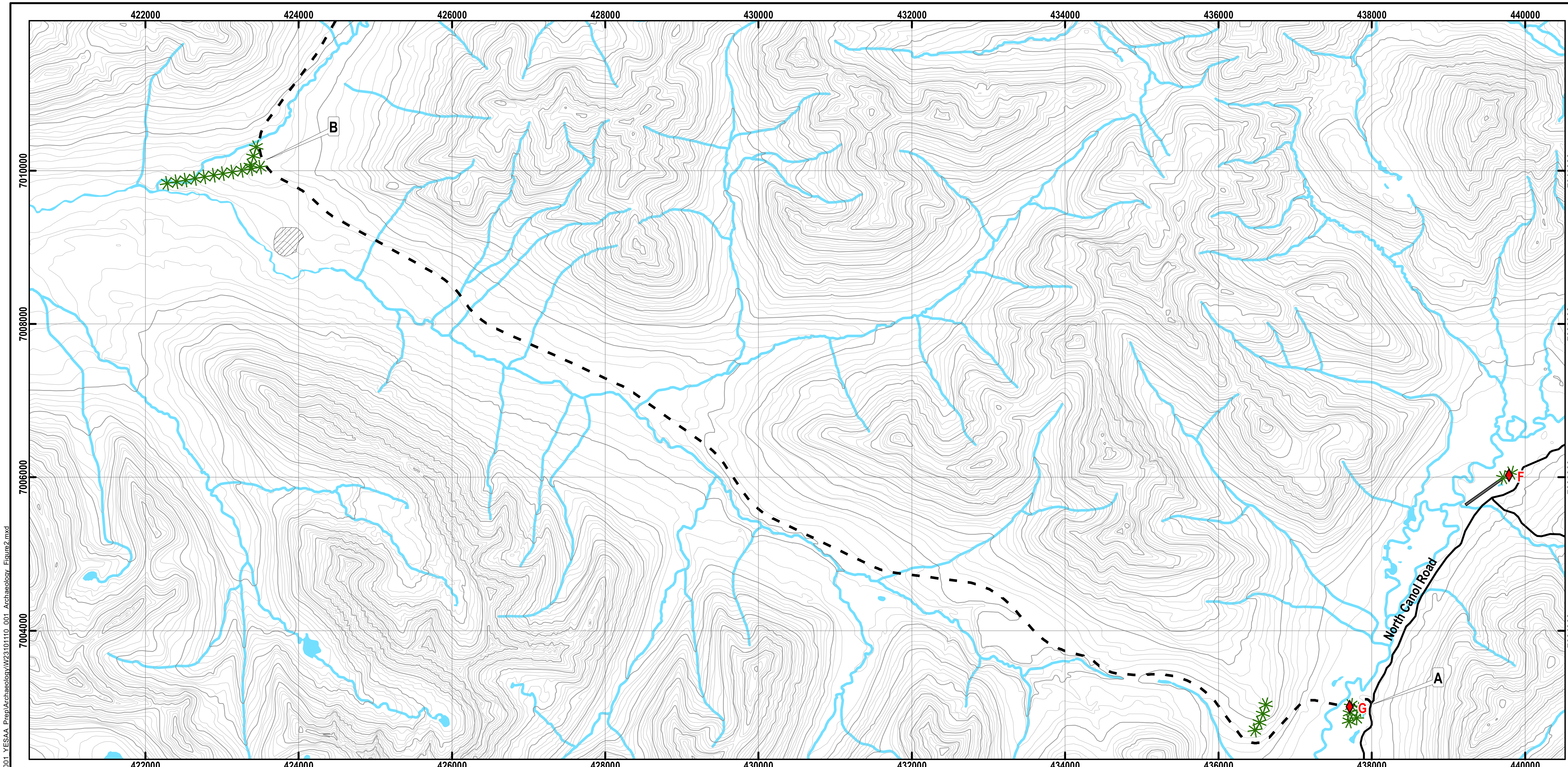
FILE NO.: W23101110_001_Archaeology_Figure1.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	BA	0

OFFICE: EBA-VANC
DATE: November 21, 2008

North American Tungsten Corporation Ltd
Points West Heritage Consulting Ltd.
EBA Engineering Consultants Ltd.

Figure 4.1.12-1



LEGEND

- Archaeological Shovel Test (ST) Locations
- Areas of Archaeological Ground Reconnaissance
- Proposed Access Road
- Existing Roads
- Macmillan Pass Aerodrome
- Areas of Moderate Potential
- Contours (20m)
- Contours (100m)
- Watercourse
- Waterbody
- A Reference node

ST	NOTES
F	4 ST judgementally placed
G	8 ST judgementally placed

ST = Shovel Test

N
W E
S

ISSUED FOR USE

NOTES

Base data source: NTDB 1:50,000,
Site Plan Design adapted from original provided by Wardrop

MACTUNG

Areas of Archaeological Assessment 2008

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:50,000

1 0.5 0 1

Kilometers

FILE NO.
W23101110_001_Archaeology_Figure2.mxd

PROJECT NO.	DWN	CKD	REV
W23101110.001	MEZ	BA	0

OFFICE	DATE
EBA-VANC	December 4, 2008

NORTH AMERICAN TUNGSTEN CORPORATION LTD

POINTS WEST HERITAGE CONSULTING LTD.

EBA Engineering Consultants Ltd.

Figure 4.1.12-2

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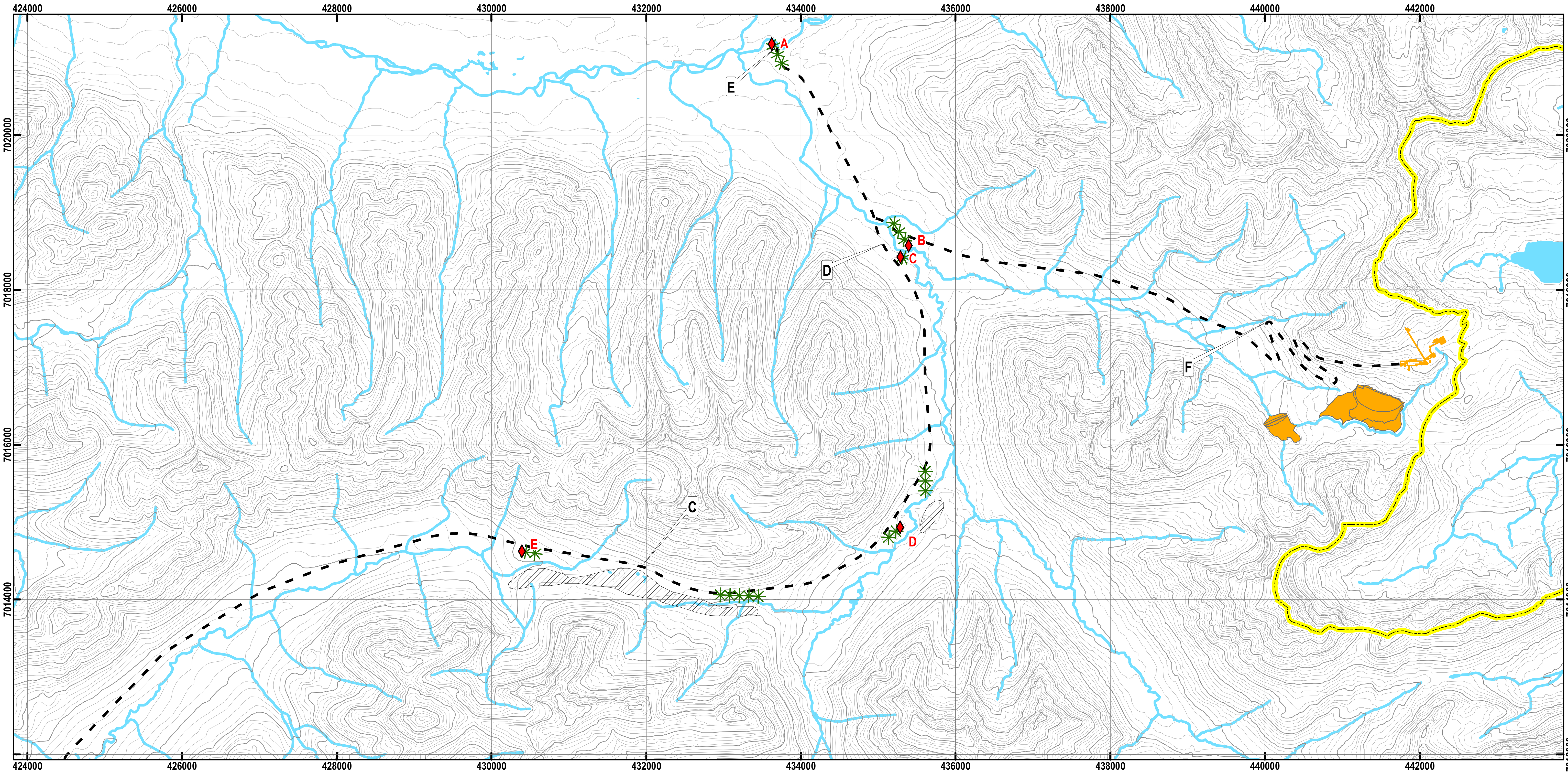

LEGEND

- Archaeological Shovel Test (ST) Locations
- Areas of Archaeological Ground Reconnaissance
- Existing Roads
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Areas of Moderate Potential
- NWT - Yukon Territory Border
- Contours (20m)
- Contours (100m)
- Watercourse
- Waterbody
- A Reference Node

ST	NOTES
A	12 ST over 2 terraces, 10 m apart
B	4 ST at 10 m intervals running south
C	4 ST judgementally placed
D	4 ST one on each knoll
E	4 ST at 10 m intervals, running east

ST = Shovel Test

N
W E
S

ISSUED FOR USE

NOTES

Base data source: NTDB 1:50,000,
Site Plan design adapted from original provided by Wardrop

MACTUNG

Areas of Archaeological Assessment 2008

PROJECTION: UTM Zone 9
DATUM: NAD83

Scale: 1:50,000

1 0.5 0 1

Kilometers

NORTH AMERICAN TUNGSTEN CORPORATION LTD

POINTS WEST HERITAGE CONSULTING LTD.

EBA Engineering Consultants Ltd.

FILE NO.: W23101110_001_Archaeology_Figure3.mxd

PROJECT NO.	DWN	CKD	REV
W23101021.008	MEZ	BA	0

OFFICE: EBA-VANC
DATE: December 4, 2008

Figure 4.1.12-3

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4.2 SOCIO-ECONOMIC CONDITIONS

4.2.1 Introduction

This section provides a description of the economic and social setting within the project area to facilitate the consideration of socio-economic components that may be affected by the project. Full baseline information for each of the communities and First Nations under consideration is appended to this proposal (Appendix J1).

4.2.1.1 Project Area, Land and Resource Use

The Mactung project falls within the Kaska and Nacho Nyak Dun traditional territories. The region's traditional land stewards reside in Ross River. Although traditional subsistence hunting does occur (and some recreational hunting) the project area is not particularly rich in game and does not appear to be heavily used by hunters.

The project area is regularly used by trappers. In winter the North Canol Road is not maintained as a road but is readily accessible by snow machine. Trappers use the North Canol Road as a trapline trail. The North Canol Road is mostly covered by the the Ross River Group trapline. Trapline #112, registered under Gregory Keating and Neilson Sisson is partly within the Mactung project area. Data from the Yukon Department of Environment show that the region around the project area has experienced trapping activity in each of the past ten years with total fur harvest varying from 105 to 1,612 pelts annually.

The Mactung project area falls within Yukon outfitting concession #9, owned by Koser Outfitters Ltd. A wilderness tourism operator in the area is the Dechenla Lodge, located along the Canol Heritage Trail, approximately 20 km over the border in the NWT, with access from the North Canol Road.

The project area is remote and at high elevation. There is no agriculture or timber harvesting in the region and no oil or gas exploration. The Macmillan Pass area has seen considerable mineral exploration since the 1960s, but there are no operating mines in the region. The closest mineral properties to Mactung are the Jason and Tom lead-zinc deposits located about 13 km southeast of Macmillan Pass. These deposits, owned by HudBay Minerals, are not currently being explored or developed but some environmental remediation work is being carried out. The nearest active mineral properties to Mactung are the Selwyn project at Howard's Pass (along the NWT border approximately 55 km northwest of Cantung) and the Andrew Property located 110 km northeast of Faro.

4.2.2 Yukon Economy and Structure

The Yukon's real (adjusted for inflation) GDP totalled $1.298 billion in 2006, up from $1.260 billion in 2005. Real GDP growth has been strong, up 3.0% in 2006 and a revised 4.1% in 2005. The territory's 2006 GDP by industry is summed up in the Table 4.2.2-1.

TABLE 4.2.2-1 YUKON INDUSTRIES AS A PERCENTAGE OF GDP, 2006	
Industry	Percentage of GDP
Public administration	23.7
Finance, insurance and real estate	18.4
Construction	8.2
Health care and social assistance	7.8
Retail trade	6.4
Educational services	6.3
Other services (except public administration)	4.7
Accommodation and food services	4.3
Information and cultural industries	3.3
Mining, oil and gas extraction	3.0
Wholesale trade	3.0
Transportation and warehousing	2.7
Professional, scientific and technical services	2.5
Utilities	2.5
All others	3.2

Source: Yukon Bureau of Statistics 2006 Yukon GDP by Industry

The territorial economy is dominated by industries that are largely the purview of governments. The public sector contribution to GDP tends to be in the range of 40% of the Yukon's overall economic activity, compared to the Canadian average of about 15%. The federal government transfers to the Yukon government have been increasing, in part because of the devolution of some powers to the territorial government. Federal transfers account for approximately 70% of the Yukon government's budget. The federal government also spends directly in the Yukon and provides some funding to First Nation governments.

Although the Yukon has traditionally relied on mining as an economic mainstay, the industry entered into a prolonged slump following the closure of the Faro lead-zinc mine in January of 1998. By 2002 there were no operating hard-rock mines in the Yukon, mineral exploration spending had declined steeply, and even placer gold production had fallen to a 23-year low. The total value of mineral production in the territory fell from $225 million in 1997 to $82 million in 2003. In 2004 the value of total mineral production rose to $96 million and mineral exploration expenditures have continued to rise, being estimated at $140 million in 2007. In October 2007 Sherwood Copper officially opened the Minto mine, ending a 5 year stretch of no operating hard-rock mines in the Yukon.

Inflation, as measured by the consumer price index, has been somewhat higher in Whitehorse than in Canada as a whole since mid-2007 (note that inflation is measured for Whitehorse rather than the Yukon as a whole). The data for July 2008 show a 4.2% annual inflation rate in Whitehorse, 0.8% above the Canadian rate of 3.4%. From 2002 through 2004, Whitehorse's inflation rate was 1.1% below the Canadian rate on average.

4.2.3 Ross River

Ross River is the closest community to the Mactung property and all road traffic to and from Mactung must pass through the community. The community as a whole has wide-ranging socio-economic interests in the project. Ross River is located on the south bank of the Pelly River near the confluence of the Ross and Pelly Rivers. The South Canol Road runs through the community with a seasonal ferry providing access to the North Canol Road during the summer. The community is approximately 10 km from the Campbell Highway.

Ross River is the home community of the Ross River Dena Council (RRDC), a Kaska First Nation. The RRDC is not recognized as a self-governing First Nation by the federal government under the Umbrella Final Agreement, but does see itself as exercising inherent self-government rights over its traditional territory. The First Nation delivers a variety of services to its citizens in the community. There is no other form of local government in the community.

4.2.3.1 Ross River: Community Demographics and Economy

- Ross River's population in June 2008 was 383.
- 87% of the population identify themselves as aboriginal in the 2006 Census.
- Ross River has a high proportion of single parent families, 37.5% of all families compared to the Yukon average of 20.7%.
- The 2006 Census found that Ross River had a labour force participation rate of 73.3%, not far from the 78.1% for the Yukon. Unemployment, however, was found to be very high at 21.2%, pointing to high levels of seasonal and/or underemployment.
- Various levels of government provide Ross River's economic base. In 2006 the Census found that 53% of the labour force was employed in public administration, education, health care and social assistance. The most common jobs are in the trades and in the transportation occupational cluster, which includes most construction workers, equipment operators and truck drivers (many of whom are employed by governments).
- Average incomes in Ross River are considerably below the territorial average. The 2006 Census found the average family income in Ross River, $50,585, was approximately 60% of the Yukon average of $86,085.
- In the 2005 tax year (the latest for which data are available); residents of Ross River reported a total of $5.36 million in income from all sources.

- Ross River has two general stores with gas stations, one hotel with a restaurant, and a number of other businesses, including at least two general contractors.
- Anecdotally, many Ross River residents continue to rely on traditional economic pursuits, especially hunting and trapping, for a significant portion of their economic needs.

Ross River's relatively high levels of unemployment and underemployment, coupled with the high proportion of residents experienced in the trades and transportation occupations, indicates that the Mactung project may be able to draw a small proportion of its labour force from the community.

4.2.3.2 Ross River: Infrastructure and Social Infrastructure

- Ross River has a seasonal ferry that crosses the Pelly River. On average, the ferry operates on demand for 145 days per year (May 22nd to October 14th) and carries an average of 28 vehicles per day.
- Policing in Ross River is the responsibility of the RCMP who maintain a detachment in the community.
- Fire and ambulance services are provided by volunteer organizations.
- The Yukon government maintains a health centre staffed with community nurse practitioners in the community.
- The Ross River School offers Kindergarten through Grade 10. A total of 67 students were enrolled in all grades in June 2008.
- The community has some recreational facilities including a hockey rink but not a full-fledged recreation centre.
- In developing an integrated community sustainability plan in 2006, people in Ross River identified substance abuse as a serious health and social problem in the community and made the elimination of such abuse as a long-term community goal.
- Another community health issue identified in the plan was the need for clean, high quality water in the community and better means of sewage disposal.
- On a per capita basis Ross River tends to have one of the highest levels of reported crime in the Yukon. In 2003, for example, there were 68.1 reported crimes per 100 residents, almost double the Yukon average of 32.4 per 100 residents.

Ross River has had considerable experience with the mining industry and a number of residents have worked or are currently working in the mining industry. Given their experience and knowledge of the industry, people in Ross River have a sophisticated approach to new mining development and wish to benefit from economic growth while remaining highly aware of, and concerned, about environmental issues.

4.2.4 Faro

Faro, like Ross River, is fairly close to the project and the community as a whole has socio-economic interests in the development of the Mactung mine, especially if some of the mine's new employees choose to make their home in the community. Faro, located above the north bank of the Pelly River approximately 70km from Ross River, is the Yukon's newest community. It was built in 1969 to house the Anvil Mine workers and their families.

Faro has been an incorporated municipality since 1970 and the Town collects property taxes, delivers a variety of municipal services, and has the authority to pass bylaws in the municipality.

4.2.4.1 Faro: Community Demographics and Economy

- Faro's short history has been marked by wild swings in population as the former mine has opened and closed.
- Faro's population in June 2008 was 385.
- 16% of the population identify themselves as aboriginal in the 2006 Census.
- Faro has a low proportion of single parent families, 14.3% of all families compared to the Yukon average of 20.7%.
- The 2006 Census found that Faro had a low labour force participation rate of 64.3%, well below the 78.1% figure for the Yukon. Unemployment, however, was found to be relatively low at 13.9%, indicating that significant numbers of residents were not working by choice.
- Various levels of government provide a substantial number of the jobs in Faro. In 2006 the Census found that 39% of the labour force was employed in public administration, education, health care and social assistance.
- About 14% of the labour force reported that they worked in mining.
- Average incomes in Faro are somewhat lower than the territorial average. The 2006 Census found the average family income in Faro, $68,599, was approximately 80% of the Yukon average of $86,085.
- In the 2005 tax year (the latest for which data are available); residents of Faro reported a total of $9.24 million in income from all sources.
- The Yukon Bureau of Statistics keeps a spatial price index for Faro and the latest available figures (for October of 2006) show that the cost of living in the community is 16.7% higher than in Whitehorse.
- Faro has been struggling to maintain even basic business services such as a gas station and general store in the community.

Faro has a high proportion of its work force either working in mining or having the skills and experience necessary to work in the industry. The Mactung project may therefore be able to draw on the community for a small proportion of its workforce.

4.2.4.2 Faro: Infrastructure and Social Infrastructure

- Faro has far more housing (and the related municipal infrastructure such as sewer and water) than it has people. The town could easily accommodate a population three or four times greater than it has now.
- Policing in Faro is the responsibility of the RCMP who maintain a local detachment.
- Fire protection, ambulance and search and rescue services are provided by volunteer organizations.
- The Yukon government maintains the Faro Community Health Centre staffed by nurse practitioners.
- The Yukon government provides schooling in Faro through the Del van Gorder School which offers classes from Kindergarten through to Grade 12. In June 2008 total enrolment was 44 for all grade levels.
- Yukon College operates a satellite community campus in Faro. The community campus provides academic upgrading courses, GED, computer training and various occupation-related courses.
- Faro has a municipal recreation centre that offers a variety of programs and recreation opportunities — including an indoor hockey rink, a four sheet curling rink, summer swimming pool, squash court and weight room — and it has a highly unusual golf course that wends its way through the center of the community.
- On a per capita basis, the reported crime rate in Faro has tended to be the lowest in the Yukon. In 2003, for example, Faro had 7.2 reported crimes per 100 residents, far below the Yukon average of 32.4.

The community of Faro has had, and continues to have, a lot of experience with the mining industry. One of the overriding goals of the community is to attract enough additional permanent residents (especially families with children) to ensure a population high enough to support, maintain and build on its existing infrastructure and services.

4.2.5 Watson Lake and Liard First Nation

Watson Lake is situated in the south-eastern corner of the Yukon at the junction of the Alaska Highway and the Campbell Highway. Watson Lake, along with neighbouring Upper Liard, Two Mile and Two and One-Half Mile Villages, is the home community of Liard First Nation (LFN). Because Mactung is located in the Kaska traditional territory, Liard First Nation has an identified interest in the project.

Watson Lake itself has been an incorporated municipality since 1984 and the Town collects property taxes, delivers a variety of municipal services, and has the authority to pass bylaws in the municipality. The Liard First Nation acts as the only form of local government in Upper Liard, Two Mile and Two and One-Half Mile.

4.2.5.1 Watson Lake and Liard First Nation: Demographics and Economy

- Watson Lake had a population of 1,596 in June of 2008.
- The 2006 Census found a stark difference in employment between the Town of Watson Lake and the three neighbouring Kaska villages. The labour force participation rate in the town was 81.3%, higher than for the Yukon as a whole and much higher than the LFN rate of 63.8%. The unemployment rate in the Upper Liard, Two Mile and Two and One-Half Mile Villages, at 45.9%, was almost four times higher than the 11.9% rate in Watson Lake.
- Among residents of the three Kaska villages, the most common occupations are in sales and service, trades, transport, equipment operators, utilities and manufacturing.
- Overall levels of education in Upper Liard, Two Mile and Two and One-Half Mile are much lower than the Yukon as a whole, with 56.6% of the population aged 15 to 64 not yet having a high school diploma or its equivalent (the Yukon number is 21%). However, nearly 21% of 15 to 64 year olds in the three villages have an apprenticeship or trades certificate, nearly double the Yukon figure of 11.8%.

The very high levels of unemployment in the Liard First Nation villages, coupled with the high levels of residents with trades certificates and apprenticeships points to the likelihood that Mactung could readily draw a portion of its workforce from the community.

4.2.6 Mayo and First Nation of Nacho Nyak Dun

Mayo is located in central Yukon approximately 410 km north of Whitehorse. The community is the home of the First Nation of Nacho Nyak Dun. Because Mactung is located on an overlap between Nacho Nyak Dun and Kaska traditional territory, the Nacho Nyak Dun First Nation has an identified interest in the project. However, Mayo is more than 700 km away from the Mactung site by road and is therefore unlikely to see significant socio-economic effects from the project.

4.2.6.1 Mayo: Demographics and Economy

- In June 2008 the population of Mayo was 460 people.
- The 2006 Census found that Mayo had a higher labour force participation rate than the Yukon as a whole, 81.6% to 78.1%, but also had a higher unemployment rate, 16.1% to 9.4%.
- Those employed in Mayo most commonly fall into the group of occupations classified as management, business, finance & administrative by the Census.
- The 2006 Census found that one third of Mayo residents aged 15 to 64 had not yet completed high school, but the community has a higher proportion of its workforce than the Yukon in holding a college diploma or certificate (27.3% to 24.5%).

5.0 PROJECT DESCRIPTION

5.1 PROJECT IDENTIFICATION

This section contains detailed information of the construction, operation, and decommissioning phases of the project, as well as alternatives to the project.

Design standards and parameters have been identified throughout Section 5 as applicable. Required authorizations and regulatory approvals for the project are identified in Section 1.5. Risk management planning and contingency responses (to address accidents, malfunctions, and emergencies) for this project are described in a separate document: Emergency Response Plan (Appendix M2).

5.1.1 Principal Project

NATC is proposing to design, construct, operate, maintain, decommission, and abandon a tungsten extraction and concentrating mine in east-central Yukon. The principal objectives of the project are to:

- Extract tungsten-bearing ore from Mt. Allan by underground Long-Hole Blasting (LHB) stoping and cut-and-fill mining.
- Concentrate the tungsten mineral at a milling rate of 2,000 tonnes-per-day (tpd) using a scheelite gravity and flotation process.
- Transport the tungsten concentrate to market by way of Edmonton, AB, and Vancouver, BC.

5.1.2 Accessory Activities

In support of the project, NATC is proposing designing, constructing, operating, maintaining, decommissioning, and abandoning:

- A 35 km access road from the North Canol Road (Highway #6) to the pipeline road with a controlled access gate;
- A 13 km access road and water pipeline from the Hess River Tributary to the mine site;
- Macmillan Pass Aerodrome upgrades to accommodate 19-passenger Beachcraft-sized aircraft, or equivalent;
- Freshwater intake facility and associated infrastructure on the Hess River Tributary;
- Water treatment and distribution system, including fire protection;
- Tungsten Processing Mill;
- Ammonium nitrate fuel oil (ANFO) storage facility and emulsion plant, producing 1,300 kg/day of ANFO explosives;
- Workforce accommodation complex and first-aid station;

- Equipment maintenance facility;
- Warehouse, workshop and laboratory facility;
- Administration office and communication system;
- Wastewater treatment facility;
- Solid waste facility (storage and incinerator)
- Powerhouse containing 5 x 2.5 MW diesel generators and power distribution system;
- Waste oil burner for building heating;
- Diesel Fuel Storage Facility for storage of 3.3 million litres of diesel,
- Storage facilities for other hazardous materials (e.g., propane, waste oil, engine oil, lubricants etc.);
- Dry-stacked tailings facility for surface storage of filtered tailings;
- Site haul roads;
- Water diversion structures;
- Water retention dam and reservoir;
- Underground portal, ventilation, conveyor and ramps; and
- Underground crusher and grizzly feeder.

NATC is also planning to conduct the following additional accessory activities:

- Ground transportation of tungsten concentrate from the mine to market via Edmonton, AB, and Vancouver, BC, using the North Canol Road, Robert Campbell Highway, and Alaska Highway.
- Air and ground transportation of supplies, including fuel, food, equipment, etc., from Vancouver, BC, and Whitehorse, YT, to the mine, using the Macmillan Pass Aerodrome, North Canol Road, Robert Campbell Highway, and the Alaska Highway.
- Air and ground transportation of personnel from surrounding Yukon communities to the mine, using the Macmillan Pass Aerodrome and North Canol Road.

5.2 ALTERNATIVES AND CHOSEN APPROACH

5.2.1 Alternatives to the Project

Without construction of a mine at this site, it would not be possible to access the world-class tungsten resource available in the Mactung deposit. This project outlines a feasible method for extracting, concentrating, and marketing the tungsten while considering the effects of the project on the surrounding environment, social and First nations' cultures, and the economic climate in Yukon.

The only alternative to this project is not to mine the Mactung tungsten deposit, which would result in a critical tungsten shortage on the world market. Not developing the deposit would also negate any potential economic gains, lose potential employment and training opportunities, and reduce building opportunities for residents of surrounding communities and Yukon.

5.2.2 Alternative Means to Carrying Out the Project

NATC has considered several alternative means for carrying out the project. Each alternative for each relevant accessory activity is subsequently discussed below.

5.2.2.1 Macmillan Pass Aerodrome to Pipeline Road Access Road

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

NATC considered one alternative to building the 35 km access road from the North Canol to the pipeline access road. The alternative is summarized below.

NATC considered using the existing access road into the Mactung property instead of developing a new access road as proposed. The existing access road is insufficient for transporting concentrate ore as it does not meet width requirements for two-way haul truck traffic and it exceeds 12% grade. These conditions make the existing road prohibitive for use by haulage trucks. To prepare the existing access road for this project would require realignment, assessment, and permitting. Specifically, the work required for the existing access road upgrade would include upgrading a 15 km section (2 km of which is in the NT) of the North Canol road from the Macmillan Pass Aerodrome to the existing access road intersection, upgrading a 6.5 km section of the existing 11 km seasonal access road and constructing a new 7 km section of all-seasonal access road in the NT. The lengthy and uncertain permitting process for the NT portion of the road alignments would also affect the likelihood of timely implementation of this project.

5.2.2.2 Macmillan Pass Aerodrome Upgrades

NATC gave consideration to using the Tsichu River aerodrome located about 14 km northeast of the Yukon/NT border along the North Canol road rather than upgrading the Macmillan Pass Aerodrome in Yukon. The aerodrome upgrades at the Tsichu River location would be simpler and less expensive; however, without the NT access road, this option is not feasible. Also, the Tsichu River upgrade option was not considered to be viable due to the anticipated permitting challenges and time delays associated with conducting work in the NT. There would be little to no socioeconomic benefits to the NT to offset the strain on the environment related to the aerodrome upgrade.

5.2.2.3 Freshwater Intake Facility and Associated Infrastructure

The freshwater intake facility and associated infrastructure includes:

- Upgrading a 13 km access road from the mine site to the Hess River Tributary,

- A 13 km water pipeline from the mine site to the Hess River Tributary, and
- Freshwater intake structure, including pumphouse.

NATC considered two alternatives to the freshwater intake facility and associated infrastructure:

- Using the water impounded by the ravine dam on the mine site
- Drawing water from Cirque Lake in the NWT.

NATC has designed the milling process to use recycled water in all possible applications. However, supplemental fresh water at a rate of 33 m^3/h will be required for portions of the process and for treatment and use as potable water. The water impounded by the ravine dam is not considered chemically suitable for use at the mine without significant treatment. Removing water from Cirque Lake was not considered to be viable due to the limited catchment area above Cirque Lake making continuous water supply not possible and to the permitting challenges and time delays associated with conducting work in the NT. There would be little to no socioeconomic benefits to the NT to offset the anticipated strain on the environment related to withdrawing water from Cirque Lake.

5.2.2.4 Tungsten Processing Mill

NATC considered various mill rates and process designs to assess the feasibility of constructing a mine at Mactung. The milling rate of 2,000 tpd was selected because it was the most efficient milling rate for the grade of ore available at Mactung. Milling at a higher rate would increase the world supply of tungsten to a level that would depress the price of tungsten and potentially force the mine to close prematurely. A higher milling rate would also result in a shorter life span of the mine, which is less favourable from a socioeconomic viewpoint. Milling at a lower rate also does not allow a return on the investment to make the mine economically feasible.

NATC reviewed several different process flow sheets using the gravity and flotation and process. The differences related primarily to maximizing tungsten recovery and producing marketable concentrates. Each flow sheet assessed would have a similar effect on the environment, with the exception of the conventional tailings disposal versus dry-stacked tailings disposal. The dry-stacked tailings option was selected due to the ability to use the filtered tailings in the underground permafrost mine as backfill, plus the significant advantage in mine reclamation and closure planning.

5.2.2.5 On-Site Infrastructure and Facilities

NATC considered locating some infrastructure off site in Ross River or Whitehorse, YT, rather than on site. Infrastructure such as the mill, equipment maintenance facilities, powerhouse, tailings disposal areas, and ammonium nitrate production and storage facility could not be moved off site because the nearest community is too far away to make it feasible due to excessive transport costs, logistics, and environmental considerations, such as increased generation of greenhouse gases.

The distance to the closest community also necessitated an on-site workforce accommodation complex. Some administration facilities could possibly be located away from the mine site; however, technical staff will be located near the mine. Splitting the administration into two locations is not practical, so all administration will occur at the on-site office with the exception of accounting and finance, which will continue in the Vancouver, BC office. The corporate headquarters will remain separate from the on-site administration and will continue to operate from the existing Vancouver, BC, and Whitehorse, YT, locations.

5.2.2.6 Underground Mining Method

NATC considered using an open pit mining method as opposed to the underground mining method currently proposed. The open pit mining method would involve stripping the overburden from the ore body and mining from the top of the ore body down.

However, the higher grade ore is found at lower elevations in the ore body, making it preferable to mine the lower portion of the ore body first. There is an opportunity to have an open pit mine later to extract the lower grade ore that will be left above the underground mine.

5.2.2.7 Dry-Stacked Tailings Storage Facility

NATC considered three tailings disposal options: conventional slurry disposal, thickened slurry disposal, and dry-stacked tailings disposal.

Conventional and thickened tailings both require permanent tailings impoundment dams. The on-site topography dictates that a high tailings dam would be required to impound the amount of tailings expected to be generated. The crest elevation of the required tailings dam would exceed the elevation of the soil deposits in the valley. Therefore, portions of the dam would need to be constructed into the rock on the north side of the mountain valley. Construction into this mountain face is not practical and is potentially dangerous due to the steepness of the mountain slopes.

There are also potential closure problems with using an unconsolidated tailings type (such as conventional or thickened tailings). Experience shows that closure costs are often higher because it is not possible to operate construction equipment on the soft sediments without significant work.

The dry-stacked tailings disposal method selected has the benefit that it does not require a permanent tailings impoundment dam, only a temporary water retention dam downstream of the facility. Also, the tailings are placed in a consolidated manner, which will facilitate closure activities.

The location of the dry-stacked tailings facility was selected to ensure it is contained within the containment area of the water retention dam. In addition, the selected location does not effect the stream in the valley because the toe of the tailings pile is designed to be set back at least 30 m from the banks of the stream. Furthermore, it is potentially expandable to accommodate the tailings generated if NATC wishes to develop additional phases of the mine in the future.

5.2.2.8 Process Water Retention Structure

A water retention dam is required to create a reservoir to store the process water while it ages (~30 days). This aging process allows the flotation reagents to decompose to ensure there is no interference with the sulphide and scheelite flotation circuits when reclaimed water is used in the process. The dam is also designed to impound any runoff water from the dry-stacked tailings facility and the mine infrastructure area.

NATC considered using an in-ground type of pond to retain the process water during its aging process. The in situ soils are highly permeable so a synthetic liner would be required across the entire pond. In addition, due to the mountainous terrain, there is no suitable location for a pond large enough to retain the volume of water required, so the capacity would have to be made up from several smaller ponds. These options have a higher chance of failure and are less economical.

5.2.2.9 Waste Disposal

NATC considered hauling waste oil, solid, and sewage waste to Ross River for disposal. However, this option was not selected due to excessive costs and environmental effect, such as increased release of greenhouse gases.

5.2.3 Comparison and Selection of Alternatives

The comparison and selection of alternatives was discussed in the previous section and will not be repeated here.

5.3 TECHNOLOGIES

Several technologies are proposed for use as part of the overall Mactung mine development:

- Long-hole blasting mining method
- Mechanized cut and fill mining method
- Underground conveyor and crusher
- Sulphide flotation
- Gravity concentration
- Scheelite flotation
- Concentrate drying

- Magnetic separation
- Filter presses for dewatering tailings (dry-stacked tailings)
- Heat traced water supply lines
- Sewage Treatment Plant
- Utilidor structures for service lines
- Waste oil burners
- Solid waste incinerator
- Geosynthetics for use in the water retention dam.

The underground mining methods proposed were chosen to mine the ore body in the most efficient manner. The drilling methods incorporated in the mining method are chosen to be pneumatic to prevent freezing of drill fluids in the permafrost conditions.

Considerations for permafrost were also made during the mine ventilation design. Fresh air will not be heated in the winter to reduce the thaw bulb that will form around all the underground openings. Fresh air may be cooled during the summer to keep the temperature underground cool enough to preserve the marginal permafrost that currently exists at the site.

Underground crusher stations and conveyor belts are in use in several other northern mine sites. The presence of permafrost and the use of the conveyor-way as a return-air-conduit are not expected to significantly hinder the efficiency of the use of this equipment. A similar set-up is currently in use at the EKATI Diamond Mine, NT. This mine has a 2.4 km long conveyor system incorporated with an underground crusher to bring ore to the surface from its underground operations.

The ore processing methods proposed for the Mactung property is similar to the processing method currently in use at NATC's existing Cantung property. This processing method has worked well at Cantung and is also anticipated to work well at the Mactung property due to the similar geology and mineralogy between the two deposits. The process method was confirmed through a series of laboratory bench scale tests and pilot plants conducted in the 1970s and 1980s. These laboratory bench scale tests and pilot plant results were reviewed, and a new process flow sheet was developed in 2007/2008.

Heat tracing of water lines is used throughout northern Canada to prevent freezing of water distribution lines. The system must be property designed for the type, size, and insulation of a pipe as well as the anticipated environmental conditions. There should be no issues with using this technology at the Mactung property.

The sewage treatment plant proposed for the Mactung property is a containerized rotating biological contactor. This sewage treatment system is successfully employed at many remote sites in Canada. The system is completely insulated and containerized allowing it to be placed anywhere, and according to manufacture's literature, it can operate to sustained outdoor temperatures as low as -40ºC. Similar types of sewage treatment systems are in place at the EKATI Diamond Mine, Diavik Diamond Mine, and the Minto Copper Mine.

Enclosed insulated utility corridors (utilidors) are proposed for use at the Mactung mine. Since the process plant and accommodations complex infrastructure are separated, there is a need to move utility services between them. Burying pipes to a sufficient cover depth is not feasible in the mountainous terrain. Utilidors have been used for decades in many remote northern communities and mine sites. Examples of a community and a mine site that employ utilidors are Inuvik, NT, and the EKATI Diamond Mine, NT.

Waste oil burners and solid waste incinerators are common in remote areas of human habitation. Waste oil and combustible solid wastes can be incinerated on site to produce heat, instead of hauling garbage and waste oil back to a community, such as Whitehorse, for disposal, thus reducing greenhouse gas emissions. Incineration also destroys food waste, which often attracts animals to the site. With no outdoor food waste disposal or storage, the chance for human to animal interaction is decreased. The use of incinerators and waste oil burners is common at remote mine sites; for example, it is currently in use at the Ketza River property, Minto Copper Mine, EKATI Diamond Mine, and the Diavik Diamond Mine.

NATC is proposing the use of a filter press system to dewater the mine tailings. This tailings system is currently in use at the Minto Copper Mine, YT, and Pogo Gold Mine, Alaska, and was in use at the Raglan Nickel Mine, QC. With a diligent tailings disposal procedure, there is no concern of the tailings freezing in place before they can be placed and compacted in the dry-stacked tailings facility. Any surface drainage will be directed off the stacked tailings and into the reservoir of the ravine dam.

NATC is proposing to place 50% of the tailings on surface and the other 50% of tailings underground as backfill. The surface stacked tailings will be placed and compacted to reduce the liquefaction potential of the tailings, but the underground tailings will be placed in a loose state. Since the underground tailings are placed in an unconsolidated condition, there is a potential for the underground disposed tailings to liquefy if exposed to a seismic load. To account for potential liquefaction of the backfilled tailings, bulkheads will be installed to close in the mined-out and backfilled stopes. The use of unconsolidated backfill material is a common practice worldwide in the mining industry.

NATC is proposing to use geosynthetics in lieu of high quality aggregates and low permeable core material in construction of its water retention dam. Geosynthetics have been used successfully in many water retention dams around the world. The proposed liner system, which replaces the traditional core of the dam, is fabricated from high-density polyethylene and has a secondary liner consisting of bentonite clay needle-punched between two pieces of nonwoven geotextile. This two liner system has been effectively used in a cold weather environment for two dams at the EKATI Diamond Mine.

NATC is also proposing to use geosynthetics to replace high-quality aggregates required for drains, erosion protection, and spillways. The drains will be fabricated from a layer of soil reinforcing grid bonded between two pieces of nonwoven geotextile. The nonwoven geotextile filters the silt particles out of the soil (to prevent piping) and the soil grid provides a strong conduit in which the water will flow. The erosion protection used on the upstream slope and the spillway will be a fabric formed grout. A sock is sewn from nonwoven geotextile and then rolled into place on the dam. The sock is then pumped full of grout, creating a 150 mm thick grout panel. The fabric formed grout system is a common grout placement system and has been used throughout Canada in many applications.

5.4 PROJECT PHASES AND SCHEDULING

5.4.1 Project Schedule

A Gantt chart summarizing the anticipated project schedule is included in Figure 5.4.1-1. This schedule assumes the YESAA application will be submitted by late 2008, the YESAA recommendation will be complete by the end of 2009, Quartz Mining Licence Part 1 by early 2010 to allow for non-water-related construction to begin, and a Type A water licence and a Quartz Mining Licence Part 2 by summer of 2010. Long delivery equipment will be ordered as early as summer 2009. NATC may also apply for a Type B Water Licence for the construction phase of the project to allow for construction of access roads and other associated work that would required a Water Licence.

If the permitting portion of the project is completed on schedule, then construction will begin in the spring of 2010. A schedule of proposed construction activities is included in Figure 5.4.1-2. Construction of each component will begin upon receipt of the applicable regulatory approval (permit, licence). Construction of the access road and aerodrome upgrades will be completed first during the summer of 2010. At the same time, the camp and site development construction will begin, which will last until summer 2012. The camp and site development item includes the following development: three levels of cut and fill pads and all the building infrastructure construction except for the process plant and the powerhouse.

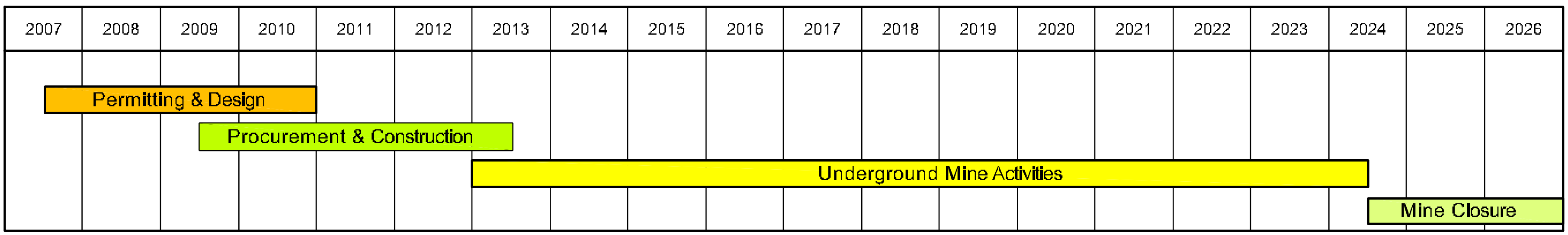
Construction of the process plant will commence immediately after the site pad and foundation is prepared, approximately fall 2010. Construction is expected to take 24 months, lasting until fall 2012. The power plant and power line infrastructure construction will commence in spring 2011 and will take approximately 15 months to complete.

The dry-stacked tailings facility and water retention dam construction will begin in spring 2011 and is expected to take approximately 18 months to complete, with little work completed during the winter of 2011.

Mine pre-development will commence at the beginning of 2011 and will last for approximately 21 months, ending in time for the site commissioning to take place in the fourth quarter of 2012. This correlates with the commencement of mining activities at the beginning of 2013.

The underground production phase will commence at the end of 2012 and is expected to last 11 years. Underground mining activities are projected to end in 2024. Approximately two years prior to this date, NATC will determine whether it is feasible to continue mining. If so, subject to regulator approval, overburden stripping will begin for development of the open pit. Open pit mining could extend the mine life by approximately 16 years, ending mine activities in 2040.

Closure activities will follow the underground mining phase should it be determined that the open pit is not feasible. Closure activities immediately after underground mining will take approximately two years and be completed by the end of 2026. If the open pit mine is feasible, then closure is expected to take approximately three years and be complete by the end of 2043.



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Overall Project Schedule

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Figure 5.4.1-1

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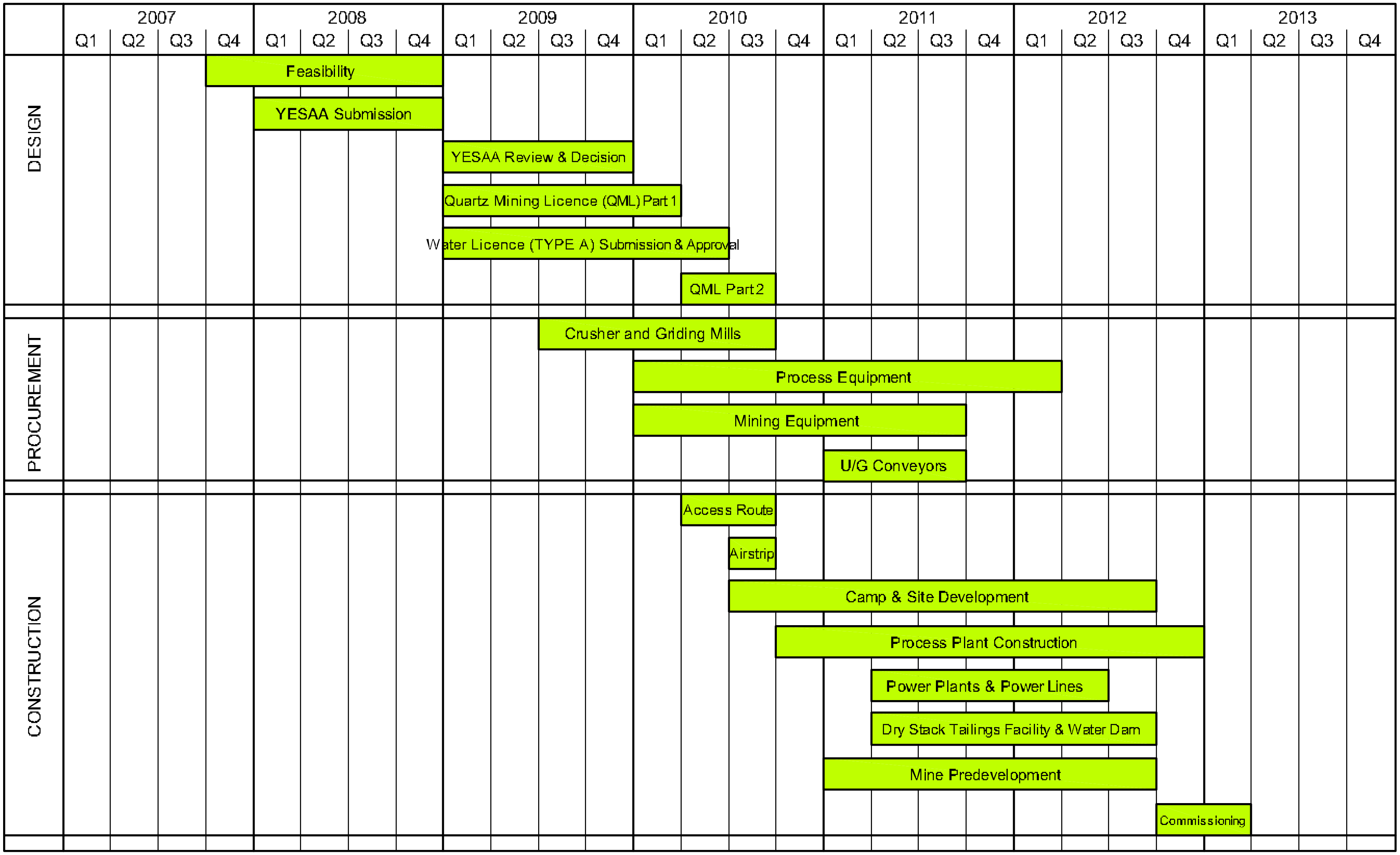

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Construction Phase
Project Schedule

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Figure 5.4.1-2

5.4.2 Construction Phase

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The construction phase of the Mactung project will commence in the Spring of 2010 and be completed and commissioned by fall 2012, at which time the operation phase will begin. The construction phase of the project will include the following activities sorted by their start dates:

- Establish staging areas near Ross River and near the Macmillan Pass Aerodrome;
- Construct temporary construction camp near the aerodrome;
- Develop one borrow site near aerodrome for aerodrome upgrades;
- Develop borrow sites along proposed access road for road construction;
- Upgrade existing Macmillan Pass Aerodrome;
- Upgrade the existing tote road (quad trail) to a haul road from the North Canol to approximately km 17.5;
- Construct a new haul road from approximately km 17.5 to the Tributary A crossing;
- Upgrade existing service road to a haul road from Tributary A crossing to the Mactung site;
- Upgrade existing seasonal service road to all-season service road from Tributary A crossing to the Hess River tributary;
- Construct water intake infrastructure;
- Develop two borrow sites near mine;
- Construct infrastructure pads and site roads;
- Move construction camp to location of permanent camp;
- Close and abandon temporary aerodrome camp;
- Construct fuel storage facility;
- Construct process plant;
- Construct explosives magazine and emulation plant;
- Construct equipment maintenance facility and administration building;
- Develop underground access;
- Construct underground crusher and conveyor;
- Construct powerhouse;
- Develop underground access to ore body;

- Construct the ravine dam;
- Construct the dry-stacked tailings facility foundation;
- Construct surface water management infrastructure; and
- Commission facilities.

5.4.2.1 Staging Areas

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

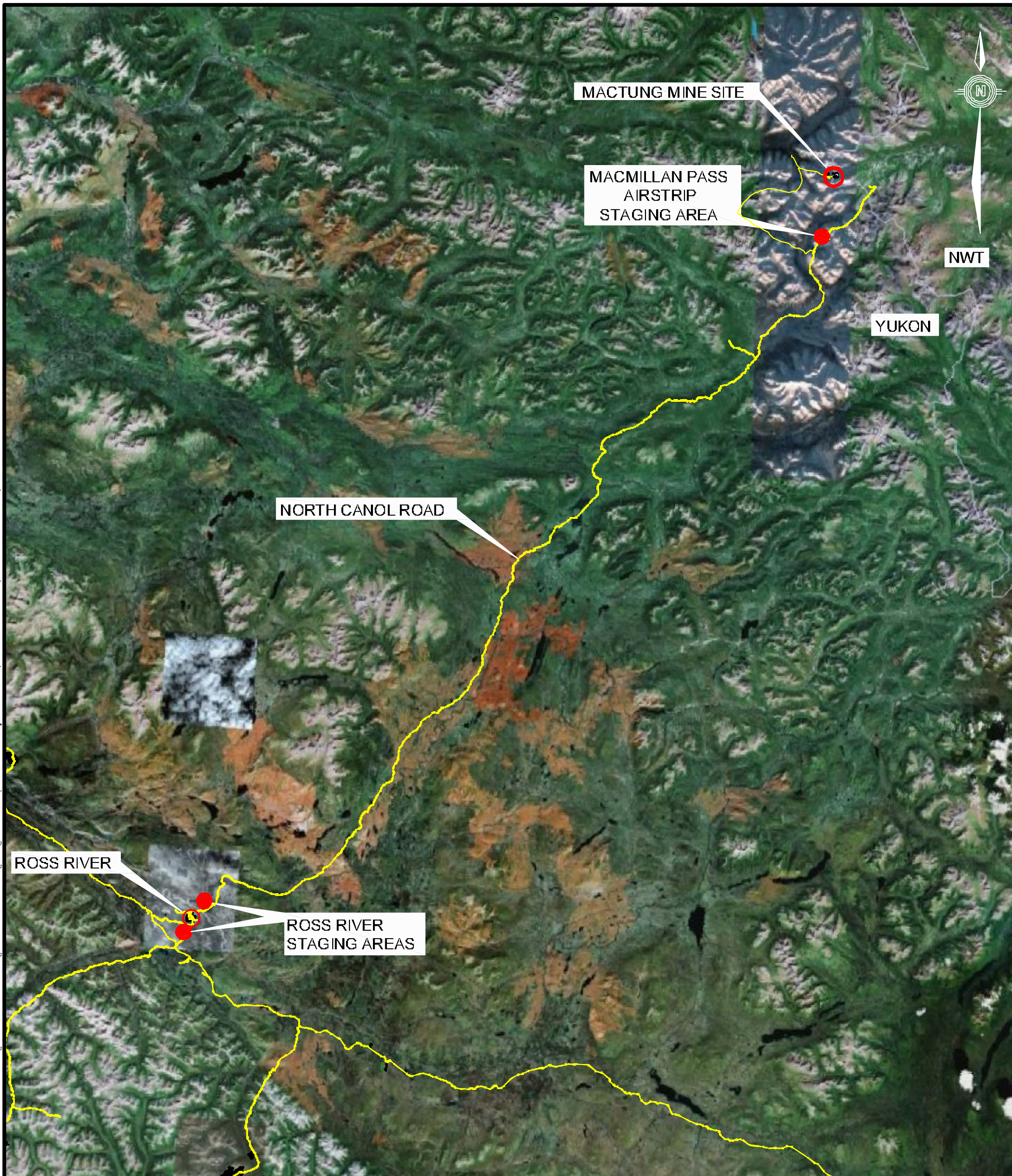
The staging areas will be constructed at the three locations identified in Figure 5.4.2-1. Construction of the staging areas will be limited to removing vegetation cover in the area; levelling the ground surface either by balanced cut/fill methods (i.e., the amount of material cut will be equal to the amount of fill required to create a level pad) or by a combination of cut and importing fill from existing nearby borrow areas to level the site; and placing gravel surfacing to allow the areas to be accessed by trucks and heavy equipment and to promote drainage off the pad into the surrounding forested areas. General plans of the three staging areas are included in Figures 5.4.2-2 and 5.4.2-3.

A timber salvage plan will need to be developed with Government of Yukon Department of Energy, Mines, and Resources, Forestry Branch (Forestry) as part of the tender package. Tree removal need to be conducted in accordance with Yukon Forestry.

The staging areas will be sized to accommodate construction material storage that is transported from the various vendors to the applicable construction site but will not exceed 20 ha. The materials will be hauled from the vendor to Ross River at a faster rate than they can be hauled from Ross River to the site, necessitating a staging area near Ross River. Since there can also be delays associated with crossing Pelly River (especially in freeze-up and break-up seasons), one staging area will be constructed on each side of the river.

The staging area at the aerodrome will allow short-term storage until the equipment is required on site. Not all equipment will be staged at this location, but equipment may be staged here for durations of up to 1 year.

All staging areas will be securely fenced to protect both NATC and the public. The two staging areas in Ross River will be used until the end of the reclamation phase. At that time, they will be closed, reclaimed, and abandoned. The staging area near the Macmillan Pass aerodrome will be closed, reclaimed, and abandoned after the construction phase of the project is complete.



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Staging Area Locations

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Figure 5.4.2-1

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Ross River Staging Areas

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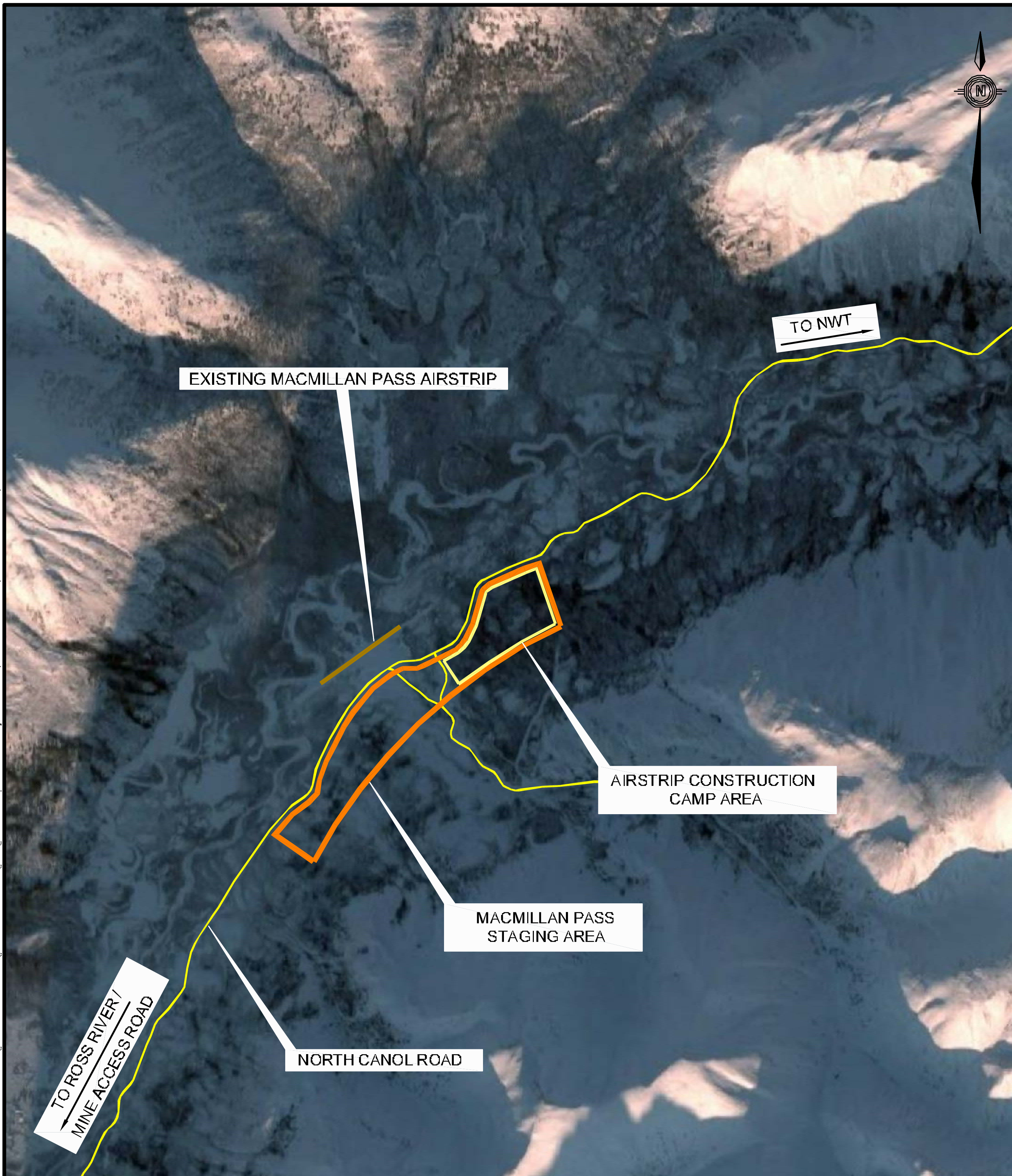
Figure 5.4.2-2

FIGURE 5.4.2-2] December 2, 2008 - 8:52:20 am [BY: BOB RICHMOND]



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MacMillan Pass Staging and Camp Area

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Figure 5.4.2-3

5.4.2.2 Borrow Sites for Construction near Aerodrome

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

NATC proposed to develop one borrow area near the existing Macmillan Pass Aerodrome. Development of the borrow areas will include removing trees, as necessary; stripping organics; and developing a pit by hauling selected fill to the construction area. The developed pit will have at least one access point and sideslopes of 33.7° (1.5H:1V), except in the working face. Material produced in the pit that is unacceptable for use in construction of the aerodrome and access road upgrades will be stored in the pit.

The borrow pit will be sized to provide the required amount of fill to complete the upgrades to the aerodrome. The estimated volume of fill required for the aerodrome upgrades is 150,000 m^3. These design standards are typical industry standards when developing a pit.

A timber salvage plan will be developed with Yukon Forestry as a part of the tender package. Tree removal will be conducted in accordance with Yukon Forestry.

5.4.2.3 Temporary Construction Camp

A temporary construction camp will be constructed near the Macmillan Pass Aerodrome to facilitate upgrading the aerodrome and constructing the access road. The camp will be designed to house up to 49 people. It will later be moved to the main site and used as temporary accommodations for construction staff. The camp will consist of modular trailers, including a kitchen/diner module, seven sleeper modules, a wash car module, a sewage treatment module, and a water supply module. A temporary diesel generator will power the camp. Heat for the construction camp will be generated using propane furnaces. Solid waste will be incinerated in a propane-fired solid waste incinerator.

Construction of the temporary construction camp will be limited to removing trees in the area, if required; levelling the ground surface by either balanced cut/fill methods or by a combination of cut and importing fill from existing nearby borrow areas to level the site; and placing a gravel surfacing to allow the areas to be accessed by trucks and heavy equipment and to promote drainage off the pad into the surrounding forested areas. Treated sewage effluent will be disposed into an approved septic field/rock drain. The temporary construction camp location is shown in Figure 5.4.2-3.

The use of modular trailers on a pad is a typical method for temporary camps. It allows demobilizing the camp, decommissioning the site, and abandoning the area to be easy and quick. This type of camp is used worldwide and is an industry standard.

5.4.2.4 Upgrade Existing Macmillan Pass Aerodrome

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The existing aerodrome at Macmillan Pass is approximately 460 m long and 15 m wide. NATC is proposing to upgrade the aerodrome to 1,375 m long and 30 m wide. The upgraded aerodrome will be capable of handling a 19-passenger Beechcraft 1900 or similar aircraft. NATC is also proposing to construct a 90 m by 60 m apron to allow the simultaneous parking of two Beechcraft 1900 aircraft.

Canadian Aviation Regulations summarize the design requirements for a civil aerodrome. The upgrades will be conducted in accordance with these regulations; additionally, the design will be such that the transverse and longitudinal slopes will be no greater than 2%, and the finished elevation of the aerodrome will be above the 1:100 year inundation area for the Macmillan River flood. A flood protection berm may be required to prevent erosion of the aerodrome embankment; this will be determined during detailed design. The aerodrome will be designed for visual flight rules and runway lights will be provided for night use. The proposed aerodrome upgrades are shown in Figure 5.4.2-4.

The aerodrome upgrade designs will be reviewed and approved by the Government of Yukon, Department of Highways and Public Works, who is the owner of this infrastructure. The upgrades will be constructed using the best equipment adapted for the job and in accordance with any additional specifications provided by this Department.

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Airstrip Upgrades

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Figure 5.4.2-4

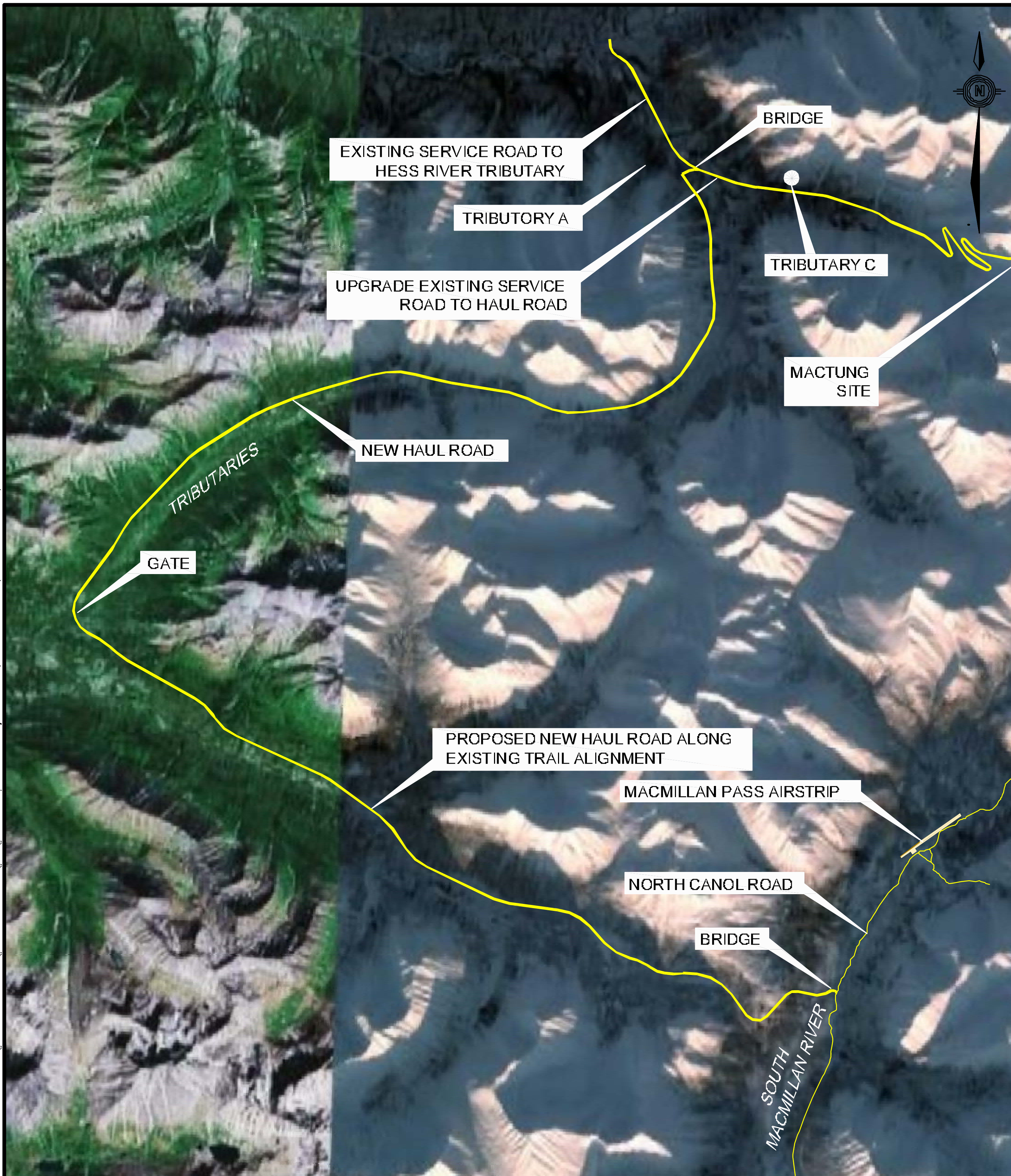
5.4.2.5 Upgrade Existing Tote Road and New Haul Road Construction

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

NATC is proposing to construct a new 35 km haul road from 3 km south of the Macmillan Pass Aerodrome, through three mountain valleys to the Mactung mine site. This road will connect to a road constructed under a mining land use approval which is further described in Section 5.4.2.6. The road will be 8 m wide with a 1 m deep and maximum of 3 m wide ditch, and a 4 m cleared section on either side of the alignment. The road will be designed for speeds between 30 and 50 km/h and have an average grade of 8% with a maximum grade of 12%. The 1 m deep ditch on either side of the road (if necessary, local topography will dictate) will accommodate stormwater flows and spring melt runoff. Cut sections of the road will have 26.7° (2H:1V) slopes and fill sections of the road will have 18.4° (3H:1V) slopes. The road will be surfaced with at least 0.2 m of crushed gravel. The road alignment will follow an old abandoned tote road alignment for the first 17.5 km. The road alignment will then continue over undisturbed ground to the existing pipeline service road near Tributary A. At approximately km 34.5, a bridge will be constructed near the intersection of the haul road and the pipeline service road across Tributary A (on the Mactung mining claims).

The road will traverse a number of potential avalanche areas. Avalanche control measures, including snow pack monitoring, controlled blasting, and impact barriers, will be designed and implemented in the sections of the road that will be in potential avalanche areas. The proposed roads cross approximately 25 streams (less than 5 m wide) and 3 rivers (more than 5 m wide).

The three river crossings are the South Macmillan River, Hess River Tributary A and potentially Tributary E. These rivers will be crossed, if required, by constructing single-lane bridges, similar to those constructed along the North Canol Road. The 25 streams will be crossed by installing culverts. Stream crossing culverts sized to accommodate at least the 1:50 year peak flow for stream being crossed, but a minimum size of 900 mm will be used. The roadway in the vicinity of the culvert crossings will be designed for an overtopping scenario. Regular repairs and maintenance, including snow removal in the areas of culverts, will be conducted to ensure the roadway is in a condition to accept overtopping flows at all times. The road alignment is shown in Figure 5.4.2-5, and a typical cross-section is shown in Figure 5.4.2-6. Typical culvert crossing road overtopping plan is shown in Figure 5.4.2-7.



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Access Road Alignment

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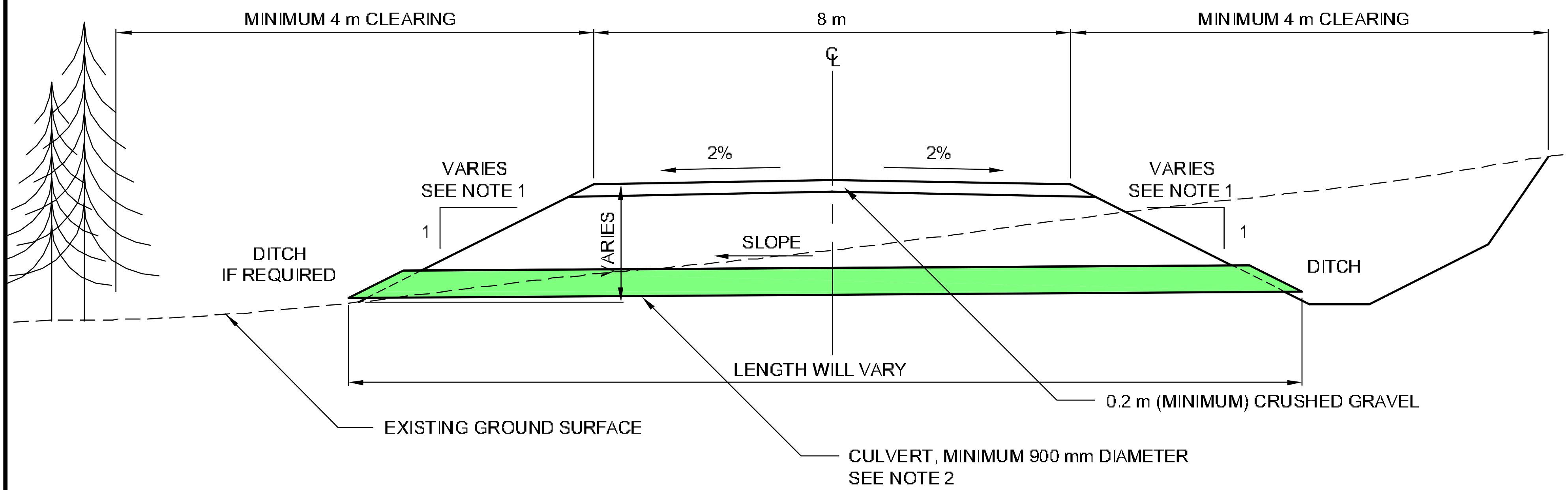
Figure 5.4.2-5



NOTES:

1. SIDE SLOPES OF ROAD WILL VARY DEPENDING ON CUT OR FILL CONDITIONS. FOR CUT SECTIONS OF THE ROAD THE SIDE SLOPE WILL HAVE A 2H:1V SLOPE, FOR FILL SECTIONS OF THE ROAD THE SIDE SLOPES WILL HAVE A 3H:1V SLOPE.

2. FLOW DIRECTION AND SLOPE WILL VARY, DUE TO TOPOGRAPHY.

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Access Road - Typical Culvert Cross-Section

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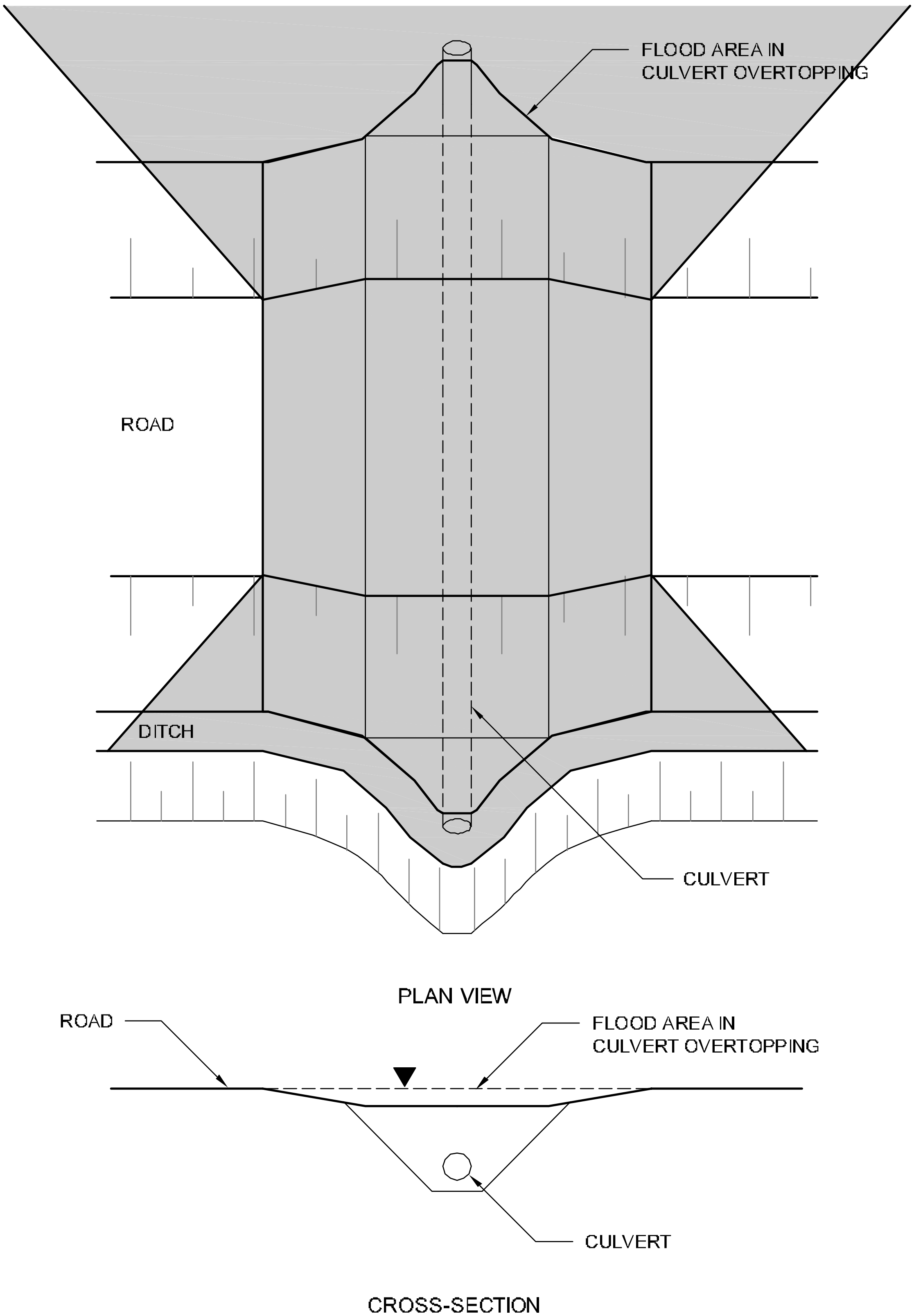
Figure 5.4.2-6



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Culvert Crossing - Road Overtopping

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Figure 5.4.2-7

5.4.2.6 Upgrades to Existing Road to Hess River Tributary

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

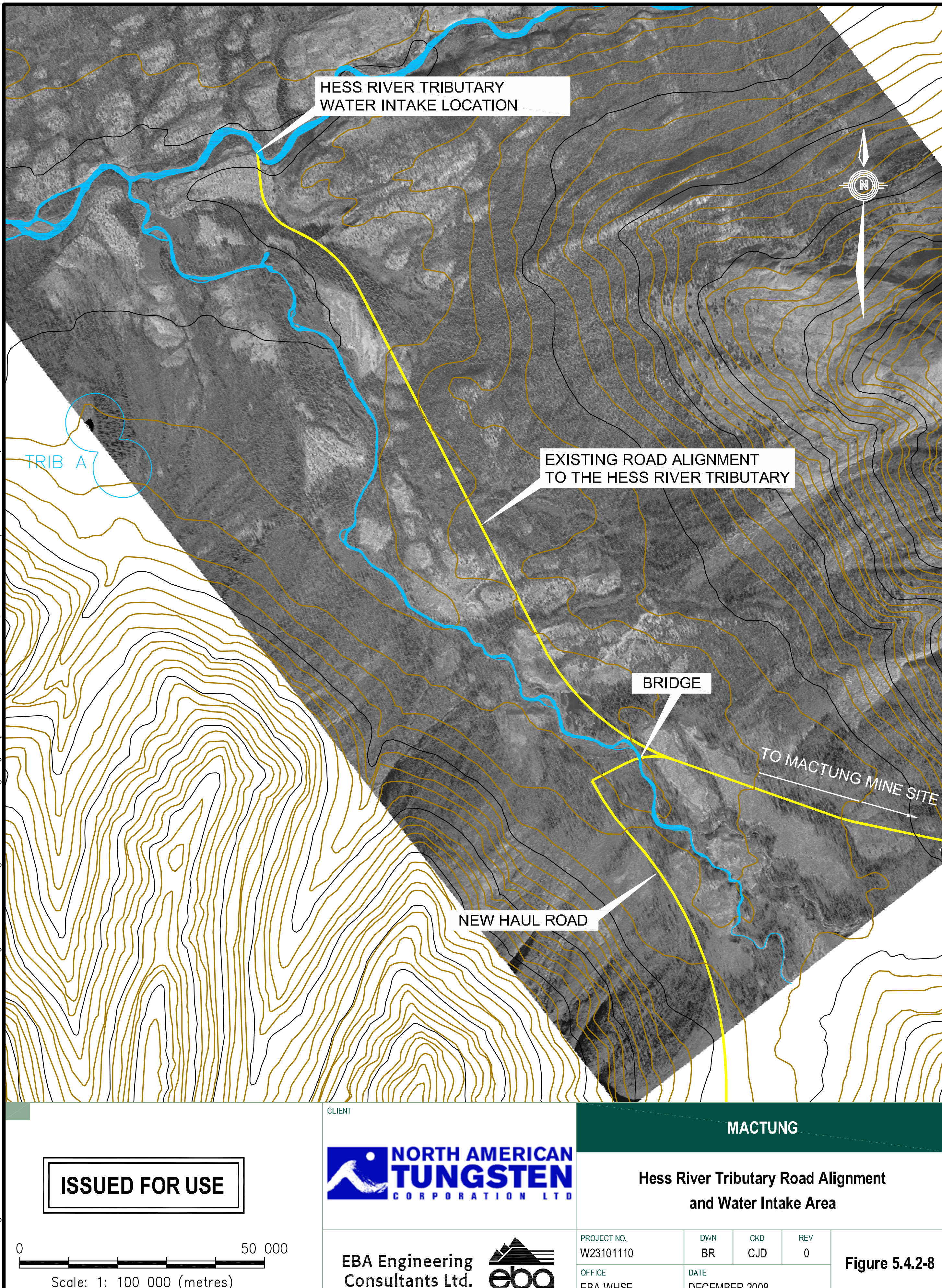
NATC has already proposed to construct a 3 km long 5 m wide road to from the location where the haul road will cross Tributary A to the Hess River Tributary. The Hess River Tributary is where the fresh water intake source will be for the mine.

The upgraded road will be 5 m wide with a 2.5 m cleared section on either side of the alignment. The road will be designed for speeds between 30 and 50 km/h and have an average grade of 8% with a maximum grade of 12%. The road will have a 1 m deep ditch on either side to accommodate stormwater flows and spring melt. Cut sections of the road will have slopes at 63.4° (0.5H:1V) in rock sections and 33.7° (1.5H:1V) in soil sections and fill sections of the road will have 18.4° (3H:1V) slopes. The road will be surfaced with at least 0.2 m of crushed gravel.

No bridges are anticipated for this section of the road, and the minimum culverts sized to accommodate at least the 1:50 year peak flow for stream being crossed, but a minimum size of 900 mm will be used. The roadway in the vicinity of the culvert crossings will be designed for an overtopping scenario. All of the above has been outlined in the separate YESAA application for this road, and the upgrades to be considered under this application are discussed below.

Since the road will traverse several potential avalanche areas, avalanche control measures, including snow pack monitoring, controlled blasting, and impact barriers, will be designed and implemented in the sections of the road that are in potential avalanche areas.

Regular repairs and maintenance, including snow removal in the areas of culverts, will be conducted to ensure the roadway is in a condition to accept overtopping flows at all times. The road alignment is shown in Figure 5.4.2-8 and a typical cross-section is shown in Figure 5.4.2-9.



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Hess River Tributary Road Alignment and Water Intake Area

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Figure 5.4.2-8

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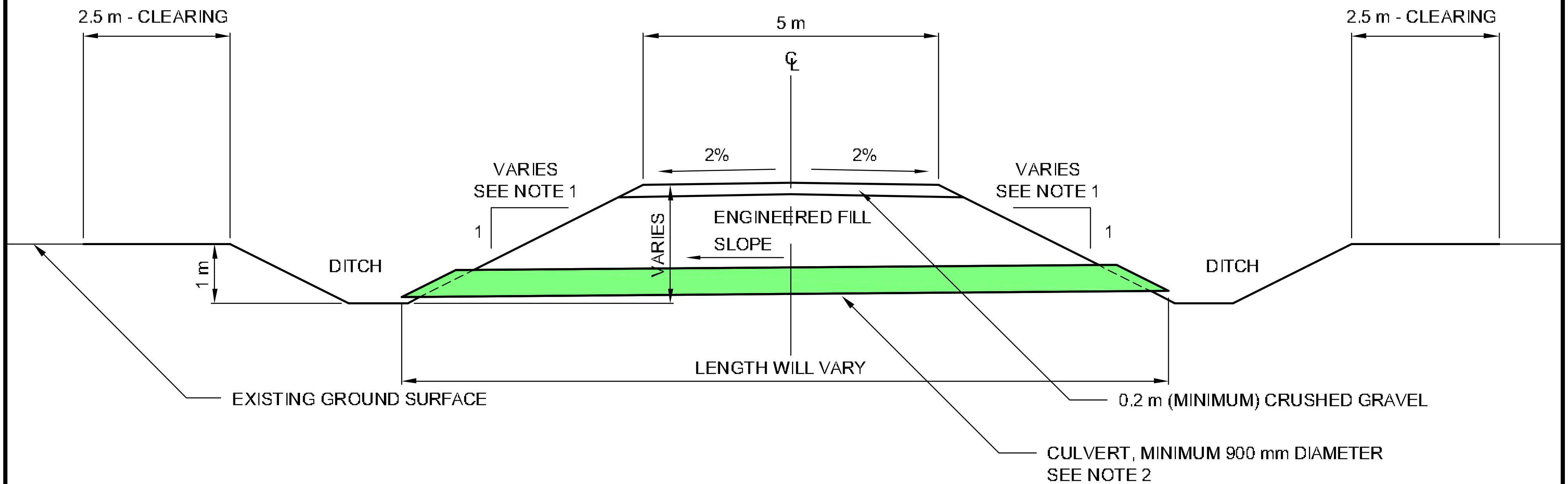

NOTES:

1. SIDE SLOPES OF ROAD WILL VARY DEPENDING ON CUT OR FILL CONDITIONS. FOR CUT SECTIONS OF THE ROAD THE SIDE SLOPE WILL HAVE A 2H:1V SLOPE, FOR FILL SECTIONS OF THE ROAD THE SIDE SLOPES WILL HAVE A 3H:1V SLOPE.
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Hess River Tributary Road
Culvert Crossing - Typical Cross-Section

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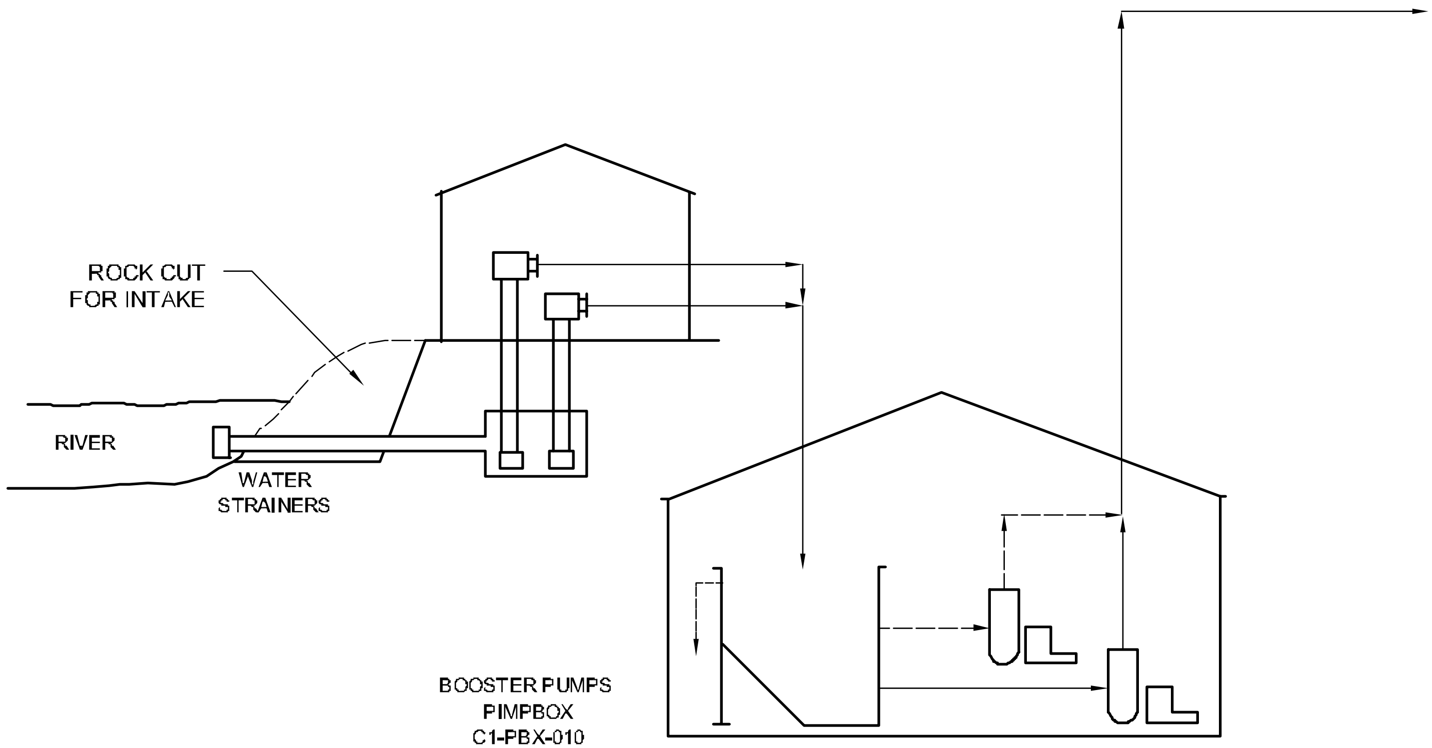
Figure 5.4.2-9

5.4.2.7 Water Intake Infrastructure

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The water intake infrastructure at the Hess River Tributary is required to supply the camp and mill with fresh water for domestic use and for use in the processing of the ore. The fresh water intake infrastructure will consist of a slot cut into the rock bank of the Hess River Tributary; two submersible pumps, each capable of supplying approximately 33 m^3/h; and one 13 km long pipe with a diameter varying from 100 mm to 250 mm.

Only one pump will operate at a time to ensure continuous water supply if one pump fails or requires service. The fresh water will be pumped from the Hess River Tributary to the mine site through one 100 mm diameter to 250 mm diameter insulated and heat-traced steel and/or HDPE pipes. The pipe sections will be constructed on a pipe bench adjacent to the access roads. The freshwater pipeline will connect to the freshwater and firewater storage tank near the accommodations complex on site. The freshwater and firewater storage tank will be insulated and fabricated of carbon steel. It will be approximately 10 m high with a diameter of 11 m. The tank will have a usable capacity of 810 m^3, with freshwater and firewater capacities of 128 m^3 and 682 m^3, respectively. A plan and section of the intake structure are shown in Figure 5.4.2-8 and Figure 5.4.2-10, respectively. A plan and section of the pipeline bench are shown in Figure 5.4.2-11. The freshwater and firewater storage tank is shown in Figure 5.4.2-12.



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Water Intake Cross-Section

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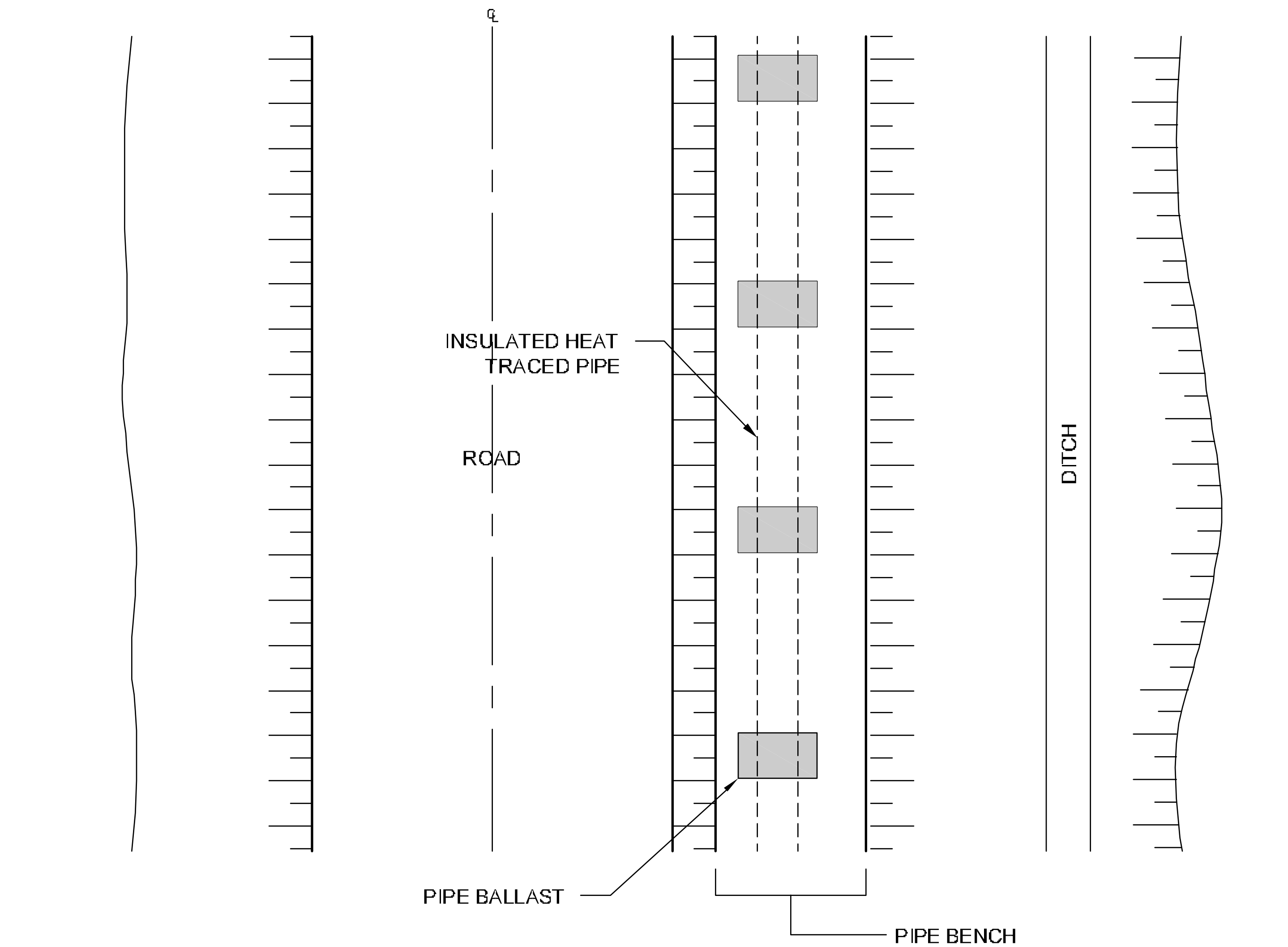
Figure 5.4.2-10



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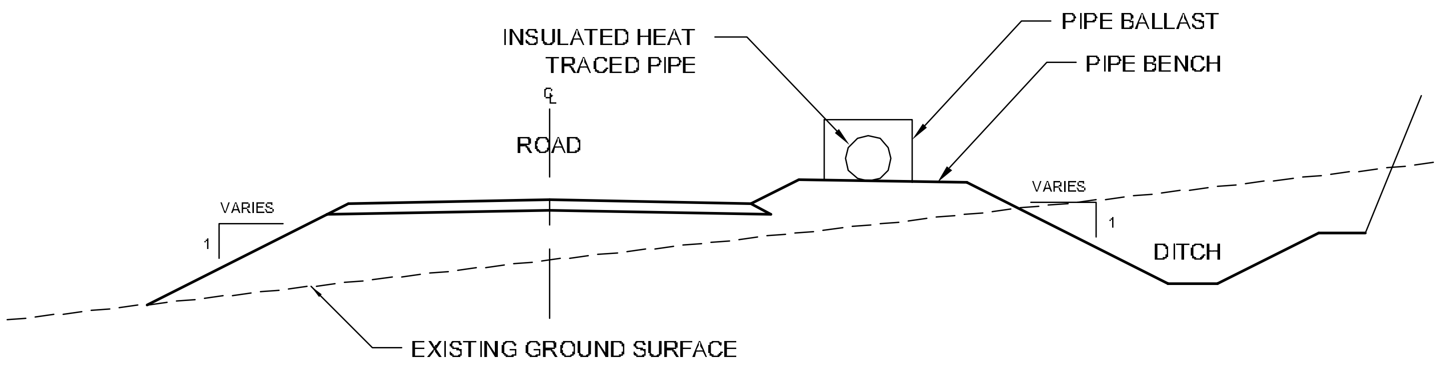

CROSS-SECTION

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		Pipe Bench - Plan and Cross-Section			
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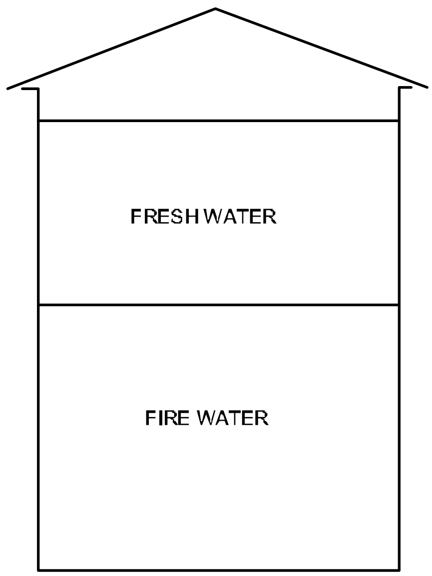
		OFFICE EBA-WHSE	DATE DECEMBER 2008		Figure 5.4.2-11



FRESH / FIRE WATER
TANK
11 000 X 10 000

REFERENCE: WARDROP Engineering Inc. drawing,
Project No.: 0753390101, Drawing No. A0-30-020

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Fresh and Fire Water Tank

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Figure 5.4.2-12

5.4.2.8 Borrow Areas for Development at Mine Site

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

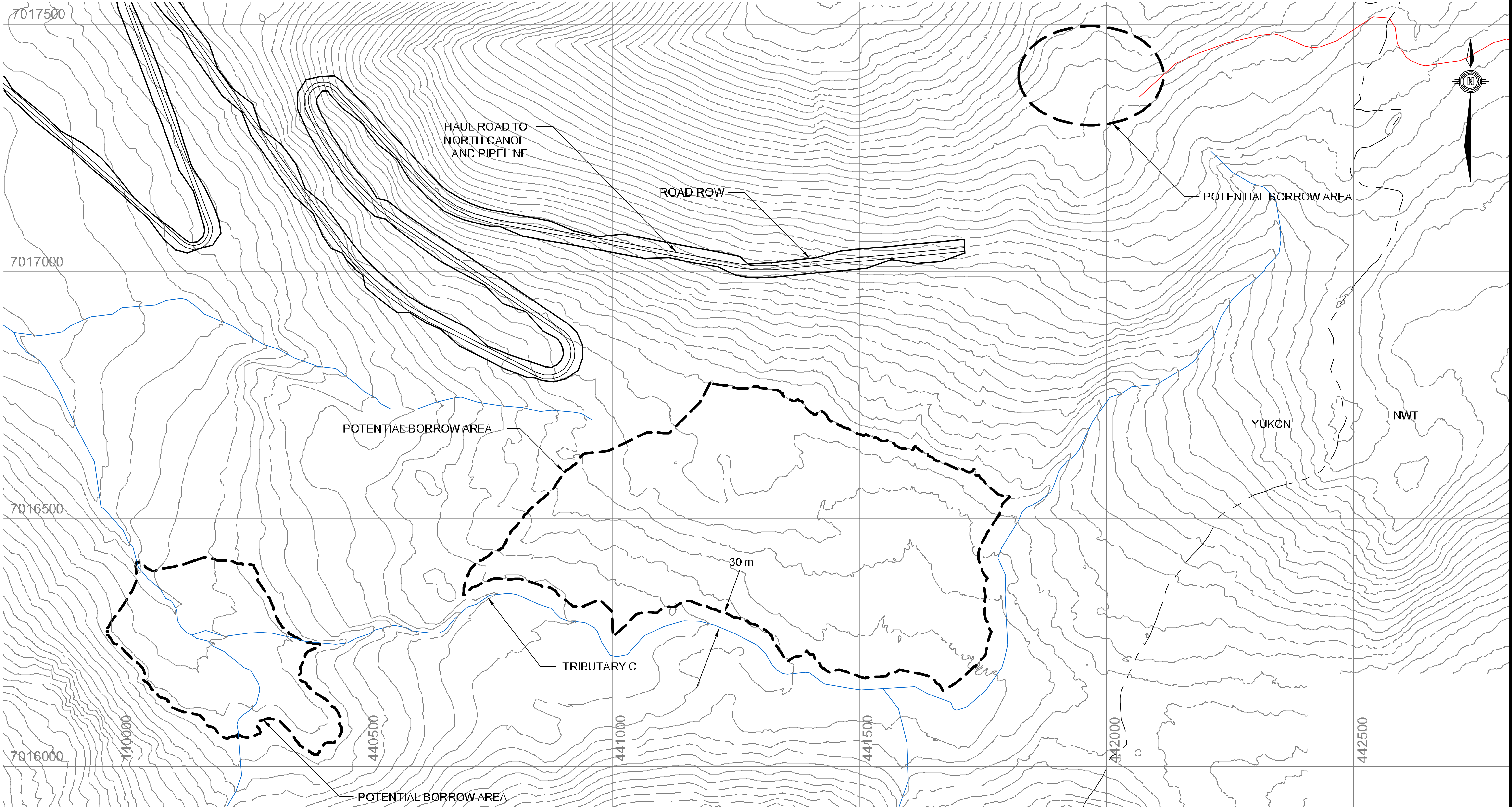
NATC is planning to develop up to three borrow areas near the proposed mine site, as shown in Figure 5.4.2-13. Two of the proposed borrow areas are to be developed as pits and one as a quarry.

Development of the pit borrow areas will include stripping of organics and development of a pit by hauling selected fill to the construction area. The developed pit will have at least one access point and sideslopes of 33.7° (1.5H:1V), except in the working face. Material produced in the quarry that is unacceptable for use in mine site development will be stored in the pit. These design standards are typical industry standards when developing a pit.

The borrow pits will be sized to provide the required amount of fill to meet the demand for engineered fill to complete the mine site development. The estimated volume of fill required from the pits is approximately 500,000 m^3.

Development of the quarry borrow areas will include stripping of organics; stripping of overburden soils, which will be used as engineered fill if it meets the specifications; and development of a quarry by drilling and blasting the bedrock. The developed quarry will have at least one access point and sideslopes of 14°(4H:1V) in the overburden soils and 27° in the blasted rock. Once the bedrock is blasted, it will be processed using a mobile rock crusher designed to process the blasted rock to specifications developed during detailed design phase of the project. Processing will include crushing with a jaw crusher, crushing with an eccentric hydraulic cone crusher, screening with a vibratory screen deck, and then washing in a suitable plant for production of concrete fine aggregate. Material produced in the quarry that is unacceptable for use in mine site development will be stored in the pit. These design standards are typical industry standards when developing a quarry.

The borrow quarry will be sized to provide adequate fill to meet the demand for high quality aggregates to complete the mine site development. The estimated volume of high quality aggregate required to be borrowed from the quarry is approximately 50,000 m^3.



NOTE:
Contours shown at 10 m intervals.

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0 — 250
Scale: 1: 7 500 (metres)

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Potential Site Borrow Areas

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Figure 5.4.2-13

5.4.2.9 Infrastructure Pads and Site Roads

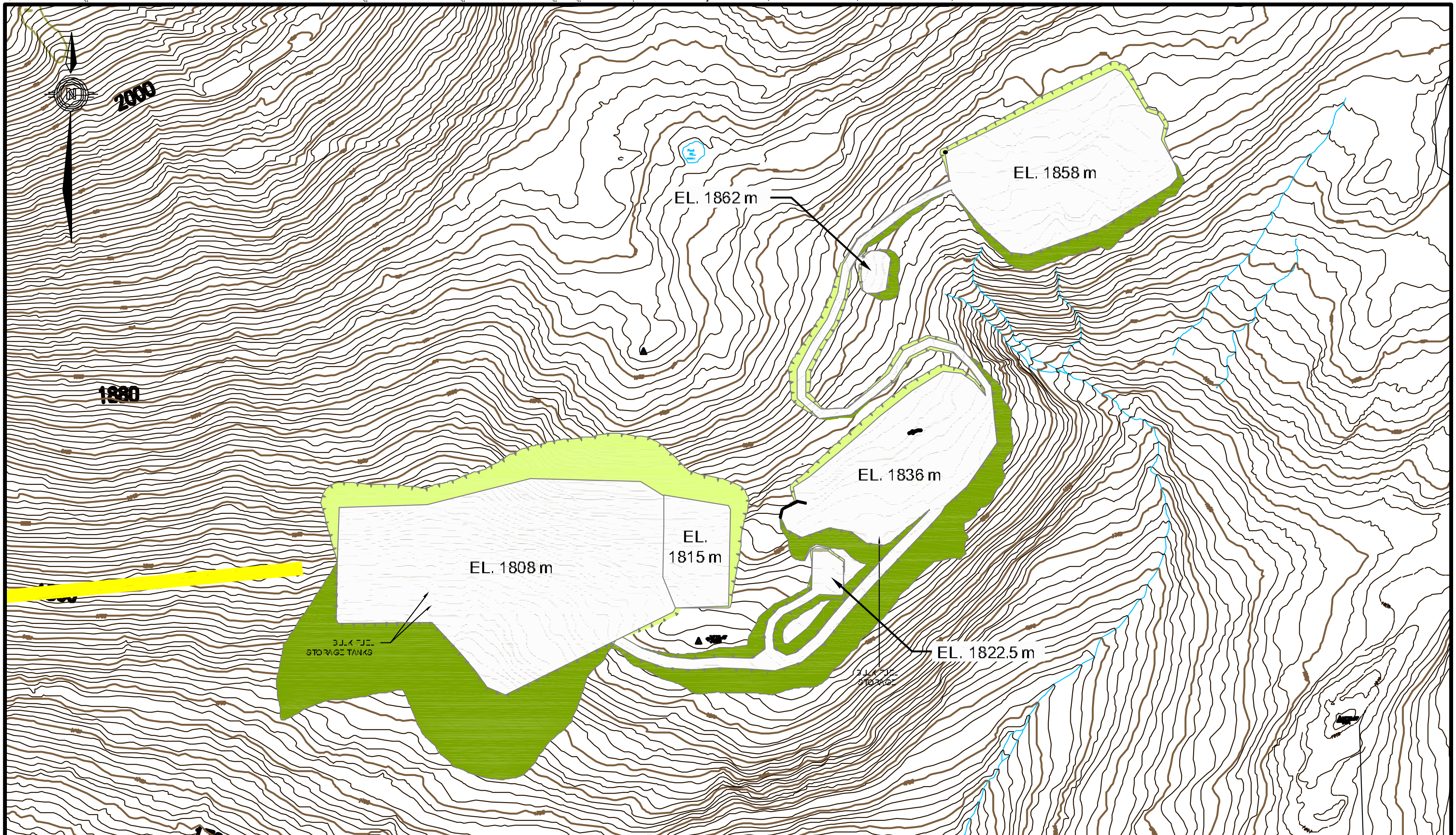
Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

NATC will construct a network of site roads and infrastructure pads on the north side of the valley as shown in Figure 5.4.2-14. The infrastructure pads are required to provide level areas on which the infrastructure buildings will be constructed. The site roads will connect the infrastructure pads together and to the proposed tailings storage area, water retention dam, borrow, and accommodation sites.

Construction of the infrastructure pads will involve clearing the overburden soil and blasting the bedrock to below the desired pad elevation. Broken blast rock fill will then be used to extend the desired pad width and to level the pad to the design elevation. The fill used to create the infrastructure pads will be placed and compacted as they will be used to support foundations for buildings and some equipment. Slope angles will be determined during detailed design but will be in the order of 45° (1H:1V) for rock cuts and approximately 18° (3H:1V) for rock fills. Infrastructure foundations will be cast directly onto the bedrock surface prior to the placement of the levelling fill.

Due to the bedding angle and quality of the bedrock, it may be necessary to provide a retaining wall or rock reinforcement for the bedrock cut slope behind the powerhouse, process plant, and equipment maintenance facility. This will be reviewed during the detailed design phase and included in the design if necessary. This will not change the proposed overall footprint of the infrastructure.

Q:\Edmonton\Drafting\DIVISIONS2007\Other Offices\W231\W23101110\Base ACAD Drawings\W23101110-Yessa Figures Section 5 - Drawing 1.dwg [FIGURE 5.4.2-14] December 12, 2008 - 9:04:11 am [BY: BOB RICHMOND]



LEGEND

FILL AREA

CUT AREA

ISSUED FOR USE

0 200

Scale: 1: 4 000 (metres)

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Site Infrastructure
Pads and Site Roads

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OFFICE	DATE		
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Figure 5.4.2-14

5.4.2.10 Mine Site Accommodations Complex

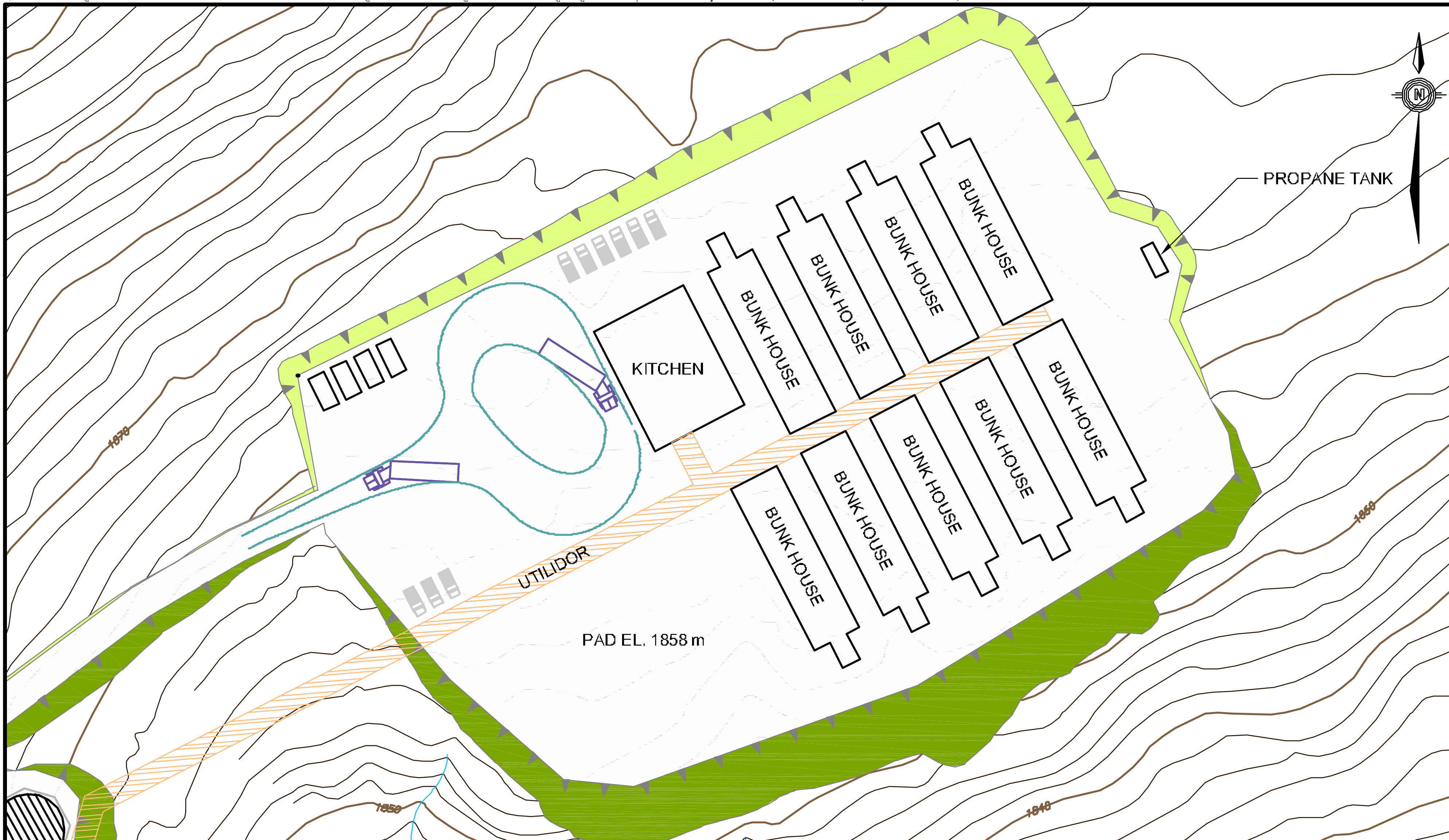
Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The mine site accommodations complex will be constructed on the 1858 m elevation infrastructure pad for use during the construction, operation, and decommissioning phases of the mine. The complex will be able to accommodate approximately 250 people during construction. During the operation phase, the complex will house up to 150 people. The accommodations complex will be constructed from modular units and will include a kitchen, a dining room, dorms, male and female washrooms with showers, a sewage treatment plant, a potable water treatment facility and distribution system, and a recreation complex (complete with games and gym facilities). A temporary diesel generator will power the camp until the main generators and power distribution systems are online. Fresh water will be trucked to the potable water treatment facility until the fresh water intake pumps and pipeline are online. Heat for the accommodations complex will be generated using propane furnaces.

Construction of the accommodations complex will be limited to placing the modules on the compacted gravel fill overlying bedrock. The modules will be connected together in accordance with the manufacture's recommendations and specifications. The potable water and sewage treatment facilities will be temporary and replaced with the permanent camp system when constructed. Treated sewage effluent will be disposed into a rock drain until the ravine dam is constructed. After construction of the dam, the treated sewage effluent will be discharged into the reservoir. The potable water, sewage treatment, and power systems will be designed to accommodate an additional temporary 49-person camp to be installed during construction. Solid waste will be incinerated in a propane fired solid waste incinerator. The layout of the accommodations complex is shown in Figure 5.4.2-15.

The use of modular units on a compacted gravel pad is a typical method for constructing accommodation complexes for remote sites. Constructing the modules off site means all the units are pre-wired and plumbed to the appropriate codes, making it easier and faster to get the complex commissioned. The units can also later be separated into their original modules, which will facilitate demobilization of the structures, decommissioning of the site and abandonment of the area. As the quality of modular buildings are improving, they are becoming more popular worldwide in this type of application and are also becoming an industry standard.

Q:\Edmonton\Drafting\DIVISIONS2007\Other Offices\W231\W23101110\Base ACAD Drawings\W23101110-Yessa Figures Section 5 - Drawing 1.dwg [FIGURE 5.4.2-15] December 12, 2008 - 9:06:00 am [BY: BOB RICHMOND]



LEGEND

- FILL AREA
- CUT AREA

ISSUED FOR USE

0 50

Scale: 1: 1000 (metres)

CLIENT

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Accommodation Complex

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Figure 5.4.2-15

5.4.2.11 Decommission Aerodrome Camp and Relocate Construction Camp to Mine Site

The temporary construction camp will be moved to the mine site once the access road construction and aerodrome upgrades are complete; this is anticipated to occur in September 2010. The construction camp will be installed adjacent to the permanent accommodations complex and will share its water, wastewater, and power infrastructure. The additional load on the infrastructure has been accounted for in the design of the accommodations complex.

Decommissioning of the aerodrome camp will include relocating all the modular trailers from the aerodrome site to the mine site. No trailers, hose, pipe, wire, debris, garbage, or equipment will be left on the site. The septic pit/rock drain used for discharging the treated sewage effluent will be backfilled, and the cleared pad will be revegetated.

5.4.2.12 Bulk Fuel Storage

Bulk fuel will be stored in three separate tanks. A tank will be located near the process plant to store fuel for use in the plant and power plant. The tank will be 15.5 m in diameter and 11 m high, storing 2,075,000 litres of diesel fuel. A second tank will be located in the same area as the first tank and store fuel for use in concentrate driers. The tank will have a diameter of 10 m and be 10 m high, storing 785,000 litres of diesel fuel. A third tank will be located near the equipment maintenance facility will store fuel for the mobile equipment fleet. The tank will have a diameter of 8 m and be 9 m high, storing 450,000 litres of diesel fuel. Tank locations are shown in Figure 5.4.2-16.

All bulk fuel storage tanks will be single walled tanks placed inside lined, bermed containment areas. The secondary containment areas will be sized to hold the larger of 110% of the largest tank or 10% of the total maximum volume of all tanks in the facility, in accordance with the National Fire Code.

5.4.2.13 Process Plant

A process plant building will be required to house the equipment required to process the ore into a tungsten concentrate. The process plant will be built with construction materials shipped to site and will not be a modular or pre-fabricated building. The process plant will be constructed on the 1808 m elevation infrastructure pad.

The foundations required for heavy or vibratory (major) equipment will be founded directly on bedrock and fill will be placed around them to level the pad to the design elevation. Foundations for lighter static (minor) equipment and for the process plant building will be founded on compacted fill placed to level the infrastructure pad to the design elevation, as described in the infrastructure pads and site roads section. The process plant building shell will be installed next. The building will be erected on the building foundation.

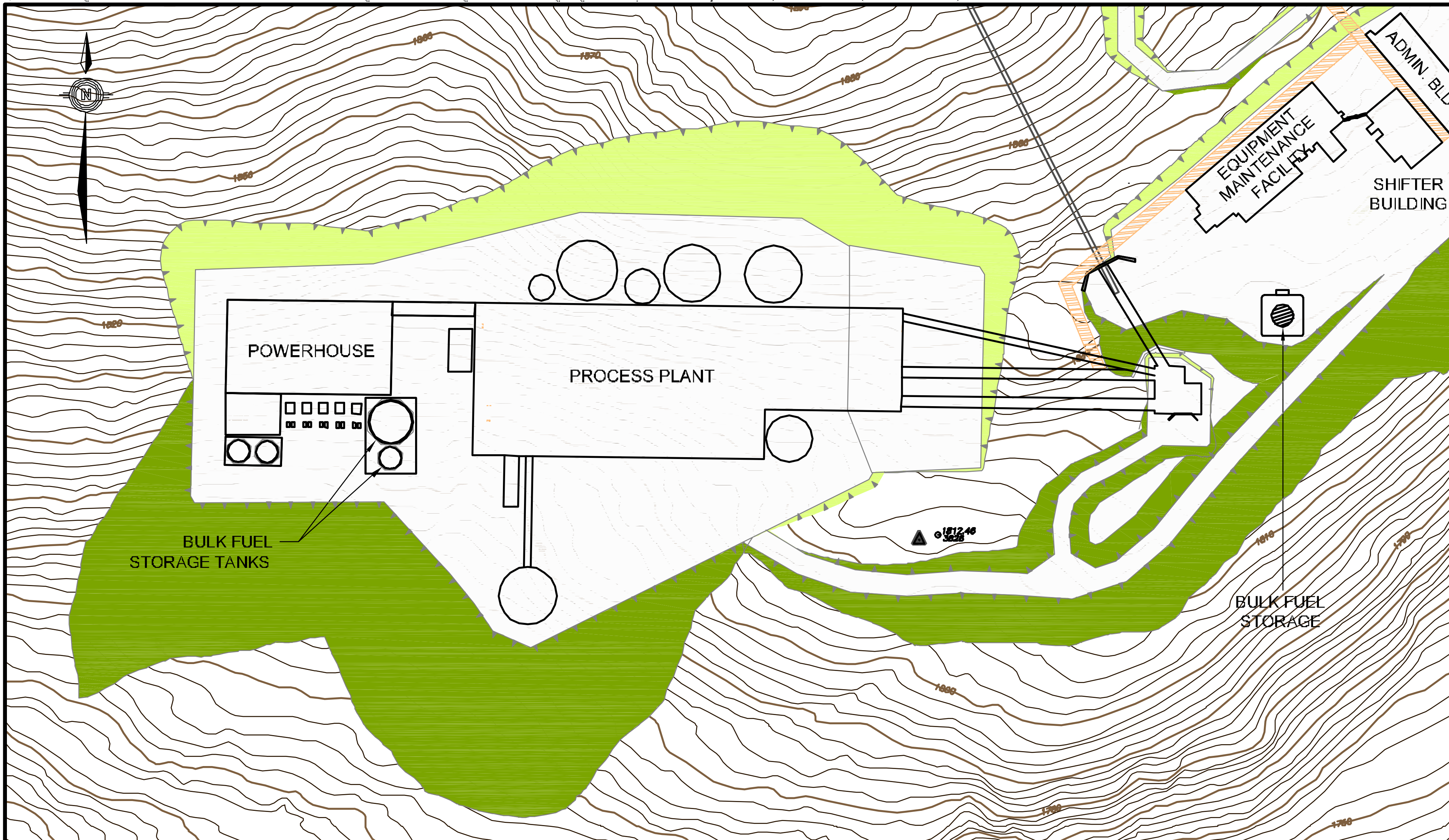
Once the building is in place, the major equipment will be installed on the previously poured foundations, and the floor slab will be poured. Once the floor slab is complete, the mechanical and electrical connections for the major equipment will begin, and the installation of the minor equipment will commence. Installation of the ancillary equipment (stairs, catwalks, walkways, railings, etc.) will occur throughout the construction of the process plant, as applicable. The layout of the process plant including fuel tanks is shown in Figure 5.4.2-16.

5.4.2.14 Equipment Maintenance Facility and Administration Building

To support the mining and processing operations an equipment maintenance facility/warehouse building and an administration/shifter building will be required. The equipment maintenance facility building will be an approximately 60 m long by 16 m wide by 13 m high single-storey building. The building will be built with materials shipped to site and not as a modular or pre-fabricated building. The administration building will also house the mine dry and be 44 m long by 14.5 m wide by 6 m high. The administration building will be a pre-engineered building. Both buildings will be construction on the 1836 m elevation infrastructure pad.

Depending on the size of some equipment, such as cranes and hoists, some foundations on bedrock may be required. If this is the case, then those foundations will be founded directly on bedrock and fill will be placed around them to level the pad to the design elevation. Foundations and the buildings will be founded on compacted fill placed to level the infrastructure pad to the design elevation, as described in the infrastructure pads and site roads section.

Once the building shell is complete, the floor slabs will be poured, and equipment will be installed in the equipment maintenance facility. Construction of the buildings will continue with the interior walls, electrical and mechanical systems, and interior finishing. Each bay in the equipment maintenance facility will have a drain connected to an oil/water separator. Waste oils will be recycled or used in the waste oil heater. The equipment maintenance facility and administration buildings are shown in Figure 5.4.2-17.



LEGEND

FILL AREA

CUT AREA

0 100

Scale: 1: 2 000 (metres)

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Process Plant

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Figure 5.4.2-16

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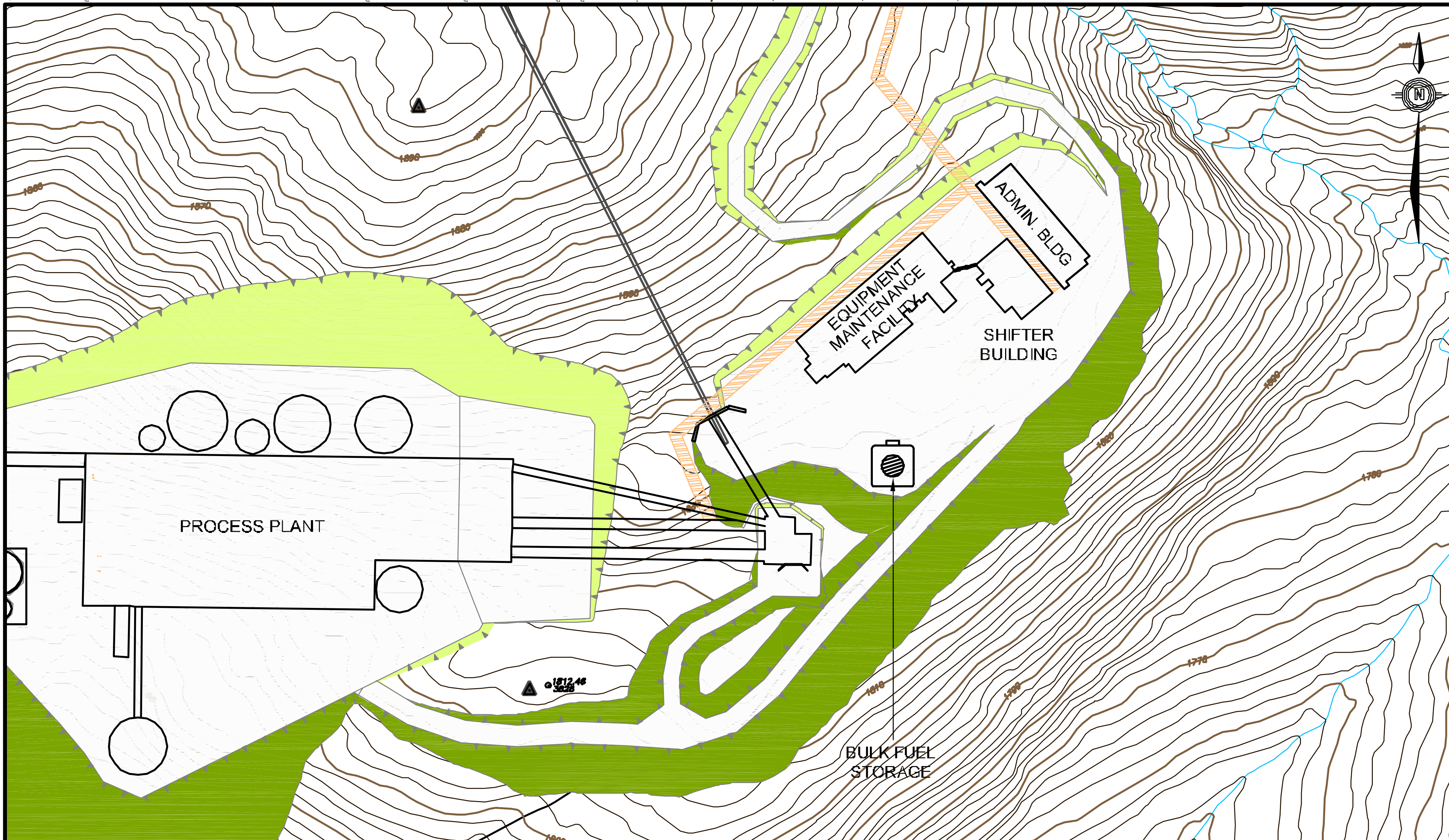

LEGEND

- FILL AREA
- CUT AREA

ISSUED FOR USE

0 100

Scale: 1: 2 000 (metres)

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Administration Building, Shifter Building, and Equipment Maintenance Facility

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Figure 5.4.2-17

5.4.2.15 Underground Mine Pre-Production

Access to the underground mine will be provided by two portals. One existing portal will be rehabilitated at elevation 1895 m (this was advanced to facilitate the 1973 bulk sampling program), and the second portal will be new and established at elevation 1836 m.

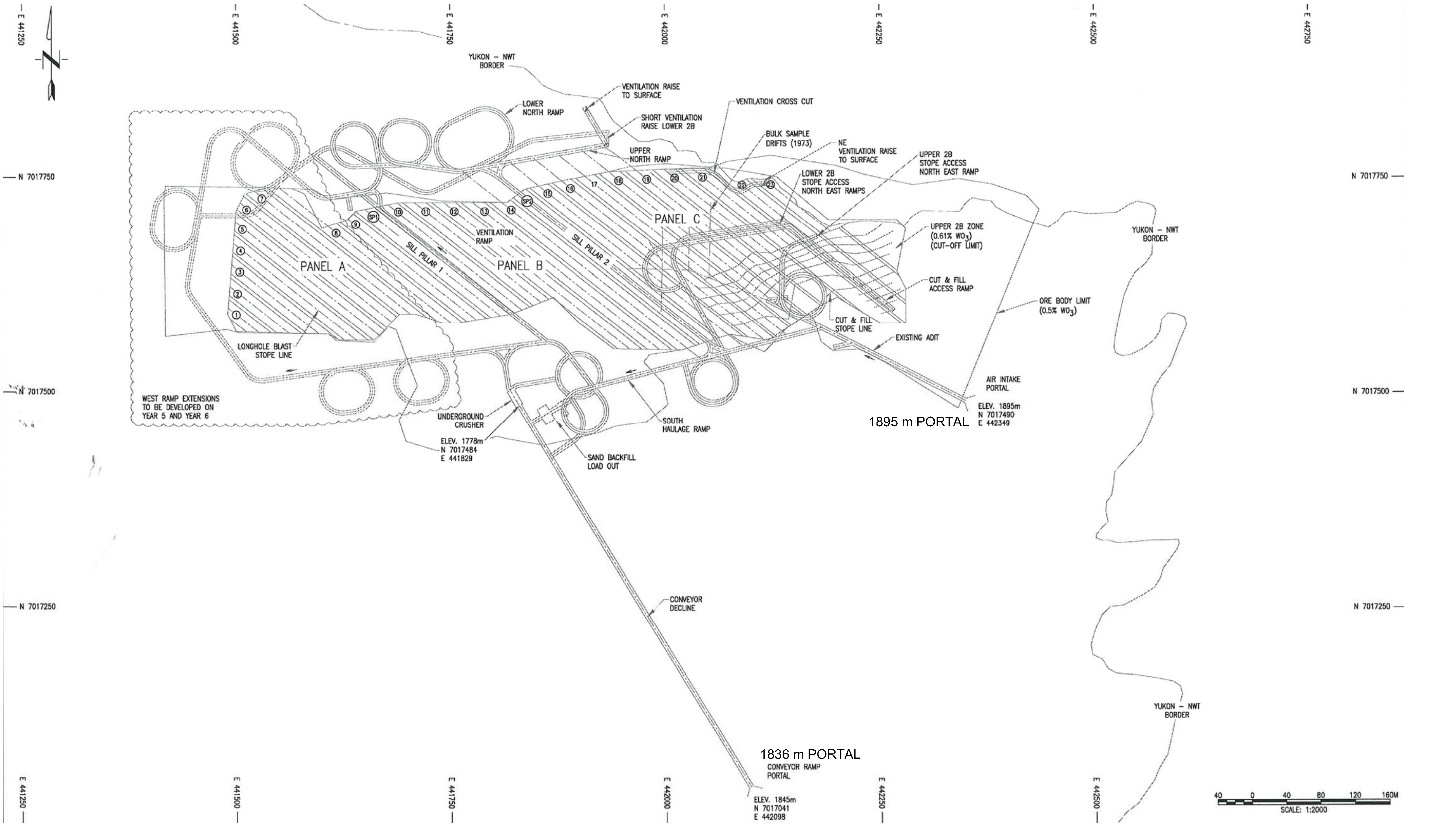
Pre-production will include the following (each item is explained in further detail below):

- Rehabilitation of the 1895 m portal and drifts;
- Development of the north and south ramps;
- Development of the 1836 m portal;
- Development of the conveyor decline;
- Excavation of the crusher station area;
- Excavation of the backfill loading station area;
- Development and installation of the ventilation system;
- Development of the northeast ramp to MCF mining area; and
- Development of stope lines.

The underground infrastructure is shown in Figure 5.4.2-18.

Approximately 124,000 m^3 of waste rock will be produced through the development of the underground infrastructure. This fill will be temporarily stockpiled approximately 500 m from the existing adit portal and conveyor entrances. Approximately 92,000 m^3 and 32,000 m^3 of waste rock will be stockpiled near the existing adit and conveyor portals, respectively. This fill will be used in the construction of site access roads and infrastructure fill pads, and it may be crushed for use in concrete aggregate if it is considered to be non-acid generating. Potentially acid generating waste rock will be used as backfill in the underground stopes during mine operations and a portion may also be blended with non-acid generating waste rock and used in construction of the infrastructure pads.

The level of detail provided in this description is only conceptual and dimensions, volumes, lengths and measurements are approximate and provided only to give the reader an appreciation for the size and scope of the project.



REFERENCE: WARDROP Engineering Inc. drawing, Project No.: 07533901.01, Drawing No. A0-40-004

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Proposed Underground Infrastructure

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OFFICE: WHSE	DATE: DECEMBER 2008		

Figure 5.4.2-18

Q:\Edmonton\Drafting\DIVISIONS2007\Other Offices\W231\W23101110\Base ACAD Drawings\W23101110-Yessa Figures Section 5 - Drawing 2.dwg [FIGURE 5.4.2-18] December 12, 2008 - 10:55:06 am (BY: BOB RICHMOND)

Rehabilitation of the 1895 m Portal

Rehabilitation of the portal at the 1895 m elevation will consist of widening the existing 3 m by 3 m entrance to 5.2 m wide by 4.6 m high. The condition of the existing portal will be reviewed as a part of detailed design, and if necessary, a reinforcement structure (multi-plate culvert) will be designed for the entrance. The widening will be completed by experienced miners, using drift mining techniques. The back and sides of the adit will be drilled and blasted to widen the opening. The adit will extend approximately 200 m into Mount Allan to intersect the South Ramp. The support system for the drift in the vicinity of the adit will be systematic bolting, 1.5 m by 1.5 m spacing with screening. The support system will be upgraded as rock mass conditions dictate.

Development of Ramps

All ramps will be 5 m x 4 m, have a maximum grade of 15%, and be advanced using drift mining techniques normally used by experienced miners. Several groups of ramps will be advanced: South Ramp Group, Northeast Ramp Group, and North Ramp Group. The South Ramp Group will connect the 1895 m Adit to the Crusher Station. The Northeast Ramp Group will connect the South Ramp Group to the Panel C mining area. The North Ramp Group will be the access points for the Panel A and Panel B mining areas. The North and South ramp groups will be connected by Sill Pillars #1 and #2. The support system for all ramps will be systematic bolting, 1.5 m by 1.5 m spacing with screening. The support system will be upgraded as rock mass conditions dictate.

Development of the 1836 m Portal

Development of the portal at the 1836 m elevation will consist advancing a 5.2 m wide by 4.6 m high adit. If rock conditions are poor, a multi-plate culvert will be installed at the entrance to improve stability. The adit will immediately transition into the 512 m conveyor decline. The support system for the drift in the vicinity of the adit will be systematic bolting, 1.5 m by 1.5 m spacing with screening. The support system will be upgraded as rock mass conditions dictate.

Development of the Conveyor Decline

The conveyor decline will extend 520 m from the 1836 m adit to the crusher station at a 13% decline. The decline will be developed by experienced miners using the drift mining technique. The finished decline will be 5 m wide by 5 m high. The support system for the conveyor decline will be systematic bolting, 1.5 m by 1.5 m spacing with screening. The support system will be upgraded as rock mass conditions dictate.

Excavation of the Crusher and Backfill Stations

The underground crusher station will be at elevation 1778 m, approximately 71 m lower than the conveyor portal. The crusher station room will be 10 m wide, 24 m long, and 17 m high. The backfill loading station will be at elevation 1778 m near the crusher station. The backfill loading station room will be 12 m wide, 20 m long, and 6 high. The backfill loading bay will be adjacent to the backfill loading station at elevation 1778 m. The backfill loading bay will be 7 m wide 15 m long and 6 m high. The three areas will be developed using cave mining and have both screening and cable ground support. Foundations for the equipment will be cast from concrete directly on rock. All three areas will be excavated into low-grade competent hanging wall rock.

Ventilation System

A temporary ventilation system will be installed with the beginning of development. Ventilation will include conveying fresh air to development headings through flexible ducting forcing the return air to flow up the decline and out the adit opening. The same temporary ventilation system will be used during operation in the MCF section of the mine.

The permanent ventilation system will be constructed simultaneously with the declines, ramps, and crusher and backfill rooms. The operating ventilation plan will include installation of a stand-alone mine axial fan, with a secondary backup fan, at the 1895 m adit. The fan will force fresh air into the mine through the 1895 m adit and decline. Two raises, one 3 m by 3 m and one 2 m by 2 m, and the conveyor decline will provide the necessary return routes for the exhaust air. The system will also incorporate ventilation doors, stoppings, bulk heads, auxiliary fans, and regulators, as required. Ventilation will be designed in accordance with Yukon's Occupational Health and Safety Regulations.

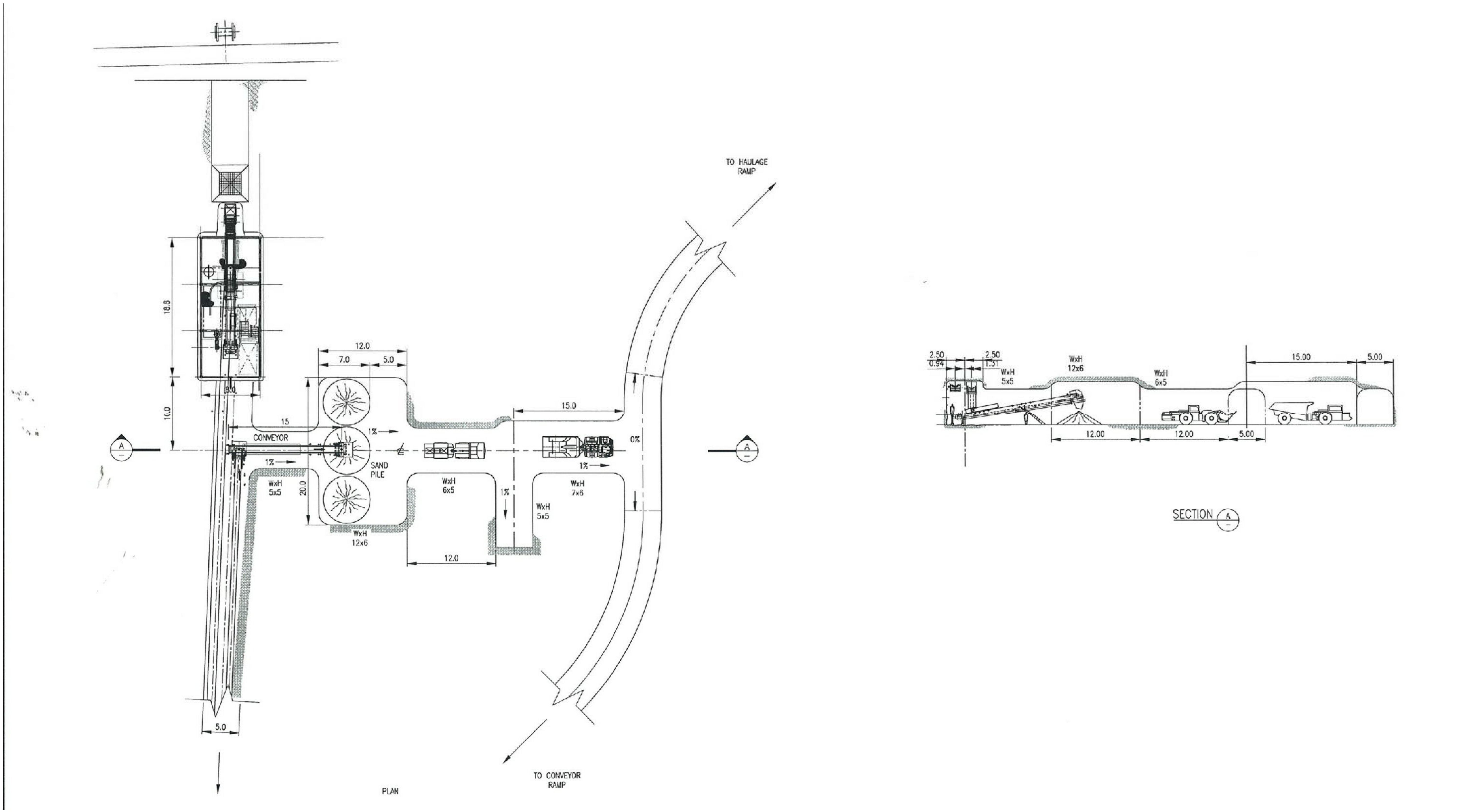
The stand-alone mine axial fan will be installed on concrete foundation near the 1895 m portal. The foundation area will be prepared and a concrete foundation will be poured over the rock. The fan and ducting will be installed to connect to the 1895 m adit. If necessary, a refrigeration unit will also be installed with the fan to cool the air before forcing it into the decline, to preserve the permafrost. Ventilation doors, stoppings, bulkheads, auxiliary fans, and regulators will be placed as necessary.

Underground Crusher and Conveyor

The underground crusher will be a jaw type crusher complete with a grizzly feeder. The crusher and grizzly will be installed on concrete foundations, which will be cast directly on bedrock. Once the machinery is installed, the controls and power connections will be made. The crusher setup is shown in Figure 5.4.2-19.

The conveyor system will have two conveyor belts. One conveyor will transport the ore from the crusher station to the plant and the other will transport the tailings backfill from the plant to the underground backfill station. The conveyors will be installed hanging from the back of the decline using rock anchors. The conveyors will also serve as a transport point for system control power cable running underground to the crusher station. The conveyors will hang high enough in the decline to allow equipment to pass beneath it.

Both of these setups are common practice in underground mining. An underground crusher and conveyors are currently in use at the EKATI Diamond Mine, NT.



REFERENCE: WARDROP Engineering Inc. drawing, Project No.: 0753390(.0?), Drawing No. A0-40-003

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	Underground Crusher Plan and Cross-Section
PROJECT NO.	W23101110
DWN	BR
CKD	CJD
REV	0
OFFICE	WHSE
DATE	DECEMBER 2008

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Figure 5.4.2-19

5.4.2.16 Powerhouse

To provide electricity for the mine site, a powerhouse with five diesel generators (2.5 MW each) and a heat recovery system will be required. The powerhouse will be a single-storey 20 m long by 10 m wide by 7 m high pre-engineered building. The powerhouse will be built west of the process plant on the 1808 m infrastructure pad.

Foundations for the diesel generators will be cast directly onto bedrock and foundations for the structure and heat recovery system will be cast on compacted granular fill. For the generator foundations, once the concrete is cast directly on bedrock, fill will be placed around them to level the pad to the design elevation. Heat recovery systems and the buildings will be founded on compacted fill placed to level the infrastructure pad to the design elevation, as described in the infrastructure pads and site roads section. The powerhouse location is shown in Figure 5.4.2-16.

Once the building shell is complete, the floor slabs will be poured and equipment will be installed in the powerhouse. Construction of the buildings will continue with the interior walls, electrical and mechanical systems, and interior finishing.

5.4.2.17 Ravine Dam

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

A dam and reservoir are required to store 120,000 m^3 of process water while it ages prior to it being reused in the process plant. Approximately 30 days of residence time is required to allow the reagents used in the process to break down prior to the water being reclaimed for use in the mill. The reservoir is designed to work as a plug flow reactor. The dam and reservoir are also required to detain runoff water from the affected mine footprint for water quality testing prior to it being released. NATC has classified the ravine dam as a significant consequence classification in accordance with the Canadian Dam Safety Guidelines (CDA).

According to the CDA, for significant classified dams, a 1:1000 year seismic event is recommended for design use. Also, CDA guidelines recommend that the design inflow flood be between a 1:100 and 1:1000 year flood event for a significant classified dam. The 1:100 year flood event was selected because the watershed is very small (2.5 km^2 of undiverted area) and flood inflows were determined from a regression analysis of the nearby South Macmillan River at km 407 of North Canol Road, as well the structure will be decommissioned at mine closure with no water retaining capabilities. Reducing from the South Macmillan River basin size of 997 km^2 to the design basin size of 2.5 km^2 will result in conservative flow estimates. Conservative inflows combined with the minimal effects of uncontrolled discharge (discharge of water if the reservoir is subjected to an event larger than the design event) is the reason that NATC has selected to use the lower bound of the guidelines.

The ravine dam will be approximately 315 m long and 35 m high, at its highest point. The dam will have a crest width of 25 m to both facilitate two-way haul traffic and improve its stability. The downstream slope angle will be 21.8° (2.5H:1V) and the upstream slope angle will be 18° (3H:1V) with a toe buttress which will have a crest width of 5 m and a slope angle of 14° (4H:1V). The dam will have a geosynthetic liner system with a concrete plinth, geosynthetic drain system, geosynthetic erosion protection system, and a sand and gravel superstructure.

Construction of the dam will involve stripping the entire dam footprint to the surface of the highly weathered and fractured bedrock. The stripped sand and gravel will be stockpiled for use as engineered fill later. The highly weathered and fractured bedrock surface will be excavated using machinery and hand scaling (no drilling and blasting as it may further fracture the bedrock at depth) to a less weathered competent bedrock surface. A concrete plinth will be constructed along this excavated area to facilitate the liner system to bedrock connection. The downstream portion of the superstructure will be constructed from engineered fill. The geocomposite drain and geosynthetic liner system will be placed on the surface of the downstream superstructure. The geosynthetic liner system will be covered with liner bedding and then the upstream superstructure will be constructed from engineered fill. The emergency spillway will be excavated through the crest and the fabric formed erosion protection will be installed along the upstream slope and through the emergency spillway.

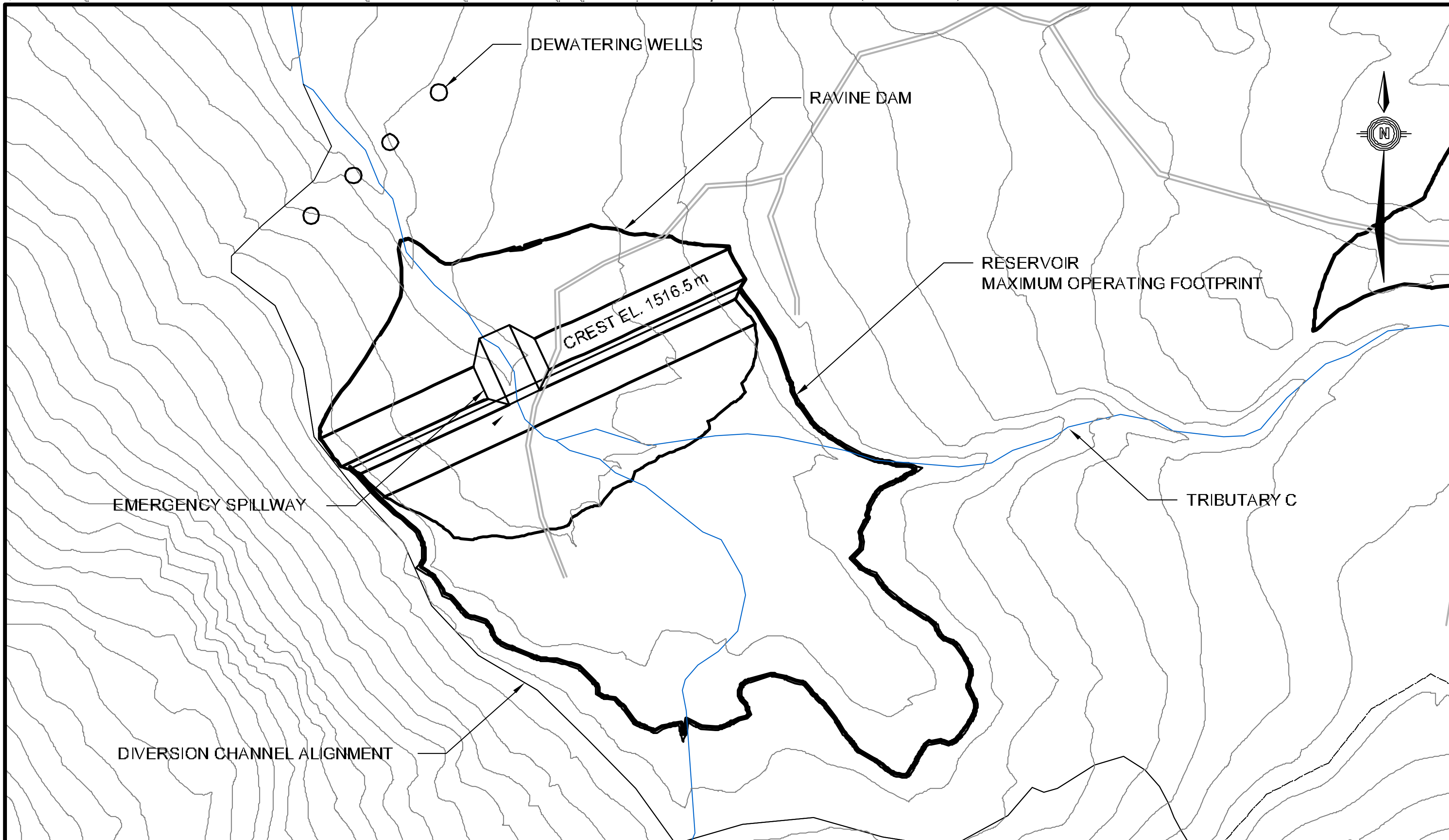
The following is a brief description of the materials to be used to construct the dam and a plan and typical cross-section are provided in Figures 5.4.2-20 and 5.4.2-21, respectively.

Engineered Fill

Engineered fill will comprise the bulk of the dam structure and will be sourced from a borrow pit upstream of the ravine dam, increasing the size of the reservoir. Processing of the engineered fill should be limited to removal of boulders at time of truck loading and avoiding areas of high silt content in the pit. The engineered fill will be a well-graded gravel and sand with some silt. The borrow pit will not be developed to the bedrock surface leaving at least a 600 mm thick layer of compacted soil to reduce the flow rate of reservoir water into the fractured bedrock.

Geocomposite Drain

Geocomposite drain will be used to prevent porewater pressure build up in the engineered fill in the event of liner leakage. The geocomposite drain will also be used as downstream bedding for the liner system. The geocomposite drain will be a Geo-Comp 5, supplied by Layfield Plastics, or approved equivalent. The geocomposite drain is a single piece of Geo-Net (a plastic net used for soil reinforcement) bonded between two pieces of nonwoven geotextile.



NOTE:
Reservoir shown is maximum operating level.

ISSUED FOR USE

0 200

Scale: 1: 4 000 (metres)

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Ravine Dam Plan

PROJECT NO	DWN	CKD	REV
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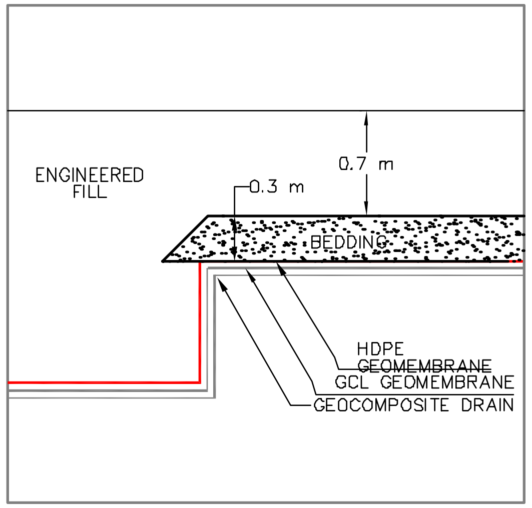
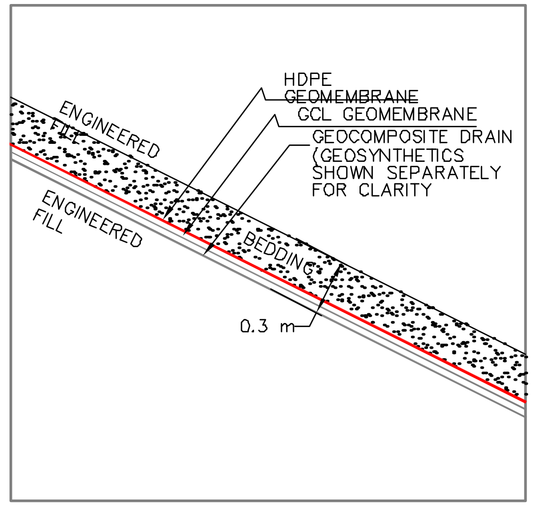
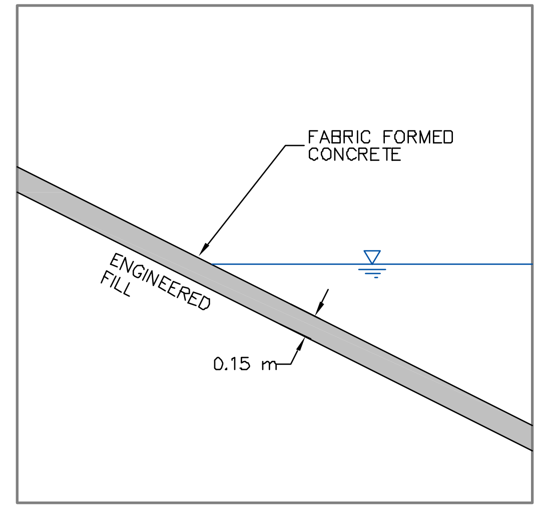
Figure 5.4.2-20



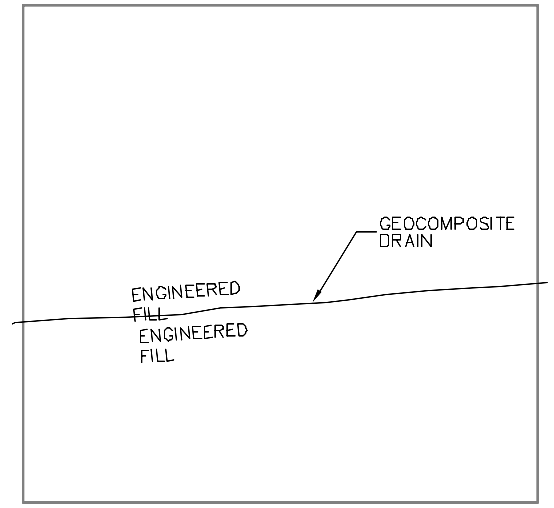
1 LINER ARMOR
SCALE: 1 : 50



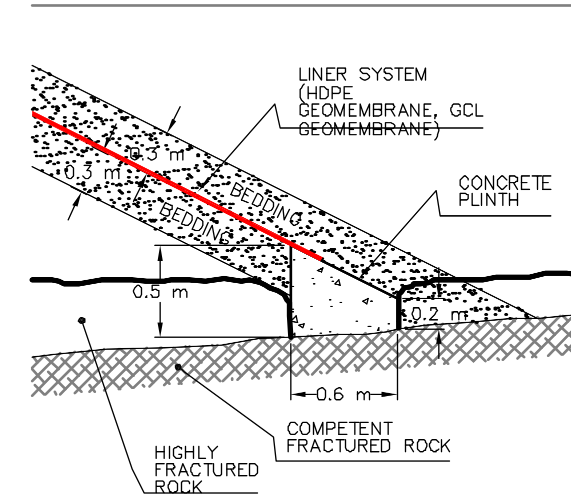
2 LINER SYSTEM ABOVE DRAIN
SCALE: 1 : 50



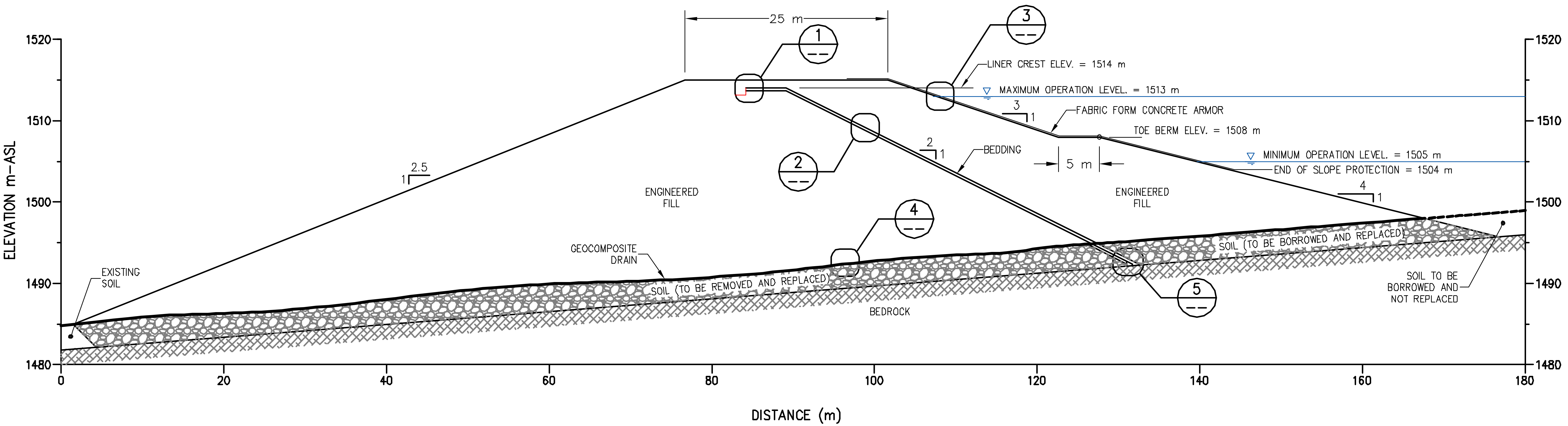
3 SLOPE ARMOR
SCALE: 1 : 50



4 DRAIN DETAIL
SCALE: 1 : 50



5 LINER SYSTEM CONNECTION
SCALE: 1 : 50



RAVINE DAM TYPICAL SECTION
SCALE: 1 : 500

NOTES

1. ALL DIMENSIONS IN METRES UNLESS OTHERWISE NOTED
2. NOT FOR CONSTRUCTION

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Client: NORTH AMERICAN TUNGSTEN CORPORATION LTD	MACTUNG
	Ravine Dam Typical Cross-Section

PROJECT NO.	DWN	CKD	REV	
W23101110	BR	CJD	0	Figure 5.4.2-21
OFFICE: WHSE	DATE: DECEMBER 2008			

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Liner Bedding

Liner bedding will be used to protect the liner system from the engineered fill, and will be sourced from a borrow pit upstream of the ravine dam. Processing of the liner bedding will require screening. The liner bedding will be a well-graded sand with trace silt.

Grout-filled Fabric Formed Armour

Grout-filled fabric formed armour (fabric form) will be used to prevent erosion of the dam crest when the reservoir is operating. Fabric form is an enclosed sewn sock of nonwoven geotextile. The sock is sewn together in the factory to customized dimensions. Each sock is then pumped full of grout (20 to 30 MPa) in sections creating a series of grout panels. The grout panels will be 150 mm (6") thick after hydration. Fabric forms are available from Layfield Plastics and other geotextile suppliers.

Overburden Excavation

The overburden excavation quantity will involve removing unconsolidated soils beneath the foundation of the dam. Review of existing geotechnical information shows that the material should qualify for use as borrow material for engineered fill if boulders are removed and areas of high silt content are avoided.

Rock Excavation

Rock excavation is required to remove highly fractured bedrock which can provide a conduit for seepage water. The rock excavation will occur immediately beneath the concrete plinth creating a less permeable connection between the concrete and bedrock surface. Rock excavation will be limited to the highly weathered and fractured bedrock surface. Rock excavation will be conducted mechanically (with a ripper tooth attached to a bulldozer or an excavator, or by hand tools). Drilling and blasting is not recommended as it may further fracture the underlying rock. Since the bedrock excavation is limited to highly fractured and weathered rock, it will not be suitable for reuse as construction material, except for access roads.

Concrete Plinth

The liner system will be bolted to the sloped face of a concrete plinth; this is required to facilitate the connection of the competent bedrock surface to the liner system. The concrete plinth will be a 30 MPa reinforced concrete beam bolted to the underlying bedrock. Concrete aggregate will be sourced from the quarry. Processing of the concrete aggregate will involve controlled blasting in the quarry, crushing with both a jaw and hydraulic cone crushing plant, screening, and washing.

Liner System

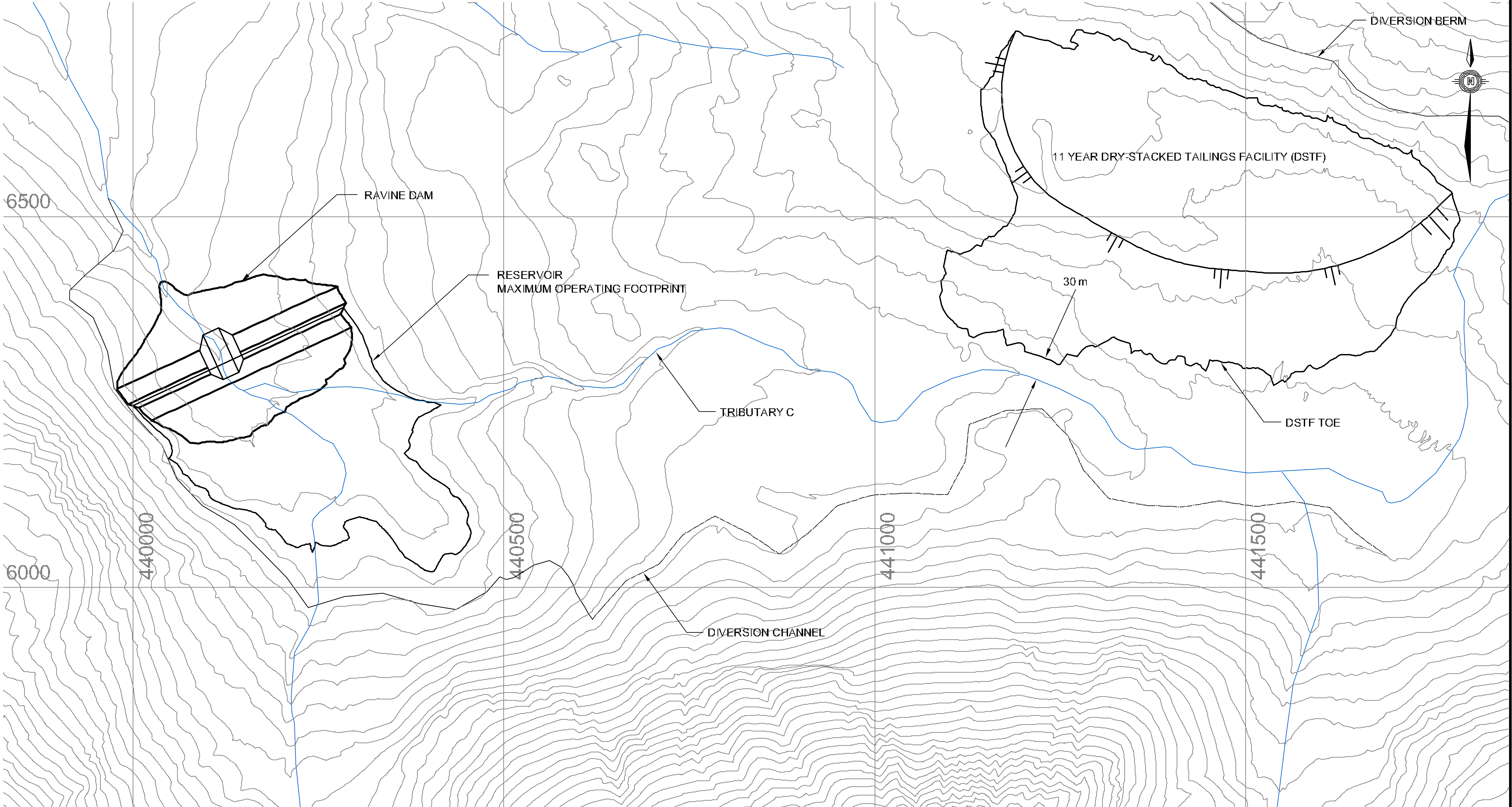
The primary containment barrier will be a 40 mil double-sided textured high-density polyethylene (HDPE). The secondary containment barrier will be a geosynthetic clay liner, which will be 4.5 kg/m^2 of bentonite needle-punched between two 300 g/m^2 nonwoven geotextiles. These two geosynthetics will comprise the liner system. The liner system will only be installed in the structure of the dam. The reservoir will be unlined.

5.4.2.18 Dry-Stacked Tailings Facility

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The dry-stacked tailings facility (DSTF) will be where the dewatered tailings will be stacked on the ground surface. Construction of the area will be limited to removing any organic soil layers and compacting the existing granular soils. The ground will be cleared as it is needed, and the total areas to be cleared will be approximately 25 ha.

The site access road will be developed and the portion of the DSTF footprint required for placement of tailings in the first year of operation will be prepared. Foundation preparation will include removing organic material, which will be stockpiled at the base of the pile for potential use during reclamation. The existing sand and gravel soils will be compacted using a 15-tonne steel-drum vibratory compactor to provide a compacted base for the tailings placement. The placement and compaction of the tailings will occur during the operation phase of the project. The compacted granular base will also act as a blanket drain under the DSTF structure to allow groundwater and seepage water to freely drain from beneath the pile. Figures 5.4.2-22 and 5.4.2-23 show the complete tailings pile in plan and section, respectively.



NOTE:
Contours shown at 10 m intervals.

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0 250
Scale: 1: 5 000 (metres)

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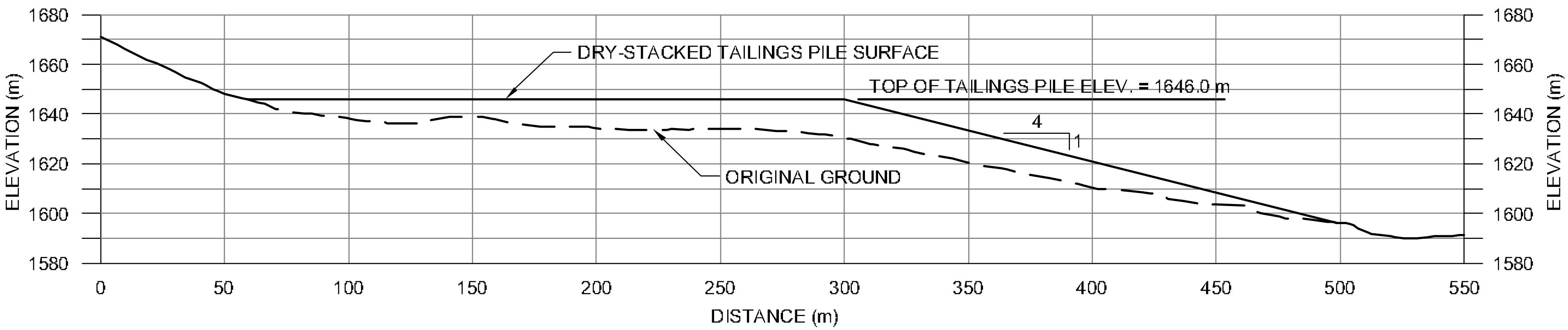
MACTUNG			
DSTF Plan			
W23101110	BR	CJD	0
WHSE	DECEMBER 2008		

Figure 5.4.2-22



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0 100
Scale: 1: 2 500 (metres)

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DSTF - Typical Section

PROJECT NO.	DWN	CKD	REV
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OFFICE: EBA-WHSE	DATE: DECEMBER 2008		

Figure 5.4.2-23

5.4.2.19 Water Diversion Structures

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

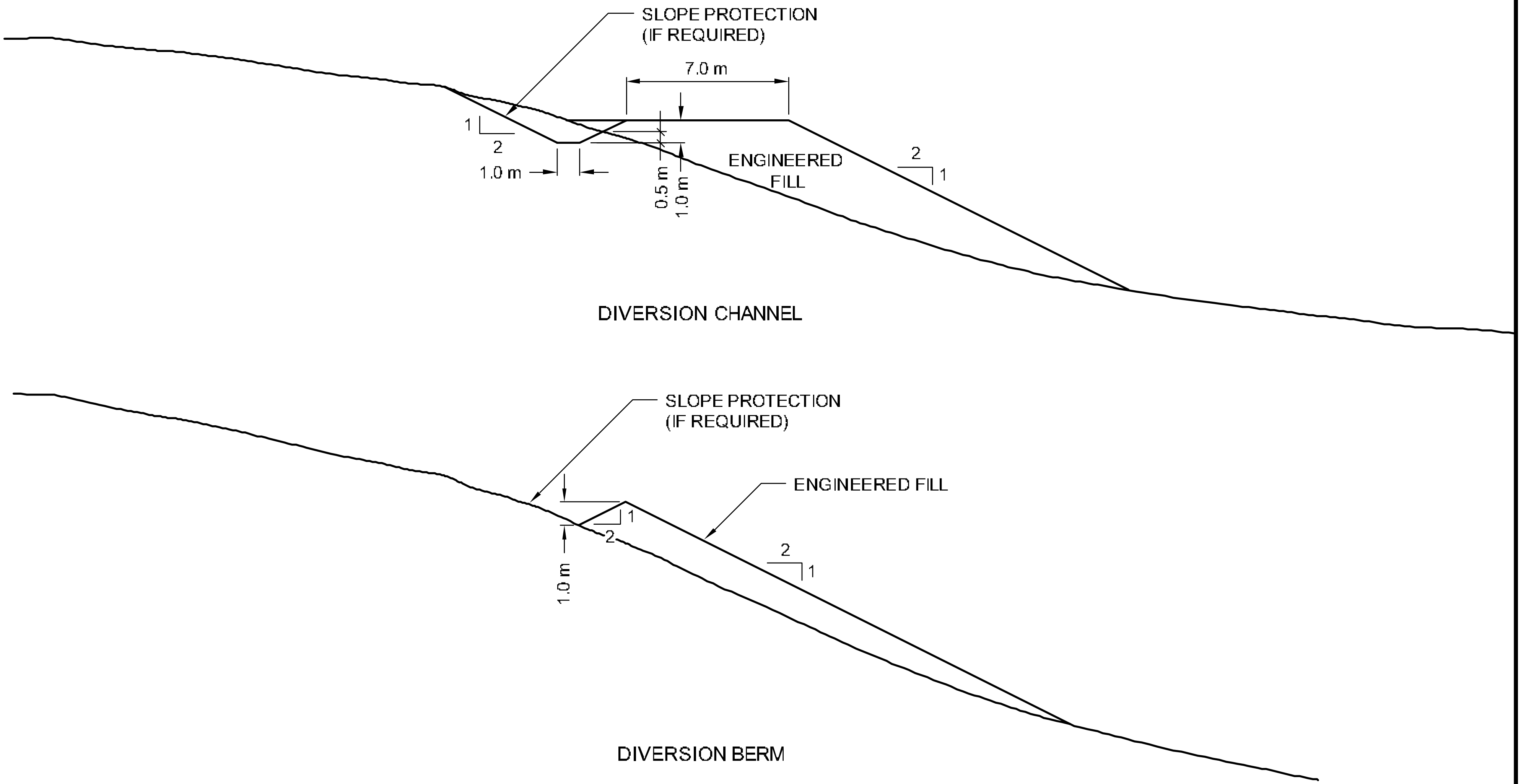
Two water diversion structures will be constructed on the site to promote water flow around the DSTF and the ravine dam. One will be a berm structure constructed from compacted fill upgradient of the DSTF. The other will be a cut-and-fill structure constructed on the north side of the valley below the DSTF. The locations of the two structures are shown in Figure 5.4.2-22.

The intent of the diversion berm upgradient of the DSTF is to divert the 1:100 year runoff flow around the DSTF pile during operation. The grade of the berm will be split near its centre; half the flow will be diverted to the east and half the flow will be diverted to the west. Both diversions will flow into the stream at the bottom of the valley and report to the reservoir. The diversion berm is only required during the operation phase of the project.

The intention of the runoff diversion structure upgradient of the ravine dam is to route the 1:100 year runoff water from the north side of the valley around the ravine dam. The runoff water on the north side of the valley will not be effected by the mining activities, with the exception of the flow through the diversion structure. The water will flow freely down a natural drainage path into the valley bottom stream. The runoff diversion structure is only required during the operation phase of the project.

Construction of the diversion berm upgradient of the DSTF will require surface preparation and the placement and compaction of granular fill. The thin organic layer will be stripped from the surface and the exposed soils will be compacted. A 1 m high berm will then be constructed with 2H:1V sideslopes. The berm will not have a wide crest; however, equipment will be able to access the area immediately upstream of the berm to conduct annual maintenance. Erosion protection will be added to the upstream side of the berm if significant erosion is observed during operation. Maintenance will include repairing localized eroded areas, repairing shallow surface slumps of material on the shell of the berm, and removing accumulated snow in the spring. A typical cross-section of the berm is shown in Figure 5.4.2-24.

Construction of the runoff diversion structure upgradient of the ravine dam will require both excavation and fill placement. A cut will be made to allow a 1 m wide flat section with slopes on either side. The cut slope will vary from 1.5H:1V to 2.5H:1V, depending on the soil conditions. The excavated soil will be used to construct a fill slope on the lower side of the hill from the cut. The fill slope will be 2H:1V and will have a 6 m wide bench separating the inside and outside slopes. The bench will allow equipment to access the entire length of the structure to conduct maintenance during operation. If the volume of fill required is larger than the anticipated cut, the additional material will be sourced from the borrow pit upstream of the ravine dam or in the vicinity of the DSTF. An erosion protection geomembrane will be added to the base and inside slopes if significant erosion or seepage is observed during operation. Maintenance will include repairing localized eroded areas, repair of shallow surface slumps and removal of accumulated snow in the spring. A typical cross-section of the diversion structure is shown in Figure 5.4.2-24.



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0 10
Scale: 1: 250 (metres)

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Diversion Structures
Typical Sections

PROJECT NO	DWN	CKD	REV
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Figure 5.4.2-24

5.4.2.20 Water Usage

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

Water usage for the construction phase is limited to water for the camp facilities and small volumes of water required to increase the moisture content of the construction fills to optimum moisture content (3% to 5% increase in moisture content). Water for the camp will be hauled from the Hess River Tributary to the fresh water storage tanks in the camp trailers. Water for construction will be taken from Tributary C. It is expected that the water usage for the camp will be approximately 200 litres per person per day or 50,000 litres per day at peak capacity.

5.4.2.21 Waste Handling

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

As expected, there will be several types of waste generated during the construction phase of the project. The waste types, volumes, and handling and disposal methods are summarized in Table 5.4.2-1.

TABLE 5.4.2-1 WASTES GENERATED DURING CONSTRUCTION PHASE

Waste Type	Description	Volume	Handling Method	Disposal Method
Solid Waste	General waste produced in camp, including food scraps	1.3 kg/person/day to 325 kg/day (maximum)	Bagged garbage hauled in a truck	Propane fired incinerator. Ashes will be disposed of with non-combustible waste in the DSTF.
Construction Waste	Wood, drywall, metal, etc. from building construction	20 kg/m² of floor area of combustible and non-combustible waste. Solid waste accounted for above	Sorted in bins to solid waste, combustible waste, non-combustible waste, hazardous waste and each waste hauled to disposal site	Solid waste accounted for above, combustible waste incinerated, non-combustible waste held near DSTF for later disposal, hazardous waste accounted for below
Lubricants	Oils used in machinery, glycol, etc.	Estimated at 5% of fuel consumption – 125,000 litres/year	Stored in bulk waste oil containers, specific to waste type	Waste oil that is usable in a waste oil heater will be used to produce heat, all other wastes in this category will be hauled off site to an approved disposal area
Sewage	Human Waste, grey water.	Estimated to be the same as water consumption at 200 litres/person/	Sewage will be collected in holding tanks in the camp and	Sewage treatment facility will produce two types of waste, treated sewage effluent and sewage

TABLE 5.4.2-1 WASTES GENERATED DURING CONSTRUCTION PHASE

Waste Type	Description	Volume	Handling Method	Disposal Method
		day (maximum of 50,000 litres/day)	temporary facilities used for construction then hauled in a truck, not used to haul fresh water to the camp, to the sewage treatment facility	sludge waste. Sewage sludge waste will be incinerated with solid waste. Treated sewage effluent is accounted for below.
Treated Sewage Effluent	Liquid effluent exiting the sewage treatment plant	Estimated to be the same as water consumption at 200 litres/person/day (maximum of 50,000 litres/day)	Effluent will be pumped in an insulated, heat traced HDPE pipeline. In emergencies the effluent will be hauled in a water truck which is not used to haul fresh water to the camp	Treated effluent will be disposed of in a rock drain, designed to the standards of the Yukon Government. Each camp site setup will have a rock drain constructed
Hazardous Specified Waste	Paint, waste from hydrocarbon spill clean-up, aerosol cans, batteries, cleaning chemicals etc.	Estimated to be 0.25 kg / m^2 of floor area to be constructed	Hazardous waste will be separated and stored in approved containers	Hazardous waste will be hauled off-site and disposed of in an approved facility
Brush	Wood or woody debris generated from road clearing	Estimated a maximum of 50 ha of clearing	Trees will be handled in accordance with plan established with forestry department	Depending on plan developed with forestry department. Either stockpiled for use by community or burned
Vegetation and overburden	Stripping of topsoil and unused soil from borrow pits and road construction	Estimated to be 391,000 m^3. 200,000 m^3 along the road alignment 36,000 m^3 on site at the mill and 30,000 m^3 at the ravine dam and 125,000 m^3 at the DSTF	These materials will be stockpiled in or near borrow pits along the access road alignment or on site	These materials will be used in the reclamation of borrow pits or final reclamation of the site

5.4.2.22 Energy Requirements

There will a demand for approximately 1 MW of power during the construction phase. All power will be generated on site by diesel generators. The camp and surface facilities will be serviced by one 500 kW diesel generator unit. The underground pre-development will be serviced by two portable underground electrical power centres each rated at 250 kW and a maximum of ten portable generators, all rated at 10 kW or less, for use at construction sites.

5.4.2.23 Quality Control / Quality Assurance

As a part of the contract, any contractors hired for construction will be required to conduct a quality control program on their work. NATC will use a combination of external consultants and the internal project management team to conduct quality assurance on all aspects of the construction. Quality assurance will include, but not be limited to:

- Daily inspections of all construction projects; and
- All required testing as detailed in design reports, construction specifications, permits and licences.

5.4.2.24 Work Force Requirements

NATC will conduct all the pre-production mining with their personnel and equipment. This personnel required on site at any given time is summarized in Table 5.4.2-2. This section is written as a guideline only. Actual numbers of staff may very depending on the actual needs of the project. The equipment types listed are provided only to give the reader an appreciation for the size and scale of the equipment being used, NATC will review their equipment list during the detailed design phase and these units will likely vary somewhat.

TABLE 5.4.2-2 NATC'S CONSTRUCTION PHASE LABOUR FORCE

Position	Number of Employees
Engineers, geologists, technical staff	12
Mine Foremen and Superintendents	10
Drillers and Blasters	12
Operators	15
Non-skilled labourers	15
Mechanics and skilled trades	10
Total	**74**

The rest of the workforce required for the construction phase will be a combination of skilled and non-skilled labour. The breakdown by month is summarized in Table 5.4.2-3.

The peak personnel on site at any given time is 250, 74 NATC personnel and 176 contractor personnel.

TABLE 5.4.2-3 CONTRACTOR CONSTRUCTION PHASE WORKFORCE

Month	Project Management		Camp Services		Civil / Structural		Electrical / Mechanical		Total
	Skilled	Non-Skilled	Skilled	Non-Skilled	Skilled	Non-Skilled	Skilled	Non-Skilled	
June 2010	3	1	1	5	10	12	2	1	35
July 2010	5	1	1	9	25	26	4	2	73
Aug 2010	11	1	2	13	32	30	8	4	101
Sept 2010	11	1	2	20	38	41	15	5	133
Oct 2010	13	1	2	20	38	43	20	10	147
Nov 2010	13	1	2	20	40	56	20	10	162
Dec 2010	13	1	2	20	40	56	24	10	166
Jan 2011	13	1	2	20	40	60	30	10	176
Feb 2011	13	1	2	20	40	60	30	10	176
Mar 2011	13	1	2	20	40	60	30	10	176
Apr 2011	13	1	2	20	40	60	30	10	176
May 2011	13	1	2	20	40	60	30	10	176
June 2011	13	1	2	20	40	60	30	10	176
July 2011	13	1	2	20	40	60	30	10	176
Aug 2011	13	1	2	20	40	60	30	10	176
Sept 2011	13	1	2	20	40	60	30	10	176
Oct 2011	13	1	2	20	40	60	30	10	176
Nov 2011	13	1	2	20	40	60	30	10	176
Dec 2011	13	1	2	20	40	60	30	10	176
Jan 2012	13	1	2	20	40	60	30	10	176
Feb 2012	13	1	2	20	40	60	30	10	176
Mar 2012	13	1	2	20	40	60	30	10	176
Apr 2012	13	1	2	20	40	60	30	10	176
May 2012	13	1	2	20	40	60	30	10	176
June 2012	13	1	2	20	40	60	30	10	176
July 2012	13	1	2	20	40	60	30	10	176
Aug 2012	13	1	2	20	40	60	30	10	176
Sept 2012	13	1	2	20	40	39	30	10	155
Oct 2012	13	1	2	20	36	37	30	10	149
Nov 2012	13	1	2	20	31	32	30	10	139
Dec 2012	13	1	2	20	29	29	25	10	129

NATC is proposing to use the following equipment during the construction phase:

- 2 – Tamrock DD420-40C Jumbo Drills
- 2 – Tamrock DS 310 Rock Bolters
- 4 – PHQ250JHML Jackleg Units
- 4 – PHQ250MCSR Stoper Units
- 1 – Diamec 252/1600U4PHC Exploration Drill
- 3 – Toro LH410 Load-Haul-Dump Trucks
- 4 – EJC 30 SX Haul Trucks
- 1 – Caterpillar GR 12 H Grader
- 1 – Toyota HZJ79 ANFO Loader
- 6 – Toyota HZJ79 Service Trucks
- 1 – Maclean SL-3 Scissor Lift
- 2 – Maclean CS-3 Cassette Carriers

NATC's contractors will use equipment they have available; however, the equipment fleet should be similar to the list below:

- 2 – Caterpillar 769 or 777 Haul Trucks
- 4 – Caterpillar D350 Haul Trucks
- 2 – Caterpillar 980 Loaders
- 2 – Caterpillar 16H Graders
- 1 – Caterpillar D6 Bulldozer
- 1 – Caterpillar D8 Bulldozer
- 1 – Caterpillar 315 Excavator
- 1 – Caterpillar 345 Excavator
- 2 – Caterpillar CS-583D Soil Compactors
- 2 – Caterpillar IT38 tool carriers
- 1 – Tamrock 345 Hydraulic Reed Drills
- 1 – Fresh Water Tank Truck
- 1 – Sewage Tank Truck
- 1 – Fuel/Lube Service Truck
- 20 – Ford F350 Trucks

5.4.2.25 Access and Transportation

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

Access to the site will be provided by land and air. Access to Ross River will be via Alaska Highway for all traffic from Whitehorse and Robert Campbell Highway for all other traffic. A summer barge and a winter road ice bridge will be used to cross the Pelly River at Ross River along the North Canol Highway. Access to site will be along an upgraded North Canol Highway to 3 km before the Macmillan Pass Aerodrome where the mine site access road begins. An access road will be constructed by upgrading an existing bulk sample access trail. Ground access will be for all bulk supplies and groceries.

Staging areas, as described above, will be used during construction. There will be one staging area on the east side of the Pelly River at Ross River, one staging area on the west side of the Pelly River outside Ross River, and one staging area near the Macmillan Pass Aerodrome.

During construction, the mine will be serviced by standard 5-axle or 6-axle 40-tonne trucks and 10-tonne "hot-shot" trucks. It is expected that there will approximately 2 to 4 loads a day on average with a peak of 10 trucks per day.

Personnel will be transported to site by a combination of aircraft and buses. The workers will be flown from locations such as Edmonton, Vancouver, Smithers and Whitehorse to the Macmillan Pass Aerodrome by chartered aircraft. The workers will be picked up from the aerodrome by a bus and taken to the mine site. It is anticipated that there will be six flights a week to site during the construction phase of the project. Personnel will also be transported from communities, such as Ross River and Faro, to site by company owned and operated ground transport.

NATC will be responsible for maintenance of the Macmillan Pass aerodrome and the mine access road. The Government of Yukon will be responsible for maintenance of all Yukon Highways used to access the site. NATC understands that Yukon Government will commit to upgrading and maintaining the North Canol, including the Ross River crossing.

The mine site access road alignment is shown in Figure 5.4.2-5. There will be 28 stream crossings. The stream crossings will be culverts in all instances, except for three major crossings that will have bridges. The design of the crossings is summarized in a previous section.

A spill response plan is included in Appendix M2.

5.4.2.26 Fuel, Hazardous Materials and Explosives Management

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

Fuel will be stored in two new double-walled enviro-tanks each with a capacity of 7,500 litres, one existing double-walled enviro-tank with a 5000 litre capacity, and in a mobile fuel truck, which, when not in use, will be stationed at the mine site camp. Fuel storage at the aerodrome camp will be limited to the fuel tank on the generator. The temporary double-walled enviro-tanks will be demobilized from site once one of the mobile equipment bulk fuel storage tanks is constructed and commissioned. At that time, refuelling of the fuel truck will be conducted from the bulk fuel tank.

Explosives will be used during construction of the infrastructure site pads and during pre-production of the underground mine. Both ANFO and Geldyne high explosive will be used. The explosives will be stored at the South Haul Ramp and also at the North Haul Ramp in accordance with the applicable laws and standards.

5.4.3 Operation Phase

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

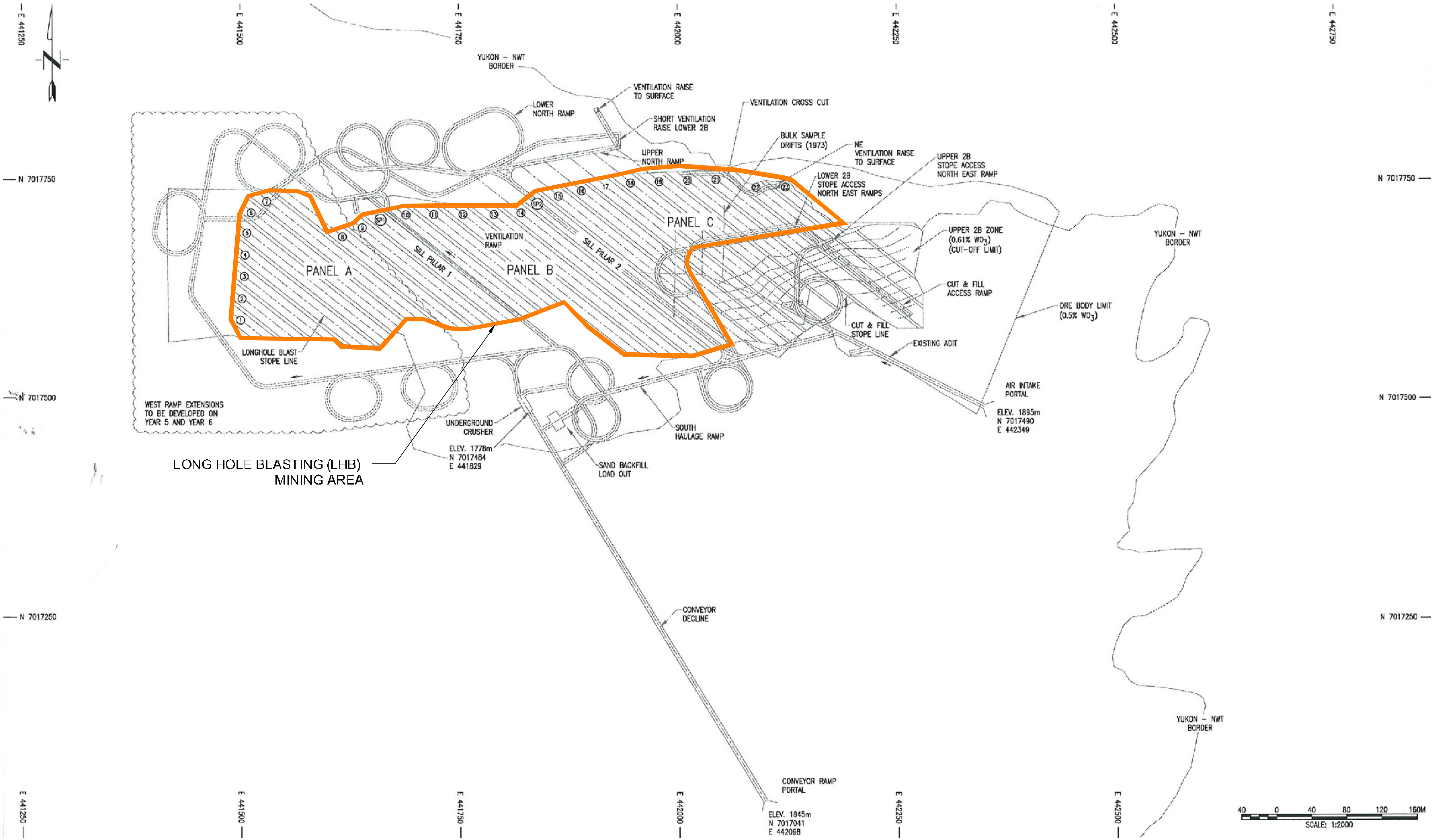
The operation phase of the project will commence in early 2013 and be completed by the end of 2024, at which time the reclamation phase will begin. The operation phase of the project will include the following ongoing activities:

- Underground mining using long-hole blasting method;
- Underground mining using mechanized cut-and-fill method;
- Processing tungsten ore using a scheelite gravity and flotation process;
- Depositing dewatered tailings as underground backfill;
- Depositing dewatered tailings in a surfaced stacked pile;
- Pumping water from the Hess River Tributary to the mine site;
- Operating a 150-person camp;
- Operating water and wastewater treatment facilities;
- Producing ANFO explosives;
- Maintaining a fleet of mobile equipment;
- Generating electrical power;
- Operating the ravine dam;
- Transporting tungsten concentrate to market via Edmonton, AB, and Vancouver, BC;
- Transporting personnel and supplies to site by air using the Macmillan Pass Aerodrome;
- Transporting personnel and supplies to site by ground using the Robert Campbell; Alaska, Klondike and North Canol highways; and
- Maintaining water diversion structures.

5.4.3.1 Underground Mining – Long-hole Blasting

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

Long-hole Blasting (LHB) mining will be used in areas where the ore zone is greater than 12 m thick and 17 m wide with a dip of less than 20°. The areas proposed for LHB mining are shown in Figure 5.4.3-1.



REFERENCE: WARDROP Engineering Inc. drawing,
Project No.: 0753390100, Drawing No. A0-40-004

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Long Hole Blasting Mining Area

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OFFICE	DATE		
WHSE	DECEMBER 2008		

Figure 5.4.3-1

LHB stopes will be 17 m wide, 12-40 m high and 60 m long. Rib pillars, 4 m wide, will be left between stopes. The stopes may extend to up to 230 m along the strike of the ore body, if necessary. In these cases, a transverse pillar, 4 m wide, will separate the 60 m long stopes. The LHB mining method is shown in Figure 5.4.3-2.

The deposit is divided into two ore zones and three panels. The two ore zones are the Upper and Lower 2B zones, and they are separated by approximately 20 m of waste. The Upper 2B zone will be mined first.

The three panels are created by two temporary sill pillars located along the stoping lines. The panels are divided based on ore grade distribution, proposed extraction sequence, and ore zone dip. The zones and panels are shown in Figure 5.4.3-3 and 5.4.3-4.

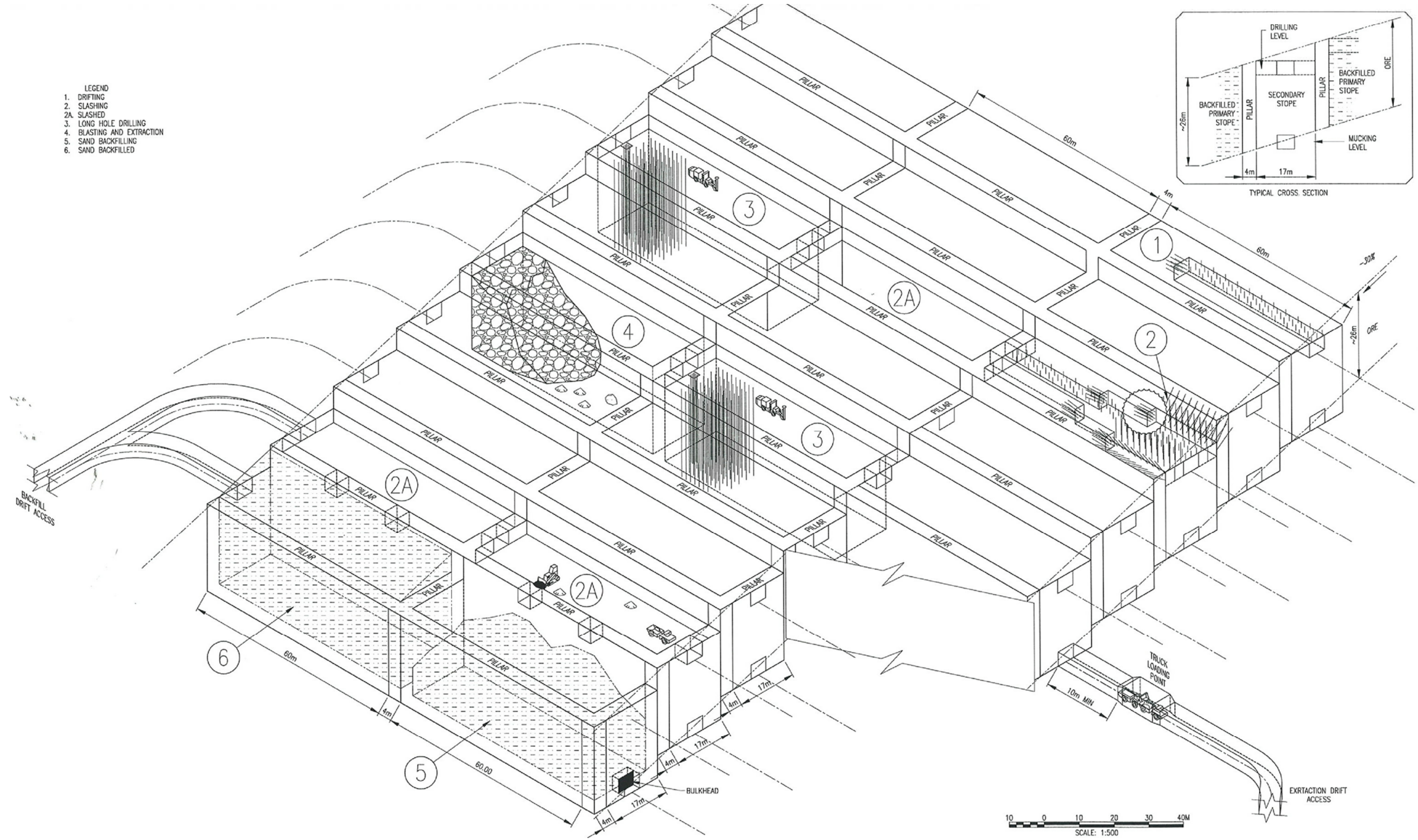
Panel A is along the west edge of the ore body and contains nine stope lines. Mining of this panel is scheduled for later in the mine life.

Panel B is located in the centre of the ore body close to the crusher station and contains five stopes. Mining of this panel is scheduled to begin half way through the proposed mine life.

Panel C is along the east side of the ore body and contains nine stopes. Approximately half this panel will be mined using the LHB method and is proposed as the first area of LHB mining. Mining of this panel is to occur early in the mine life.

Primary stope lines will be parallel and 21 m apart (17 m wide future stope and 4 m wide future rib pillar). Primary stopes will be mined first, and secondary 17 m wide stopes will be mined between the primary stope lines after they are completely backfilled.

There will be a 17 m wide drilling sill above the stope. From here a Tamrock DL310-7 Longhole DTH Drill will drill the holes to be loaded for blasting. The holes will be loaded with ANFO (ammonium nitrate and fuel oil mixture) and blasted. The broken ore will fall on to the floor of the stope, where it will be loaded into Sandvik LH410 30-t Load Haul Dump (LHD) trucks. The mined ore will be hauled to an ore pass leading to the primary crusher, where it will be dumped. The ore will move by gravity through the ore pass into the primary crusher. At this point, the processing begins.



REFERENCE: WARDROP Engineering Inc. drawing, Project No.: 07533901.01, Drawing No. A0-40-002

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Long Hole Blasting Mining Schematic Diagram

PROJECT NO.	DWN	CKD	REV
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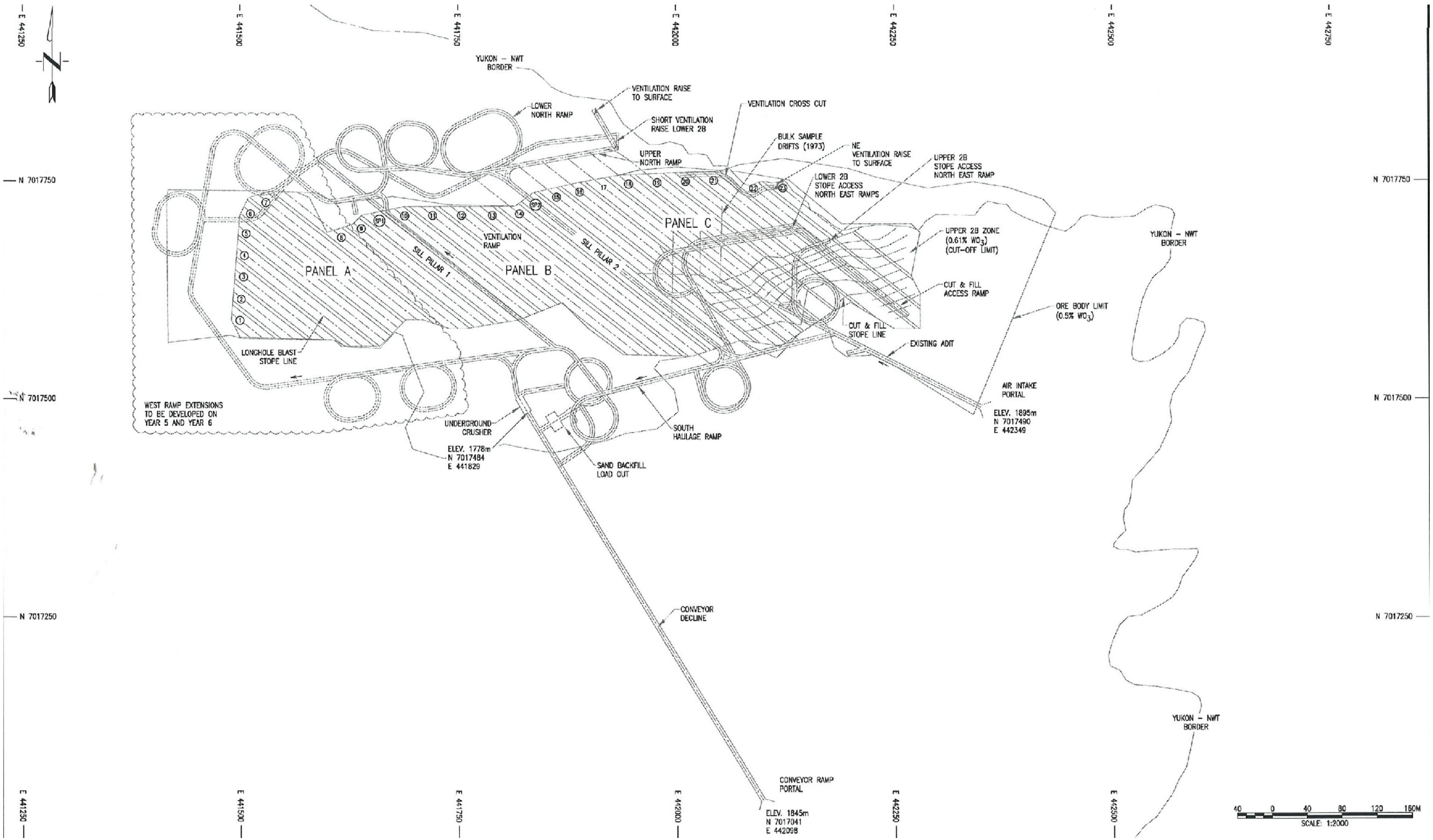
Figure 5.4.3-2

Q:\Edmonton\Drafting\DIVISIONS2007\Other Offices\W231\W23101110\Base ACAD Drawings\W23101110-Yessa Figures Section 5 - Drawing 2.dwg [FIGURE 5.4.3-2] December 12, 2008 - 9:39:32 am (BY: BOB RICHMOND)



REFERENCE: WARDROP Engineering Inc. drawing, Project No.: 07533901.01, Drawing No. A0-40-005

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Underground Mining Panels
Upper 2B Zone

PROJECT NO.	DWN	CKD	REV	
W23101110	BR	CJD	0	**Figure 5.4.3-3**
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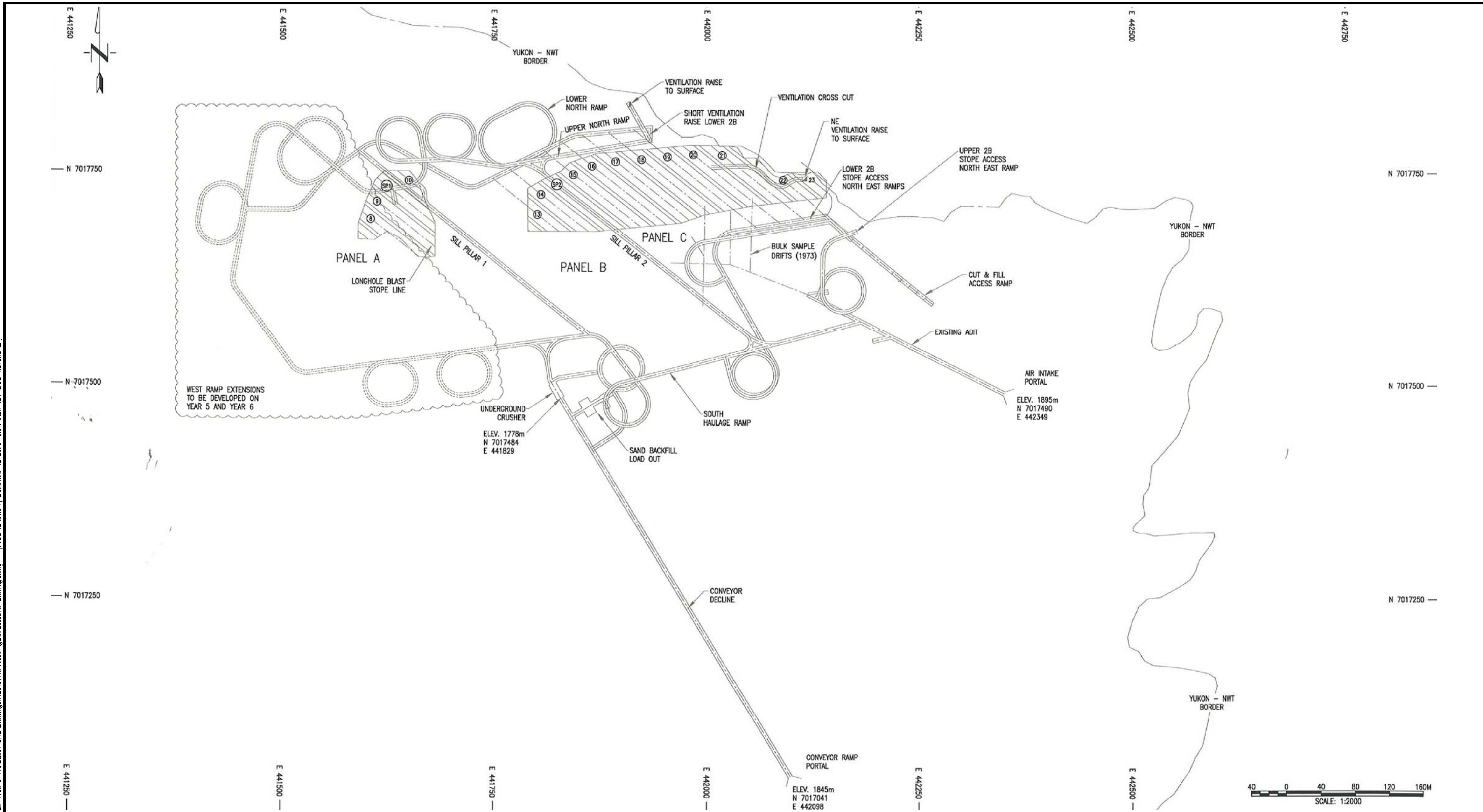
O:\Edmonton\Drafting\DIVISIONS2007\Other Offices\W231\W23101110\Base ACAD Drawings\W23101110-Yessa Figures Section 5 - Drawing 2.dwg [FIGURE 5.4.3-3] December 12, 2008 - 9:41:26 am (BY: BOB RICHMOND)



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REFERENCE: WARDROP Engineering Inc. drawing,
Project No.: 07533901.01, Drawing No. A0-40-005

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Underground Mining Panels
Lower 2B Zone

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Figure 5.4.3-4

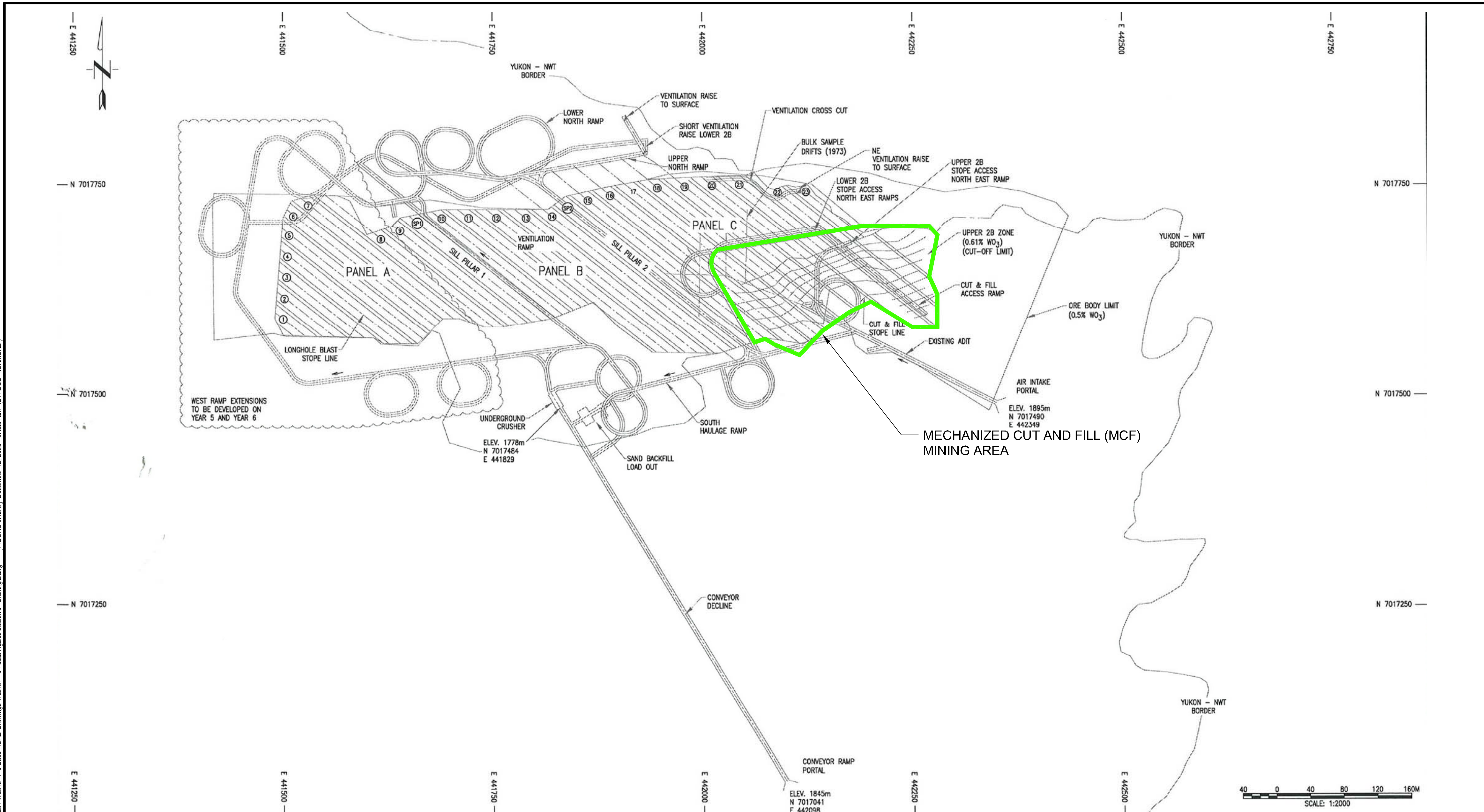
5.4.3.2 Underground Mining – Cut-and-Fill

Mechanized cut-and-fill (MCF) mining will be used in areas where the ore zone is less than 12 m thick and 17 m wide with a dip greater than 20°. The areas proposed for MCF mining are shown in Figure 5.4.3-5.

MCF stopes will be 17 m wide, up to 12 m high and 50 m to 120 m long. Rib pillars, 3 m wide, will remain between stopes. The back of the first cut will be 4 m high. The cut will be advanced 4.6 m per blast, beginning at the lower elevation of the stopes. The entire stope line length will be mined. No transverse pillars will be left. Once the first cut is complete, the stope will be backfilled to within 1 m of the back and the second cut (maximum height of 4 m) will be advanced to the end of the stope line. This process will be repeated until the hanging wall is reached. The MCF mining method is shown in Figures 5.4.3-6.

The back of each cut will be stabilized with 2.1 m long friction stabilizer bolts and 16 m long grouted cable bolts. These systems will be installed on a staggered grid. The walls of the stope will be reinforced with 2.1 m long friction stabilizer bolts drilled on a 2.1 m grid. Mining the bolted and cable-bolted ground will be mined with the ore as steel scrap. The steel will be separated during the mucking and loading process or on the grizzly screens installed in the ore pass. The primary crusher operator will monitor the crushing operation for steel scraps. There will also be an electromagnet installed on the conveyor belt loading point to trap the steel scrap and protect the conveyor belt from being ripped and the secondary and tertiary crushers from being damaged.

MCF mining will be limited to half the stopes in Panel C where the ore thickness is limited and the ore body is steeply sloped. In this area, portions of the ore body are beneath the 1895 m adit. A crown ore pillar 20 m long, 20 m wide and 10 m high will be left beneath the 10 m thick waste rock crown pillar.



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Mechanized Cut and Fill Mining Area

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Figure 5.4.3-5

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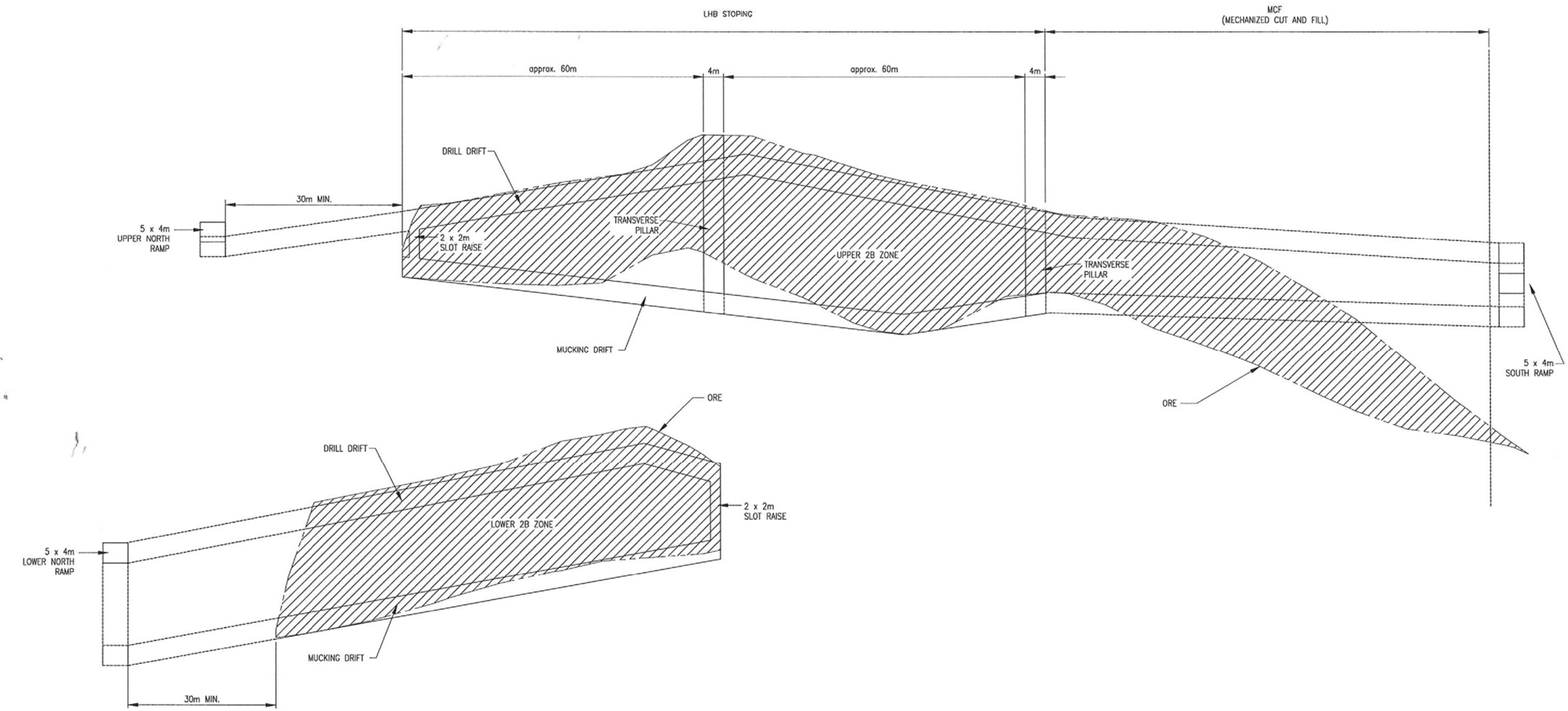

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Mechanized Cut and Fill Mining Area
Schematic Longitudinal Section

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Figure 5.4.3-6

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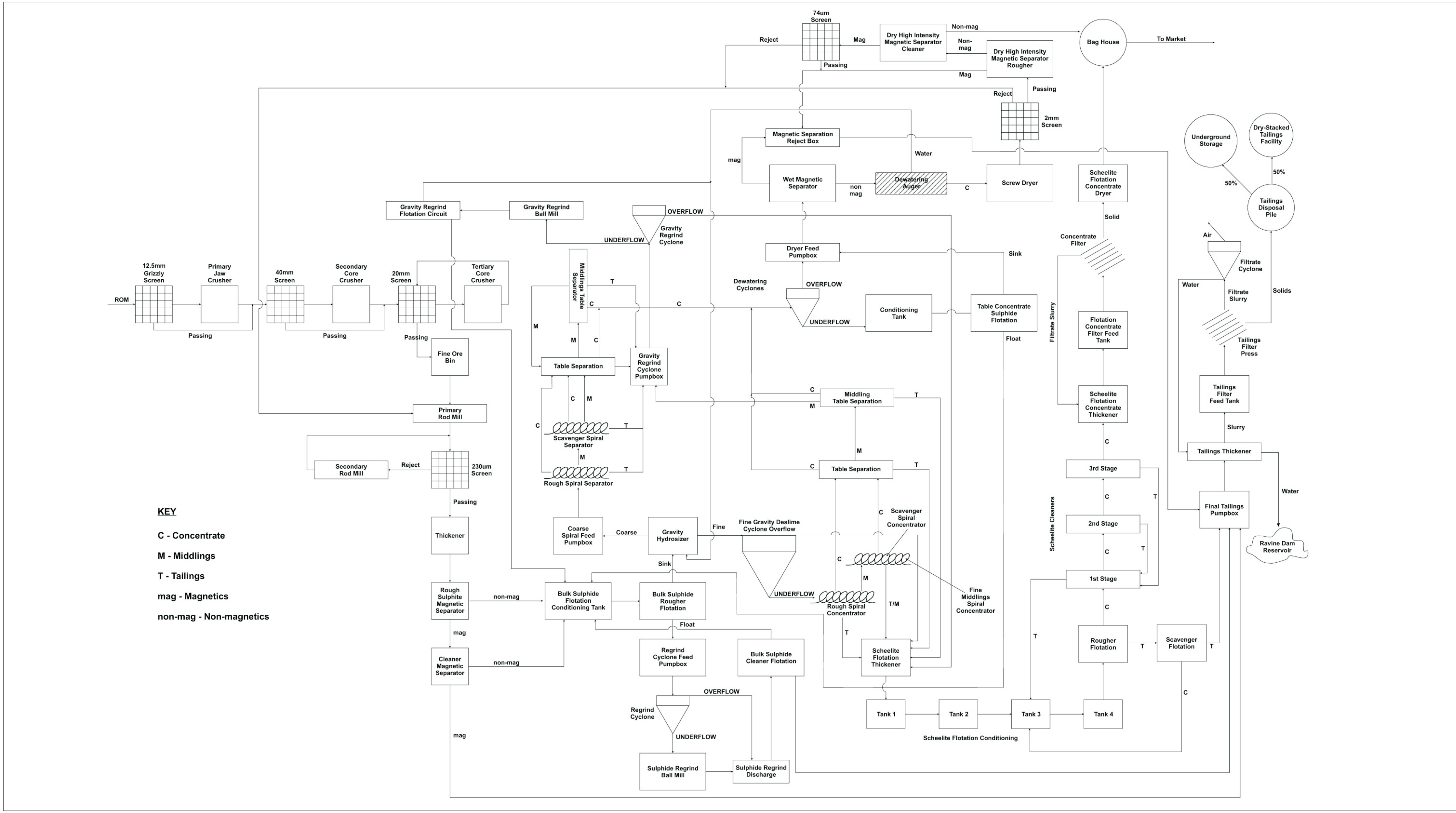
5.4.3.3 Processing Tungsten Ore

The proposed process, as outlined in Mactung Feasibility Study (Wardrop, 2008), to concentrate the ore at Mactung comprises the following operational steps:

1. Primary Crushing
2. Secondary and Tertiary Crushing
3. Primary and Secondary Grinding
4. Sulphide Magnetic Separation
5. Bulk Sulphide Flotation Circuit
6. Gravity Concentration Circuit
7. Coarse Gravity Concentration Circuit
8. Fine Gravity Concentration Circuit
9. Gravity Regrind Circuit
10. Table Concentrate Sulphide Flotation Circuit
11. Gravity Concentrate Dewatering and Magnetic Separation Circuit
12. Scheelite Flotation Circuit
13. Scheelite Flotation Concentrate Dewatering Stage
14. Final Tailings Dewatering Stage

Each operational step in the process is further described in the subsequent sections. A visual description flow sheet is provided in Figure 5.4.3-7.



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Overall Process Flow Sheet

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Figure 5.4.3-7

1. Primary Crushing

- A static grizzly screen will reject any individual rocks larger than 750 mm.
- A vibratory grizzly screen will separate the ore into rocks smaller than 125 mm and rocks larger than 125 mm.
- A primary jaw crusher, with a dust collection system, will accept the rocks smaller than 750 mm and larger than 125 mm and reduces them to ore with a maximum particle size of 100 mm.
- A conveyor system will move both the crushed ore and ore passing the 125 mm vibratory grizzly screen from underground to the surface.
- A magnet will remove tramp iron from the ore on the conveyor belt.
- A 500 tonne capacity coarse ore bin, with emergency overflow, will accept the underground ore.

2. Secondary and Tertiary Crushing

- A screen will allow particles less than 40 mm in diameter to bypass the secondary crusher.
- A secondary, open circuit, hydraulic cone crushing system will reduce the P_{80} ore size (80% of the ore is smaller than) to 38 mm.
- A second screen will allow particles less than 20 mm in diameter to bypass the tertiary crusher.
- A tertiary, closed circuit, hydraulic cone crushing system will reduce the P_{80} ore size to less than 16 mm.
- A fine ore bin will hold 2,000 t or one full day of plant feed.

3. Primary and Secondary Grinding

- Conveyor belts and feeders will move the crushed ore from the fine ore bin to the primary rod mill.
- The primary rod mill grinding system will reduce the P_{80} ore size to 500 µm at 80% solids.
- A rod mill discharge pump box, with added process water, will dilute the solids content of the ore to 45% and will move the slurry to the grinding classification screens.
- A vibratory screen deck with four screens, of which only three will operate at one time, will reject the ore particles larger than 230 µm at 75% solids. The ore that passes through the screen deck will have a P_{80} of 150 µm at 25% solids and will advance to the grinding thickener.

- A secondary rod mill grinding system will reduce the P_{80} of the ore particles larger than 230 μm to 150 μm (this will discharge back into the rod mill discharge pump box).

4. Sulphide Magnetic Separation

- A grinding thickener will remove a portion of the water in the ore smaller than 230 μm, increasing the solids content to 50%. The thickener overflow will be returned to the process water tank for recycling.
- Three rougher magnetic separators (RMS) will remove the magnetic product for further processing in the cleaner magnetic separator (CMS).
- A CMS process will remove non-magnetic product that passed through the RMS. Magnetic product from this stage becomes tailings.
- The non-magnetic material from the CMS and RMS will be combined to feed the bulk sulphide flotation circuit.

5. Bulk Sulphide Flotation Circuit

Bulk sulphide flotation will remove sulphide minerals from the ore to facilitate the recovery of tungsten in the gravity circuit.

- A conditioning tank with a residence time of five minutes will introduce the flotation reagents (Collector KAX, frother DF250, and activator copper sulphate).
- Product from conditioning tank will go to rougher flotation cells. Rougher flotation will be performed in six flotation cells with a residence time of 30 minutes.
- The sludge from the bulk sulphide rougher flotation cells will be advanced to the gravity hydrosizer.
- The concentrate from the bulk sulphide rougher flotation cells will consist of predominately sulphide minerals and will go to the sulphide regrind circuit to grind oversize material.
- Two cyclones (only one active, the other is a spare) will be used as classifiers in the bulk sulphide regrind circuit.
- The cyclone overflow with a P_{80} 60 μm particle size will be discharged into the sulphide regrind ball mill to liberate locked sulphide and associated scheelite minerals.
- The sulphide regrind mill will grind feed material to a particle size of P_{80} 90 μm. The mill will operate in an open circuit to minimize overgrinding of scheelite in the feed material.
- The sulphide regrind mill discharge and regrind cyclone overflow will go to the sulphide cleaner flotation circuit.
- The bulk sulphide cleaner flotation will be carried out without additional flotation reagents and consists of five flotation cells with a residence time of 30 minutes.

- The float from the bulk sulphide cleaner flotation will go to the final tailings pump box for thickening and filtering.
- The tails from the bulk sulphide cleaner flotation will be returned to the bulk sulphide flotation conditioning tank to recycle to the bulk sulphide flotation circuit.

6. Gravity Concentration Circuit

- Tails from the bulk sulphide rougher flotation circuit will be classified into fine and coarse particle streams by way of a gravity hydrosizer.
- Coarse material (P_{80} > 110 μm) will be processed further in the coarse gravity concentration circuit
- Fine material (P_{80} < 110 μm) will be processed in the fine gravity concentration circuit.

7. Coarse Gravity Concentration Circuit

- Coarse material from the gravity hydrosizer will be fed into a two-stage spiral separation process.
- The rougher spiral concentrators will produce three products: a rougher concentrate, a rougher middlings, and a rougher tailings.
- The rougher concentrate will proceed directly to a two-stage shaking table concentration process.
- The rougher tailings will make their way to the gravity regrind cyclone pumpbox.
- The rougher middlings will advance to the scavenger spiral separation, which is the second stage of spiral separation
- Scavenger spiral separation similarly will produce three products. The scavenger concentrate and scavenger middlings will join the rougher concentrate in the two-stage table separation, and the scavenger tailings will be routed to the gravity regrind cyclone pump box.
- The two-stage table separation process will separate concentrate from tailings using two sets of tables. The tailings will be sent to join the tailings from the spirals in the gravity magnetic separation and regrind cyclone pump box while the concentrate advances to dewatering cyclones for drying and eventual bagging and shipment.

In summary, the coarse gravity concentration circuit will yield two streams of material: tailings bound for the gravity regrind circuit for further processing, and concentrate bound for dewatering magnetic separation and eventual bagging and shipment.

8. Fine Gravity Concentration Circuit

- Fine material from the gravity hydrosizer will be fed into the four fine deslime cyclones.
- Overflow material from the deslime cyclones (P_{80} 40 µm) will report to the scheelite flotation thickener for further processing.
- Underflow material from the deslime cyclones will be discharged to the two-stage fine gravity spiral concentrators.
- The fine gravity spiral concentrators and two-stage fine gravity table separation will operate in a similar manner to their coarse counterparts. The resulting concentrate will be advanced to the dewatering cyclones, the tailings will be sent to the scheelite flotation thickener, and the middlings will join the coarse tailings in the gravity regrind cyclone pump box.

9. Gravity Regrind Circuit

- Tailings from the coarse gravity concentration circuit and middlings from the fine gravity regrind circuit will begin the gravity regrind circuit in the gravity regrind cyclone pump box.
- Four regrind cyclones will classify the material. The cyclone underflow will have a particle size of P_{80} 30 µm and will be discharged to the scheelite flotation thickener. The cyclone overflow will have a particle size of P_{80} 180 µm and will be reground in the gravity regrind ball mill.
- The gravity regrind ball mill will discharge material with a particle size P_{80} 100 µm to the regrind mill discharge pump box.
- From there the material will be treated in the gravity regrind sulphide flotation circuit for the removal of liberated sulphide minerals.
- The gravity regrind sulphide flotation circuit will contain five conventional mechanical flotation cells.
- The gravity regrind flotation concentrate will be pumped back to the bulk sulphide flotation circuit conditioning tank to re-enter the bulk sulphide flotation circuit.
- The gravity regrind flotation tailings will re-enter at the beginning of the gravity concentration circuit (at the gravity hydrosizer).

10. Table Concentrate Sulphide Flotation Circuit

- Concentrates from both the coarse and the fine two-stage table separation processes will enter the two dewatering cyclones at the front of the table concentrate sulphide flotation circuit.
- Cyclone overflow (P_{80} 10 µm) will be directed to the dryer feed pumpbox.

- Cyclone underflow will feed the table concentrate conditioning tank en route to the table concentrate sulphide flotation circuit.
- The conditioning tank will facilitate the mixing of the flotation reagents, KAX and DF250. The conditioning tank overflow will enter the table concentrate sulphide flotation circuit.
- The flotation circuit will have a residence time of 30 minutes. The sulphide-rich froth will be returned to the bulk sulphide flotation circuit. The sludge will join the dewatering cyclone overflow in the dryer feed pumpbox.

11. Gravity Concentrate Dewatering and Magnetic Separation Circuit

- Tungsten rich product will be run through a wet magnetic separator, dewatered, dried, run through a high intensity magnetic separation process, and bagged for export.
- The wet magnetic separator will remove the remaining magnetic sulphide minerals. The magnetic product will go to the magnetic separation rejects pumpbox and, ultimately, the final tailings pumpbox. The non-magnetic product will advance to the dewatering auger.
- The dewatering auger will increase the slurry density from 13% to 80% solids. The auger overflow water will be returned to the gravity hydrosizer at the beginning of the gravity concentration circuit. The dewatered concentrate will be fed into the holoflite screw dryer.
- The holoflite screw dryer will operate at a temperature of 120°C. The off-gases from the dryer will be discharged to the atmosphere through the dryer exhaust fan.
- The concentrate will be cooled with a series of water cooled conveyors and will be delivered through a gravity concentrate oversize screen to the dry high-intensity magnetic separator.
- The gravity concentrate oversize screen will return particles larger than 2 mm in size to the primary rod mill for reprocessing.
- The dry high-intensity magnetic separator will consist of a rougher magnetic separation step and a two-stage cleaner high-intensity magnetic separation step. The magnetic separators will be rare-earth permanent high intensity magnetic separators.
- Magnetic material removed by the rougher high-intensity magnetic separator will go to the magnetic separation rejects pumpbox. The non-magnetic concentrate will advance to the cleaner high-intensity magnetic separator.
- Magnetic material removed by the cleaner high-intensity magnetic separators will pass through a vibrating screen. Particles larger than 74 μm will be returned to the primary rod mill for reprocessing while particles smaller than 74 μm will go the magnetic separation rejects pumpbox.

- Non-magnetic material from the cleaner high-intensity magnetic separators will report to a baghouse and concentrate packaging area.

12. Scheelite Flotation Circuit

- The scheelite flotation circuit will recover any remaining fine scheelite particles that were not recovered by the preceding gravity concentration circuit.
- The material entering the scheelite flotation circuit will be treated in the scheelite flotation feed thickener, which will thicken the slurry from 15% solids to 60% solids.
- The material will then pass through a series of four conditioning tanks, which will prepare the slurry for flotation by adding the following substances:
  - Caustic soda and soda ash will be added to Tank 1 to adjust the pH of the feed slurry to 10.5
  - Quebracho and sodium silicate will added to Tank 2 to depress silicate and sulphide minerals
  - Pamak, a fatty acid, will be added to Tank 3 as a scheelite flotation collector
  - Emcol, a fatty acid, will be added to Tank 4 as a secondary scheelite collector.
- Upon completion of flotation conditioning, the slurry will enter four mechanical flotation cells for rougher flotation.
- The concentrate from the rougher flotation will advance to the scheelite cleaner flotation circuit while the tailings from the rougher flotation will be sent to the scheelite scavenger flotation circuit.
- The scheelite scavenger flotation circuit will consist of four mechanical cells. The concentrate removed from the scavenger flotation cells will be returned to the third conditioning tank while the tailings will be sent to the final tailings pumpbox.
- The cleaner scheelite flotation circuit will consist of three cleaner flotation stages. The first cleaner scheelite flotation circuit will be comprised of four conventional mechanical cells. The tailings obtained will be returned to the third conditioning tank while the concentrate will advance to the second cleaner scheelite flotation circuit.
- The second cleaner scheelite flotation stage will be conducted in a column flotation type cell. The second cleaner concentrate will feed the third cleaner stage, and the tailings will be re-treated in the first cleaner flotation circuit.
- The third cleaner scheelite flotation stage will also be a column flotation-type cell. The concentrate will advance to the scheelite flotation concentrate dewatering stage, and the tailings will again be returned to the first cleaner flotation circuit.

13. Scheelite Flotation Concentrate Dewatering Stage

- The concentrate from the cleaner scheelite flotation stage will be thickened in the scheelite flotation concentrate thickener from 22% solids to a density of 60% solids.
- The scheelite concentrate will then be pumped using a peristaltic pump to the flotation concentrate filter feed tank where it will be prepared for filtration by the addition of a filter aid.
- The mix will then be passed through the vacuum belt filter, which will reduce the moisture content from 40% to 10%. The filtrate from the vacuum filter will be recycled to the scheelite flotation concentrate thickener.
- The filter cake will be discharged into the scheelite flotation concentrate dryer to further reduce the moisture content.
- The flotation concentrate dryer will reduce the moisture content to less than 0.5% for bagging in a manner similar to the gravity concentrate.

14. Final Tailings Dewatering Stage

- Tailings accumulated in the final tailings pumpbox will be sent to the tailings thickener, which will increase the solids content from 35% to 60%.
- The clear thickener overflow solution will be discharged into the reservoir to allow it to age for approximately 30 days, facilitating the decomposition of the flotation reagents before being recycled into the process water tank.
- The tailings thickener underflow will be pumped through a set of automatic plate and frame pressure filters, which will further reduce the moisture content to roughly 20%.
- The tailings will then be discharged via a belt conveyor as underground backfill or surface tailings disposal.
- The filtrate from the pressure filters will report to a cyclone-type air and water separator for removal of entrapped air to the atmosphere. The water will then be returned to the tailings thickener.

5.4.3.4 Underground Backfill Placement

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

Underground backfill of the stopes will consist of classified, dewatered, unconsolidated tailings. The moisture content of the tailings is expected to be approximately 20%. It is anticipated that, with tailings gradation, moisture content, and unconsolidated placement, the backfill will be susceptible to liquefaction induced by seismic activity or other dynamic forces, such as blasting. To accommodate for this, bulkheads will be installed at draw points to seal off the backfill material. Bulkheads will prevent backfill material from entering the cross-cuts and drifts and provide drainage. Bulkheads will consist of either a wooden or a concrete wall sealing off the stope at the draw point. Bulkheads will be designed to allow water to drain from the stope.

Backfill will be transported from the mill site to the underground workings by a conveyor located next to the ore conveyor in the main conveyor decline. The tailings will be deposited into a stockpile room adjacent to the primary crusher. The tailings will be loaded into the 30-t load-haul dump (LHD) units and hauled to a mined out stope as the LHD returns to an active stope to load and haul more ore to the primary crusher.

Once the backfill is dumped at the head of a mined out stope or at a cross-cut into a mined out stope, it will be pushed into place using a GR 12 H remote controlled grader/dozer unit. Depositing waste rock can possibly occur simultaneously with the tailings placement. In the areas where MCF mining is used, the backfill will be capped with waste rock to facilitate equipment travel during the next cut.

Once a stope is backfilled within 1 m of the back of the stope, a bulkhead will be installed at the stope entrance and it will be sealed. No personnel will enter the stope, and no backfill will be able to escape.

The underground mine is partially in permafrost and partially below permafrost. The anticipated mine area below permafrost is approximately 20%. Where the mine is excavated into marginal permafrost conditions, it is assumed that the backfill will eventually freeze; however, this process may take many years. The backfill is considered to remain unfrozen throughout the life of the mine.

Approximately 175,000 m^3 of waste rock is expected to be developed during the operation phase. This rock will be used as backfill over the tailings fill sections in the MCF mining area to facilitate mining of the second and third levels. It will also be placed as backfill with tailings, where convenient for the mining process. The placement of co-disposal waste rock and tailings should have no negative effects on the structural or geochemical stability of the backfill in general. Also, waste rock backfill may be used in the portion of the underground mine below the water table.

5.4.3.5 Surface Stacked Tailings Placement

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The tailings that are not used in underground backfill will be surface stacked. At the end of operation, it is estimated that 2,130,500 m^3 of tailings will be backfilled within the mined out stopes and that 2,130,500 m^3 of tailings will be surfaced stacked. The tailings will be deposited outside of the mill using a conveyor belt. They will be loaded into 30-t haul trucks and hauled to the DSTF. Here, the tailings will be spread into a 600 mm thick lift and compacted using a 15-t vibratory compactor. The tailings will be compacted to at least 95% of the maximum dry density, as determined by ASTM D698, the industry-recognized laboratory test for determining maximum dry density of soils. Compaction of the tailings will force some water to seep from the pile. This water seepage has been estimated based on experience at other site as 10% of the total volume of water entering the DSTF from the mill.

Experience at the Minto Mine, YT, shows that the tailings can sit outside at northern winter temperatures for at least 12 hours before the outer edge of the pile is frozen to the point where it is difficult to load them into a truck. The outer edge of the stockpile will begin to freeze if left out; however, only a "skin" of a less than 100 mm will develop in 4 to 6 hours. If the tailings are compacted immediately after placement, NATC will be able to achieve the desired compaction of the tailings.

The DSTF will be constructed from compacted tailings. At completion, the pile will have a 4H:1V slope and a 100 m long by 30 m wide pad, graded at approximately 2% towards the edges to promote drainage off the pile. Compaction of the tailings reduces the void ratio of the material and significantly reduces the liquefaction potential of the tailings. The tailings pile is designed to withstand a 1:500 year seismic event for the area, in accordance with the Mined Rock and Overburden Piles (1994) developed by the BC Mine Waste Rock Pile Research Committee.

The natural soils beneath the DSTF will allow dissipation of porewater pressures that may be introduced through seepage water from the tailings or daylighting groundwater. It is not anticipated that permafrost will develop in the pile during the life of the mine. However, tailings placed in the winter may not completely thaw during the subsequent summers if they are covered with enough tailings. General placement procedure will be to place the first lift of tailings over the majority of the base during the summer, to ensure that soils are unfrozen at the time of bury, to allow them continue to work as a drain. The DSTF plan and section, at the end of mine life, is shown in Figures 5.4.2-22 and 5.4.2-23, respectively.

5.4.3.6 Pumping Water from the Hess River Tributary to the Mine Site

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

Water will be pumped from the Hess River Tributary to the mine site through a 100 mm to 250 mm diameter insulated and heat-traced pipeline. The pumps at the intake station will run year-round during the operation phase. However, there will be provisional storage on site for when the system is down for maintenance or repair. The system may intermittently not run while the process plant is not operational.

The pumps will be electrical and powered from the main power generation system. The power line will run adjacent to the pipeline on the pipeline bench along the shoulder of the access road.

5.4.3.7 Operating a 150-Person Camp

Either a single or shared room accommodations will be provided for workers in the accommodations complex. Plant workers will work 12-hour shifts and underground workers will work 10-hour shifts, 7-days a week on a 3-week in and 1-week out rotation.

Transportation to the site will be provided by air to the Macmillan Pass Aerodrome and bus from the aerodrome to the site. During shift work, employees will be transported underground by a man-carrier or will walk to their station in the process plant by way of covered, insulated, and heated walkways.

All meals will be provided at the camp through the kitchen/canteen in the accommodations complex. Employees will pack a lunch to eat on their lunch breaks near their workstations. A recreation facility will be available for employees in their off-time.

5.4.3.8 Potable and Wastewater Treatment Plants

The mine will have both a potable water treatment facility and a wastewater treatment facility. Potable water will be treated from the freshwater storage tank, serviced from the Hess River Tributary pipeline, and treated waste water will be discharged into the reservoir.

The potable water treatment system will be a packaged reverse-osmosis or ultraviolet treatment system and a hypo-chlorinator, which will treat the freshwater to Canadian Drinking Water Standards. The potable water will be chlorinated before it is distributed in the site potable water distribution system. The potable water will only be used to service the camp and will not be used for mine process activities. Process plant water will be pumped directly from the Hess River Tributary.

The water distribution system will be 45 mm to 60 mm diameter steel pipes installed within utilidors. The water treatment plant will be located near the accommodations complex and treated water will be pumped throughout the site.

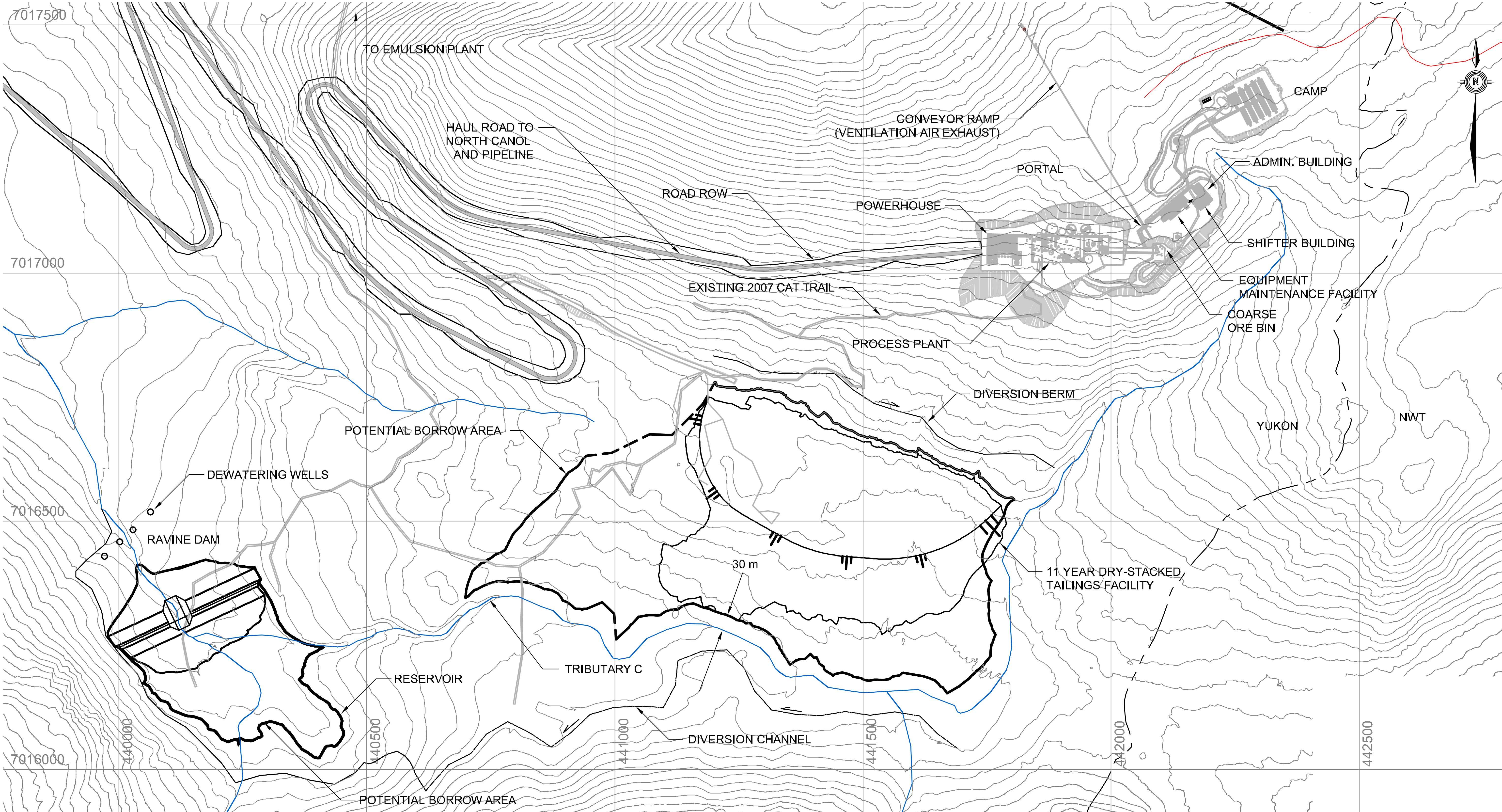
The wastewater collection system will be gravity-fed to the treatment plant located approximately 1 km southwest and downslope of the accommodations complex. Insulated HDPE pipes running through the utilidors will connect the mine site infrastructure with the wastewater treatment plant.

The wastewater treatment plant will be a rotating biological contact unit built to produce effluent in accordance with Yukon Water Board requirements for treated sewage effluent. Treated effluent will be discharged from the plant into the reservoir, where it will be mixed with process and runoff water.

5.4.3.9 Ammonium Nitrate Fuel Oil Emulsion Plant

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The ammonium nitrate fuel oil (ANFO) emulsion plant will be located on the west side of Mount Allen, as shown in Figure 5.4.3-8, and will be constructed in accordance with Explosives Act requirements. The plant will produce 1000 kg of ANFO a day in a package type explosive, which will be hauled overland to the underground portal. The ANFO truck will haul the explosives underground, by way of the conveyor decline, after which the blast holes will be loaded.



NOTE:
Contours shown at 10 m intervals.

ISSUED FOR USE

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Scale: 1: 7 500 (metres)

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MACTUNG

General Site Plan

PROJECT NO.	DWN	CKD	REV
W23101110	BR	CJD	0
OFFICE	DATE		
WHSE	DECEMBER 2008		

Figure 5.4.3-8

Q:\Edmonton\Drafting\DIVISIONS\2007\Other Offices\W231\W23101110\Base ACAD Drawings\W23101110\Yessa Figures Section 5 - Drawing 3.dwg [FIGURE 5.4.3-8] December 12, 2008 - 10:00:34 am (BY: BOB RICHMOND)

5.4.3.10 Equipment maintenance facility Operation

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

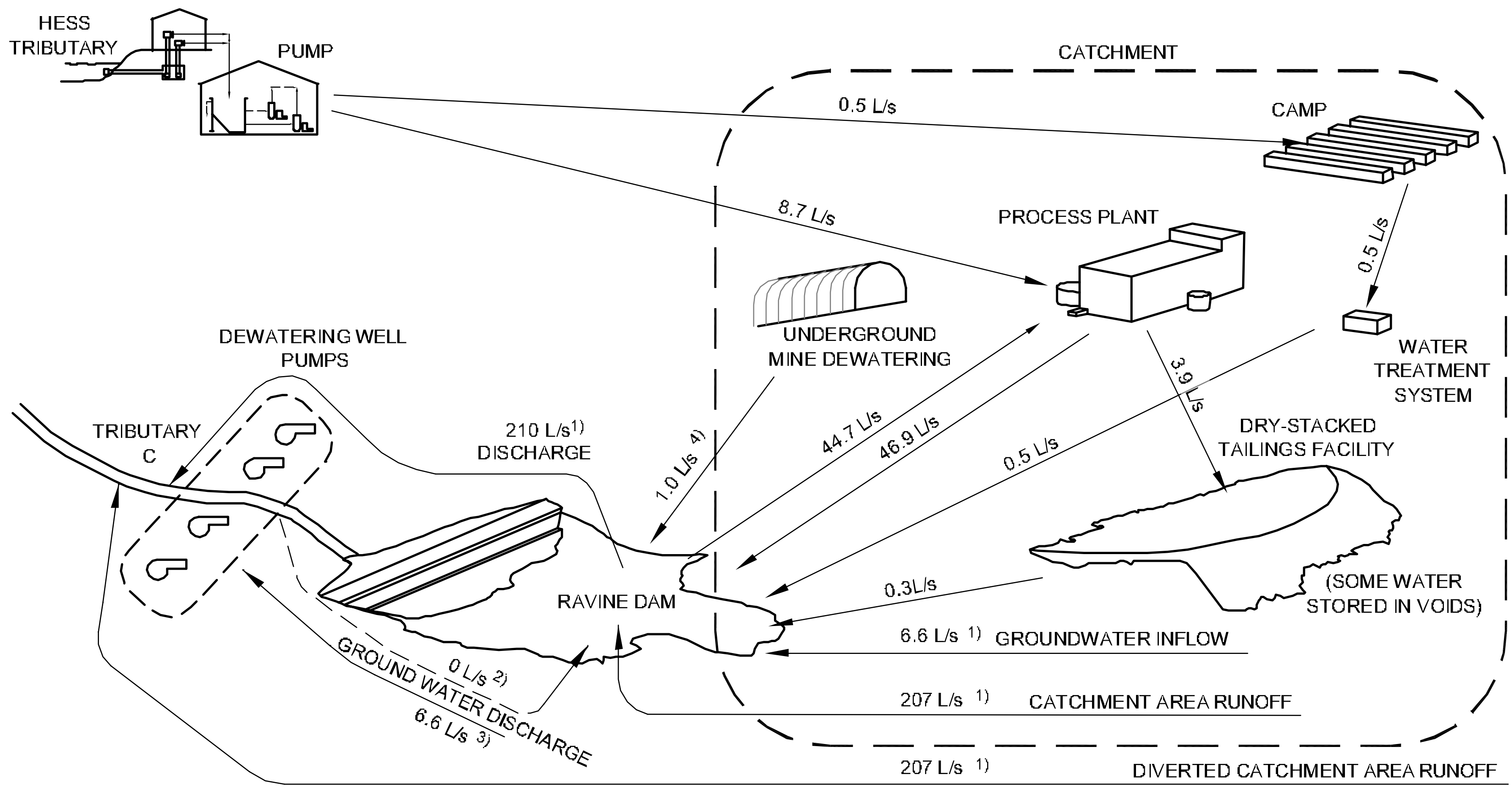
All equipment maintenance will be conducted on the surface in the equipment maintenance facility. The equipment maintenance facility is located near the shifter building as shown in Figure 5.4.2-17. The equipment maintenance facility will have bulk storage capacity for fuels, oils and lubricants that are required for the operation of the mobile equipment fleet. These liquids will be stored in supplier provided bulk storage containers. It is anticipated that the products listed in Table 5.4.3-1, Table 5.4.3-2, and Table 5.4.3-3 will be stored on site.

TABLE 5.4.3-4 AVERAGE YEAR WATER BALANCE BY MONTH (L/S)

	Process Water	Runoff	DSTF Seepage	GW Discharge	Treated Effluent	UG Mine Dewatering	Process Water Reclaim	Reservoir Discharge	GW Seepage
	Inflow	Inflow	Inflow	Inflow	Inflow	Inflow	Outflow	Outflow	Outflow
January	46.9	6	0.3	6.6	0.5	1.0	-44.7	-10	-6.6
February	46.9	4	0.3	6.6	0.5	1.0	-44.7	-6	-6.6
March	46.9	4	0.3	6.6	0.5	1.0	-44.7	-5.4	-6.6
April	46.9	5	0.3	6.6	0.5	1.0	-44.7	-6	-6.6
May	46.9	81	0.3	6.6	0.5	1.0	-44.7	-87	-6.6
June	46.9	207	0.3	6.6	0.5	1.0	-44.7	-210	-6.6
July	46.9	131	0.3	6.6	0.5	1.0	-44.7	-171	-6.6
August	46.9	77	0.3	6.6	0.5	1.0	-44.7	-81	-6.6
September	46.9	59	0.3	6.6	0.5	1.0	-44.7	-61	-6.6
October	46.9	35	0.3	6.6	0.5	1.0	-44.7	-38	-6.6
November	46.9	15	0.3	6.6	0.5	1.0	-44.7	-18	-6.6
December	46.9	9	0.3	6.6	0.5	1.0	-44.7	-12	-6.6
Total Yearly Volume (m^3)	1479038	1665196	9461	208138	15768	31536	-1307612	-1862300	-129298

Water quality in the pond will be monitored using monitoring stations. Stations will be located at the end of pipe and at some distance downstream, as determined through the water licensing process. NATC intends to ensure the water quality at the end of pipe discharge location will be in compliance with MMER regulations and the downstream monitoring point will be in compliance with the CCME water quality guidelines to receiving waters. At this time it is expected that water will not require treatment and therefore will be released to the environment.

Should the water be out of discharge compliance, there are provisional pumping wells proposed for 100 m downstream of the dam to pump groundwater back into the reservoir. These wells will be able to pump most of the groundwater seepage back into the reservoir for treatment and discharge.



NOTES:

1) PEAK FLOW VALUES, FLOWS VARY
2) RECOVER WELLS ONLY OPERATIONAL IF WATER QUALITY DOES NOT MEET DISCHARGE CRITERIA.
3) NORMAL OPERATING FLOW, FLOW WILL VARY.
4) UNDERGROUND MINE DEWATERING ONLY IN SECOND HALF OF MINE LIFE.

Not To Scale

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CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Mine Site Water Balance

PROJECT NO.	DWN	CKD	REV
W23101110	BR	CJD	0
OFFICE	DATE		
EBA-WHSE	DECEMBER 2008		

Figure 5.4.3-9

If NATC discovers that the water in the reservoir is exceeding discharge criteria, they will design and purchase a treatment system. In an average year, if the water does not meet discharge criteria, the reservoir can store water from beginning of November until the beginning of June the following year. However, if the pumps are not turned on in June the dam will overtop. Should this happen the water will flow through emergency spillway and into Tributary C.

5.4.3.11 Water Diversion Structures

Operation of the water diversion structures will be limited to ongoing maintenance and snow clearing. The diversion structure on the north side of the valley and the diversion berms uphill of the DSTF will both require snow clearing in late winter to open an area for overland runoff water to flow. Snowfence may be installed uphill of the diversion structures to keep large pieces of snow and ice from blocking the water flow route along these diversion structures during freshet if circumstances arise. The diversion channel will have a sediment control structure at the outfall (e.g., a silt fence of a sedimentation sump).

5.4.3.12 Water Usage

Water usage for the operation phase will involve pumping freshwater from the Hess River Tributary to the site for use as process water and for treatment and use as potable water for the camp facilities. It is expected that the water usage for the camp will be approximately 200 litres per person per day or 30,000 litres per day at peak capacity. Make-up water for the process is estimated to be approximately 46.9 L/s. The process will also reclaim water fro the reservoir at approximately 44.7 L/s. Other water flows are described throughout the report and summarized in Section 5.4.3.12.

5.4.3.13 Quality Control / Quality Assurance

NATC will use a combination of external consultants, an internal project management team, and internal mine staff to conduct quality assurance on all aspects of the tailings placement, backfill placement, mine planning, mine operation, ventilation operation, and all other tasks as necessary. Quality assurance will include, but not be limited to:

- Daily inspections of all ground conditions and ventilation systems,
- Regular review of mine plan, and
- Annual inspections of all dams and water diversion structures.

All required testing and instrumentation monitoring as detailed in design reports, construction specifications, permits, and licences will be conducted.

5.4.3.14 Work Force Requirements

NATC will conduct all the operation mining with their personnel and equipment. This labour force is summarized in Table 5.4.3-5. With scheduled rotations, there will only be 150 people on site at any given time.

TABLE 5.4.3-5 NATC'S OPERATION PHASE LABOUR FORCE

Position	Number of Employees
Engineers, geologists, technical staff	15
Mine foremen and superintendents	10
Drillers and blasters	19
Equipment operators	32
Miners and labourers	29
Mechanics and skilled trades	26
Plant foremen and superintendents	10
Plant operators	35
Plant maintenance	26
Plant equipment operators and labourers	30
Total	**232**

5.4.3.15 Waste Rock Disposal

All waste rock will be disposed as described in the Underground Backfill Section.

5.4.3.16 Tailings Disposal

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

All tailings disposal will be conducted as described in the DSTF and Underground Backfill Sections. The ravine dam design is summarized in the Construction Phase Section.

5.4.3.17 Access and Transportation

Access to the site will be provided by land and air. Access to Ross River from the south will be via Alaska and Robert Campbell Highways. A summer barge and a winter road ice bridge will be used to cross the Pelly River at Ross River along the North Canol Highway. Access to site will be along an upgraded North Canol Highway to 3 km before the Macmillan Pass Aerodrome where the mine site access road begins. Ground access will be for all bulk supplies, fuel, and groceries.

NATC will have a material laydown near the warehouse that will be used during the operation phase. The staging area will be on the infrastructure pad adjacent to the truckshop. A cover-all building may be constructed if large items need to be stored without being covered with snow during the winter.

During operation, the mine will be serviced by standard 5-axle or 6-axle 40-tonne trucks and 10-tonne "hot-shot" trucks. It is expected that there will approximately 2 to 4 loads a day on average with a peak of 10 trucks per day.

Personnel will be transported to site by a combination of aircraft and buses. The workers will be flown from locations such as Vancouver and Whitehorse to site by chartered aircraft. The workers will be picked up from the aerodrome by a bus and taken to the mine site. It is anticipated that there will be three flights per week to site during the construction phase of the project. Workers will also be transported to site by company ground transport from communities such as Ross River and Faro.

NATC will be responsible for maintenance of the Macmillan Pass Aerodrome and the mine access road. The Government of Yukon will be responsible for maintenance of all Yukon Highways used to access the site, including the North Canol Road.

The mine site access road alignment is shown in Figure 5.4.2-5. There will be 28 stream crossings. The stream crossings will be culverts in all instances, with the exception of three locations. The three major crossings will have bridges. The design of the crossings is summarized in a previous section.

5.4.3.18 Fuel, Hazardous Materials and Explosives Management

Fuel will be stored in as described in the Bulk Fuel Storage section of the Construction Phase description. NATC will have procedures in place for refuelling mobile equipment. Generators and plant driers will be connected to the fuel tanks by pipelines with the appropriate emergency shutoff systems in place.

Explosives will be used during the underground mining. Both ANFO and Geldne high explosive will be used. ANFO will be produced onsite at the emulation plant. It is anticipated that the emulation place will produce 1000 kg of explosives per day. Explosives will be hauled underground in a truck equipped for the hauling of explosives. The explosives will be stored, in accordance with the applicable laws and standards, at both the South Haul Ramp and the North Haul Ramp.

All other hazardous materials will be handled as described in the waste management section above.

5.4.4 Decommissioning / Abandonment / Reclamation Phase

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

NATC has prepared a detailed Decommissioning and Closure Plan and it is included in Appendix M1. Please refer to the closure plan for details on this phase.

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6.0 ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS ASSESSMENT

6.1 ENVIRONMENTAL ASSESSMENT METHODS

6.1.1 Environmental

The methods used to assess the environmental effects of the project were developed in accordance with the Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions (referred to herein as "the guidelines"; YESAB, 2005) as well as other assessment literature and resource documents.

The environmental effects assessment includes the following components:

- Valued Components Identification;
- Baseline Information Summary;
- Temporal and Spatial Boundaries Identification;
- Effects Characterization and Mitigation; and
- Significance Determination.

A brief description of each component is described in the following subsections.

6.1.1.1 Identification of Valued Components

Valued environmental components, or VCs, are components of the environmental that are considered important based on cultural values or scientific concerns by the members of the public, First Nations, scientists, or government (NRCan, 2003). In accordance with the YESAB guidelines (2005), valued component categories include focal species, special elements, community values, ecological processes, and/or representations, which encompass the scope of this assessment.

Valued components were identified through community and stakeholder meetings, baseline studies analysis, review of academic literature, guidelines, government documents, and other published documents (i.e., produced by a community), professional experience and other sources.

6.1.1.2 Identification of Temporal and Spatial Bounding

Each valued component has a defined temporal and spatial boundary. These boundaries identify how proposed project activities and valued components overlap in time and geographical area. The temporal and spatial boundaries provide the basis for the effects characterization and significance determination.

6.1.1.3 Summary of Baseline Information

The summary of baseline information represents data pertinent to the effects assessment. The summary includes information necessary for the determination of effects and their significance, such as scientifically established criteria or indicators. Consideration of past, current and other future projects is included in this assessment. The Existing Conditions section (Section 4.0) describes existing baseline conditions in more detail.

6.1.1.4 Effects Characterization and Mitigation

The effects characterization presents and analyzes the anticipated interaction between the proposed project activities and the valued components. This exercise allows for the prediction of potential effects and corresponding mitigation measures.

For each valued component, potential effects are determined based on the project activities associated with each mine phase: construction, operation, decommissioning, reclamation and abandonment. Effects are described in detail and are characterized as either direct or indirect. Corresponding mitigation measures have been identified for the "elimination, reduction, or control of adverse environmental and socio-economic effects" (YESAB, 2005, p. 38).

6.1.1.5 Significance Determination

For each potential effect the anticipated level of success of the applied mitigation measures was determined. The success of mitigation measures is ranked as complete, partial, or none. If the success of mitigation is determined to be complete, then no further significance analysis of the effect is deemed necessary, and the significance is deemed to be "low". Where the success of mitigation is determined to be partial or none, a full significance ranking is conducted. This additional ranking will then result in a determination of "low", "moderate", or "high" significance. Figure 6.1.1-1 illustrates the steps taken to determine significance.

Through review of YESAA documents and guidelines, as well as previously conducted assessments, the following criteria have been used for the significance determination.

Direction – The predicted change from baseline for an ecological area. Described and ranked as neutral if there is no net change or negative if there is a reduction in abundance or movement, or a change in behaviour.

Magnitude – The degree, extensiveness, or scale to which an activity may affect a valued component. Magnitude may be defined as low if less than 5% of the VC is affected, moderate if 5-10 % of the VC is affected, or high if more than 10% of the VC is affected.

Geographic Extent – The geographic location or area where the effect is predicted to occur. The geographic extent may be identified as local if the effect is contained within the immediate footprint of the project, regional if the larger, surrounding area is affected (i.e., watershed), territorial if the effects may occur throughout the Yukon.

Duration – The length of time that an effect is expected to occur as a result of an activity. Short-term duration is defined as less than one year, medium-term duration is defined as one to ten years, and long-term duration is defined as greater than ten years.

Reversibility – The amount of time needed for a VC to recover from an effect. Short-term reversibility describes effects that are reversible within 26 years (i.e., all project phases), long-term reversibility describes effects that are reversible within 100 years, and irreversible effects are effects deemed to be permanent.

Frequency – The predicted rate of occurrence over which an effect may take place. Frequency is defined as low if it occurs once, medium if it occurs intermittently or periodically, or high if it occurs continuously.

Probability of Occurrence – The likelihood that the environmental effect identified will occur if the project proceeds.

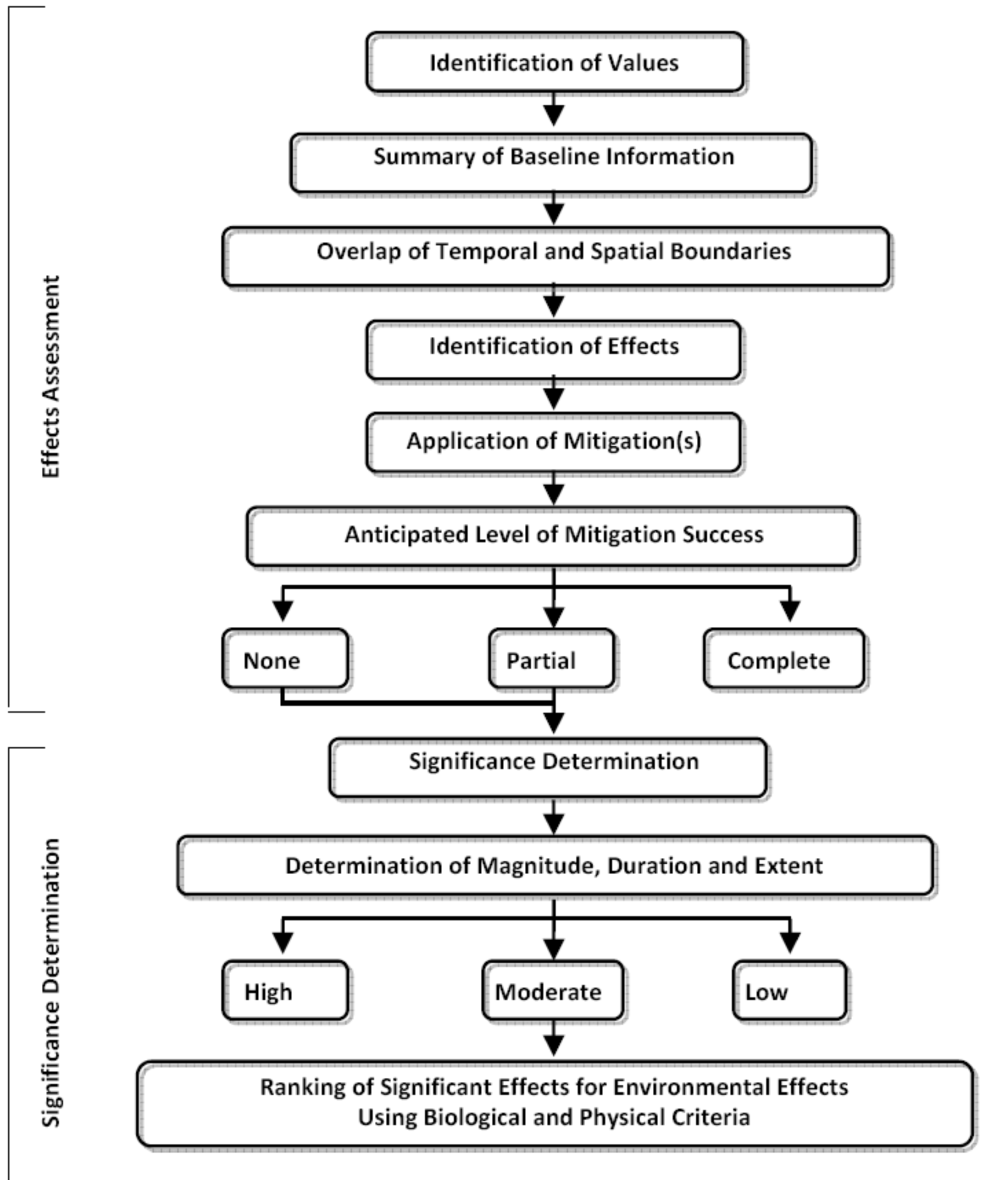


Figure 6.1.1-1: Significance Determination Steps

6.1.2 Socio-Economic

The methods used to assess the environmental effects of the project were developed in accordance with the *Guide to Socio-economic Effects Assessments* (YESAB, 2006) as well as other assessment literature and resource documents.

The socio-economic effects assessment includes the following components:

- Identification of Valued Components;
- Baseline Information;
- Effects Assessment and Mitigation/ Enhancement; and
- Significance Determination.

A brief description of each component is described in the following subsections.

6.1.2.1 Identification of Valued Components

Valued socio-economic components, or VSECs, are defined by YESAB (2006) as those parts of the socio-economic fabric that are valued because of their importance to the community, specifically because of their:

- integral connection to, or reflection of, the socio-economic system;
- commercial or economic value; and/or,
- role in maintaining quality of life in a community.

Some VSECs are specific to a particular community or interest, but many overlap among communities and interests. The VSECs have been identified through a variety of means:

- existing community plans;
- community meetings/workshops;
- meetings between North American Tungsten and First Nations representatives; and
- stakeholder input on similar projects.

6.1.2.2 Summary of Baseline Information

YESAB (2006) provides the following guidance for measuring changes using baseline indicators. Baseline information is compared against specific measures to identify the change. The indicators are derived from the VSECs and measure change in human population, communities and social and economic relationships resulting from a proposed project. Within each indicator, various measures are used to describe current conditions and predict change.

6.1.2.3 Effects Assessment and Mitigation/ Enhancement

The methods used during socio-economic effects assessment are similar to those used during environmental effects assessment. Effects are characterized and analyzed to determine the anticipated interaction between the proposed project activities and the VSECs. Potential VSEC effects are determined based on the project activities associated with each mine phase: construction, operation, decommissioning, reclamation and abandonment. This exercise allows for the prediction of potential effects and corresponding mitigation measures. Mitigation measures are designed to eliminate, reduce or control adverse effects (YESAB, 2005).

6.1.2.4 Significance Determination

Significance analysis is used to determine the anticipated level of success following implementation of mitigation measures. Significance is described as positive effect, no significant adverse effect, or significant adverse effect.

In accordance with YESAB (2006), the following criteria were used to determine significance:

- **Direction of change** – The predicted change from baseline conditions, described as positive, negative, or both positive and negative.
- **Magnitude** – Predicted scale of the effect.
- **Geographic extent and location** – The geographic location or area where the effect is predicted to occur.
- **Duration and frequency** – The length of time and frequency that an effect is expected to occur; long-term, frequent residual effects are more often significant.
- **Reversibility –** Used to identify the effort required to "undo" the effect.
- **Socio-economic context** – Describes the existing conditions in which an effect may occur.
- **Likelihood of occurrence –** The probability that the effect will occur, and the uncertainty involved in determining the probability (in the context of scientific or traditional knowledge).

Table 6.1.2-1 describes the definitions used to determine the significance or value attributed to each criteria.

TABLE 6.1.2-1 SOCIO-ECONOMIC SIGNIFICANCE DETERMINATION DEFINITIONS

	Residual Effects							Likelihood	
Rank/ Value	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Probability	Uncertainty
1	<1 to 5 years	<1 ha	Negligible effects to socio-economic fabric	95 to 100%	Very high degree of community resilience to type of change	Negligible	Occurs never or once	None	Low level of confidence
2	5 to 10 years	1 to 75 ha	Low effects to socio-economic fabric	75 to 95%	High degree of community resilience to type of change	Low	Occurs rarely and at sporadic intervals	Low	Medium level of confidence
3	10 to 25 years	75 to 200 ha	Moderate effects to socio-economic fabric	60 to 75%	Moderate degree of community resilience to type of change	Moderate	Occurs on a regular basis and at regular intervals	Medium	High level of confidence
4	25 to 100 years	200 to 300 ha	Extreme effects to socio-economic fabric	40 to 60%	Low degree of community resilience to type of change	High	Continuous	High	-
5	> 100 years	> 300 ha	Catastrophic effects to socio-economic fabric	< 40%	Very low degree of community resilience to type of change	Very high	-	-	-

Note: direction is described as positive change (+), negative change (-), and positive and negative change (+/-)

6.2 POTENTIAL ENVIRONMENTAL EFFECTS

6.2.1 Natural Landscape, Soil Stability and Terrain Hazards

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

6.2.1.1 Identification of Valued Components

Through conducting surficial geology and terrain hazard baseline studies, four valued components have been identified: natural landscape, the stability of soils, water quality and human safety. The natural landscape component was identified due to its importance to both ecological processes as well as social values. Soil stability and water quality were selected as they are ecological processes that are inherent to the health of an ecosystem. Human safety was selected as a valued component due to the potential effects of terrain hazards such as rockfalls, avalanches and landslides to affect the safety of on-site employees.

6.2.1.2 Summary of Baseline Information

Surficial Geology

At the Mactung site, low soil temperatures, a short growing season, and slow rates of plant reproduction, organic accumulation, and decomposition contribute to poorly developed soil profiles. Soils are generally absent on the upper, moderately steep to steep slopes where erosional processes are most active. Most of the residual soils in the study area include regosols, brunisols, organisols and crysosols. The nature of these soils are discussed in more detail in Section 4.1.3.

Steep terrain and climate factors such as rain and snowmelt can contribute to increased soil erosion on the lower and middle slopes from May to September, particularly during spring freshet. Natural erosion can be particularly acute where steep-sided stream gullies incise deeply into thick deposits of lateral moraine. Susceptibility to soil erosion may increase in areas with restricted layers such as shallow bedrock and on moderately steep (50-70%) to steep (>70%) gradient slopes.

Most of the project area is overlaid with predominantly coarse-textured soils with low soil detachability, abundant coarse surface fragments and good drainage, which indicate potentially low susceptibility to erosion. The area is underlain by colluvium and till. Limited soil development and generally coarse soil texture indicates a low probability of detrimental soil compaction. The region lies in the zone of discontinuous permafrost (Oswald and Senyk 1977). No permafrost was intersected in any of the shallow hand pits used for terrain assessment during the ground-truthing program. Soil drainage all along the proposed route was generally well-drained and there is judged to be a low probability of intersecting ice-rich soils.

Terrain Hazards

Active geomorphologic processes in the study area include rockfall, debris slides, debris flows, avalanche, gully erosion and periglacial processes (e.g., rock glaciers). Rockfall is the most common process in the area and results in the formation of extensive talus slopes. There were no recent active debris slides or debris flows observed in the area during the field studies conducted in 2007 and 2008. There is a moderate to high potential for avalanche (i.e., rapid slides or flows of snow) activity in the study area. Gully erosion on the valley sideslopes is seasonally active with most erosion expected to occur during spring run-off. Geomorphologic processes are discussed in more detail in Section 4.1.3.

6.2.1.3 Identification of Spatial and Temporal Bounding

Spatial bounding for project natural landscape, soil stability and water quality are the cleared footprint, which includes the mine site, ravine dam, dry-stacked tailings facility, access road, borrow pits, quarries, pumping station, aerodrome and staging areas. The temporal bounding for the natural landscape and human safety VC is from May to October during the construction and decommissioning phases and year-round during the operation phase. For soil stability and water quality, the temporal bounding is from late May to October for all project phases.

6.2.1.4 Effects Characterization

The effects characterization portion of this section has been conducted and presented by valued component.

Natural Landscape

The removal of vegetation and the stripping of organic soil for the road, aerodrome, staging areas and borrow sites may result in negative effects to the natural landscape leading to a reduced aesthetic value. Vegetation studies have been completed to identify ecosystems on the Mactung property and along the proposed access road. The results of these studies will be used to reduce or avoid development in areas with potentially sensitive, rare or valuable ecological significance. Due to the relatively remote location of the site, the aesthetic effect to humans will be minimal.

Soil Stability and Water Quality

Effects to soil stability and water quality may occur through the alteration of natural landscapes during road construction and development of mine infrastructure, borrow sites, quarries and staging areas. Typical practices that may affect the physical environment include: removal of surficial material to form potentially unstable cutslopes; placement of fill on unstable natural slopes; stripping to expose underlying soils; and alteration of the landform resulting in redirection and/or concentration of natural drainage channels.

Without proper mitigation, cutslopes and fillslopes can become unstable in some terrain and may be subject to failure and erosion. Exposed soils on slopes above streams or connected to streams by ditches can cause increased levels of suspended sediment in streams. In the absence of proper drainage management, alteration of natural drainage patterns can result in unnatural run-off concentrations directed to unstable slopes that could initiate erosion or mass movement. These potential effects can be mitigated with proper construction and maintenance practices.

Native parent soils are mostly coarse-grained, which are less susceptible to erosion than fine-textured soils. During regular road inspection and maintenance, areas that have the potential for soil erosion will be identified. Such erosion can be mitigated by seeding, armouring or other techniques recommended by a qualified professional.

The proposed access road will provide access to the Mactung property from the North Canol Road. The first 17.5 km of the access road will be upgraded from an existing mine exploration road, after which, a new 17 km access road will be constructed which will lead to the edge of the Mactung claims. From here, approximately 10 km of exploration road will be upgraded to haul road quality and will lead to the mine site. The first section of the road (from North Canol Road) is located mostly on mid-valley slopes with some lower valley slopes. The new section of road will be located mostly through irregular terrain on valley floors and some lower valley sideslopes. Standard cut and fill methods will be the primary technique used for road construction. For much of the alignment, road construction will create cutslopes on the inside (i.e., upslope) of the road width and fill placements on the outside (i.e., downslope).

Human Safety

The human safety VC is mainly a consideration in this section due to potential landslides, rockfalls and avalanches along the road alignment.

There were no active or recent landslides observed in the Mactung property or proposed road areas. The proposed road alignment is in areas with a low probability of flooding, which can be a significant contributing factor to landslides.

Rockfall is an ongoing erosion process forming talus slopes at the base of upper valley slopes of bedrock but has a low probability of affecting human safety.

Avalanche hazard has been identified in the study area, primarily along the proposed road alignment. There is a high probability of avalanches in some parts of the project area, based on preliminary avalanche potential studies undertaken during winter 2007/2008.

6.2.1.5 Mitigation Measures

The mitigation portion of this section has been conducted and presented by valued component. Mitigation measures are based on standard mitigative measures and the development of adaptive management plans (AMP) to address the hazards. AMPs of this nature include the Mactung Emergency Response Plan (Appendix M2), the Mactung Spill Contingency Plan (Appendix M2), an avalanche hazard management plan (will be developed), and other operational plans for project infrastructure. An AMP ensures a sufficient inspection frequency and reporting structure when dealing with potential effects, such as avalanches. The project AMPs will be developed and updated as necessary for all project phases to ensure they remain relevant.

Natural Landscape

NATC will employ the following mitigative strategies to reduce potential negative effects on the natural landscape from an aesthetic standpoint.

- To reduce the development footprint, road widths will be kept to a minimum and stripping for extraction of borrow materials will be limited to minimum requirements.
- Where the probability of soil erosion is moderate or high, exposed soils will be revegetated with native species to enhance soil stability. Drainage will be assessed and managed to maintain natural drainage patterns where possible and ensure that new drainage patterns are directed to areas with stable soil and terrain.
- Slope stability studies have been initiated and will be completed to aid road design and construction. If unstable slopes are identified, they will be avoided or suitable construction methods will be used to increase stability in these sections. Road maintenance inspections will be conducted throughout all project phases, which will allow for timely mitigation of any areas where slope instability is found to be an issue.

Soil Stability & Water Quality

NATC will implement standard mitigation measures during road design, construction and maintenance. Under the guidance of a qualified professional, standard mitigation measures will be used and, where possible, improved upon during the detailed design and construction stage. Mitigation measures include the following:

- Road cutslopes will be finished at stable slope gradients. The actual finished slope gradient of cutslopes will depend on the characteristics of surficial material. Table 6.2.1-1 shows typical slopes recommended for various materials. Final cutslope gradient will be determined by an experienced professional following assessment of site-specific soil texture.

TABLE 6.2.1-1 TYPICAL CUT SLOPE RATIOS

Material	Horizontal: Vertical Cut Slope
Till	0.25:1
Soft rock	0.5:1 (benched)
Sandy or gravel alluvium	1:1 to 1.5:1
Bouldery glaciofluvial	0.5:1 to 1.5:1
Lacustrine or silt till	1:1 to 2:1
Hard rock	0.25:1 (benched)

- Fillslopes will generally be prepared by removing vegetation and organic soils prior to placement of fill material. If fillslopes are constructed in terrain with natural slopes greater than approximately 30%, fill material will be keyed-in to existing surficial material and compacted. Terrain at potential fillslopes will be assessed during pre-design geotechnical evaluation and if shallow bedrock or permafrost is detected, site-specific recommendations for road design in these sections will be developed by a qualified professional.
- Ground-truthing of terrain along the existing exploration access road and proposed new section of access road to the Mactung mine site indicated that surficial materials were mostly well-drained to moderately well-drained. There were no drainage-related mass movement processes observed in the study area. Culverts will be placed at all natural watercourses. The diameter of the culverts will be at least 900 mm. Recommendations for culvert-spacing in areas with infrequent natural watercourses will be developed during assessment for final detailed design. Natural drainage micro-watersheds will be defined to avoid over-concentration of run-off to culverts. Outlets of culverts that are not placed at natural stream channels will be armoured to disperse the flow energy on to natural slopes and sumps will be installed when required at culvert entrances to help trap sediment.
- Road maintenance will include monitoring and clearing of culverts, if required, to ensure maximum design function during periods of peak volume run-off.
- If sections of permafrost are identified during geotechnical evaluation for detailed road design, recommendations will be developed for these areas to minimize potential degradation of permafrost, such as placement of geotextile over undisturbed ground and a minimum fill thickness of 1.4 m.
- Standard mitigation measures will be used to reduce the potential for introduction of sediment to streams during construction. Sediment fences will be placed in ditches and other appropriate locations if intercepted run-off contains unacceptable levels of suspended sediment, as defined by the Yukon government Water Licence, which is required for this project. If necessary, construction will be suspended during periods of high precipitation to reduce the potential for the introduction of unacceptable levels of suspended sediment to streams.
- Upon completion of road construction, NATC will develop and implement a monitoring program and schedule to assess the ongoing condition of roads, culverts and stream crossings. The monitoring program will include stability, condition and erosion potential of road bed, cutslopes and fill slopes. The integrity and function of ditches and culverts and the integrity and stability of bridge abutments will also be monitored. Monitoring will be conducted to identify potential erosion processes that could result in unacceptable levels of suspended sediment in streams. If monitoring of potential erosion in streams indicates that action is required, then practical measures can be implemented such as adding sediment fences in key locations and the temporary

diversion of run-off away from streams. Both the DFO and Yukon government regulators will be consulted regarding proposed mitigation measures.

Human Safety

NATC will employ the following mitigation strategies to reduce potential negative effects on human safety:

- As no active or recent landslides were observed in the study area, no mitigation measures are suggested other than on-going monitoring of slopes as a component of other on-going field monitoring (e.g., road monitoring).
- The probability of rockfalls affecting human safety is low. However, a reporting system will be in place for users of the access roads to report potential rockfall areas or actual fallen rocks that have the potential to affect human safety. Reports of such observations will result in action being taken to remove fallen rocks from roads.
- Avalanche conditions will be assessed and avalanche frequency will be recorded to create a baseline for avalanche prediction before the construction phase begins. Avalanche hazards will be monitored when potential avalanche activity is determined to be moderate to high. Development activity in areas of high avalanche hazard will be limited and closely monitored during periods of high avalanche probability. An avalanche safety program will be developed and implemented, and the appropriate safety equipment will be available on site during construction, operation and decommissioning.

Environmental values and mitigation measures are summarized in Table 6.2.1-2.

TABLE 6.2.1-2 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR NATURAL LANDSCAPES, TERRAIN HAZARDS AND SOIL STABILITY

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Mine site road construction and use, borrow site development, staging areas and aerodrome expansion.	Natural Landscape	Visual effect of road corridor from clearing and stripping.		• Minimum road widths to be used. • Cleared slopes to be revegetated.		✓	
		Visual effect of borrow pit and quarry sites from clearing and excavating.		• Aesthetics will be considered for borrow pit site selection. • Minimum size borrow pits will be used.		✓	

TABLE 6.2.1-2 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR NATURAL LANDSCAPES, TERRAIN HAZARDS AND SOIL STABILITY

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
	Soil Stability	Loss of vegetation.		• Revegetate disturbed areas with native vegetation.			✓
		Soil erosion.	Soil erosion increasing sediment loading in streams	• Seeding, armouring or other mitigative techniques. • Relevant cut slope ratios will be used. • Conscientious drainage management.			✓
		Increase in potential for landslides along road.	Potential risk to human safety	• Engineered cut and fill slopes. • A slope stability assessment will be conducted. • Specific design parameters will be applied to sections identified with permafrost.			✓
		Gullying, mass movement or erosion caused by alteration of natural drainage patterns.	Potential risk to human safety	• Adequately-sized culverts to be used. • Sections with inadequate culvert frequency will be identified. Additional culverts placed where necessary. • Armoured outlets of culverts where no natural stream channel exists.			✓
	Water Quality	Decreased water quality through increased sediment loading.		• Use of silt fences. • Ditch filters and settling ponds/sumps at culvert inlets.			✓

TABLE 6.2.1-2 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR NATURAL LANDSCAPES, TERRAIN HAZARDS AND SOIL STABILITY							
Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
		Avalanche blockage of ditches or diversion channels.	Increase in sediment loading	• Scheduled inspections of access roads and diversion channel to allow for timely removal of snow.			✓
	Human Safety	Potential risk from rockfalls or fallen rocks.		• Reporting system in place for potential rockfalls and actual fallen rocks			✓
		Potential risk from avalanches.		• Development of an avalanche management and safety training program			✓

6.2.1.6 Significance Determination

The effects of project activities on the valued components of water quality, soil stability and human safety from a geology and terrain hazards standpoint are considered low, following the implementation of proposed mitigation measures. Therefore, further significance determination has not been completed for these effects.

The visual/aesthetic effects on the natural landscape, following implementation of mitigation measures, will not be completely mitigated. The overall significance of the effects has been assessed by considering the magnitude, extent and duration of the project activities. The results of this assessment are summarized in Table 6.2.1-3.

TABLE: 6.2.1-3 SUMMARY OF SIGNIFICANCE DETERMINATION FOR NATURAL LANDSCAPES					
Project Component	VC	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Mine infrastructure, roads and borrow pits	Natural Landscape (aesthetics)	Negative	Moderate	Long Term	High

The overall significance of the aesthetic effects of the mine infrastructure, road corridors and borrow pits on the natural landscape (post mitigation) are considered to be moderate, as per YESAB's assessment guidelines (2006). The area is not subject to significant recreational use due to its remote location and limited level of access which means that the aesthetic effects are limited to a small number of people. Decommissioning of the mine infrastructure and roads will reduce the overall visual effects, and over time the effects will continue to diminish.

6.2.2 Acid Rock Drainage and Metal Leaching

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

6.2.2.1 Identification of Valued Components

Surface water and groundwater quality have been identified as valued components (VCs) that may potentially be affected by ARD and ML processes. Both VCs are considered to be important elements of the ecosystem and of public interest due to the emphasis placed on water quality within legislation and regulation.

6.2.2.2 Summary of Baseline Information

Natural acid rock drainage (ARD) and metals leaching (ML) have been observed in some of the surface streams in the project area. Tributary A upstream of the confluence with Tributary C has natural pH values that are below CCME guidelines for the protection of aquatic life during winter months. Natural metal concentrations in exceedance of the CCME guidelines have also been recorded at different times of the year in both Tributary A and Tributary C.

6.2.2.3 Identification of Temporal and Spatial Bounding

The temporal scope of this assessment may be defined as approximately 20 years, from the start of construction and lasting 3 years beyond closure. Due to the nature of surface and groundwater and the climatic site conditions, the overlap between the project activities and VCs is between May and October each year when surface waters are flowing.

The spatial boundaries of the water quality effects assessment as it relates to potential acid rock drainage and metal leaching issues is directly associated with the area of surface waterbodies surrounding the mine site, borrow pits and quarry.

6.2.2.4 Effects Characterization

The effects characterization focuses on describing the project's potential effects on the VCs. This section examines the effects of clearing and construction, operation, and decommissioning for each of the major project areas including the mine and mine infrastructure, the dry-stack tailings area and borrow area, the ravine dam and reservoir, the access road, and the aerodrome.

A geochemical and mineralogical comparison between the Mactung and Cantung deposits was conducted by EBA Engineering Consultants Ltd. and Wardrop Engineering Inc. This comparison determined whether data from the Cantung operation could be used to assist in understanding the potential effects of the proposed Mactung project (Appendix D2). The Mactung and Cantung deposits were determined to have comparable mineralogy and metals content, with the Mactung mine samples having slightly more copper and selenium than that of the Cantung mine samples. The Mactung ore grade materials were found to have slightly lower neutralization potential than that of the Cantung ore grade materials reviewed for the study.

A geochemical model for the project was developed using the Phreeq software package. Details on this model and the inputs used are provided in the water quality effects assessment portion of this report (Section 6.2.8.2).

ARD and ML processes occur once the material in question has been exposed to oxygen and water. Rock that is near to the surface is often within a fractured and weathered zone, where prior weathering has resulted in the formation of a weathering rind on the larger blocks. The ARD and ML processes affecting these previously weathered materials should not change dramatically provided that the materials are not physically altered.

Weathering, from exposure of freshly mined rock to oxygen and water, may be accelerated by freeze-thaw processes. The primary period for initial oxidation and weathering processes will be closely linked to the snow-free period from late May to early October at the mine site. The transport of soluble weathering products that have developed on the surface of mineral grains is expected to occur during the open water period from May to October.

During the initial years of dry-stacked tailings placement, weathering from exposure of freshly processed rock to oxygen and water will also be closely linked to the snow-free period (i.e., May to October). Some freezing and glaciation of the surface of the dry-stacked tailing facility (DSTF) is expected to occur during the winter months which will help to limit oxygen and moisture ingress into the tailings. Seepage from the DSTF at a rate of 74,000 m^3/yr will occur primarily during compaction when the moisture content of the materials is reduced. This seepage will be primarily alkaline process water with some minor dilution from precipitation and is expected to occur from June to October. The seepage is expected to be lateral along the surface of the individual construction lifts due to the low permeability of the compacted silty material.

Construction Phase

The construction period is proposed to occur from summer 2010 until the end of 2012. The following activities have the potential to affect hydrologic processes during the construction phase:

- rock cuts from access road upgrades and new road construction;
- extraction of materials for aerodrome construction activities;
- waste extraction from underground workings during pre-mining development; and
- rock extraction for mine site infrastructure construction.

Rock Cuts for Access Road Upgrades and New Road Construction

Upgrades to existing road sections and construction of new sections of road will potentially include excavation of rock. Where possible, the construction and upgrade activities will be limited to shallow rock cuts that will occur within the already fractured and weathered bedrock zone. Terrain mapping conducted along the proposed access road indicates that the route traverses glaciofluvial or morainal deposits. Proposed rock cut areas will be assessed during the detailed design phase through geochemical sampling. Potentially acid generating (PAG) materials excavated as a part of this project activity will be addressed within the following subsections. The overall volume of fresh bedrock materials to be encountered along the access road from the aerodrome to the mine site are expected to be minor (<5,000 m^3) due to the nature of the road construction.

An estimated 200,000 m^3 of granular fill material will be required for upgrades and construction of the access road to the mine site. This granular material will be sourced from existing surficial deposits and screened for use as a construction material. These deposits are granular and have been subjected to a long period of groundwater flow since deglaciation. This contact with oxygenated groundwater can promote the development of weathering rinds on the clastic component. The weathering rinds of the clasts will remain an effective barrier to further weathering and metals leaching provided the material is not crushed for use as a construction aggregate. Crushing of materials destroys the weathering rind and exposes fresh mineralization to oxygen and water. Materials characterization, as per Price (1998), will be conducted of granular materials that are intended to be crushed to ensure proper consideration of ARD and ML processes.

Extraction of Materials for Aerodrome Construction Activities

Approximately 150,000 m^3 of granular material is required for construction and upgrades to the aerodrome facility in the Macmillan valley. This material will be sourced from existing surficial deposits and screened for use as a construction material. Crushing of materials destroys the weathering rind and exposes fresh mineralization to oxygen and water. Materials characterization, as per Price (1998), will be conducted of granular materials that are intended to be crushed to ensure proper consideration of ARD and ML processes. Aerodrome construction requires minimal processing of the granular materials therefore potential effects to water quality from ARD and ML are expected to be minor.

Waste Extraction from Underground during Pre-Mining Development

Two temporary stockpiles of waste rock from the underground workings will be established in close proximity to the portals. Approximately 32,000 m^3 of waste rock will be generated near the main conveyor decline adjacent to the processing plant infrastructure pad. Approximately 92,000 m^3 of waste rock will be stored near the ventilation adit portal. The preference is to utilize this waste rock material for construction of the camp and mill pads should acid base accounting (ABA) characterization of the material show it to be acceptable.

Any material that is classified as PAG will be disposed of underground as backfill during the initial mining stages. It may be necessary to temporarily store the PAG materials on surface for rehandling to the underground workings during the operation phase. Rehandling of these materials during the operation phase would be conducted under the progressive reclamation program. Mitigation measures to reduce potential effects from materials temporarily stored on surface are described in the following subsection. However, the effects from materials stored on surface were determined to be low based on the limited volume, small stockpile footprint, the location of these stockpiles within the undiverted ravine dam catchment, and the ability to place the materials underground during decommissioning activities.

Potential Rock Extraction for Mine Site Infrastructure Construction

Rock will be excavated during construction of surface infrastructure pads. Initial ABA analyses from the construction borrow and ravine dam sites indicate that the rock materials are overall net neutralizing with some PAG component within the rock types present in the individual areas. The infrastructure pad for the processing plant and powerhouse will require a bench cut into rock to create a stable foundation on which to place the infrastructure. Blasting will likely be required for this activity and excavated rock during this bench cut is intended to be used as fill for the infrastructure pad.

A total of 50,000 m^3 of high quality aggregate is required for the construction phase and this material will be used to make concrete for site infrastructure. The small overall volume of rock required for aggregate is not anticipated to present an ARD or ML concern during this or subsequent project phases.

Site access road construction below the infrastructure pad will involve some cut and fill construction through steep terrain. The surficial rock in this portion of the site is highly fractured and as a result it is anticipated that there will be little exposure of fresh, unweathered rock surfaces from these shallow surface rock cuts.

Potential ARD/ML Effects from Accident and Malfunctions (Construction Phase)

Potential ARD and ML effects during the construction phase would likely be primarily due to improper materials usage for construction. An example of this would be the use of PAG materials to construct the surface infrastructure pads. The management of this type of a situation as it relates to the materials characterization and water management programs that will be in effect at the Mactung mine during all project phases is addressed in the following mitigation measures section.

Operation Phase

The operation phase of the current project is expected to occur between 2013 and 2023. The direct effects of ARD and ML on VCs during the operation phase are mainly associated with the following project activities:

- PAG tailings disposal into dry-stacked tailings facility;

- potential metals leaching from rock materials used in the surface infrastructure pads;
- construction phase PAG stockpiles at surface; and
- construction phase PAG materials encountered during access road construction and upgrades.

PAG Tailings Disposal into Dry-Stacked Tailings Facility

The overall footprint of the DSTF represents approximately 4% of the post-mining project area within the surface water catchment basin. A total of 2,130,000 m^3 of tailings will be placed into the DSTF during the approximately 11 year operational phase of the project. The tailings for the proposed Mactung mine are conservatively assumed to all be potentially acid generating as recent metallurgical testing has not been conducted on materials from the Mactung and the ore grade materials were characterized as primarily PAG. The facility will be constructed as a side-hill fill with the initial tailings materials being placed into the base of the dump and covered with fresher tailings from subsequent processing. The result will be that the oldest tailings are buried at depth at the base of the dump and will be subjected to reduced oxygen and moisture inputs. Seepage through the DSTF tailings during this project phase is anticipated to be minor due to the low conductivity of the compacted tailings and operational phase water management plans which will be focussed on keeping water away from the tailings.

The estimated neutralization potential (NP) of the ore grade materials is approximately 84 tonnes $CaCO_3$/1,000 tonnes while the average Maximum Production Acid (MPA) is approximately 146 tonnes $CaCO_3$/1,000 tonnes. The tailings are assumed to have a similar range of NP and MPA values as the ore. Tailings from the nearby Cantung Mine are estimated to have a time to acidity of slightly over 9 years based on humidity cell testwork. The NP of ore grade materials at the Mactung site have been identified as being lower than that of the Cantung ore grade materials, this suggests that the time to acidity for materials at Mactung could potentially be shorter than indicated by the Cantung humidity cell.

The process water used during the operation phase is estimated to have an average pH value of 8.2. The moisture content of the placed tailings will be approximately 16% with the retained moisture being sourced from alkaline process water. Some of the process water stored in the tailings will drain as seepage through the pile and provide some buffering capacity to offset potential acidic weathering effects that may occur during the later years of this project phase.

Metals Leaching from Rock Materials Used in Surface Infrastructure Pads

The infrastructure pad for the camp and processing plant are estimated to cover a surface area of approximately 6.4 ha and 1.6 ha respectively within the 252.5 ha ravine dam catchment. These two pads account for approximately 3.1% of the total undiverted catchment area. During the operation phase, potential metal loading from rock used in the construction of these infrastructure pads is deemed to have a low potential effect due to their location within the ravine dam catchment and the small overall footprint of these pads.

Construction Phase PAG Material from Pre-Mining Development

Should PAG materials from the two temporary stockpiles not be able to be placed underground during initial construction phase then this material will be stockpiled at surface during the operation phase. The remaining waste will be rehandled underground as part of ongoing progressive reclamation activities at the site during the first three years of operations. Run-off from stockpiled materials has the potential to negatively affect surface water quality through increased metal loadings. The PAG volumes are small and the stockpiles would be located within the undiverted catchment, making the potential effect of ARD or ML from weathering of stockpiled PAG materials low. Underground disposal of PAG waste during this project phase will fully mitigate any potential negative ARD and ML related effects.

Construction Phase PAG Materials Encountered along Access Road

Low volumes of freshly exposed PAG material are expected to be encountered during the construction phase of the project and it is anticipated that a small temporary stockpile would be used to store this material prior to final disposal. The potential effect of PAG materials encountered along the access road would be reduced water quality because of lower pH values and possibly increased metal loadings. Inspections will be conducted in areas where PAG materials are known to occur to evaluate whether there is any evidence of acidic run-off along the road that may be related to construction phase materials. Visual indicators, such as iron-staining and the occurrence of chemical precipitates within ditches, will be used to identify potential areas of effect. Mitigation of the potential effects of PAG materials along the access road are described in further subsections.

Potential Hydrologic Effects from Accident and Malfunctions (Operation Phase)

Potential ARD and ML effects during the operation phase would relate primarily to leaching and weathering of PAG construction materials and metals leaching from the DSTF in excess of estimates. The management of this type of a situation is addressed in the mitigation measures section (Section 6.2.2.5) as it relates to the materials characterization and water management programs that will be in effect at the Mactung Mine during all project phases.

Decommissioning Phase

The decommissioning phase of the project is presently scheduled to be conducted during the two year period from 2024 to 2025. Additional works may be required during the summer of 2026 and these would be anticipated to be conducted primarily along the access road to the site. The potential direct effects of ARD and ML on VCs during the decommissioning phase of the project are mainly associated with the following project activities:

- installation of dry-stacked tailings cover system (2024);

- disposal underground of any construction phase PAG mining waste rock stockpiled at surface (2025);
- sealing of underground workings (2025); and
- disposal of potential PAG materials used to construct the access road.

Installation of Dry-Stacked Tailings Cover System

The PAG tailings stored in the DSTF will be covered with a low permeability liner. Initial estimates show that an artificial liner may be required based on a lack of suitable construction materials in the immediate vicinity. An earthen cover will be placed on top of the DSTF to protect the synthetic liner. The synthetic liner would be impermeable, so that the only post closure DSTF seepage possible would be from small punctures in the synthetic liner that could potentially occur during placement, and these would neglegebly affect the ARD and ML characteristics of the pile.

Oxygen ingress into the tailings pile through small punctures in the liner is expected to be limited which would help to minimize the potential oxidation of tailings. Neutralization potential (NP) available in the un-oxidized tailings would be available to neutralize acidic seepage generated within the vicinity of any punctures in the liner. Studies on exposed PAG tailings at the Bell Mine in north-western British Columbia have shown weathering of exposed tailings to have averaged 0.03 m/yr. Acid produced from weathering of the Exposed PAG tailings at the Bell site are neutralized by underlying tailings as the seepage drains through the pile. The potential development of oxidation proximal to liner leak sites is expected to be slower than at the Bell Mine as a result of the liner limiting the effective surface area that is exposed to oxygen effects. This information indicates that the effect of small leakage from the liner would be negligible.

Sealing of Underground Workings

Sealing the underground workings will reduce oxygen and surface water access to the underground workings. This will greatly reduce the rate of weathering of any waste rock and tailings materials disposed of underground. Permafrost around the adits will further restrict groundwater flow into the underground workings ands helps to limit concerns associated with neutral metals leaching in this frozen zone. The sealing of the underground workings is part of the mitigation of effects from materials placed underground. Consideration of metals leaching from backfilled tailings and waste rock within the unfrozen portion of the underground workings is presented in the hydrogeological effects assessment portion of this proposal (Section 6.2.8.3).

Decommissioning Phase PAG Materials Encountered along Access Road

Decommissioning activities along the access road will be conducted so that PAG materials will be disposed of in-situ. Larger volumes of PAG rock that are encountered or stockpiled along the access road in encapsulation structures will not be touched as they will have already been mitigated through the encapsulation process. Design details for this method of disposal are described in more detail in the mitigation measures section (Section 6.2.2.5).

Potential ARD and ML Effects from Accident and Malfunctions (Decommissioning Phase)

Potential ARD and ML effects during the decommissioning phase relate primarily to excessive leaching and seepage from the DSTF post-closure. Potential effects would include a lowering of the pH value and increased metals loadings. Mitigation of this potential effect is described in the following section.

6.2.2.5 Mitigation Measures

This section presents mitigation measures to minimize potential effects to water quality from ARD and ML during the various project phases. The primary mitigation strategy is based on geochemical characterization and the development of an effective water management plan to minimize potential effects that may occur prior to decommissioning. The template for the geochemical characterization program in the following subsection will allow for the successful management of potential ARD and ML risks during the construction and operation phase.

Monitoring programs implemented during the operation phase will be used to ensure that final closure designs for site infrastructure will successfully mitigate any negative effects from the project. The primary mitigation method for the decommissioning phase is encapsulation and underground disposal for PAG materials at the mine site. Table 6.2.2-1 identifies the mitigation measures by project phase and activity that will be put into place by NATC. The mitigation measures are described in greater detail in the following subsections.

Geochemical Characterization Program

A geochemical characterization program was initiated to support the development of an effective environmental management plan for the Mactung project. The geochemical characterization program will be revised during the permitting process and modified for each project phase to ensure that it properly addresses potential ARD and ML issues in potentially changing conditions.

The framework provided below will allow for the successful mitigation and management of potential ARD and ML effects of the project and is based on typical permit conditions for the construction and operation of metals mines in British Columbia, which are the accepted standards in the Yukon. The program is designed to be adaptive and ensure that adequate data collection fills in data gaps and areas of uncertainty. The level of detail provided within the following subsection is deemed sufficient for the purposes of showing that potential effects of the project will be mitigated.

Pre-Mining Construction Waste

Construction waste from the pre-mining underground development will be characterized using a sampling frequency of 1 sample per 7,500 tonnes of material. This will provide that approximately 4 samples will be collected of materials to be stockpiled adjacent to the ventilation adit portal and approximately 12 samples will be collected of the materials to be stockpiled near the conveyor portal. Materials with a total sulphur content of less than 0.1% are not expected to be a concern for ARD due to the low potential acid production of this type of material.

A minimum overall blended neutralization potential ratio (NPR) of 3.0 with the PAG component volume equalling less than 50% of the overall volume has been used for the construction materials suitability evaluation criteria for the project. NATC will collect representative bulk samples of blended materials to establish a field monitoring program. Bulk samples will be placed into lined bins or barrels to allow for leachate sample collection for chemical analysis.

This conservative approach has been taken to ensure mitigation of potential ARD and ML effects. Additional data may be collected for ongoing geochemical characterization work during the detailed mine planning phase.

The ABA results for these materials would be reviewed to determine suitability as construction materials. If blending is not feasible then materials segregation will be conducted with separate volumes of PAG and non-acid generating (NAG) materials being temporarily stored on the surface. Materials segregation is the more costly conservative approach but would maximize the potential availability of construction materials while minimizing the PAG volumes to be placed underground.

PAG Material Encountered Along the Access Road during Construction Phase

The volume of PAG rock that will be encountered along the access road will be minimized by construction design which minimizes drill and blast sections. Naturally fractured and previously exposed bedrock is expected to make up the majority of rock excavated during the road upgrades. New access road construction occurs in an area where thick surficial materials exist and less than 1% of the new road length is anticipated to require potential drilling and blasting of bedrock for construction. Bedrock in the near surface fractured zone and in existing road cuts will have been exposed to natural weathering processes for several thousand years. Unless substantial physical alteration (i.e., grinding or crushing) to the material occurs it will not significantly change its geochemical behaviour. Characterization of materials on a bulk tonnage basis is not applicable to this type of situation.

Where PAG volumes of fresh rock exposed in rock cuts are small ($<50\ m^3$) NATC proposes to utilize the rock for sub-grade construction within the road near to the source location. The compacted running surface of the final access road should limit oxygen and water infiltration into the road thus limiting weathering processes.

ABA characterization to determine mitigation requirements for encapsulation will be conducted in areas where drilling and blasting activities result in the exposure of fresh bedrock. The most conservative approach would be encapsulation of PAG materials on a pad of net neutralizing materials with sufficient available NP to provide neutralization of the sulphide mineralization.

Encapsulation pad design is based on the use of calcium carbonate ($CaCO_3$) (NP $\simeq$ 1000 kg $CaCO_3$ /1000 tonnes) as the primary neutralization material in the pad. Base pad thickness would depend on the total volume of fresh PAG materials expected to be encountered and stockpiled during construction activities. The rock types along the access road do not contain comparable levels of sulphide mineralization as at the Mactung mine.

An example of the estimated limestone requirement for an encapsulation pad based on material with a net neutralization potential (NNP) of 50 kg $CaCO_3$/1000 t is presented here to show the encapsulation design parameters that will be used to mitigate potential effects from PAG rock along the access road. Using an estimated fresh rock total volume of 5,000 m^3 and a specific gravity of 2.7, this material would require approximately 650 kg of $CaCO_3$ to ensure sufficient neutralization potential at an NPR of 1.0. Using a target NPR of 2.0 for the design of encapsulation pads would result in a constructed pad containing approximately 1,300 kg of $CaCO_3$. The conservative rule for encapsulation facility design will be for every 50 units of negative NNP required (based on the NNP of the materials) approximately 27 kg of $CaCO_3$ per 100 m^3 of rock will be required. This means that materials with an NNP of -100 kg $CaCo_3$/1000 t would require approximately 54 kg of $CaCO_3$ per 100 m^3 of materials.

Tailings Disposed of within the Dry-Stacked Tailings Facility

The conservative use of geochemical data and results from the Cantung mine allows for the assessment and characterization of potential effects from the Mactung tailings. The real-time data set from the Cantung mine shows that potential metals leaching from the DSTF is not anticipated to have an effect on the overall project water chemistry. Confirmation of the tailings characterization for the Mactung mine will be conducted using metallurgical testing conducted during ongoing detailed design and mine planning.

Additional data that will be available prior to final permitting of this facility include results from static ARD and ML testwork, kinetic humidity cell testwork on Mactung tailings, and chemical and toxicological characterization of process water to be produced at the site. This information will be submitted to Yukon government regulators and the Yukon Water Board prior to the start of construction activities.

Operation phase characterization of the PAG tailings materials disposed of within the DSTF will be carried out on monthly composites. The monthly composites will be analyzed for ABA and total metals content to provide information for use in final closure plan design, planning objectives and preliminary methods. Volumes of tailings placed into the facility will also be recorded on a monthly basis.

The tailings materials are estimated to have the potential to become acid-generating during the operation phase based on the humidity cell data from the Cantung mine. Seepage from the DSTF will be monitored quarterly in order to better understand the behaviour of the tailings materials and to determine whether there are any indications of ARD generating materials.

Indicators for onset of ARD include increased sulphate and alkalinity concentrations and decreased pH values, which can be used to evaluate if further mitigation measures are required. Other visual indicators like chimneys (snow-free areas) will be recorded as part of ongoing performance monitoring of the tailings.

NATC will collect representative bulk samples of tailings from the initial years of the operation phase in order to establish a field monitoring program representative of the materials that may potentially become acidic prior to decommissioning. Bulk samples will be placed into lined bins or barrels to allow for collection of leachate samples for chemical analysis.

Tailings and Waste Backfilled Underground in the Unfrozen Bedrock Zone

Tailings and waste rock are required for use as backfill material in the underground workings. There are no ARD or ML concerns associated with backfill materials placed within the frozen bedrock portion of the underground workings. Tailings and waste rock placed as backfill material in the unfrozen bedrock portion of the underground workings may have a potential to contribute metals leaching. However, as they will be in a low oxygen environment no ARD is expected. The underground tailings will start to become flooded immediately following mining activities in the unfrozen bedrock zone. Given the low oxygen levels in the closed out stopes, there is a low potential to generate acid runoff.

Characterization efforts will focus on establishment of tailings and mine backfill monitoring stations to ensure that preliminary water chemistry estimates for the underground workings are within acceptable limits. Tailings characterization information will be available from the monthly composites that are tested during operations. Waste rock characterization samples for ABA and total metals content analyses will be collected at a frequency of approximately 1 sample per 15,000 tonnes of waste material.

Bulk field cells will be conducted during the operation phase to provide representative results and ensure that the preliminary closure concepts for the mine are applicable. Closed out portions of the unfrozen workings may have seepage monitored during the latter period of operation phase to provide calibration of the final closure model. Further consideration of the ML effects of underground backfilled materials is presented in the hydrogeological effects section of this document. Ongoing studies as part of the detailed mine planning will include consideration for use of a binder in the tailings disposition to reduce potential effects of metals leaching should it be deemed a concern.

Underground Disposal of Pre-Mining Development Rock

Any PAG rock encountered during the pre-mining underground development will be rehandled back underground for use as backfill in the frozen underground workings as soon as possible. The waste will be rehandled as part of ongoing progressive reclamation activities at the site. The underground disposal into a frozen area with low oxygen availability and no water mitigates any potential effects from this material. The maximum volume of PAG rock that could potentially be encountered would be 124,000 m^3, as identified previously in this section.

Installation of Impermeable Dry Cover over Tailings

Final mitigation of the tailings materials will be provided when the cover system, designed to encapsulate the materials and minimize the ability of oxygen and water to access the materials, is installed during decommissioning. The dry cover will make use of a synthetic impermeable liner that will be buried beneath a granular cover. The dry cover keeps ultraviolet (UV) rays from causing degradation of the synthetic material, which would result in the eventual failure of the liner. The surface of the dry cover will be graded back towards the slope to drain water away and prevent pooling of water on the cover.

A French drain may be installed at the lower perimeter of the DSTF. The French drain would be installed immediately inside the edge of the liner and would allow for collection of seepage post-closure in the event that the liner is not functioning as per design.

Mitigation of Accidents and Malfunctions

Mitigation of potential ARD and ML program accidents and malfunctions will be conducted through the application of the geochemical characterization program outlined in this section of the proposal. Water management at the mine site is designed such that drainage from all areas potentially affected by PAG materials storage or placement will be directed to the ravine dam and reservoir prior to discharge to the receiving environment. Monitoring wells located downstream of the ravine dam allow for pumping back of any groundwater seepage from the facility that is not in compliance with potential Water Licence discharge criteria.

Inspections of the DSTF cover system will be conducted at a frequency to be determined by Government of Yukon, Energy Mines and Resources; however, the duration of the inspection period is anticipated to extend to the initial 3 year post-closure period. Mitigation of the potential for malfunction of the DSTF cover system will be provided in the form of Financial Security provided by NATC to allow for ongoing periodic inspections in addition to repairs to the cover system in the first 10 years following closure. Failure or malfunctioning of the DSTF cover are deemed to be of low significance based on the relatively small size (~ 4%) of this facility within the post-mining drainage basin.

Table 6.2.2-1 summarizes the potential direct and indirect effects, proposed mitigation measures, and the anticipated success of the mitigation measures.

TABLE 6.2.2-1 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR ACID ROCK DRAINAGE/ METALS LEACHING							
Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Construction Phase							
Waste extraction from underground during pre-mining development. (2011)	Water Quality	Exposure of unweathered sulphide mineralization in waste rock to oxygen and water.	Potential periods of run-off containing metals and/or weathering products to surface flow or to shallow groundwater.	• Geochemical characterization to minimize PAG volumes. • Underground disposal within frozen bedrock zone.		✓	
Rock cuts from access road upgrades and new construction (2010)	Water Quality	Exposure of un-weathered, to partially weathered materials, to increased oxygen and water access	Run-off containing metals and/or weathering products to surface flow or to shallow groundwater.	• Construction design to minimize drill and blast (avoidance) • Encapsulation of PAG material			✓
Quarrying of borrow material for ravine dam construction	Water Quality	Exposure of un-weathered, to partially weathered materials, to increased oxygen and water access	Run-off containing metals and/or weathering products to surface flow or to shallow groundwater.	• Geochemical characterization to minimize PAG volumes. • Underground disposal of any PAG rock from activity.			✓
Operation Phase							
PAG Tailings disposal into DSTF (2013-2023)	Water Quality	Exposure of un-weathered, fine-grained materials, to increased oxygen and water access	Potential periods of run-off containing metals and/or weathering products to surface flow or to shallow groundwater.	• Geochemical characterization to understand long term ARD/ML behaviour of tailings materials. • Final encapsulation of materials		✓	
Waste extraction from underground during pre-mining development. (2011)	Water Quality	Exposure of unweathered sulphide mineralization in waste rock to oxygen and water.	Potential periods of run-off containing metals and/or weathering products to surface flow or to shallow groundwater.	• Underground disposal within frozen bedrock zone.			✓

TABLE 6.2.2-1 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR ACID ROCK DRAINAGE/ METALS LEACHING

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success: None	Anticipated Success: Partial	Anticipated Success: Complete
Operation Phase (cont'd)							
Waste rock and tailings backfilled in un-frozen bedrock zone	Water Quality	Increased metal loading to groundwater	-	• Geochemical characterization program to determine whether effects exist.			✓
Decommissioning Phase							
Installation of Dry-Stack Tailings Cover System (2024)	Water Quality	Impermeable liner reduces/eliminates oxygen and water availability.	Significant reduction in weathering rates, reduction in metal loadings from facility	• Encapsulation and isolation of PAG tailings.		✓	
Sealing of Underground Workings (2025 or 2026)	Water Quality	Reduction in ability for oxygen and water infiltrate frozen component of underground workings.	Significant reduction in oxygen content of underground workings. Thermal barrier will allow for pre-mining frozen bedrock conditions to resume.	• Isolation of underground materials from oxygen			✓

6.2.2.6 Significance Determination

A summary of the potential effects of acid rock drainage and metals leaching as a result of the project activities are shown in Table 6.2.2-2. The potential effects can be mitigated for much of the materials through implementation of mitigative measures and a geochemical characterization program, as identified in the previous section.

The potential effects from the DSTF are deemed to be mitigated through use of an impermeable cover system and the proposed allowance for long term monitoring and repairs. Synthetic covers have design lives on the order of 100 or more years and are used successfully at other mining projects to mitigate effects from PAG tailings. This mitigation and monitoring is based on the conservative assumption that all tailings will be PAG; however, it is known that some of the ore grade materials are classified as NAG.

The small volumes of PAG rock incorporated into the access road to the site will represent less than 1% of the overall materials within the individual watersheds traversed by the road. The potential effects from PAG material are deemed to be of low significance provided that larger volumes of PAG rock, if encountered, are encapsulated as per the guidance provided earlier in the mitigation section. Decommissioning of the road will mitigate the long term potential for effects from exposed bedrock.

TABLE 6.2.2.2-2 SUMMARY OF SIGNIFICANCE DETERMINATION FOR ACID ROCK DRAINAGE/ METALS LEACHING

Project Component	VC	Direction	Magnitude/ Extent/ Duration	Duration	Reversibility	Frequency
Construction Phase						
Waste extraction from underground during pre-mining development. (2011)	Water Quality	Negative	Moderate	Medium term	Short-term	Low
Operation Phase						
PAG tailings disposal into DSTF (2013-2023)	Water Quality	Negative	Moderate	Long term	Long term	High
Decommissioning Phase						
PAG tailings in DSTF (2023 onwards)	Water Quality	Negative	Low	Long term	Long term	High

6.2.3 Climate

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

6.2.3.1 Identification of Valued Component

Climate has been selected as a valued component due to its importance as a special factor of the environment. Further, with the emphasis being placed on climate and its rate of change, through government and research organizations, this valued component is of high importance to society as a community value.

According to the Intergovernmental Panel on Climate Change (IPCC, 2008), climate may be defined narrowly as "the average weather or more rigorously as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. These relevant quantities are most often surface variables such as temperature, precipitation, and wind."

6.2.3.2 Summary of Baseline Information

A three-metre meteorological station equipped with instrumentation to measure wind speed and direction, air temperature, relative humidity and incident solar radiation was installed at the Mactung property on July 15, 2005, approximately 50 m from the Mactung camp. Weather data were collected and analyzed for a three-year period, from the date of installation until August 27, 2008.

Daily maximum wind gusts at the Mactung property are typically on the order of 7 m/s however, the maximum wind gust recorded over the entire period of record reported was 23 m/s. Higher wind gust speeds tend to occur in the winter months. The daily maximum recorded wind speed for the period of record reported is illustrated in Figure 4.1.5-2.

The mean summer air temperature is typically between 5°C and 10°C, with daily minimum temperatures of approximately 5°C and daily maximum temperatures of approximately 15°C. The maximum air temperature recorded at the station over the study period was 20°C. Mean winter temperatures have more day-to-day variation, but are typically between -10°C and -20°C. The minimum air temperature recorded at the site over the period of record was -37.3°C. During the winter season, air temperatures rarely rise above freezing. The daily minimum, mean, and maximum air temperatures for the entire period of record are illustrated in Figure 4.1.5-3.

The warmest period of the year is from June to late August. October through March represents the coldest period, with seasonal transitions occurring in April and May and from late August through September. A summary of average monthly temperatures for the period of record are summarized in Section 4.1.5.

Relative humidity at the Mactung property is typically near 90% throughout the year, but frequently drops to 30% or lower for periods of up to one day. During the winter months, the maximum relative humidity tends to be slightly lower than during the summer. During the summer months, relative humidity tends to have a larger daily range (±30% from the daily mean) than during the winter (±17%). The lowest relative humidity observed at the site over the period of record was 12.5%.

Precipitation data recorded from 1998 to 2005 at the Meteorological Service of Canada Macmillan Pass meteorological station was used to estimate yearly precipitation at the Mactung property. The Macmillan Pass station is located approximately 16 km southeast of the Mactung property at 63º 14' 36.9" N and 130º 2' 7.1" W, on the west side of the mountain, approximately 481 m below the Mactung property's elevation. It is anticipated that due to the relative difference in elevation and location on the mountain between the meteorological station and the Mactung property, that the precipitation estimate may be low.

Based on the entire period that the Macmillan Pass station has been operational (1998 to 2005) the average annual precipitation is 672 mm (water equivalent). The average monthly distribution of precipitation for Macmillan Pass is presented in Table 4.1.5-1. Months with greater than 50 mm of precipitation commonly occur throughout the year, with January having the least precipitation, typically less than 30 mm. Based on temperature data recorded at the Mactung property, this precipitation can be expected to fall as snow from October to April. Precipitation occurring in September and May has the potential to fall as snow, freezing rain, rain or mixed precipitation.

6.2.3.3 Effects Characterization

Project activities will result in the emission of carbon dioxide (CO_2) and other greenhouse gases (GHGs). The release of GHGs has been linked to global warming and is of concern to regulators and potentially, stakeholders. Greenhouse gas emissions include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). By using the relative potentials of these compounds, it is possible to convert them into CO_2 equivalents. Because GHG emissions management is a territorial and a national issue, it is important to know the estimated levels of emissions nationally and territorially. Environment Canada (2005) estimates the Yukon Territory's 2005 emission level at 0.42 Mt/a (or 420 kilotonnes/a). Despite an increasing population, the Yukon has had a decreasing level of emissions since 1995 (Table 6.2.3-1).

TABLE 6.2.3-1 TRENDS IN GREENHOUSE GAS EMISSIONS, YUKON

	1990	1995	2000	2003	2005
Total GHG Emissions (Mt)	0.56	0.57	0.47	0.46	0.42

Source: Environment Canada, 2005 – Table A10-12.

Mt/a – megatonne per annum. One megatonne = 1,000,000 tonnes or 1,000 kilotonnes.

Tamerlane Ventures Inc. (2007) estimated that diesel-fired power plant at their Pine Point Pilot Project, consisting of sets of generators capable of producing 6,000 kW, would produce approximately 56 kt/a (although the number and size of generators was yet to be determined at the time of the emissions calculations). Mactung will use five 2.5 MW generators to achieve 12,500 kW. By using a pro-rated method to calculate emissions, it is estimated that Mactung may emit up to 117 kt/a.

Additional emissions would be generated from underground mine production and ore processing. Tamerlane Ventures projected emissions of approximately 87 kt/a of GHGsbased on a production rate of 2,800 tonnes per day. Mactung is projected to produce 2,000 tonnes per day, which may create up to 62 kt/a of GHG emissions.

These calculations provide a rough estimate of the potential GHG emissions that may be generated by the Mactung project. Potential Mactung project emissions represents a 43% increase over the 2005 Yukon GHG emissions of 420 kt/a (or 0.42 Mt/a), and a 0.025% increase over the estimated 2005 Canadian GHG emissions of 728,000 kt/a (or 728 Mt/a). It is important to note that the Yukon has one of the lowest GHG emission rates of all provinces and territories (i.e., NWT had an estimated 2005 GHG rate of 1,580 kt/a, almost four times the emission rate as the Yukon) due to its relatively small population and few industries. Therefore, the emissions generated from a year-round operating mine will have a larger proportional increase to the Yukon GHG estimate.

The degree to which the proposed project activities may affect the climate is not measurable as there are no national or international standards or guidelines are available on which to base potential effects.

6.2.3.4 Mitigation Measures

Although the degree to which the proposed project activities may affect the climate is not measurable and NATC is committed to employing mitigation measures to minimize the project's contribution to greenhouse gas emissions:

- investigating the potential of using alternative energy sources, such as wind energy, at the site; and
- using state-of-the-art power generators that are designed to produce fewer emissions;
- the efficient use of vehicles and machinery on site.

6.2.3.5 Significance Determination

The release of GHG and the issue of climate change are beyond regional in geographic extent since it is a national and global concern. The Mactung project-related GHG emissions will be of a relatively short-term nature. In addition, there is a high degree of uncertainty in predicting effects associated with project-specific emissions and controversy pertaining to the reversibility of GHG emissions and global warming. As a result, no climate related significance has been attributed to the Mactung project GHG emissions estimate provided.

The overall significance of the effects of the project on climate can not be established due relative size of the project in relation to climate as a whole. The absence of nationally or internationally recognized standards or guidelines for addressing this issue means that no further significance analysis has been completed.

6.2.4 Air Quality

6.2.4.1 Identification of Valued Component

Air quality has been selected as a valued component, as project activities may result in emissions that may affect ambient air quality. Air quality represents a special element within the environment as well as an important value to community health and well-being. Effects associated with air quality have also been considered within this project proposal as it relates to the health of wildlife species and vegetation.

6.2.4.2 Summary of Baseline Information

To date, no air quality monitoring has been undertaken at the proposed Mactung mine site or any other adjacent sites. The only air quality monitoring program within the Yukon is conducted in Whitehorse as part of the National Air Quality Surveillance (NAPS) Network. The air pollutants monitored at this station include carbon monoxide, nitrogen dioxide, nitric oxide, ground level ozone, and fine particulate matter. Reports for the Whitehorse NAPS station from 1998, 2000, 2001, and 2004 concluded that the ambient air pollutant levels were good and rarely exceeded the levels specified in the National Air Quality Objectives.

Hydro-meteorology equipment was installed at the Mactung property in July 2005. As reported in Section 4.1.5.2, winds at the Mactung property are known to originate from two prevailing directions, both west and northeast. This duality in prevailing wind direction is a result of the orientation of the valley in which the Mactung property is located. During the winter months, winds blow more frequently from the northeast and in the summer, winds were observed to be blowing more frequently from the west and southwest.

The average maximum gust on a daily basis is approximately 7.0 m/s. On a calm day, maximum wind gusts are in the order of 4.0 m/s, whereas on a windy day maximum gusts are in the order of 10.0 m/s.

6.2.4.3 Identification of Temporal and Spatial Bounding

Consideration of effects on air quality from the proposed project activities will include the spatial areas associated with:

- the mine site and aerodrome;
- the access road, North Canol Road, and Robert Campbell Highway; and
- the flight route between Whitehorse International Airport and Macmillan Pass Aerodrome.

Construction activities will occur from 2010 through to 2012, and then mine operations will commence and continue until approximately 2024. Decommissioning and reclamation will occur over the course of a 2-3 year period directly following operations.

6.2.4.4 Effects Characterization

The proposed project area is located in a remote area of the Yukon where no other local sources are known to affect the air quality. As a result, it is assumed that the ambient air quality for the area is consistent with background levels found elsewhere in Northern Canada.

Although it is not feasible to make a direct comparison between Whitehorse ambient air quality levels and those found at the Mactung property, an assumption may be drawn. It is reasonable to assume that the proposed project site will have better ambient air quality than that measured in Whitehorse due to the comparatively less traffic, fewer oil based heating systems, and lack of wood smoke present at the project site.

Project activities that may affect air quality through the production of either fugitive dust or gaseous emissions include:

- development of roads and surface structures through blasting and clearing;
- quarrying and borrowing for construction/foundation materials;
- operations at the mine site, such as crushing, blasting and hauling;
- use of diesel and propane fuel for power production;
- burning of waste using a solid waste incinerator;
- transport of equipment and supplies along the Robert Campbell Highway, the North Canol Road and mine access road; and
- transport of equipment, supplies and personnel via air from Whitehorse International Airport to the Macmillan Pass Aerodrome.

Effects associated with these activities may contribute to temporary, localized reduced air quality, which may lead to diminished environmental health (through damage to vegetation, soils and wildlife). Based on the proposed project activities, the effects associated with the project may be discussed through consideration of emissions and dust generation.

6.2.4.5 Emissions from Transport, Power Generation and Waste Incineration

Emissions will be produced through the operation of power generators, the transport of equipment, supplies and personnel and the burning of waste. These activities can reduce ambient air quality and could potentially affect the health of employees and the natural environment if emissions are produced in sufficient quantity. Given the remote nature of the mine site, North Canol Road, mine access road and aerodrome, as well as the relatively small scale of the operation, effects on the environment and human health are considered to be minimal. Further, the emissions generated at the mine site are expected to disperse relatively quickly due to its location and sufficient wind movement.

NATC will apply mitigation measures in response to the identified potential effects in order to ensure that emission generation is minimized to the extent possible. Mitigation measures will include:

- adherence to the Air Emissions Permit issued by Government of Yukon, Department of Environment, pursuant to the Air Emissions Regulations under the Yukon *Environment Act* (2002); and
- efficient use of air and ground transportation to minimize fuel usage and therefore minimize emissions.

To date neither the Government of Canada nor the Government of Yukon have established emissions thresholds to guide industry in the production of emissions that contribute to climate change, as such these parameters have not been considered.

6.2.4.6 Dust Generation from Clearing, Blasting, Quarrying, Borrowing and Crushing Operations

Dust will be produced through clearing, construction and operation of roads, quarries, borrow pits, and mine site infrastructure. Dust is typically identified as an annoyance, but in higher concentrations may pose risks to human health and safety. This may be especially important in the areas where visibility is of key importance. Dust may also carry through the air and deposit on surrounding vegetation, having potentially negative effects on the vegetation.

NATC will apply the following mitigation measure to minimize possible effects associated with dust generation.

- in areas of high activity and/or dry conditions, NATC will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust.

Given the remoteness of the project activities and application of the identified mitigation measures, effects on air quality are expected to be of low significance.

Table 6.2.4-1 presents a summary of the potential effects and application of mitigation measures.

TABLE 6.2.4-1 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR AIR QUALITY							
Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Operation of power generators, transport of equipment, supplies and personnel and burning of waste.	Air Quality	Lowered air quality.	Reduced health of employees and the natural environment	• Adherence to Air Emissions Permit Conditions. • Efficient transport of equipment, supplies and personnel.			✓
Clearing, construction and operation of roads, quarries, borrow pits, and mine site infrastructure.		Lowered air quality.	Risks to human health and safety. Health of vegetation.	• Application of dust suppressants.			✓

6.2.4.7 Significance Determination

The overall effects of the project on air quality, following implementation of mitigation measures, are determined to be low. Therefore, no further significance analysis is required.

6.2.5 Noise Levels

6.2.5.1 Identification of Valued Components

In considering environmental aesthetics, noise has been designated a valued component due to its importance to community health and well being. This valued component may be identified as a community value and is specific to its effects on humans. Noise may also be considered as an effect, specifically to wildlife; consideration has been given to the effects of noise on wildlife in the appropriate sections of the effects assessment (Section 6.2.7).

6.2.5.2 Summary of Baseline Information

Noise is often described as unwanted sound and is defined as pressure variation in air which is detectable by the ear. The relative loudness or intensity of sound energy is measured in decibels (dB).

Noises in rural or remote settings may seem amplified depending on the existence of barriers to the source. However, sound levels may be reduced by increasing distance, air density, wind, and obstructions (i.e., natural landscape features). Background sources of natural noise in the project area range from short-term soft sounds, such as the sound of the wind in the trees (30-50db), to short-term loud cracks and rumbles, such as the sound of falling rocks (60-80db).

Noise levels at the proposed mine site are currently not monitored but include year-round natural ambient noise and noise from exploration activities in the summer.

6.2.5.3 Identification of Temporal and Spatial Bounding

Noise associated with the project will be generated in the areas where project activities occur. At kilometre 447 of the North Canol Road, a 45 km access road will be constructed to the proposed mine site. The mine site development will include land clearing and infrastructure construction. The Macmillan Pass Aerodrome expansion will be completed during the construction phase, with two staging areas at the Macmillan Pass Aerodrome and at approximately kilometre 230 of the North Canol Road. Goods and materials will be transported by air and ground according to the following routes:

- air transportation routes: between Whitehorse International Airport and Macmillan Pass Aerodrome; and
- ground transportation routes: between Watson Lake and the project site via the Robert Campbell Highway (passing through the community of Ross River).

The project will begin construction in 2010 and continue through to 2012, at which time operation will begin. Full operation at the site will continue year-round until approximately 2024 and will be followed by 2-3 years of decommissioning, reclamation and eventual abandonment. Noise is expected to be generated by project activities throughout the lifespan of the project.

6.2.5.4 Effects Characterization

The proposed mine site is situated in a remote portion of the Yukon where the existing background noise is consistent with those of a natural setting. Some additional noise is present during the summer as part of the ongoing exploration activities, such as drilling and use of a small generator.

Human presence within the project area is expected to increase due to increased ability to access the area and the project itself. Specifically, human-related activity in the vicinity of North Canol Road is anticipated to increase due to easier access from regular road maintenance and mine-related traffic.

Various sources of noise that may be associated with the proposed Mactung mine include:

- construction of the mine facilities and infrastructure;
- mine operations;
- decommissioning the mine site and reclamation of the project footprint; and
- ground and air transport of equipment and materials.

Noise associated with the proposed project will be generated primarily from the use of equipment and facilities on the site. Increases in noise are expected during the construction, operation and decommissioning phases and will only affect the immediate vicinity where these activities are taking place. The average daily and long-term ambient noise levels in the area are anticipated to be low. Further, noise will be temporary in nature, as it is limited to the project timeline, that is, following mine decommissioning, no noise will be generated.

Temporary effects associated with ground and air transport of goods will occur in populated communities. The Town of Ross River will be exposed to noise from mine transport vehicles driving on the Robert Campbell Highway, as they pass through the community. The frequencies of shipments to and from the site will depend on the project phase:

- construction phase – 10 round trips per day (or 20 one-way trips per day);
- operation phase – 4 round trips per day (or 8 one-way trips per day); and
- decommissioning phase – 1 round trip per day (or two one-way trips per day).

Effects resulting from an increase in traffic may include a slight disruption during daily activities due to temporary noise elevations.

6.2.5.5 Mitigation Measures

To minimize the effects of noise disruption within the Town of Ross River, NATC will ensure that traffic only moves through the community between the hours of 7:00 am and 8:00 pm. This mitigation measure is meant to limit excess noise to hours of community activity. The mitigation has been assigned an anticipated level of success of complete.

6.2.5.6 Significance Determination

Based on the applied mitigation the effects associated with noise disturbance were determined to be of low significance. Therefore, no further significance analysis is required.

6.2.6 Vegetation

The following section describes the potential effects, recommended mitigation measures, and significance determination of potential residual effects for vegetation.

6.2.6.1 Identification of Valued Components

Four main vegetation valued components (VCs) are identified as possibly being relevant to the proposed Mactung project based upon baseline study results, plant and ecosystem status (particularly in the context of conservation, sensitivity to disturbance, and cultural importance), guidelines produced by YESAB (2005), and professional experience. The VCs include 1) rare and endangered plant species and communities; 2) wetlands and riparian ecosystems; 3) old growth forest ecosystems; and 4) sensitive alpine ecosystems. These VCs are discussed in detail in the following subsections.

Rare and Endangered Plant Species and Communities

Rare and endangered plants were defined as plant species listed under Schedule 1 of the *Species at Risk Act*; listed in *The Rare Vascular Plants of the Yukon* (Douglas *et al.* 1981); or considered rare by local authorities such as NatureServe Yukon. A list was established and referenced for all potential rare plants in the LSA (Section 4.1.8).

Wetland and Riparian Ecosystems

Wetland ecosystems are defined as "areas where soils are water-saturated for a sufficient length of time such that excess water and the resulting low soil oxygen levels are the principal determinants of vegetation and soil development" (Mackenzie & Moran 2004). Wetland ecosystems include fens, bogs, marshes, and swamps. Riparian areas are defined as terrestrial areas adjacent to and a result of the presence of rivers or streams.

Wetlands have been identified by YESAB (2005) as a focal plant community to consider during the effects assessment process. These ecosystems provide important habitat for fish and migratory birds which are protected under federal regulations, specifically the *Fisheries Act* and *Migratory Birds Convention Act*. Both wetland and riparian ecosystems contribute to landscape biodiversity, maintain water quality, provide habitat required by protected plant species and unique plant assemblages, are considered high quality habitat for fish and wildlife, and are vulnerable to disturbance.

Old Growth Forest Ecosystems

Old growth forest ecosystems are considered a VC because they are slow to recover from disturbance, can provide habitat for unique and potentially rare plant species, and provide important habitat to wildlife, such as birds of prey. Characterization of old growth forest ecosystems as a vegetative VC has been completed following the field description procedures used in British Columbia (BC Ministry of Environment, Lands, and Parks and BC Ministry of Forests 1998). Old growth forests are assigned a structural stage of "7", which generally include forests greater than 250 years old in similar communities in northern British Columbia (Wong *et al.* 2003) (see Table 6.3.5.2-3).

Alpine Ecosystems

Alpine ecosystems are considered a VC due to their high value as wildlife habitat for species such as caribou, birds of prey, and grizzly bears. These areas also contribute to landscape biodiversity, provide habitat for a number of protected plant species and unique plant assemblages, and are inherently sensitive to disturbance and slow to recover due to harsh growing conditions. Alpine plant communities occur above the tree line and are often exposed to extreme cold, wind, and poor soil conditions. Disturbances to these communities are likely reversible over the long-term (e.g., within 100 years); however due to the extreme climatic conditions and slow growth rates, effects are not considered reversible in the short-term.

6.2.6.2 Summary of Baseline Information

Rare and Endangered Plant Species

Rare plant surveys (RPS) were completed over a three year period as part of on-going environmental baseline studies at Mactung (EBA 2007a; EBA 2007b; EBA 2008).

The scope and methods used to conduct the surveys are described in Section 4.1.8. The focus of the rare plant surveys for the Mactung project was on the mine footprint, with additional surveys conducted throughout the LSA (Figure 4.1.8-3). One rare plant, dwarf nagoonberry (*Rubus arcticus* spp *acaulis*), was observed in 2006 within the LSA, but was located outside the 200 m buffer. In 2008, heart-leaved twayblade (*Listera cordata)* was observed within the 200 m proposed access road buffer; however it was later determined that this plant is no longer considered rare in the Yukon (Bruce Bennett, pers. comm. 2008).

A rare plant survey of this type cannot confirm the absence of rare plants at the site; rather it can only confirm their presence. Reasonable sampling effort was used to investigate areas with high potential to support rare plants and areas where construction of the mine and road may have a significant impact on rare plants, were they to occur.

All proposed project footprint areas were surveyed except for the area associated with the aerodrome expansion. Areas with a similar plant community structure to that found in the vicinity of the aerodrome were surveyed elsewhere in the LSA and rare plants were not identified in these plant communities. Based on the results of the baseline studies, it is considered unlikely that any rare plants occur within the Mactung project footprint. On the basis of these results, no further examination of rare and endangered plants in relation to the proposed Mactung project occur in this report.

Rare and Sensitive Plant Communities

A list of rare plant communities does not currently exist for the Yukon or the Mactung LSA. Certain plant communities described during baseline studies had either restricted distributions within the LSA (e.g., are locally "rare"), or were thought to be particularly sensitive to disturbance. These communities include wetlands, riparian areas, sensitive alpine communities, and old growth forest; all of which are described in more detail in the following sections. A summary of all ecosystems observed within the local study area (LSA) are provided in Tables 4.1.8-2 and 4.1.8-3.

Wetland and Riparian Ecosystems

Four sensitive wetland and riparian ecosystems were observed in the Mactung LSA and include: Sedge-Sphagnum, Sedge-Bluebell, Willow-Bluebell, and Willow-Sedge. The total area of wetlands and wetland complexes within the LSA is 1,063 ha or approximately 7.5%. These ecosystems are described in detail in Tables 6.2.6-1 and 6.2.6-2.

TABLE 6.2.6-1 DESCRIPTION OF WETLAND AND RIPARIAN VALUED COMPONENTS

Ecosystem Unit	Code	Description
Sedge – Sphagnum	CS	This area was observed in low-lying depressions along the access road and generally occurs as a continuous fen wetland system. The vegetation unit is dominated by *Carex aquatilis* with a minor component of *Carex podocarpa* and *Potentilla palustris*. These sites are generally depressional to flat areas with poorly drained, subhygric soils in valleys bottoms. The groundcover was dominated by *Sphagnum* species

TABLE 6.2.6-1 DESCRIPTION OF WETLAND AND RIPARIAN VALUED COMPONENTS		
Ecosystem Unit	Code	Description
		such as *Sphagnum fuscum* and moss species such as glow moss (*Aulacomnium palustre*) and golden fuzzy moss (*Tomenthypnum nitens*). The high *Sphagnum* cover observed in this ecosystem makes it vulnerable to the effects associated with dust generation and physical disturbance. In addition these areas are considered valuable habitat for wildlife.
Sedge–Bluebell	CM	These areas were observed in the lower Alpine and Shrub Taiga of the Yukon between 1,620 m a.s.l. and 1,370 m a.s.l. The vegetation unit is dominated by *Carex podocarpa* and a diverse mix of forbs including *Mertensia paniculata, Senecio triangularis, Artemesia arctica, and Polemonium acutiflorum*. These sites are generally gentle sloping, with moderately drained submesic to mesic soils, and occurring in sheltered valleys. This unit is similar to Willow-Bluebell and may occur at higher elevations with submesic soils. These units may indicate seepage areas or occur along high elevations streams. These areas are high in diversity and considered valuable habitat for wildlife.
Willow –Bluebell	SM	The Willow-Bluebell unit occurs adjacent to streams and seepage areas. These areas were observed in the lower Alpine and Shrub Taiga of the Yukon between 1,525 m a.s.l. and 1,455 m a.s.l. and in the Wooded Taiga at 1,400 m a.s.l.. The dense canopy is dominated by medium to tall willow species *Salix planifolia, Salix glauca, Salix alaxensis, and Salix barrattianna*. The understory is a diverse mix of forbs including *Mertensia paniculata, Senecio triangularis, Artemesia arctica, and Polemonium acutiflorum*. These sites are generally gentle sloping, moderately drained, with moist to wet soils, and occurring in sheltered valleys. These areas are high in diversity and considered valuable habitat for wildlife.
Willow – Sedge	SC	The Willow-Sedge unit occurs adjacent to streams and rivers in floodplains. These areas were observed in the Shrub Taiga between 1,500 m a.s.l. and 1,450 m a.s.l. and the Wooded Taiga between 1,300 and 1,150 m a.s.l. The dense canopy is dominated by medium to tall willow *species Salix alaxensis, Salix planifolia, and Salix glauca*. The understory is characterized by sedge species (*Carex aquatilis and C. podocarpa*), *Equisetum* species, and moss species. These sites are generally flat, moderately to well drained, with submesic to mesic soils. These areas are high in diversity and considered valuable habitat for wildlife.

TABLE 6.2.6-2 SUMMARY OF WETLAND AND RIPARIAN VALUED COMPONENTS			
Code	Ecosystem Unit	Area (ha)	Percent of LSA (%)
SC	Willow-Sedge	774.5	5.49
PM:SC	Spruce Moss: Willow-Sedge	154.3	1.09
CS	Sedge-Sphagnum	81.5	0.58
SM	Willow-Bluebell	67.9	0.48
CM	Sedge-Bluebell	26.8	0.19

TABLE 6.2.6-2 SUMMARY OF WETLAND AND RIPARIAN VALUED COMPONENTS			
Code	Ecosystem Unit	Area (ha)	Percent of LSA (%)
FS:CS	Fescue-Willow: Sedge-Sphagnum	14.3	0.10
SC:FC	Willow-Sedge: Fescue Sedge	12.4	0.09
SC:CS	Willow-Sedge: Sedge-Sphagnum	9.9	0.07
BC:CS	Birch-Lichen: Sedge-Sphagnum	6.0	0.04
SC:WD	Willow-Sedge: Marsh/Fen	3.6	0.03

Old Growth Forest

No ecosystem units in the LSA were described as being greater than 250 years old during the course of field surveys or ecosystem map development; therefore, it has been concluded that no old growth communities are present (Table 6.2.6-3). On the basis of these results, no further examination of old growth forest ecosystems in relation to the proposed Mactung project will occur in this report.

TABLE 6.2.6-3 SUMMARY OF VEGETATION STRUCTURAL STAGES WITHIN THE MACTUNG LSA			
Code	Structural Stage	Area (ha)	Percent of LSA (%)
1	Sparse/Bryoid	1.4	0.01
1a	Sparse (<10% cover)	2,384.8	16.73
1b	Bryoid (>50% cover)	256.2	1.80
2a	Forb	94.7	0.66
2b	Graminoid	754.9	5.30
2d	Dwarf Shrub	1,401.2	9.83
3a	Low Shrub (<2m)	4,165.6	29.23
3b	Tall Shrub (2-5m)	387.6	2.72
5	Young Forest (40-80 years)	570.1	4.00
6	Mature Forest (80-250 years)	4,081.7	28.64
7	Old Growth Forest (>250 years)	0	0
Not Applicable	Water	5.2	0.04
Not Applicable	No Data	149.5	1.05

Alpine Ecosystems

One sensitive alpine ecosystem was observed in the Mactung LSA: Heath-Lichen. The total area of alpine and alpine complexes within the LSA is 1,469.3 ha or approximately 10.4%. These ecosystems are described in detail in Tables 6.2.6-4 and 6.2.6-5.

6.2.6.3 Identification of Spatial and Temporal Bounding

Spatial overlap of vegetation VCs with project activities will be restricted to areas cleared for construction of the mine infrastructure, the road, and the aerodrome expansion. The generation of dust during operations may have marginal further effects within a 200 m buffer of the road and aerodrome.

Temporal overlap of vegetation VCs with project activities depend primarily upon when individual plant species are actively growing and present above ground, or for wetlands, the season during which activities occur. Wetlands are most sensitive to disturbance during the summer when the ground is soft and not frozen. In general, most project construction activities are planned during the summer months (May to September) when plants are most sensitive to disturbance and when wetland substrate is susceptible to disturbance and scarring by motorized vehicles and heavy equipment.

6.2.6.4 Effects Characterization

The vegetation effects characterization focused on describing how the proposed Mactung project activities may impact the vegetation VCs identified. This section examines the effects of clearing and construction, operation, and decommissioning on each of the major project areas including the mine, mine infrastructure, dry-stack tailings area, borrow area, ravine dam and reservoir, access road, and aerodrome (Figure 4.1.8-1). Table 6.2.6-6 provides a summary of the overlap between project activities and VCs, their potential direct and indirect effects, associated mitigation strategies, and predicted level of success of the mitigation measures. A detailed examination of the project effects related to each phase of the mine project is provided in the following subsections.

TABLE 6.2.6-6 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR VEGETATION

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Clearing and Construction	Rare and Endangered Plant Species	None identified	None identified	Not required			✓
	Wetland and Riparian Ecosystems	Clearing of vegetation	Not applicable	Salvage soil and seed stock; revegetate immediately		✓	✓
	Old Growth Forest	None identified	None identified	Not required			✓
	Alpine Ecosystems	Clearing of vegetation	Not applicable	Salvage soil and seed stock; revegetate immediately		✓	✓

TABLE 6.2.6-6 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR VEGETATION

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Operation: Dust generation from mine and road	Wetland and Riparian Ecosystems	Accumulation of trace elements in plants	Reduced health of plant; accumulation of trace elements in wildlife	Dust suppression; monitor accumulation			✓
Operation: Dust generation from road and aerodrome	Wetland and Riparian Ecosystems	Covering plant, resulting in plant mortality	Altered soil conditions, changing species presence	Dust suppression		✓	
	Alpine Ecosystems	Covering plant, resulting in plant mortality	Alter soil conditions changing species presence	Dust suppression			✓
Operation: Worker activities including use of off-road vehicles	Wetland and Riparian; Alpine Ecosystems	Trampling, resulting in plant mortality	Soil compaction and scarring	Restrict vehicle use to established roads and trails		✓	
Operation: road maintenance including piling snow and using salt/ sand	All ecosystems	Compaction of vegetation; smothering of vegetation by sand/ salt	Alteration of soil chemistry and vegetation physiology	Restrict the placement of snow and sand piles to areas that are less sensitive		✓	
Decommissioning: Removal of buildings, reclamation of ravine dam and dry-stack tailing areas	All ecosystems	Leave exposed soil	Colonization by non-native species	Ensure all exposed soil and reclamation areas are replanted			✓
		Apply singular seed mix to all areas	Reduced biodiversity	Implement ecosystem specific revegetation plans			✓
		Apply non-native seed mixes	Loss of native species; increased	Use native species mixes (preferably			✓

TABLE 6.2.6-6 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR VEGETATION							
Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
			biodiversity in the short-term and reduced biodiversity in the long-term	local stock) for revegetation			

Clearing and Construction Phase

Direct effects on the VCs are mainly associated with clearing vegetation and levelling terrain to accommodate required infrastructure. Table 6.2.6-7 outlines the ecosystem units that will be directly affected by vegetation removal for the mine and conveyor system, tailings area, runoff pond, ravine dam, and borrow area. Ecosystem units affected by the access road are listed in Table 6.2.6-8 and the expansion of the aerodrome is listed in Table 6.2.6-9.

TABLE 6.2.6-7 SUMMARY OF DIRECT EFFECTS ON ECOSYSTEMS BY MINE FOOTPRINT				
Ecosystem Unit	VC	Ecosystem Unit in Footprint (ha)	Total Ecosystem Unit in LSA [1] (ha)	Percent of Ecosystem Unit Effected in LSA (%)
Buildings				
Epilithic Lichen		2.1	2,644.0	0.1
Fescue-Sedge		0.9	468.2	0.2
TOTAL		**3.0**		
Ravine Dam and Reservoir				
Willow-Bluebell	Riparian	7.7	67.9	11.3
Heath-Lichen	Alpine	1.1	1,204.8	0.1
Fescue-Willow		0.9	190.3	0.5
Willow-Slope		0.7	1,247.3	0.1
Epilithic Lichen		0.04	2,644.0	<0.1
TOTAL		**10.3**		
Tailings Area				
Heath-Lichen	Alpine	16.6	1,204.8	1.4
Sedge-Bluebell	Alpine-Riparian	13.9	26.8	51.9
Fescue-Sedge	Alpine	4.2	468.2	0.9
Fescue-Willow		4.1	190.3	2.2
Willow-Bluebell	Riparian	0.4	67.9	0.5
TOTAL		**39.2**		

[1] LSA includes area of all affected or unaffected ecosystem units for the mine and road. LSA for the aerodrome is not included.

TABLE 6.2.6-8 SUMMARY OF DIRECT EFFECTS ON ECOSYSTEMS BY ROAD FOOTPRINT				
Ecosystem Unit	VC	Ecosystem Unit in Footprint (ha)	Total Ecosystem Unit in LSA [1] (ha)	Percent of Ecosystem Unit Effected in LSA (%)
Fir-Moss		40.0	2,231.0	1.8
Fir-Lichen		36.4	1,112.9	3.2
Birch-Lichen		34.2	1,485.9	2.3
Spruce-Moss		29.5	1,808.1	1.6
Fescue-Sedge		10.2	468.2	2.2
Willow Slope		6.3	1,247.3	0.5
Sedge-Sphagnum	Wetland	6.0	96.5	6.2
Epilithic Lichen		4.4	2,644.0	0.2
Fescue-Willow		3.7	190.3	1.9
Heath-Lichen	Alpine	3.4	1,204.8	0.3
Willow-Sedge	Riparian	2.5	896.5	0.3
Willow-Bluebell	Riparian	1.6	67.9	2.3
Birch-Moss		1.5	462.4	0.3
TOTAL		**179.6**		

[1] LSA includes area of all affected or unaffected ecosystem units for the mine and road. LSA for the aerodrome is not included.

TABLE 6.2.6-9 SUMMARY OF CLEARING AND DUST EFFECTS ON ECOSYSTEMS BY AERODROME EXPANSION						
Ecosystem Unit	VC	Cleared Area in Footprint (ha)	Dust Affected Area in 200 m Aerodrome Buffer (ha)	Total Ecosystem Unit in LSA [1] (ha)	Percent of Ecosystem Unit Effected in LSA [1] (%)	
					Cleared	Dust
Sedge-Sphagnum	Wetland	1.0	14.8	96.5	1.0	15.3
Birch-Lichen		1.1	13.0	1,485.9	<0.1	<0.1
Willow-Sedge	Riparian	0.1	23.4	896.5	<0.1	2.6
TOTAL		**2.2**	**51.2**			

[1] LSA does not include vegetation sampled within the aerodrome footprint and buffer.

Table 6.2.6-10 summarizes the total area of vegetation VCs affected by the clearing activities related to the mine, road and aerodrome.

TABLE 6.2.6-10 SUMMARY OF CLEARING EFFECTS ON ALL VALUED COMPONENTS				
Ecosystem Unit	VC	Cleared Area (ha)	Total Ecosystem Unit in LSA 1 (ha)	Percent of Ecosystem Unit Effected in LSA (%)
Heath-Lichen	Alpine	21.1	1,204.8	1.8
Sedge-Bluebell	Riparian	13.9	26.8	52.0
Willow-Bluebell	Riparian	9.7	67.9	14.5
Sedge-Sphagnum	Wetland	7.0	96.5	7.3
Willow-Sedge	Riparian	2.6	896.5	0.2
TOTAL		**54.3**		

[1] LSA includes area of all affected or unaffected ecosystem units for the mine and road. LSA for the aerodrome is not included.

The operating life of the mine is estimated to be 11 to 13 years. The largest effects to vegetation will occur during the initial clearing and construction phases, but will last through to the decommissioning and reclamation phase. Based on YESAB (2006) - *Guide to Socio-Economic Effects Assessment* this translates into a long-term duration. The geographic extent is local for all clearing activities and local for any effects associated with dust generation and worker activities related to operations.

The total area to be cleared for the mine footprint is limited to 52.5 ha overall, with 3.0 ha for buildings, 10.3 ha for the ravine dam and reservoir, and 39.2 ha for the dry-stack tailings and borrows area. An additional 179.6 ha will be cleared or upgraded for the access road from the mine to North Canol Road and an additional 2.2 ha cleared for the expansion of the aerodrome.

VCs that will be most affected by clearing and construction include: Heath-Lichen (21.1 ha), Sedge-Bluebell (13.9 ha), Willow-Bluebell (9.7 ha), Sedge-Sphagnum (7.0 ha), and Willow-Sedge (2.6 ha) ecosystems (Table 6.3.5.2-10).

The area of Willow-Sedge and Heath-Lichen to be cleared is of low significance due to the low magnitude (each less than 2% of ecosystem), local extent, and short-term reversibility (these systems can likely recover within 26 years).

Clearing of the Sedge-Sphagnum wetland community is of moderate significance due to the moderate magnitude (7.3% of this community will be disturbed, which falls within the suggested 5-10% range of affected area associated with a moderate magnitude), local extent, and short-term reversibility with mitigation (again, this community can likely recover within 26 years). Due to the limited occurrence of organic soils in the LSA, mitigation in the form of salvaging organic soil and associated seed stock from these areas for future reapplication during reclamation is recommended. This will help reduce the length of time taken for ecosystems to recover. With mitigation, the significance of the clearing of Sedge-Sphagnum ecosystems is likely low to moderate as it will partially recover in less than 10 years time.

The estimated area of Sedge-Bluebell and Willow-Bluebell to be cleared is 13.9 ha (52% of occurrence within LSA) and 9.7 ha (14.5% of occurrence within the LSA), respectively. The total area of Sedge-Bluebell and Willow-Bluebell to be cleared is small; however, the percent cover lost within the LSA is considered to be of high magnitude. Sedge-Bluebell and Willow-Bluebell are comparatively diverse alpine riparian communities that were observed at high elevations in other alpine valleys in the region. The limited extent of these two communities within the LSA may be due to the exclusion of most high alpine valleys from the LSA. These are sensitive ecosystems and some mitigation is recommended to ensure that they are properly reclaimed upon decommissioning of the mine. Mitigation measures will need to include salvaging organic soil and associated seed stock from these areas during clearing and storing for reapplication during reclamation. With mitigation, the significance of the clearing of these ecosystems is likely moderate as they will undergo at least partial recovery in less than 10 years time.

The effects of clearing and construction will also result in dust production and air emissions from vehicles and machinery that could affect ecosystems and vegetation in the area. These effects are anticipated to be more relevant during the operation phase of the project and are discussed in more detail in the following subsection.

Operation Phase

Direct effects on vegetation VCs during the operational phase of the project are mainly associated with worker activities and maintenance of the road. Main effects of worker activities include:

- trampling and compaction of vegetation and soils by personnel during regular operations or during their spare time; and
- picking berries for consumption.

Areas particularly susceptible to disturbance via trampling and soil compaction include lichen-dominated alpine plant communities and wetlands with fine-textured, water saturated soils that are slow to recover from disturbance. These effects can be mitigated by restricting personnel activities to established roads and trails and limiting the recreational use of undisturbed areas at all times.

Activities during regular road maintenance that may affect vegetation include piling snow and applying salt/ sand during winter months. Run-off from salt and minerals deposited or piled on the road can alter the chemistry, pH and physical characteristics of the substrate. Excess salt and minerals can physically damage vegetation through the burning of foliage, and can also lead to physiological changes through the alteration of soil and water pH. Prolonged and repeated exposure can also lead to changes in plant species composition, favouring those species with a higher tolerance to these materials. These effects can be mitigated by piling snow in areas that are less sensitive to mineralization and ensure that any potential salt and sand piles are removed each spring to ensure that build-up and run-off does not occur into adjacent vegetation.

Activities during operations that may also affect VCs include dust generation from the use of the road and aerodrome by vehicles and equipment, and emissions generated from the mine. Dust and particulate may have both direct and indirect affects on adjacent vegetation. Dust deposited on and around vegetation has the potential to:

- decrease photosynthesis in plants by decreasing light absorption and hinder stomatal function;
- physically abrade leaf surfaces resulting in reduced photosynthetic efficiency and increased pathogen susceptibility;
- change local soil moisture and nutrient conditions which can result in a shift in species composition and plant community distribution over time;
- result in the uptake of minerals/ metals that can become toxic to the plant at high concentrations; and
- result in the concentration of minerals/ metals within the plant that are then passed on to higher trophic levels through consumption.

The 200 m disturbance buffer (also called the "zone of influence") for vegetation was established in order to account for an area associated with the deposition of dust particles (Angold 1997; Forbes 1995) thought to be the most damaging to vegetation (e.g., those with an aerodynamic diameter >30 µm). Particles of this size and larger generally settle out closer to the source (US EPA 1995) and deposition has been shown to decrease exponentially with increasing distance from the roads the in Arctic (Auerbach *et al*. 1997; Spatt and Miller 1981).

A summary of the ecosystem units mapped within the 200 m buffer around the aerodrome and road are presented in Tables 6.2.6-7 and 6.2.6-8. Ecosystems most vulnerable to dust input are wetland communities that consist of *Sphagnum* species such as Sedge-Sphagnum, and alpine ecosystems which are dominated by lichen groundcover. Both Sphagnum and lichen species are susceptible to many of the effects previously described. Ecosystems most likely to bio-accumulate minerals/ metals from dust are riparian ecosystems and wetlands that can act as "sinks" for the dust, as minerals settle out from slow water movement. The effects of dust on vegetation are likely to be of low significance if proper mitigation is taken to suppress dust dispersion during construction and operation. As well, monitoring the levels of accumulation of metals in vegetation should take place as a precautionary approach to identify if bioaccumulation is taking place in vegetation, fish and wildlife habitat. Monitoring will include taking samples two years following the opening of the mine and every five years following this until the decommissioning of the mine.

Table 6.2.6-11 provides a summary of potential direct and indirect effects from dust emission on ecosystems within the LSA.

TABLE 6.2.6-11 SUMMARY OF POTENTIAL DIRECT AND INDIRECT DUST EMISSION EFFECTS ON LSA ECOSYSTEMS

Ecosystem Unit	VC	Ecosystem Unit Effected (ha)	Total Ecosystem Unit in LSA (ha)	Percent of Ecosystem Unit Effected (%)
Road				
Fir-Moss		420.2	2,231.0	18.8
Fir-Lichen		344.9	1,112.9	31.0
Birch-Lichen		344.1	1,485.9	23.2
Spruce-Moss		308.1	1,808.1	17.0
Willow-Sedge	Riparian	137.8	896.5	15.4
Willow Slope		65.9	1,247.3	5.3
Fescue-Sedge		60.3	468.2	12.9
Sedge-Sphagnum	Wetland	60.2	96.5	62.4
Fescue-Willow		32.5	190.3	17.1
Heath-Lichen	Alpine	30.9	1,204.8	2.6
Birch-Moss		29.9	462.4	6.5
Epilithic Lichen		28.8	2,644.0	1.1
Willow-Bluebell	Riparian	19.4	67.9	28.6
Marsh/Fen	Wetland	1.5	3.6	42.0
TOTAL		**1,884.5**	**13,919.4**	**13.5**
Aerodrome				
Sedge-Sphagnum	Wetland	14.8	96.5	15.3
Birch-Lichen		13.0	1,485.9	0.9
Willow-Sedge	Riparian	23.4	896.5	2.6
Exposed soil		9.1	-	-
Spruce-Moss		7.5	1,808.1	0.4
River	Riparian	3.9	-	-
Aerodrome		2.4	-	-
TOTAL		**74.1**	**4,287.0**	**1.7**

"-"= No area identified within LSA.

Decommissioning Phase

The effects of decommissioning the project on vegetation are mainly associated with deconstructing the mine and conducting reclamation activities. All areas of the footprint will be reclaimed post-closure of the mine including removal of all buildings, deactivation of the access road and reclamation of the ravine dam and dry-stack tailings areas. Therefore, potential effects of decommissioning will focus on issues associated with reclamation. Three primary reclamation goals include: maintaining biodiversity of plant communities after reclamation by planting more than one species; ensuring persistent non-native invasive plant species (weeds) are not used during reclamation and are controlled if introduced on-site; and ensuring that exposed soil is seeded in a timely manner in order to exclude the colonization of persistent non-native invasive plant species (weeds).

6.2.6.5 Mitigation Measures

To minimize any potential effects of the project on VCs and vegetation communities in the area, Mactung has committed to implementing mitigation measures and adopting an adaptive management approach (i.e., a feedback approach that evaluates the effectiveness of mitigation measures and responds accordingly). Construction and clearing will attempt to overlap with previously disturbed areas, where possible. These include areas of the access road that are contiguous with a historic trail, and previously disturbed areas adjacent to the aerodrome.

Other mitigation measures that will be implemented to reduce the significance of effects of the project on vegetation include:

- Salvage of organic and mineral top soils and their associated seed stock for future reapplication during reclamation and revegetation of the project area.
- Restrict off-road use of motorized vehicles and equipment and limit their use to established roads.
- Educate employees about the sensitivity of removing any local plants or plant parts for consumption.
- Educate employees regarding the sensitivite nature of alpine areas with a substrate dominated by lichen cover and wetlands with a substrate dominated sphagnum species.
- Application of dust suppressants (water), if required, during summer operation of roads and dry-stacked tailings facility.
- Restrict the placement of snow and sand piles to areas that are less sensitive to mineralization.
- Ensure any re-contouring, scarification, and reclamation of disturbed areas is conducted with appropriate and approved native seed mixes.
- Ensure revegetation measures are applied in a timely manner so as to restrict the colonization of exposed areas by non-native, invasive plants.
- Monitor potential accumulation of trace elements at established monitoring stations.

6.2.6.6 Significance Determination

Clearing and Construction Phase

Overall, clearing and construction of vegetation communities in the mine footprint are of low significance for most ecosystems due to the local extent, low magnitude and short-term reversibility of the effects from the project. Project activities will have moderate magnitude effect on one alpine ecosystem and three riparian/ wetland ecosystems (Table 6.2.6-10): Sedge-Bluebell, Willow-Bluebell, and Sedge-Sphagnum. However, these ecosystems are expected to recover in the short-term upon implementation of appropriate mitigation measures and initiation of reclamation, reducing the overall significance to moderate.

Operation Phase

With the suggested mitigation measures, the effect of operations on vegetation will be of low significance due their low magnitude, local geographic extent, short-term-duration and low to medium frequency.

Decommissioning Phase

With reclamation, the effect of decommissioning on vegetation will be of moderate "positive" significance due their low magnitude, local geographic extent, and short term duration to achieve partial to complete recovery.

Table 6.2.6-12 summarizes the significance determination for vegetation.

TABLE: 6.2.6-12 SUMMARY OF SIGNIFICANCE DETERMINATION FOR VEGETATION

Project Component	VC	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency	Overall Significance
Clearing and Construction	Wetland: Sedge-Sphagnum;	Negative	Moderate	Long-term	Low	Moderate
	Wetland: Sedge-Bluebell and Willow-Bluebell	Negative	Moderate	Short-term	Low	Moderate
	Alpine: Heath-Lichen	Negative	Moderate	Long-term	Low	Moderate
Operations: Dust generation from road and aerodrome	Wetland and Riparian Ecosystems	Negative	Moderate	Long-term	Medium	Moderate

6.2.7 Wildlife

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The proposed Mactung development has the potential to directly and indirectly affect wildlife species throughout its construction, operation, decommissioning and reclamation phases. Project infrastructure and associated activities may affect wildlife through physical or behavioural disturbances, such as habitat loss and avoidance, at a local scale. Seven valued components (i.e., caribou, moose, grizzly bear, wolverine, avian nesting habitat, hoary marmot and biodiversity) were chosen based on ecological and social significance. It should be noted that Dall's sheep were included as a focal species for the wildlife baseline assessments but were not included as a valued component (VC) in this assessment due the low frequency of observations in and around the study area.

Potential direct and indirect effects to wildlife were identified and assessed for all project components, including the construction, operation, decommissioning and reclamation of the:

- **access road, aerodrome and associated infrastructure**[1] - Approximately 17 km of new access road is proposed from the existing North Canol Road to the mine site, via low valley systems (ranging in elevation from 1,100 m to 1,400 m). Clearing and construction and/or upgrading will be required for approximately 35 km of the access road from the North Canol Road to the Mactung mineral claims. Approximately 10 km of road will be upgraded from the edge of the Mactung mining claims to the mine site. Approximately 3 km of exploration road to the Hess River Tributary is due to be constructed under a Class III mining land use permit following a separate YESAA proposal assessment (#2008-0289). The proposed road width is approximately 16 m (8 m road surface plus up to 4 m of right-of-way clearance on each side of the road). A 5.7 km portion of the access road near the mine site traverses through the valley into subalpine and alpine habitat (ranging in elevation from 1,400 m to 1,900 m). The total area to be cleared for the access road is approximately 191.2 ha. Approximately four trucks per day will arrive at and depart from the mine site carrying fuel, supplies, and bagged tungsten concentrates. Clearing will also be conducted for the existing Macmillan Pass Aerodrome upgrade. The aerodrome is currently 460 m long and 15 m wide. The upgrade would expand the aerodrome to be 1,375 m long and 30 m wide. A total area of 25.4 ha will be cleared for the aerodrome upgrade. The proposed aerodrome upgrades will accommodate larger aircraft.
- **mine site and associated infrastructure**[2] - The proposed mine site and associated infrastructure will be located between 1,760 m to 1,880 m elevation. The direct footprint of these facilities will be 2.95 ha.
- **ravine dam, reservoir and dry-stack tailings facility** - These facilities are proposed in subalpine habitat, at approximately 1,400 m to 1,650 m elevation. Water will remain inside the reservoir year-round. The direct footprint of these facilities will be 49.55 ha.

The following sections identify potential direct and indirect effects to wildlife species selected as VCs for each project phase and component.

6.2.7.1 Caribou

Identification of Valued Component

Caribou were considered to be a VC because they are listed as a species of Special Concern under the *Species at Risk Act* (*SARA*) and are susceptible to both direct and indirect effects from mining activities.

[1] Associated infrastructure for the access road and aerodrome includes: borrow pits, temporary camp and staging areas.
[2] Associated infrastructure for the mine site includes: a power plant, camp, maintenance facility, and storage facility.

Summary of Baseline Information

Caribou occurring within the study area are listed as a species of Special Concern under the *SARA*; however, a management plan has not yet been developed.

In 1982, the Redstone herd population was estimated at 7,500 individuals (Thomas and Gray 2000). Current population estimates and population trends are largely unknown. Recent baseline studies (as discussed in Section 4.1.9) indicate caribou within the study area represent only a small portion of the Redstone herd. Caribou populations in the Yukon are thought to occur at densities below the habitat carrying capacity, due to predation and hunting pressures (Yukon Fish and Wildlife Co-Management 1996). This is assumed to be the case for the Redstone herd. Harvest data from the Local Game Management Subzone (GMS #435) from 1990 to 2007 reveal a total of 204 caribou (or 3.9 caribou/ year) were taken by permit holders; this does not include animals taken by First Nations. First Nations subsistence harvesting occurs within the study area; however, harvest yield data are not available.

Caribou occupy the study area from late May to late September; however, individuals may remain until the end of November (Olsen *et al.* 2001; Creighton 2006; AMAX 1983; Gill 1978; Appendices G1 – G3). A total of 1,600 caribou were observed within the study area from 2005 to 2008 (Appendices G1-G5). Average density estimates of caribou within the study area were 275 caribou/ 1,000 km^2 in June (2006 and 2007), 457 caribou/ 1,000 km^2 in July (2006–2008), 155 caribou/ 1,000 km^2 in August (2006 and 2007), 300 caribou/ 1,000 km^2 in September (2006 and 2007) and 44 caribou/ 1,000 km^2 in October (2008).

During the spring and fall migration (late May to early June, and late September to November, respectively), caribou follow large valley systems at mid- to high-elevations to and from their summer and winter ranges. Upon arriving on their summer range (post-calving), caribou randomly disperse across subalpine and alpine habitats.

Since population trends are unknown for the Redstone herd, it is difficult to predict project effects on the entire herd. At a local level (within the study area), key monitoring indicators of potential effects on caribou can include changes in: calf/cow ratios, migration routes and local distribution, and predation and harvest data from the study area.

The Yukon Fish and Wildlife Co-Management Caribou Guidelines (1996) are adopted within this effects assessment to provide accepted caribou population monitoring criteria. Caribou populations are considered stable to increasing when 30-35 calves per 100 cows are observed in the fall; whereas, less than 30 calves per 100 cows indicates a declining population. Changes in migration routes and local distribution can signify avoidance to the development and associated activities. In addition, measures used to estimate caribou predation and harvest yields within the area can suggest the level of mortality pressure, which can affect caribou populations at a local scale.

Detailed accounts of caribou population status, life history and habitat requirements, local distribution and habitat use, and special management requirements are provided in Section 4.1.9.

Identification of Temporal and Spatial Bounding

All project activities occurring from late May to October will overlap with caribou's general seasonal distribution in the area. This includes the clearing, construction and operation phases of the access road and aerodrome, the mine site and associated infrastructure, ravine dam, and dry-stack tailings facility.

Construction of the access road and associated infrastructure (i.e., borrow pits and temporary camp) and the aerodrome upgrades are scheduled to occur between summer 2010 and summer 2012. In the fall of 2010, construction of the process plant will commence and will continue until the fall of 2012. Construction of the dry-stacked tailings facility, ravine dam and associated reservoir, power plant and associated mine infrastructure will begin in the spring of 2011 and will continue for approximately 18 months with the expectation that a limited amount of construction activities will occur during the winter.

Mine operation and eventual closure will also overlap with the presence of caribou in the general area. Mine operation is expected to commence at the end of 2012 and end in 2024. Closure activities will be initiated immediately after underground mining operations are concluded and will take approximately two years to complete.

The Regional Wildlife Study Area (RWSA) is located within a small portion of the Redstone caribou herd's post-calving and summer ranges. The Redstone herd over-winters outside of the study area, closer to the Mackenzie River drainage (described in Section 4.1.9).

Although the study area is located outside the principal calving area for this herd, calving may occasionally occur within the RWSA on secluded plateaus and upland sites. The general seasonal use of habitats within the area of the mine are shown in Figures 4.1.9-3 and 4.1.9-4.

Effects Characterization

The proposed Mactung development has the potential to directly and indirectly affect caribou throughout its construction, operation, decommissioning and reclamation phases. The proposed footprint area was used as a measure of direct habitat loss. This conservative value of direct habitat loss assumes all habitats directly affected by the development are used by caribou.

<u>Clearing and Construction: Access Road, Aerodrome and Associated Infrastructure</u>

Caribou may be directly affected by the clearing and constructing of the access road, aerodrome extension and associated infrastructure. Potential direct effects may include the following:

- increased hunter access, and consequently a potential increase in caribou mortality. Although preferred caribou habitat exists at elevations higher than the majority of the proposed access road, hunters will have greater access to formerly inaccessible caribou habitat by all-terrain vehicle (ATV) and/or on foot, as well as along the subalpine portion of the access road (5.7 km length of road). This increase in hunter access may potentially affect local caribou populations while on their post-calving and rutting ranges (late May to October).
- loss of approximately 120 ha of valley habitat. These valleys support low value caribou habitat, and therefore, direct effects along this portion of the access road, aerodrome and associated infrastructure during the clearing and construction phases are considered low.
- loss of approximately 71 ha of subalpine and alpine habitat or approximately 0.4% of the total subalpine and alpine habitat in the local study area (LSA). Direct habitat loss of subalpine and alpine habitat from clearing and construction of the access road is limited in extent, and will pose a low negative effect on caribou.

Caribou may also be indirectly affected by clearing and construction of the access road, aerodrome extension, and associated infrastructure. Potential indirect effects may include the following:

- avoidance of valley habitat. As discussed, these areas are considered low value caribou habitat, and therefore, potential indirect effects to these habitats are considered negligible.
- avoidance of subalpine and alpine habitats. As discussed, a small portion of the access road will transverse across these high use caribou habitats. Avoidance behaviour towards clearing and construction of this portion of the access road is considered a potential low negative project effect since subalpine and alpine habitats are considered common in the LSA (covering approximately 80% of the entire LSA).
- altering movement patterns. A small portion of the access road (5.7 km) is located at elevations appropriate for spring (late May to early June) and fall (late September to October) caribou migrations. As indicated by Collin (1983), caribou commonly use mid-elevation habitats along major river valleys during migration. Since the project is proposed in a relatively small valley, a large portion of the migrating herd is expected to migrate along larger valleys, outside the direct influence of the project. However, a few caribou may use the mine site valley for foraging. Potential negative effects on the local movements of foraging caribou are considered low due to the low number of caribou expected to occur in the immediate area and the large amount of similar foraging habitat available within the LSA.
- increase in predator-prey interactions along the access road, and consequently a potential increase in caribou mortality. Wolves utilize roads and other linear corridors to efficiently access prey habitats. The access road may increase the potential for prey

exposure and hunting success. Since the majority of the access road is located in less favourable caribou habitat, the potential for increased wolf-caribou interactions is considered low.

- increase in caribou predation mortality following an increase in alternate prey populations (e.g., moose). As willows and other shrub species revegetate along the periphery of the access road corridor and other disturbed areas (e.g., temporary camp), moose populations may increase. Wolf numbers increase as moose populations increase. Since wolves use caribou as an alternate prey to moose, it has been hypothesized that caribou predation mortality may increase as moose density increases in an area. This hypothesis is currently being researched in the scientific community. However in the study area, by occupying subalpine and alpine habitats more frequently, caribou spatially segregate themselves from moose, and therefore, separate themselves from a higher predation risk. An increase in caribou predation mortality as a result of an increase in early successional vegetation communities at disturbed sites is considered negligible, since the amount of early successional plant communities along pre-disturbed sites will be limited, an increase in moose populations is not expected to be high and caribou favor areas outside moose habitat.

The following mitigation measures are being proposed to reduce potential effects from clearing and construction of the access road, aerodrome extension, and associated infrastructure:

- the removal or clearing of vegetation will be limited through the efficient use of cleared land and careful planning;
- cleared areas will be revegetated following mine closure;
- a Wildlife Reporting log will be implemented for all mine employees and contractors to document all wildlife observations, including species, location, date,, time, number observed, and activity (e.g., feeding);
- the harassment of wildlife, including caribou, as defined under the Wildlife Act (Yukon), will be prohibited;
- speed limits, especially near sensitive wildlife areas, will be posted and enforced; and
- a wildlife right-of-way policy will be implemented for all mine related traffic.

Clearing and Construction: Mine Site and Associated Infrastructure

Noise levels and human presence/activities will increase with the proposed clearing and construction activities at the mine site and associated infrastructure.

Caribou may be directly affected by clearing and construction of the mine site and associated infrastructure. A potential direct effect may be the loss of epilithic lichen (2.05 ha) and fescue-sedge (0.90 ha) habitats. These habitats are used by caribou, particularly during July and August when avoiding insect harassment and heat stress. Epilithic lichen habitats are the most common habitat type, covering approximately 42% of the total LSA. Fescue-sedge habitats cover approximately 5% of the total LSA; however, only 0.08% of the fescue-sedge habitat in the LSA will be directly affected. Direct effects by the removal of these habitat types are considered low.

Caribou may also be indirectly affected by clearing and construction of the mine site and associated infrastructure. Potential indirect effects may include:

- avoidance of alpine habitat, particularly during spring (late May to early June) and fall (late September to October) migrations. As discussed, a large portion of the caribou herd migrates along major river valleys; only small groups of foraging caribou on their post-calving and rutting range may utilize the mine site valley. Potential indirect negative effects to these local resident caribou are considered low due to the low number of caribou expected to occur in the immediate area.
- avoidance of alpine habitat in July and August. Caribou occupy these areas while foraging, avoiding insect harassment and heat stress. Alpine habitats are common in the LSA and any potential negative indirect effect as a result of avoidance behaviour is considered low.

Avoidance is considered to be a neutral effect as the regional area allows for caribou to move around the project. No mitigation requirements are recommended.

Clearing and Construction: Ravine Dam and Dry-Stacked Tailings Facility

Noise levels and human presence/activities will increase with the proposed clearing and construction activities at the ravine dam site and associated infrastructure.

Caribou may be directly affected by clearing and constructing the ravine dam and dry-stacked tailings facility and subsequent operation. Potential direct effects may be the removal of 49.55 ha (or 1.5% in the LSA) of subalpine caribou foraging habitat. Direct effects from the removal of these foraging habitats are considered low.

Caribou may be indirectly affected by clearing and construction of the ravine dam and dry-stacked tailings facility and subsequent operation. Potential indirect effects may be the avoidance of migration and local movement corridors. However, as indicated above, caribou herds commonly migrate outside the zone of influence of the proposed project. Those caribou that remain in the local area for their post-calving period may utilize the mine site valley. Potential indirect negative effects to these caribou are considered low due to the low number of caribou expected to occur in the immediate area.

The following mitigation measures are proposed to reduce potential effects of clearing and construction of the ravine dam and reservoir:

- the removal or clearing of vegetation will be limited through the efficient use of cleared land and careful planning; and
- cleared areas will be revegetated following mine closure.

Avoidance is considered to be a neutral effect as the regional area allows for caribou to move around the project. No mitigation requirements are recommended.

<u>Operation: Access Road, Aerodrome, and Associated Infrastructure</u>

The operation of the access road, aerodrome and associated infrastructure will increase local noise levels and traffic.

Caribou may be directly affected by operation of the access road, aerodrome and associated infrastructure. A potential direct effect may be an increase in vehicle-caribou collisions, and consequently an increase in caribou mortality. These potential direct effects are considered low, since a large portion of the access road, aerodrome and associated infrastructure are outside caribou habitat.

Caribou may be indirectly affected by operation of the access road, aerodrome and associated infrastructure. Indirect effects may include:

- avoidance of these areas by migrating caribou during spring (late May to early June) and fall (late September to October) migrations, as discussed earlier. These potential indirect effects are considered low.
- potential increase in predator-prey interactions along the access road, and consequently a potential increase in caribou mortality. As previously discussed, the majority of the access road is located in less favourable caribou habitat, outside high-use wolf areas.
- potential increase in predation along the 5.7 km section of access road passing from the valley to the mine site. This section of the access road occurs within caribou habitat, and subsequent predation in these areas may have up to moderate effects on caribou.
- decrease in foraging habitat quality as a result of road dust and possible changes in plant composition. Potential indirect effects from altering habitat quality are considered negligible, since the majority of the access road is located outside high-use caribou habitat.

<u>Operation: Mine Site and Associated Infrastructure</u>

The year round operation of the mine site and associated infrastructure will include an increase in noise levels and human presence and activities. No potential direct effect on caribou is expected during the operations at the mine site.

Caribou may be indirectly affected by the mine operation and associated infrastructure. Potential indirect effects include:

- avoidance of habitat used by caribou to evade insects and heat stress. These areas are the most common habitats throughout the region, and therefore, the proposed mine is expected to have low potential indirect effects on caribou.
- avoidance of foraging habitat. The proposed project is expected to pose negligible effects to the majority of the herd and low negative effects to those individuals who occupy the project area during their summer residence since foraging habitat commonly occurs throughout the LSA.
- avoidance of migration corridors during spring (late May to early June) and fall (late September to October) migrations. As previously discussed, the proposed development is expected to pose negligible effects to the majority of the herd and low negative effects to foraging individuals within the immediate project area.

Operation: Ravine Dam and Dry-Stacked Tailings Facility

The ravine dam and dry-stacked tailings facility will operate year round. The operation phase of these proposed developments will include an increase in traffic, and to a lesser degree, human presence.

Caribou may be directly affected by operation of the ravine dam and dry-stacked tailings facility. Potential direct effects may include an increase in vehicle-caribou collisions, and consequently an increase in caribou mortality. These potential effects are considered low due to the low traffic volumes and low number of caribou expected to occupy the immediate area.

Caribou may be indirectly affected by operation of the ravine dam and dry-stacked tailings facility. A potential indirect effect may be avoidance of migration and local movement corridors. However, as indicated above, potential indirect effects to herd migration are considered negligible; whereas, the operation of the proposed developments may potentially have a low indirect effect on individuals remaining in the local area.

The following mitigation measures are proposed to reduce potential effects of project operations on caribou:

- an employee training program will be conducted to describe and illustrate the importance of following all wildlife mitigation measures;
- speed limits, especially near sensitive wildlife areas, will be posted and enforced;
- a wildlife right-of-way policy will be implemented for all mine related traffic;
- a no hunting policy for all mine employees and contractors will be enforced while working at Mactung (i.e., no firearms will be allowed at camp);

- an access gate will be installed near kilometre 17.5 of the access road for the duration of construction, operation and decommissioning;
- a Wildlife Reporting Log will be implemented for all mine employees and contractors;
- the harassment of wildlife, including caribou, as defined under the Wildlife Act (Yukon), will be prohibited; and
- a wildlife monitoring program will be implemented during construction, operation and decommissioning phases to assess possible disruptions to local caribou movements. This program is described in Section 6.2.7.9.

Decommissioning, Reclamation and Closure: Access Road

Heavy equipment will be used for decommissioning and reclamation of the access road. Decommissioning and reclamation activities will include the removal of all water crossings and various methods to discourage road access (e.g., re-contouring the road and/or removing a portion of the road along a steep cut). The use of heavy equipment will result in temporary increases in noise; however, this will abate following reclamation and final closure. Since the majority of the access road is outside caribou habitat, and only a 5.7 km section of the access road is within caribou habitat, as discussed previously, both potential negative and positive effects to caribou from the decommissioning of the majority of the access road is considered negligible.

Caribou may be directly affected by decommissioning, reclamation and closure of the 5.7 km access road near the mine site. A potential direct effect may be an increase in usable foraging habitat following reclamation.

Caribou may be indirectly affected by decommissioning, reclamation and closure of the 5.7 km access road near the mine site. Potential indirect effects may include:

- avoidance during the decommissioning phase. This potential indirect effect is considered low.
- decrease in hunter access, and consequently a potential decrease in caribou mortality. This reduction in hunter access has the potential to positively effect local caribou populations from late May to October.
- restored local movements for individuals occupying the immediate area to pre-project levels. These positive indirect effects will be immediate following the decommissioning of the access road.
- reduction in the predator-prey interactions, and consequently a potential decrease in caribou mortality. However, since the majority of the access road transects through less favorable caribou habitat, potential positive indirect effects from the reclamation of the access road is considered low.

Decommissioning, Reclamation and Closure: Mine Site and Associated Infrastructure

Noise levels and transportation of equipment and supplies will occur over very short periods during the decommissioning, reclamation and closure of the mine site and associated infrastructure.

Caribou may be directly affected by decommissioning, reclamation and closure of the mine site and associated infrastructure. A potential direct effect may be an increase in usable foraging habitat following reclamation. Positive effects from reclaiming the mine site and associated infrastructure will occur several years after the successful revegetation of the footprint.

Caribou may be indirectly affected by decommissioning, reclamation and closure of the mine site and associated infrastructure. Potential indirect effects may include:

- avoidance during the decommissioning phase, including those individuals who may have become habituated to regular mine operations. The decommissioning phase of the mine site and associated infrastructure is expected to have limited indirect effects on caribou.
- restored local movements for those few caribou occupying the immediate area to pre-project levels. This positive indirect effect will be immediate following the decommissioning of the mine site and associated infrastructure.

Decommissioning, Reclamation and Closure: Ravine Dam and Dry-Stacked Tailings Facility

Noise levels are expected to increase during the ravine dam decommissioning phase. The dam will be breached and drainage patterns re-established within existing streambeds. The dry-stacked tailings facility will be capped and seeded.

Caribou may be directly affected by decommissioning, reclamation and closure of the ravine dam and dry-stacked tailings facility. A potential direct effect may be an increase in usable foraging habitat following reseeding of the dry-stacked tailings facility. Potential positive effects will be several years following the successful revegetation of the footprint.

Caribou may be indirectly affected by decommissioning, reclamation and closure of the ravine dam and dry-stacked tailings facility. Potential indirect effects may include:

- avoidance during the decommissioning phase is expected to have low indirect effects on caribou since this phase is considered short-term.
- restored local movements for individuals occupying the immediate area to pre-project levels. These positive indirect effects will be immediate following the decommissioning of the ravine dam and dry-stacked tailings.

Mitigation Measures Summary

Mitigation measures will be implemented to minimize potential direct and indirect negative effects on caribou during all phases of the proposed project. The following is a summary of proposed mitigation measures:

- implement a no hunting policy for all mine employees and contractors while working at Mactung;
- a Wildlife Reporting Log will be implemented for all mine employees and contractors;
- speed limits especially near sensitive wildlife areas will be posted and enforced;
- a wildlife right-of-way policy will be implemented for all mine related traffic;
- an employee training program will be conducted to describe and illustrate the importance of abiding by all wildlife mitigation measures;
- prohibit use of ATVs and snowmobiles at Mactung;
- an access gate will be installed near kilometre 17.5 of the access road for the duration of construction, operation and decommissioning;
- roads and bridges will be decommissioned and reclaimed to discourage access;
- infrastructure will be removed from the mine site and the footprint will be reclaimed;
- the harassment of wildlife, including caribou, as defined under the Wildlife Act (Yukon) will be prohibited; and
- a wildlife monitoring program will be implemented during construction, operation and decommissioning phases to assess possible disruptions to local caribou movements.

Table 6.2.7-1 summarizes the direct and indirect effects and the anticipated success of proposed mitigation measures for each primary activity.

TABLE 6.2.7-1 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: CARIBOU

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Clearing and Construction of Access Road	-	Avoidance	• Neutral effect, no mitigation required.			
	-	Increase in predators	• No applicable measures.			
Clearing and Construction of Mine Site	-	Avoidance	• Neutral effect, no mitigation required.			

TABLE 6.2.7-1 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: CARIBOU

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Operations (including hauling)	Vehicle collisions	-	• Post speed limits • Post traffic signs in sensitive wildlife areas • Enforce that wildlife has the right of way		✓	
	Restricted movements	-	• Prohibit use of ATVs and snowmobiles at Mactung			✓
	-	Hunting/ increased mortality risk	• No hunting policy for all employees and contactors • Prohibit use of ATVs and snowmobiles at Mactung • Gated access			✓
	-	Avoidance	• Neutral effect, no mitigation required			
Reclamation (includes decommissioning and abandonment)	Facilitation of travel movement/ re-establish travel corridors	-	• Removal of infrastructure • Decommission roads, pull bridges in all locations		✓	
	-	Hunting/ increased mortality risk	• Removal of infrastructure • Decommission roads, pull bridges in all locations		✓	

Residual Effects

With implementation of the proposed mitigation measures, there are few potential negative effects on caribou foraging and movement patterns and no effects that could affect the overall health and migration of the Redstone caribou herd. Loss of habitat is anticipated until completion of reclamation and closure is completed. If revegetation is not completely successful, minor residual effects may exist. However, this is not anticipated to be of concern as it is unlikely that revegetation will be unsuccessful. Any unsuccessful revegetation will be limited in spatial extent and will not affect the Redstone herd. A wildlife monitoring program (as described in the mitigation measures above) will provide a real-time evaluation of the adopted mitigation measures and information for adapting measures to increase effectiveness where appropriate.

Significance Determination

Potential project effects are likely to be low in magnitude (less than 5% of the Redstone herd expected to be influenced by the proposed development) and local in geographical extent (Table 6.2.7-2). With the application of mitigation measures, including the recovery of favoured caribou habitat following reclamation (short-term reversibility), the significance of all project activities on local caribou populations is considered to be low.

TABLE 6.2.7-2 SUMMARY OF SIGNIFICANCE DETERMINATION FOR CARIBOU

Project Component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Clearing and Construction of Access Road	Negative	Low	Short-term	Low
Clearing and Construction of Mine Site	Negative	Low	Short-term	Low
Reservoir	Neutral	Moderate	Short-term	Low
Operation (including hauling)	Negative	Moderate	Short-term	Medium
Reclamation (includes decommissioning and abandonment)	Neutral	Moderate	Short-term	Low

6.2.7.2 Moose

Identification of Valued Component

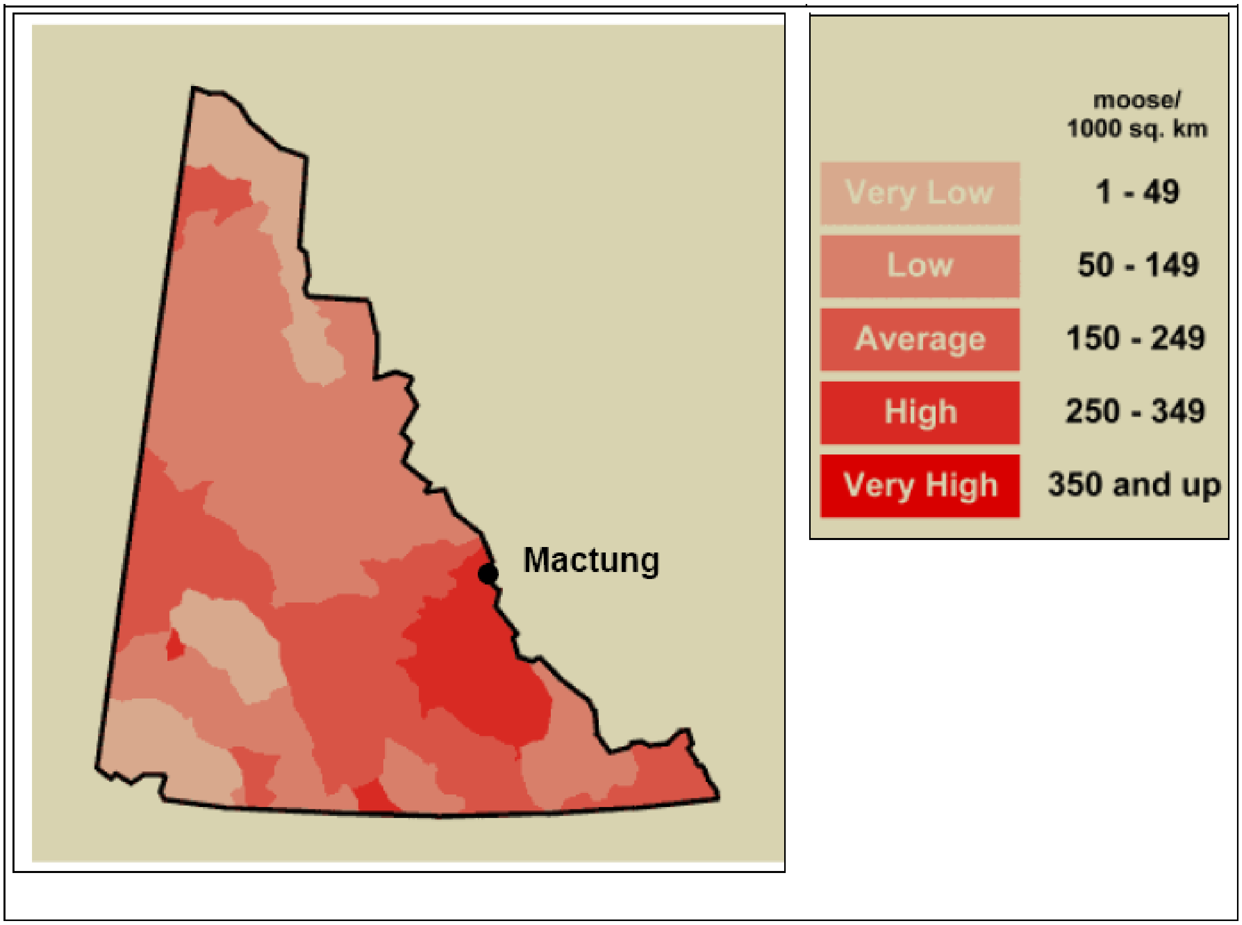
Moose were chosen as a VC because of their importance in large mammal predator-prey relationships and their importance to northern communities as a food source. Moose are susceptible to both direct and indirect effects from mining activities. Moose are not a species of special concern in the Yukon or in Canada.

Summary of Baseline Information

The Yukon moose population was estimated to be approximately 65,000 to 70,000 in 2007 (Yukon Fish and Game) with an estimated density of 285 moose/1,000 km^2 for the region in which the study area lies (Yukon Government, unpublished data). This density is likely to be high for the study area as it is a regional estimate in which larger areas of more suitable habitat occur. The project study area does contain suitable moose habitat in the valleys; however, the local topography reduces the quantity of suitable habitat in comparison with the more open, less mountainous areas within the region. The density of moose for the study area is therefore more likely to be on the lower end of the density distribution for the region. Moose population estimates for the North Canol Road and Macmillan Pass areas between 1987 and 2001 have ranged from 186 to 317 animals/ 1,000 km^2 (Yukon Government 1986, 1991, 1996, and 2005).

During the 2005-2008 wildlife program, 71 moose were observed during transect surveys and an additional 46 (117 total) were observed while conducting other work in the local study area (Section 4.1.9; Appendix G1-G5). Moose have been observed in the study area year round; however, studies suggest that moose densities decrease as winter progresses and snow depth accumulates (AMAX 1976).

Figure 6.2.7-1 Estimated Moose Densities



Note: Adapted from Moose Management Team 1996

The Mactung study area includes important year round habitat for moose. Valleys surrounding the Hess River Tributaries, South Macmillan River and Tsichu River provide important forage habitat including the aquatic areas. Previously conducted studies and baseline studies completed during project planning have identified increased moose densities during rut and post-rut periods (September/October). Calving has been recorded both in the subalpine zone, near tree line, and in the river valleys from mid May to mid June (Appendix G2, G3, and G5). Mineral licks located within the LSA have been identified as important wildlife features. High density moose tracks and antler sheds indicate frequent use of these areas. In addition, moose were observed in and around the mineral licks on numerous occasions. No specific travel corridors were identified during the 2005-2008 wildlife programs. However, all major valleys should be considered potential travel corridors for moose.

Yukon Environment (2006) key wildlife areas maps did not identify important late winter moose habitat within or adjacent to the study area.

Moose hunting does occur in the study area. The Mactung site falls within GMA 432, 435 and 1110. Between 1990 and 2007, 99 moose were harvested from these three GMAs at a rate of 2.0 moose/ year (Government of Yukon, unpublished data). First Nations subsistence harvesting occurs within the Mactung study area; these harvest yields were not available.

Effects on moose populations by the proposed mine activities can be monitored using key indicators such as calf/cow or yearling/adult moose ratios, population size and trends, movement and distribution, wolf predation, availability of forage, and harvest data from the study area. To maintain stable moose populations in the Yukon, recruitment levels of 10-20 yearlings/ 100 adult moose are required (Yukon Department of Renewable Resources 1996). A generation of moose is considered to be approximately 8.5 years (Wilson and Ruff 1999).

Identification of Temporal and Spatial Bounding

Moose have the potential to occur in the study area year-round with highest densities noted during the summer months. Project activities, such as operation (including hauling) and reclamation have the potential to affect moose whenever they occur within the project area throughout the year. Clearing and construction of the access road and aerodrome extension, mine site, ravine dam and dry-stack tailings facility only have the potential to affect moose populations during the summer and early fall (May to late September).

Moose are one of the largest and most commonly encountered mammals in the Yukon and in northern Canada (Yukon Department of Renewable Resources 1996). Within the Yukon, moose range the entire territory with the highest densities occurring in the south-eastern and central part of the territory (150 to 340 moose/ 1,000 km^2), and lowest densities occurring on the North Slope (<40 moose/ 1,000 km^2) (Yukon Department of Renewable Resources 1996). Figure 6.2.6-1 shows the estimated densities of moose across the territory. The spatial distribution of moose observed in the regional wildlife study area from 2005-2008 during the summer, fall and winter are shown in Figures 4.1.9-5, 4.1.9-6, and 4.1.9-7 respectively. The study area lies within Game Management Subzones (GMSs) 432, 435 and 1110. For the purpose of the effects assessment the local moose population and project activities have been identified to potentially overlap with project activities on a year-round basis, as described in the following sections.

Effects Characterization

A number of potential effects have been identified for local moose populations. The most significant effect would be the reduction of foraging habitat, particularly late winter forage. Vehicle collisions and restriction of movement were also identified as potential effects. Following decommissioning and reclamation, the potential exists for a net increase in usable habitat. Indirect effects on moose include avoidance, increase in predation and hunting, and increased mortality. The following sections identify potential direct and indirect effects to moose for each project phase and component.

Clearing and Construction: Access Road, Aerodrome Extension and Associated Infrastructure

The majority of the road corridor and aerodrome are located in forested valleys ranging from 1,100 m to 1,400 m elevation. The upper 5.7 km of the road is located in subalpine and alpine habitat (between 1,400 m and 1,900 m) and is not regularly occupied by moose. As mentioned previously, it is estimated that approximately 120 ha of forested habitat will be directly affected by the construction of the road and the aerodrome. This habitat is considered to be moderate quality habitat for moose. The majority of moose observed during the wildlife baseline programs were in forested valleys or at the tree line in the subalpine between 1,100 m and 1,400 m elevation.

Moose may be directly affected by clearing and constructing the access road and aerodrome extension. A potential direct effect may be loss of local, moderate moose habitat, along the access road and aerodrome during the clearing and construction phase. Habitat loss of subalpine and alpine habitat (above 1400 m elevation) for the 5.7 km section of water pipeline road is limited in extent and therefore habitat loss in this area is considered low.

Moose may also be indirectly affected by clearing and constructing the access road and aerodrome extension. Potential indirect effects may include:

- increase in predator-prey interactions along the access road, and consequently a potential increase in moose mortality. Wolves utilize roads and other linear corridors to efficiently access prey habitats. The access road may increase the potential for prey exposure and hunting success. Because preferred moose habitat occurs in valleys and treed subalpine, which is where the majority of the access road will be constructed, the potential for an increase in wolf- moose interactions is considered moderate.
- avoidance of construction areas. Noise and disturbance from road construction may temporarily reduce moose use in areas along the road corridor.
- increase in hunter access, and consequently a potential increase in moose mortality. Preferred moose habitat lies in the valleys where the access road is proposed and hunters will have greater ability to access formerly inaccessible moose habitat by ATV and/or on foot. This increase in hunter access has the potential to negatively affect local moose populations from licenced hunters (from August to October) and year-round from First Nation hunters.

The following mitigation measures are proposed to reduce potential effects from clearing and construction of the access road, aerodrome extension, and associated infrastructure on local moose populations:

- the removal or clearing of vegetation will be limited through the efficient use of cleared land and careful planning;
- cleared areas will be revegetated following mine closure;
- clearing and construction activities can be minimized during late winter when moose energy reserves are low and snow depth is high;
- a Wildlife Reporting Log will be implemented for all mine employees and contractors;
- the harassment of wildlife, including moose, as defined under the Wildlife Act (Yukon) will be prohibited;
- speed limits especially near sensitive wildlife areas will be posted and enforced; and,
- a wildlife right-of-way policy will be implemented for all mine related traffic.

Clearing and construction of the access road, aerodrome extension, and associated infrastructure may have a potential negative effect on local moose populations. Because forage habitat will be cleared for road construction, 5-10% of the local population may be affected. The effect will be local, short-term (< 1 year) and reversible. With implementation of proper mitigation measures, the significance of potential environmental effects from clearing and construction of the access road, aerodrome, and associated infrastructure is expected to be low.

<u>Clearing and Construction: Mine Site and Associated Infrastructure</u>

The mine site is located in alpine habitat which is considered to have low moose habitat suitability. To date, no moose or moose tracks have been observed in the area of the mine footprint. Clearing and construction of the mine site, however, may still indirectly affect moose. A potential indirect effect may include avoidance of constructions areas. Noise and disturbance from mine construction may reduce moose use of shrub forage areas located outside of the mine footprint.

Avoidance is considered to be a neutral effect as the regional area allows for moose to move around the project. No mitigation requirements are recommended.

<u>Clearing and Construction: Ravine Dam and Dry-Stacked Tailings Facility</u>

The proposed ravine dam footprint is approximately 13 ha. All vegetation in this area will be cleared and/or covered with additional fill during the construction of the 350 m long and 35 m high ravine dam. This area is located in subalpine and alpine (above 1400 m elevation) and is not considered to be high quality moose habitat. Moose have not been observed using this area (either by visual confirmation or by tracks). Moose pellets were observed approximately 300 m down the valley from the lower end of the dam.

A potential direct effect may include loss of moose habitat in areas located within and around the ravine dam. The effect would be considered of low significance.

A potential indirect effect may include avoidance of constructions areas. Noise and disturbance from construction may reduce moose use of shrub forage areas located outside of the mine footprint.

The following mitigation measures would be used to reduce potential effects from clearing and construction of the water retention dam and dry-stacked tailings facility:

- the removal or clearing of vegetation will be limited through the efficient use of cleared land and careful planning; and,
- cleared areas will be revegetated following mine closure.

Clearing and construction of the ravine dam and dry-stacked tailings facility are expected to have a potential negative effect on the local moose population. These effects were rated to be low as less than 5% of the population will be affected, it will be local in extent and medium term (1-10 years) in duration. Any potential effects would be reversible within 26 years or during the phases of the project and will mainly occur while construction is occurring. With implementation of proper mitigation measures, the significance of environmental effects from clearing and construction of the ravine dam and dry-stacked tailings facility is expected to be low.

Operation: Access Road, Aerodrome, and Associated Infrastructure

Moose may be directly affected by operation of the access road, aerodrome and associated infrastructure. Potential direct effects may include:

- vehicle collisions with mine traffic. The access road will be used for transportation of tungsten concentrate, supplies and personnel; and
- restrictions of natural movements through the valleys. Moose observations and tracks indicate that moose travel through valleys where the access road is proposed. During winter months, the snow will be cleared from the road and high snow banks could act as a barrier.

Moose may be indirectly affected by operation of the access road, aerodrome and associated infrastructure. Potential indirect effects may include:

- increase in hunter access, and consequently a potential increase in moose mortality. Preferred moose habitat lies in the valleys where the access road is proposed and hunters will have greater ability to access formerly inaccessible moose habitat by ATV and/or on foot. This increase in hunter access has the potential to negatively effect local moose populations from licenced hunters (from August to October) and year-round from First Nation hunters; and

- avoidance of construction and high use areas. Noise and disturbance from road use and aircraft may reduce moose use in areas along the road corridor and around the aerodrome.

Operation: Mine Site and Associated Infrastructure

Mine operations are expected to have minimal effect on local moose populations. The mine is located in an area with low habitat suitability for moose and no moose have been observed within or around the mine footprint. No direct effects on moose from mine activities are expected.

A potential indirect effect may include avoidance of areas in which mine operations occur. Noise and disturbance from mine operations may reduce moose use in areas in the valley below the mine site.

The following mitigation measures are proposed to reduce potential effects of project operations:

- an employee training program will be conducted to describe and illustrate the importance of following all wildlife mitigation measures;
- speed limits, especially near sensitive wildlife areas, will be posted and enforced;
- a wildlife right-of-way policy will be implemented for all mine related traffic;
- a no hunting policy for all mine employees and contractors will be enforced while working at Mactung;
- an access gate will be installed near kilometre 17.5 of the access road for the duration of construction, operation and decommissioning;
- a Wildlife Reporting Log will be implemented for all mine employees and contractors;
- the harassment of wildlife, as defined under the Wildlife Act (Yukon), will be prohibited; and
- a wildlife monitoring program will be implemented during construction, operation and decommissioning phases to assess possible disruptions to local moose movements.

Operation of the Mactung mine (including mining, camp activities, reservoir use, access road and aerodrome use) may have a potential negative effect on the local moose population. These potential effects were rated moderate because it is predicted that 5-10% of the population may be affected. Any effects will be local in extent and medium term (1-10 years) in duration. Any potential effects would be reversible within 26 years and will only occur while construction is occurring. With implementation of proper mitigation measures, the overall significance of environmental effects from mine operations is expected to be low.

Decommissioning, Reclamation, and Closure: Access Road

Heavy equipment will be used for decommissioning and reclamation of the access road, which will include the removal of all water crossings and various methods to discourage road access (e.g., re-contouring the road and/or removing a portion of the road along a steep cut). The use of heavy equipment will result in temporary increases in noise; however, this will cease following reclamation and final closure.

Moose may be directly affected by decommissioning, reclamation and closure of the access road. A potential direct effect may be a net increase in usable habitat. Once the road has been decommissioned and reclaimed, early successional vegetation will establish which will increase moose forage potential along the road corridor.

Potential indirect effects may include:

- avoidance. Heavy equipment will be used to remove culverts and bridges and re-contour slopes. Noise from this activity may result in moose avoiding the road areas during decommissioning. This is likely a short term effect and moose use will likely increase in the area once all work is completed; and
- hunting, resulting in increased mortality risk. As previously mentioned, access to previously inaccessible areas by hunters may result in a potential increase in moose mortality. However, decommissioning and reclaiming the road so hunters will not be able to access the area using ATVs should reduce this risk.

Decommissioning, Reclamation, and Closure: Mine Site and Associated Infrastructure

Noise levels and transportation of equipment and supplies will occur over very short periods of time during the decommissioning of mine buildings and associated infrastructure. These activities are expected to have little effect on local moose populations as studies indicated that the camp and mine site are not high use moose areas and do not contain high quality foraging habitat. Moose moving through the pass may avoid this route during periods of heavy noise but these effects are expected to be minimal. Based on the perceived limited effects, mitigation and significance determination has been deemed unnecessary.

Decommissioning, Reclamation, and Closure: Ravine Dam and Dry-Stacked Tailings Facility

The water in the reservoir will be pumped down after the operation phase. A v-notch will be built in the dam and a streambed will be reconstructed so drainage patterns can be re-established.

A potential direct effect may include revegetation of disturbed areas where vegetation previously existed. Foraging habitat, similar to what existed prior to construction, will re-establish and moose may then occasionally forage in this area.

A potential indirect effect may include moose not foraging in the vicinity of the ravine dam and reservoir while heavy equipment and personnel are working in the area. This effect would only persist during the decommissioning process.

Mitigation Measures Summary

Mitigation measures will be implemented to minimize potential direct and indirect negative effects on moose during all phases of the proposed project. The following is a summary of proposed mitigation measures:

- a no hunting policy for all mine employees and contractors will be enforced while working at Mactung;
- a Wildlife Reporting Log will be implemented for all mine employees and contractors;
- speed limits especially near sensitive wildlife areas will be posted and enforced;
- a wildlife right-of-way policy will be implemented for all mine related traffic;
- an employee training program will be conducted to describe and illustrate the importance of abiding by all wildlife mitigation measures;
- an access gate will be installed near kilometre 17.5 of the access road for the duration of construction, operation and decommissioning;
- roads and bridges will be decommissioned and reclaimed to discourage access;
- infrastructure will be removed from the mine site and the footprint will be reclaimed;
- a Wildlife Reporting Log will be implemented for all mine employees and contractors;
- the harassment of wildlife, as defined under the Wildlife Act (Yukon), will be prohibited;
- a wildlife monitoring program will be implemented during construction, operation and decommissioning phases to assess possible disruptions to local caribou movements.
- where possible, limit the extent of vegetation clearing;
- revegetate cleared areas following mine closure;
- minimize clearing and construction activities during late winter when moose energy reserves are low and snow depth is high; and
- post traffic signs in sensitive wildlife areas and areas with high wildlife use.

Table 6.2.7-3 provides a summary of potential effects and mitigation measures for moose.

TABLE 6.2.7-3 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: MOOSE

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success: None	Anticipated Success: Partial	Anticipated Success: Complete
Clearing and Construction of Access Road	Habitat loss	-	• Limit extent of clearing • Avoid clearing and construction activities during late winter (low energy reserves and high snow depth) • Reclamation through revegetation		✓	
	-	Avoidance	• Neutral effect, no mitigation required.			
	-	Increase in predators	• No applicable measures.			
Clearing and Construction of Mine Site	-	Avoidance	• Neutral effect, no mitigation required.			
Water Retention Dam	Habitat loss (summer browse)	-	• Limit extent of clearing • Reclamation through revegetation		✓	
	-	Avoidance	• Neutral effect, no mitigation required.			
Operations (including hauling)	Vehicle collisions	-	• Post speed limits • Incorporate traffic signs for sensitive wildlife areas • Enforce that wildlife has the right of way		✓	
	Restricted movements	-	• Prohibit use of ATVs and snowmobiles at Mactung • Limit snow bank height at known travel corridors			✓
	-	Hunting/ increased mortality risk	• No hunting policy for all employees and contactors • Prohibit use of ATVs and snowmobiles at Mactung • Gated access			✓
	-	Avoidance	• Neutral effect, no mitigation required			
Reclamation (includes decommissioning and abandonment)	Net increase in usable habitat	-	• None required			
	-	Hunting/ increased mortality risk	• Removal of infrastructure • Decommission roads, pull bridges in all locations		✓	

Residual Effects

Some loss of foraging habitat for moose is anticipated throughout the clearing, construction and operation phases of the mine. Once reclamation and closure of the mine site has been completed, it is likely that there will be a net increase in available foraging habitat for moose. If revegetation is not successful in localized areas, minor residual effects may occur. However, any unsuccessful revegetation will be limited in spatial extent and will not effect local moose populations. A wildlife monitoring program will evaluate the effectiveness of the adopted mitigation measures and adaptive management will be used to increase effectiveness where appropriate. This monitoring plan is discussed in further detail in Section 6.2.7.9.

Table 6.2.7-4 summarizes the significance determination for moose.

TABLE 6.2.7-4 SUMMARY OF SIGNIFICANCE DETERMINATION FOR MOOSE

Project Component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Clearing and Construction of Access Road	Negative	Low	Short-term	Low
Clearing and Construction of Mine Site	Neutral	Low	Short-term	Low
Reservoir	Negative	Moderate	Short-term	Low
Operation (including hauling)	Negative	Moderate	Short-term	Medium
Reclamation (includes decommissioning and abandonment)	Neutral	Moderate	Short-term	Low

Significance Determination

Although mine related activities have the potential to affect the local moose population, the effects are expected to be of short- to medium-term duration, local in extent, and reversible with a low to medium frequency (Table 6.2.7-4). Given the few potential negative effects on moose, the proposed project is not expected to affect the overall population density and health of moose in the wildlife regional study area with adherence to recommended mitigation measures. Therefore, the overall significance of effects from all project activities on local moose populations is expected to be low with the application of mitigation measures.

6.2.7.3 Grizzly Bear

Identification of Valued Component

Grizzly bears occur throughout the RWSA, from low elevation valleys to high alpine plateaus. The grizzly bear has been selected as a VC as it is a species of concern (COSEWIC 2002) and is considered to be a species of socio-economical value in the Yukon. Grizzly bears are not listed under the *Species at Risk Act*, nor are they specially protected in the Yukon.

Summary of Baseline Information

In 2000, the grizzly bear population in the Yukon was estimated at 6,000 – 7,000 animals (COSEWIC 2002). Based on the size of the total study area (approximately 1,200 km^2) and known relative density estimates of female grizzlies in the Mackenzie Mountains, the study area has the potential to support at least four female home territories and a small transient population. No key grizzly bear areas have been identified in or around the RWSA (Yukon Environment 2006).

Since 2005, 67 grizzly bear or sign observations (including visuals, dens, tracks, and digs) have been recorded within the study area. During this period, 34 bear observations (including sows and cubs) were recorded at 22 focal point sites. The slopes below the Mactung camp site appear to be within a productive territory. A sow and three cubs were observed approximately 2.5 km east of the camp in 2006, and 3.8 km northwest of camp in 2007.

Seventeen den sites were recorded during the 2005-2008 wildlife program, six of which are located within a 10 km radius of the Mactung camp site (Appendix G2, G3, and G5). Fescue-willow and epilithic lichen habitats, in areas with appropriate soil conditions, are considered to be important denning habitat.

Identification of Temporal and Spatial Bounding

Grizzly bear habitat use outside of the denning season is complex and influenced by many factors including plant phenology and the availability of mammalian prey. According to Miller *et al.* (1982), horsetail and alpine sweet vetch comprise 60% of grizzly bears diet in the Mackenzie Mountains (Miller *et al.* 1982). Willow-sedge habitats occurring in stream and river floodplains include an abundance of horsetail for early summer forage, in addition, fescue-willow habitats (particularly those with a high abundance of alpine sweet vetch), located on moist alpine meadows, provide good summer grizzly bear habitat. Sedge-bluebell and heath- lichen habitat types are also considered important habitat types.

In June and July, grizzly bears commonly occupy alpine areas, and begin to move down slope to subalpine areas by August when berries begin to ripen (Gill 1978; Miller *et al.* 1982). In September, subalpine and alpine habitats are used equally. The footprint area of the ravine dam, reservoir, dry-stacked tailings facility and camp area lies within high quality late summer and early fall foraging habitat. For denning, grizzly bears commonly move higher in elevation. It is possible that grizzly bears will avoid denning within close proximity to the mine site or access road due to noise and human activity levels. The temporal scale detailed in this assessment focuses primarily on the non-denning season (i.e., April to end of September).Grizzly bear distribution across a landscape corresponds to the distribution and abundance of food availability. Grizzly bears, therefore, occur in all habitat types, particularly in subalpine and alpine areas during the spring, summer and fall. Dens are commonly located on southeast facing slopes between 1,402 m to 1,829 m in elevation (Miller *et al.* 1982). Dens have been located in the RWSA and are typically occupied from early October to March/April.

Based on the seasonal distribution of grizzly bears in the area, all project activities outside the denning period will overlap with grizzly bear presence in the area (May to September) throughout the life of the project. Project activities that occur through the denning season, such as mine and access road operation, are anticipated to have minimal effect on denning bears.

Effects Characterization

Activities associated with construction, operation, maintenance and decommissioning of the Mactung mine are likely to have both direct and indirect effects on grizzly bears. Potential direct effects include loss of foraging habitat in areas that will be cleared for construction of mining related infrastructure, vehicle collisions, and restricted movements. Indirect effects may include avoidance of areas with disturbance, human conflict, and hunting, leading to potentially increased risk of mortality.

The following sections identify potential direct and indirect effects on grizzly bears for each project phase and component.

<u>Clearing and Construction: Access Road, Aerodrome Extension and Associated Infrastructure</u>

The road and aerodrome are predominantly located below 1,400 m elevation and the habitat in these areas is considered to be quality foraging habitat for grizzlies. Two potential den sites have been identified along the road corridor. These dens have not been confirmed through ground inspection. Although grizzly bears may den in the same region over consecutive years, they rarely use the same den structure (Linnell. *et al.* 2001)

No potential direct effects from road and aerodrome extension clearing and construction are expected for grizzly bears. However, grizzly bears may be indirectly affected. Potential indirect effects may include:

- avoidance of construction areas. Noise and disturbance from road construction may reduce grizzly habitat use in areas along the road corridor and around the aerodrome. Two potential dens are located in the valley where the access road will be located. Grizzly bears may avoid denning in this area due to ongoing sensory disturbance.
- human conflict. This effect can likely be avoided with proper mitigation efforts.

The following mitigation measures are proposed to reduce potential effects from clearing and construction of the access road, aerodrome extension and associated infrastructure:

- an employee training program will be conducted to describe and illustrate the importance of following all wildlife mitigation measures and review protocol for bear encounters;
- all camp and construction waste will be incinerated to prevent attracting wildlife, such as grizzly bears;
- all worksites will be kept clean and free of garbage;
- a Wildlife Reporting Log will be implemented for all mine employees and contractors;
- the harassment of wildlife, as defined under the *Wildlife Act* (Yukon), will be prohibited;
- a no hunting policy for all mine employees and contractors will be enforced while working at Mactung;
- speed limits especially near sensitive wildlife areas will be posted and enforced; and
- a wildlife right-of-way policy will be implemented for all mine related traffic.

Clearing and construction of the access road, aerodrome and associated infrastructure are expected to have a potential negative effect on local grizzly bears. These potential effects were rated to be low as less than 5% of the population will be affected. The effects would be local in extent and of short term duration (< 1 year). Any potential effects would be reversible within 26 years or during the phases of the project, and will only occur while construction is occurring. With implementation of proper mitigation measures, the significance of environmental effects from clearing and construction of the access road, aerodrome extension, and associated infrastructure is expected to be low.

Clearing and Construction: Mine Site and Associated Infrastructure

The mine site is located in alpine habitat which is considered to be high quality foraging and denning habitat for grizzlies. A sow and three cubs were observed on two occasions (2006 and 2007) foraging within 4 km of the camp.

A potential direct effect may include loss of foraging habitat. Bears have been observed foraging on the subalpine and alpine slopes around the camp site.

Potential indirect effects may include:

- human conflicts. Because bears have been using the mine site area, if garbage is not properly managed at camp and all work sites, human-bear conflicts could result. Human bear conflict will be minimal so long as proper mitigation measures are adhered to. Employees working in areas remote from the mine site where bears are observed should leave the area immediately and not return until the bear leaves the area; and

- avoidance. Noise and disturbance from mine construction may reduce grizzly use of forage areas located in the valley where the mine is located.

The following mitigation measures are proposed to reduce effects from clearing and construction of the mine site:

- keep worksite clean and free of garbage;
- effectively manage garbage at all work sites; and
- include appropriate protocols for addressing bear issues/ encounters in the Environmental Management Protocol.

Clearing and construction of the mine site and associated infrastructure are expected to have a potential negative effect on local grizzly bears. These potential effects were rated to be low as less than 5% of the population will be affected. The effects would be local in extent and of short term duration (< 1 year). Any potential effects would be reversible within 26 years or during the phases of the project, and will primarily occur while construction is occurring. With implementation of proper mitigation measures, the significance of environmental effects from clearing and construction of the mine site and associated infrastructure is expected to be low.

<u>Clearing and Construction: Ravine Dam and Dry-Stacked Tailings Facility</u>

This area is located in subalpine and alpine (above 1,400 m elevation) and contains high quality grizzly foraging and denning habitat. As mentioned above, grizzlies have been observed foraging in this area.

A potential direct effect may include loss of local bear habitat in areas located within and around the ravine dam. This loss would be considered to be locally moderate.

A potential indirect effect may include avoidance of constructions areas. Noise and disturbance from dam and reservoir clearing and construction may locally reduce bear foraging and denning use of the area surrounding the dam and reservoir.

The following mitigation measures will be used to reduce potential effects from clearing and construction of the water retention dam and dry-stacked tailings facility:

- the removal or clearing of vegetation will be limited through the efficient use of cleared land and careful planning; and
- cleared areas will be revegetated following mine closure.

Clearing and construction of the ravine dam and dry-stacked tailings facility are expected to have a potential negative effect on local grizzly bears. These potential effects were rated to be low as less than 5% of the population will be affected. The effects would be local in extent and of medium term duration (1 - 10 years). Any potential effects would be reversible within 26 years or during the phases of the project, and will primarily occur while construction is occurring. With implementation of proper mitigation measures, the significance of environmental effects from clearing and construction of the ravine dam and dry-stacked tailings facility is expected to be low.

Operation: Access Road, Aerodrome and Associated Infrastructure

Increased traffic along the access road may potentially affect local grizzly bear populations in the study area. Very few bears have been observed in and around the road corridor and aerodrome. Two bears were observed in this area between 2005 and 2008.

Potential direct effects may include:

- vehicle-wildlife collisions. The access road will be used for transportation of tungsten concentrate, supplies and personnel; and
- restrictions of natural movements through the valleys.
- Potential indirect effects may include:
- increased hunter access, and consequently a potential increase in grizzly bear mortality; and
- human-bear conflicts. Bears may be encountered during road and aerodrome use/ operations.

Operation: Mine Site and Associated Infrastructure

Mine operations are likely to have potential effects on grizzly bears in the area. The mine is located in an area with high foraging and denning habitat suitability for bears. As previously mentioned, a sow and cubs have been repeatedly observed foraging in the valley located to the southeast of the mine.

Potential direct effects may include:

- vehicle-wildlife collisions. The access road will be used for transportation of tungsten concentrate, supplies and personnel; and
- restriction of natural movement through the valleys.
- Potential indirect effects may include:
- avoidance of areas in which mine operations occur. Noise and disturbance from mine operations may reduce local grizzly bear use of the area for foraging and denning; and
- increased mortality risk. If local bears become accustomed to humans and human activity and garbage is not managed appropriately, problem bears may need to be culled to decrease risk to humans. Proper education and management should eliminate problem bears. However, if they are encountered, culling would be a last resort and all efforts would be made to keep the camp and work sites clean to avoid bear encounters.

The following mitigation measures are proposed to reduce potential effects of project operations:

- an employee training program will be conducted to describe and illustrate the importance of abiding by all wildlife mitigation measures and review protocol for bear encounters;
- speed limits, especially near sensitive wildlife areas, will be posted and enforced;
- a wildlife right-of-way policy will be implemented for all mine related traffic;
- manage all camp and mine waste in accordance with the Yukon *Wildlife Act,* to prevent attracting dangerous and nuisance wildlife, such as grizzly bears;
- Keep all work sites clean and free of garbage;
- a Wildlife Reporting Log will be implemented for all mine employees and contractors to document all wildlife observations, including the species, location, date, time, number observed, and activity (e.g., feeding);
- the harassment of wildlife, as defined under the *Wildlife Act* (Yukon), will be prohibited; and
- a no hunting policy for all mine employees and contractors will be enforced while working at Mactung; and,
- include appropriate protocols for addressing bear issues and encounters in the Environmental Management Protocol.

Operations of the Mactung mine (including mining, camp activities, reservoir use, access road and aerodrome use) will likely have a potential negative effect on local grizzly bears. These potential effects were rated to be low as less than 5% of the population will be affected, and effects are local in extent and of medium term duration (1 - 10 years). Any potential effects would be reversible within 26 years or during the phases of the project, and will primarily occur while construction is occurring. With implementation of proper mitigation measures, the overall significance of environmental effects from mine operations is expected to be low.

<u>Decommissioning, Reclamation, and Closure: Access Road</u>

Heavy equipment will be used for decommissioning and reclamation of the access road. All water crossings will be removed and natural channels will be reconstructed, and the road will be re-contoured to discourage recreational use in the area.

A potential direct effect may include a potential increase in usable habitat. Once the road has been decommissioned and reclaimed, early successional vegetation will establish which will increase forage potential for grizzly bears along the road corridor.

A potential indirect effect may include hunting, resulting in increased mortality risk. As previously mentioned, access to previously inaccessible areas by hunters may result in a potential increase in grizzly bear mortality. However, decommissioning and reclaiming the road so hunters will not be able to access the area using ATVs should reduce this risk.

Decommissioning, Reclamation, and Closure: Mine Site and Associated Infrastructure

Noise levels and transportation of equipment and supplies will occur over very short periods during the decommissioning of mine buildings and associated infrastructure. These activities may potentially affect local grizzly bears. Once the mine site has been abandoned, it can be expected that grizzly bears will resume foraging and denning in the local area.

Decommissioning, Reclamation, and Closure: Ravine Dam and Dry-Stacked Tailings Facility

A potential direct effect may include revegetation of disturbed areas, where vegetation previously existed. Foraging habitat, similar to what existed prior to construction, will re-establish and grizzly bears may continue foraging in this area.

A potential indirect effect may be bears not foraging/denning in the vicinity of the ravine dam and reservoir while heavy equipment is working in the area. This effect would only persist during the decommissioning process.

Mitigation Measures Summary

Mitigation measures will be implemented to minimize potential direct and indirect negative effects on grizzly bears during all phases of the proposed project. The following is a summary of proposed mitigation measures:

- an employee training program will be conducted to describe and illustrate the importance of abiding by all wildlife mitigation measures and review protocol for bear encounters;
- include appropriate protocols for addressing bear issues and encounters in the Environmental Management Protocol;
- a Wildlife Reporting Log will be implemented for all mine employees and;
- manage all camp, mine, and construction waste in an appropriate fashion that meets with the *Wildlife Act* (Yukon) to prevent attracting wildlife, such as grizzly bears;
- the harassment of wildlife, as defined under the *Wildlife Act* (Yukon), will be prohibited;
- speed limits, especially near sensitive wildlife areas, will be posted and enforced;
- enforce that wildlife has the right-of-way on all roads;
- prohibit ATVs and snowmobiles at Mactung;
- implement a no hunting policy for all mine employees and contractors while working at Mactung;

- the removal or clearing of vegetation will be limited through the efficient use of cleared land and careful planning;
- infrastructure will be removed from the mine site and the footprint will be reclaimed;
- cleared areas will be revegetated following mine closure.

Table 6.2.7-5 provides a summary of potential effects and mitigation measures for grizzly bears.

TABLE 6.2.7-5 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: GRIZZLY BEARS

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Clearing and Construction of Access Road	-	Avoidance	• Neutral effect, no mitigation required			
	-	Human conflict	• Keep worksite clean • Manage garbage		✓	
Clearing and Construction of Mine Site	Habitat loss (forage)	-	• Limit extent of clearing • Reclamation through revegetation		✓	
	-	Human conflicts	• Keep worksite clean • Manage garbage • EMP addresses the protocol for dealing with bear issues		✓	
	-	Avoidance	• Neutral effect, no mitigation required.			
Water Retention Dam	Habitat loss (forage)	-	• Limit extent of clearing • Reclamation through revegetation		✓	
Operations (including hauling)	Vehicle collisions	-	• Post speed limits • Post traffic signs in sensitive wildlife areas • Enforce that wildlife has the right of way		✓	
	Restricted movements	-	• Prohibit ATVs and snowmobiles at Mactung			✓
	-	Hunting/ increased mortality risk	• No hunting policy for all employees and contactors • Prohibit use of ATVs and snowmobiles at Mactung • Gated access			✓

TABLE 6.2.7-5 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: GRIZZLY BEARS						
Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
	-	Avoidance	• Neutral effect, no mitigation required			
	-	Human Conflicts	• Keep worksite clean • Manage garbage • EMP addresses the protocol for dealing with bear issues		✓	
Reclamation (includes decommis-sioning and abandonment)	Potential for net increase in available habitat	-	• Neutral effect, no mitigation required		✓	
	-	Hunting/ increased mortality risk	• Removal of infrastructure • Decommission roads, pull bridges in all locations		✓	

Residual Effects

Loss of habitat is anticipated until completion of reclamation and closure is completed. There is the potential for minor residual effects if revegetation is only partially successful. However, any unsuccessful revegetation will be limited in spatial extent and not effect local grizzly populations. A wildlife monitoring program will evaluate the effectiveness of the adopted mitigation measures and adaptive management will be used to increase effectiveness where appropriate.

Table 6.2.7-6 summarizes significance determination for grizzly bears.

TABLE 6.2.7-6 SUMMARY OF SIGNIFICANCE DETERMINATION FOR GRIZZLY BEARS				
Project Component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Clearing and Construction of Access Road	Negative	Low	Short-term	Low
Clearing and Construction of Mine Site	Negative	Low	Short-term	Low
Reservoir	Negative	Moderate	Short-term	Medium
Operation (including hauling)	Negative	Moderate	Short-term	Medium
Reclamation (includes decommissioning and abandonment)	Negative	Moderate	Short-term	Low

Significance Determination

Although mine activities will likely have some potential to affect the local grizzly bear population, the effects are expected to be short to medium term in duration, local in extent, reversible, with a low to medium frequency. The overall significance of potential effects from all project activities on local grizzly bear populations is expected to be low with the application of mitigation measures.

6.2.7.4 Wolverine

Identification of Valued Component

The wolverine was selected as a VC because it is often used as a biological indicator for ecological integrity due to its dependence on large, intact and connected ecosystems. The wolverine may be negatively affected by habitat fragmentation, over harvesting, decline of prey species (especially ungulates) and by disturbance (COSEWIC 2003). Wolverines have occasionally been observed in the study area, both by visual observation and by sign. The wolverine is a species of special concern (COSEWIC 2003) in Canada. It is not listed under the *Species at Risk Act* or as specially protected in the Yukon.

Summary of Baseline Information

Wolverines are considered abundant in the mountainous regions of the Yukon, particularly in areas with a high diversity of habitats and prey items. Two wolverines (a female and a kit) were observed within the RWSA area between 2005 and 2008 in subalpine habitat. In March 2008, six sets of wolverine tracks were observed along alpine ridges.

Wolverine distribution commonly follows a seasonal elevation trend in response to food availability and abundance. Based on telemetry data, wolverines commonly occupy higher elevations in the summer and lower elevations in the winter (Pasitschniak-Arts and Lariviere 1995). In the spring and summer the wolverine diet consists primarily of eggs, insects, berries and small mammals. In winter, larger mammals make up an important component in the wolverines diet.

Wolverines commonly construct dens on steep, southerly exposed slopes in alpine or subalpine habitats, prior to giving birth (i.e., January to April) (Pasitschniak-Arts and Lariviere 1995). No wolverine dens were observed in the study area during the Wildlife Baseline Program (Section 4.1.9; Appendices G1-G5).

Identification of Temporal and Spatial Bounding

Wolverines can be expected in all habitat types within the study area throughout the year. Like grizzly bears, wolverines distribute themselves in low densities across the landscape in relation to prey distribution and abundance.

Based on the seasonal distribution of wolverines in the area, all project activities throughout the year will overlap with the presence of wolverines for the duration of the project.

The wolverine is a habitat generalist and occupies habitats wherever its prey occurs. In Canada, the wolverine occurs throughout the majority of northern Canada. Within the Yukon, they range across the entire territory and their relative density is reported to be high (COSEWIC 2003). The wolverine occurs in all habitat types from forested valleys to alpine and may use the majority of the landscape located in the Mactung RWSA. Wolverine distribution is often related to prey density, and are therefore associated with areas where high ungulate densities occur (Kelsall 1981 as cited in COSEWIC 2003).

Effects Characterization

Because wolverines are very sensitive to human disturbance, all activities associated with construction, operation, maintenance and decommissioning the Mactung mine may potentially have both direct and indirect effects on wolverines. Sensory disturbances will likely be the most frequent disturbance types for wolverines. Although the wolverine may be found in the study area year round, it occurs in low numbers and will typically avoid areas with high human use.

Clearing and Construction: Access Road, Aerodrome Extension, and Associated Infrastructure

No direct effects from road and aerodrome extension clearing and construction are expected for wolverines. A potential indirect effect may include avoidance of constructions areas. Sensory disturbance may deter wolverines from hunting or passing through areas where construction is occurring.

This effect has been characterized as neutral because the regional area allows for movement around the disturbance area. No actions are required to mitigate this effect. Once activity has been discontinued, the wolverine will likely use the project area as it had in the past.

Clearing and Construction: Mine Site and Associated Infrastructure

Wolverines are often associated with habitats that support high prey densities. The area around the mine supports ground squirrels, pikas and marmots, all of which are potential prey items for the wolverine. The marmot is considered to be an important food item for denning females and for females throughout the summer (Lofroth, pers. comm., as cited in COSWEIC, 2003). The alpine and subalpine habitat types are not limiting within the RWSA.

No potential direct effects from clearing and construction of the mine site and associated infrastructure are expected for wolverines. A potential indirect effect may include avoidance of constructions areas. Sensory disturbance may effect wolverine behaviour and reduce wolverine activities such as denning, foraging and travelling in areas with mining activities.

No actions are required to mitigate this as it is neutral effect which will likely be reversed once the activity has been discontinued. The regional area allows for wolverine movement around areas with activity.

Clearing and Construction: Ravine Dam and Dry-Stacked Tailings Facilities

There are no potential direct effects anticipated for the wolverine. A potential indirect effect may be avoidance of constructions areas. Sensory disturbance may effect wolverine behaviour and reduce wolverine activities such as denning, foraging and travelling in areas with mining activities.

No actions are required to mitigate avoidance as it is considered to be neutral and the effect will be reversed once the activity has been discontinued. This action has been characterized as natural because the regional area allows for wolverine to move around the disturbance area.

Operation: Access Road, Aerodrome and Associated Infrastructure

Increased traffic along the access road will potentially deter wolverines from using habitats located adjacent to the road corridor. No potential direct effects from road and aerodrome operation were identified for the wolverine. Potential indirect effects may include:

- avoidance of construction areas. Sensory disturbance may effect wolverine behaviour and reduce wolverine activities such as denning, foraging and travelling in areas with extensive noise disturbance; and,
- risk of increased mortality. Construction of the access road will increase access to the local area which may lead to an increase in trapping efforts and increased wolverine mortality.

No actions are required to mitigate avoidance as it is neutral as wolverines can move around the disturbance. The effect will be reversed once the activity has been discontinued. The following mitigation measures are proposed to limit effects from trapping:

- limit access to the area through installation of a gate along the access road; and
- decommission the road and remove water crossings upon completion of mining and decommissioning activities.

Operation: Mine Site and Associated Infrastructure

Mine operations may potentially affect wolverines foraging/hunting, possibly denning and/or moving through the mine operations area. High summer prey densities occur in the area. No potential direct effects were identified. A potential indirect effect may include avoidance of areas in which mine operations occur. Noise and disturbance from mine operations may reduce wolverine use in (both foraging/hunting, denning and movement).

No actions are required to mitigate avoidance as it is neutral and wolverines can move around areas with high disturbance. The effect will be reversed once the activity has been discontinued.

Decommissioning, Reclamation, and Closure: Access Road

The sensory disturbances related to the mine operation and access road will be mitigated upon decommissioning and reclamation, which will make the area available for wolverine use. No potential direct effects were identified; however, a potential indirect effect may include a risk of increased mortality. The access road may lead to increased trapping efforts in the local area, which may lead to increased mortality.

The following mitigation measures are proposed to reduce potential effects of project operations:

- limit access to the area through installation of a gate along the access road; and
- decommission the road and remove water crossings.

Decommissioning, Reclamation, and Closure: Mine Site and Associated Infrastructure

Noise levels and transportation of equipment and supplies will occur over very short periods during the decommissioning of mine buildings and associated infrastructure. These activities may reduce wolverine use of the area. Once the mine site has been abandoned, it can be expected that wolverines will use the area surrounding the mine footprint as they had previously.

No potential direct effects were identified; however, a potential indirect effect may include avoidance of areas in which mine operations occur. Noise and disturbance from mine operations may reduce wolverine use of the area for foraging/hunting, denning and movement.

No actions are required to mitigate avoidance as it is neutral, wolverines can move around the area of disturbance and the effect will be reversed once the activity has been discontinued.

Decommissioning, Reclamation, and Closure: Ravine Dam and Dry-Stacked Tailings Facility

The decommissioning and reclamation of the ravine dam and reservoir may increase wolverine use in this area. No potential negative direct or indirect effects were identified. Decommissioning, reclamation, and closure of the mine site are expected to have a neutral effect on the local wolverine population.

Mitigation Measures Summary

Mitigation measures will be implemented to minimize potential direct and indirect negative effects on wolverine during all phases of the proposed project. The following is a summary of proposed mitigation measures:

- all infrastructure will be removed from the site; and
- roads and water crossings will be decommissioned to prevent access.

Table 6.2.7-7 provides a summary of potential effects and mitigation measures for wolverines.

TABLE 6.2.7-7 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: WOLVERINE

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Clearing and Construction of Access Road	-	Avoidance	• Neutral effect, no mitigation required.			
Clearing and Construction of Mine Site	-	Avoidance	• Neutral effect, no mitigation required.			
Water Retention Dam	-	Avoidance	• Neutral effect, no mitigation required.			
Operations (including hauling)	-	Avoidance	• Neutral effect, no mitigation required.			
	-	Risk of increased trapping and mortality above local sustainable rate	• Install and use gates.		✓	
Reclamation (includes decommissioning and abandonment)	Discontinuation of sensory disturbance	-	• Neutral effect, no mitigation required.			
	-	Risk of increased trapping and mortality above local sustainable rate	• Removal of infrastructure. • Decommission roads, pull bridges in all locations		✓	

Residual Effects

Localized avoidance is anticipated until completion of reclamation and closure. There is the potential for minor residual effects if revegetation and reclamation efforts are only partially successful and access to the area is not resolved. A wildlife monitoring program will evaluate the effectiveness of the adopted mitigation measures and adaptive management will be used to increase effectiveness where appropriate.

Table 6.2.7-8 summarizes the significance determination for wolverine.

TABLE 6.2.7-8 SUMMARY OF SIGNIFICANCE DETERMINATION FOR WOLVERINE				
Project Component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Clearing and Construction of Access Road	Negative	Low	Short-term	Low
Clearing and Construction of Mine Site	Negative	Low	Short-term	Low
Reservoir	Negative	Moderate	Short-term	Medium
Operation (including hauling)	Negative	Moderate	Short-term	Medium
Reclamation (includes decommissioning and abandonment)	Neutral	Moderate	Short-term	Low

Significance Determination

The overall significance of potential effects from all project activities on local wolverine populations is expected to be low with the application of mitigation measures.

6.2.7.5 Avian Nesting Habitat

Identification of Valued Component

Bird species represent a large and diverse group of species many of which have broad range of life requirements. Bird nesting habitat was chosen as a VC as the effects of a project on nesting habitat can provide a surrogate measure of potential project effects on local breeding bird populations.

Summary of Baseline Information

A total of 112 bird species may nest within the study area (Sections 4.1.9.6.8 to 4.1.9.6.10; Appendix G2, G3, and G5). Of these possible 112 breeding species, two species are listed as Threatened (under COSEWIC), two as Special Concern (under COSEWIC), two as May Be At Risk (in the Yukon), one as specially protected (under the *Wildlife Act* (Yukon)), nine as Not At Risk, and the remaining 96 species were not evaluated by COSEWIC.

Occurrence and breeding success of birds in an area are governed by food abundance, availability of suitable nesting habitat and predation. Within the study area, birds breed at varying densities, wherever appropriate life requisites are met.

Nesting habitat favoured by species with special conservation status, including the Common Nighthawk, Olive-sided Flycatcher, Rusty Blackbird, Short-billed Dowitcher, Short-eared Owl, American Kestrel and Gyrfalcon are described in Table 6.2.7-9. All of these species, except for the Common Nighthawk, were recorded in the study area during former and or contemporary surveys.

TABLE 6.2.7-9 SUMMARY OF NESTING HABITAT FOR SPECIES WITH SPECIAL CONSERVATION STATUS			
Species	Conservation Status	Favoured Nesting Habitat	Nesting Habitat within the Local Study Area
Common Nighthawk (not observed)	Threatened (COSEWIC)	Nest on the ground in bare soil, sand, gravel or rock in open habitats such as recently burned or harvested forests, open forests, wetlands, rocky barrens and wetlands as well as mine tailings, quarries, railways and gravel roads	Aerodrome, Canol Road and existing staging areas, valley wetlands and rocky barrens in subalpine and alpine
Olive-sided Flycatcher	Threatened (COSEWIC)	Nest in conifer trees (including dead trees and snags) in open and edge habitats, including burn areas and wetlands. Often associated with young forests (0-30 years) or old mixed wood forests (>125 years).	Valley wetlands and may occur in forests to the tree line
Rusty Blackbird	Special Concern (COSEWIC)	Nests in various tree species (both living and dead coniferous and deciduous), shrubs or on top of stumps over or near wetlands, beaver ponds and streams	Low valleys, including those along the proposed access road and aerodrome
Short-billed Dowitcher,	May Be At Risk in the Yukon (CESCC 2006)	Nests on the ground in marshy wetlands with scattered trees and shrubs	Low valley wetlands
Short-eared Owl	Special Concern by COSEWIC	Nests on the ground in open wetlands at low elevations, low shrub habitats and in wet sedge meadows	Birch – lichen habitats, particularly along the Tsichu River, valley wetlands
American Kestrel	May Be At Risk in the Yukon (CESCC 2006)	Nests in cavities in mature spruce (usually dead trees) in open forests	Spruce – moss habitat types in low valleys, including the Hess River Tributary and along the proposed access road
Gyrfalcon	specially protected in the Yukon	Nests in stick nests constructed by Common Ravens or Golden Eagles on cliff ledges, or scrapes in the substrate of a cliff ledge	Subalpine and alpine precipitous terrain

Ecological Land Classification (ELC) data was collected and mapped in a 225 km^2 Local Study Area (LSA) centered on the mine site (refer to Appendix F2). This information was collected to provide a better understanding of potential available bird nesting habitat within the LSA, including those with special conservation status. Available nesting habitat in the LSA is assumed to be similar to habitat available throughout the entire study area. Since birds nest in a variety of habitats, it is assumed the entire LSA (225 km^2) may provide appropriate nesting habitat. Appropriate nesting habitat is not considered a limiting resource for birds occurring within the local study area.

In 2006 to 2008, waterfowl, cliff nesting raptors and breeding bird studies were conducted throughout the study area. Results of these waterfowl surveys indicated productive waterfowl nesting habitats are largely within the low valley systems. Waterfowl broods (as evidence of nesting success) were observed in three separate habitat types: beaver ponds, wetlands and mid- to large-sized ponds. Beaver ponds are considered productive waterfowl nesting habitats and were observed to have the highest number of broods. However, waterfowl are expected to nest in, and or adjacent to, all appropriate aquatic habitats.

During the raptor surveys, a total of seven raptor nests were observed, all within the Yukon Territory (Figure 4.1.9-10). Of these seven nests observed, only one was occupied and the remaining six were considered old, abandoned nests. Two Gyrfalcon, three Golden Eagle and two Common Raven nests were on mid elevation cliffs. The Yukon Government (2006) mapped Gyrfalcon and Golden Eagle nesting habitat across much of the subalpine and alpine habitat in the study area (Figure 4.1.9-10).

During the breeding bird surveys, habitats such as birch-lichen: willow-sedge complex, birch-moss: water complex, fescue-willow, willow-bluebell, willow-sedge and spruce-moss habitats had the highest average number of breeding birds detected per survey station, which are assumed to correlate to the highest average number of nests (habitats are mapped and discussed in Figure 4.1.8-2 and in Sections 4.1.8 and 4.1.9). These habitat types largely occur in valley systems, except for fescue-willow and willow-bluebell habitats, which are located in moist subalpine and alpine, respectively.

For the most part, population trends and nesting success of birds throughout the Yukon are unknown due to limited research. However, at a local level (within the study area), key monitoring indicators of appropriate avian nesting habitat can include changes in: breeding bird densities, breeding bird distributions and reproductive success. Detailed accounts of waterfowl, raptor and other upland bird nesting requirements, local distribution and habitat use, and special management requirements are provided in Section 4.1.9.

Identification of Temporal and Spatial Bounding

Some species are year-round residents while the majority are migratory and are present only during their breeding season. Those species nesting within the study area also vary in their nesting times. Owls and some raptors are generally considered early nesters, whereas, other bird species, such as passerines nest later. In general, most breeding owls lay eggs by early May. However, laying dates for Great Horned Owls in the Yukon range from the end of February to early April (Alexander *et al.* 2003). Other raptor species, including Gyrfalcons, American Kestrels, Golden Eagles and Rough-legged Hawks complete egg laying between April to June (Alexander *et al.* 2003; Clum and Cade 1994). In general, passerines, shorebirds, and waterfowl begin nesting between May to the end of June.

All project activities occurring from February to the end of June will overlap with bird nesting times. This includes the clearing, construction and operation phases of the access road and aerodrome extension, the mine site and associated infrastructure, and ravine dam and dry-stack tailings facility. Clearing operations for the majority of the project components will be completed during the summer months and will therefore overlap with nesting birds in the area.

The bird species are diverse with differing life requirements, including nesting habitat. Bird nesting habitat can be expected to occur throughout the entire study area in all habitat types including wetlands, coniferous stands, shrub stands, different vegetated seral stages, dry uplands to wet lowlands, and vegetated to sparsely vegetated alpine sites. Nests may be built in tall trees and shrubs, tree cavities, grass/sedges, ledges and rocky cliffs, sandy banks, and on the ground. All newly cleared and constructed project areas are expected to overlap with potential nesting areas.

Effects Characterization

The proposed Mactung development may directly and indirectly affect bird nesting throughout its construction, operation, decommissioning and remediation phases. However, the majority of expected potential direct effects will likely occur during the clearing and construction phases. Detailed accounts of potential bird nesting effects are described in the following subsections.

The proposed footprint area was used as a measure of direct habitat loss. This conservative value of direct habitat loss assumes all habitats directly affected by the development were appropriate bird nesting habitat.

Clearing and Construction: Access Road, Aerodrome Extension, and Associated Infrastructure

Bird nesting habitat may be directly affected by clearing and constructing the access road, aerodrome extension and associated infrastructure. Potential direct effects may include:

- loss of 120 ha of valley nesting habitat (or approximately 3.5% of the total low elevation habitat in the LSA). Low valleys support a diversity of habitat types important for nesting birds, including species of special conservation status, such as the Olive-sided Flycatcher and the American Kestrel (Table 6.2.7-9). Several of these habitats in the low valleys (willow-sedge and spruce-moss habitats) had the highest average number of breeding birds detected per survey station, which relate to the highest average number of nests. In addition, these low valley systems support beaver ponds, wetlands and small to mid-sized ponds important for nesting waterfowl. The loss of these low valley habitats may pose a moderate negative effect on bird nesting habitat;
- loss of approximately 71 ha of subalpine and alpine nesting habitat. Direct habitat loss of these areas near the mine site is limited in extent, and thus will pose a low negative effect to bird nesting habitat. This portion of the access road will directly affect 1.5% of the available subalpine and 0.1 % of available alpine habitat within the LSA. This direct effect to bird nesting habitat is considered low; and
- increase in nesting substrates (buildings, gravel pads and other infrastructure) for a few bird species. This direct effect to bird nesting habitat is considered low.

Bird nesting habitat may be indirectly affected by clearing and construction of the access road, aerodrome extension and associated infrastructure. Potential indirect effects may include:

- altering nesting habitat quality due to dust, noise and human activities. These indirect effects are considered to pose a moderate negative effect on bird nesting habitat; and
- increase in fragmented nesting habitats, including increases in the amount of habitat edges and isolation of one habitat fragment from another. For some species, habitat edges are a preferred nesting habitat, whereas, other species require interior forest habitat. AXYS (2001) reports forest fragmentation and habitat loss modeling exercises suggest a threshold of 20% available breeding habitat across a landscape will support population survival, regardless of the level of forest fragmentation. Since the proposed development will affect approximately 3% of the available habitat in the LSA, these indirect effects are considered to pose a low negative effect on bird nesting habitat quality in the study area.

Clearing and Construction: Mine Site and Associated Infrastructure

Noise levels and human presence/activities will increase with the proposed clearing and construction activities at the mine site and associated infrastructure.

Bird nesting habitat may be directly affected by clearing and construction of the mine site and associated infrastructure. A potential direct effect may include loss of 2.05 ha of epilithic lichen and 0.90 ha of fescue-sedge habitats. A low number of breeding birds were detected within these habitats during the 2006-2007 surveys. Epilithic lichen habitats are the most common habitat type within the LSA, covering approximately 42% of the total LSA. Fescue-sedge habitats cover approximately 5% of the total LSA; however, only 0.08% of the fescue-sedge habitat in the LSA will be directly effected. Direct effects from the removal of these habitat types are considered low.

Bird nesting habitat may be indirectly affected by clearing and constructing the mine site and associated infrastructure. A potential indirect effect may be the alteration of nesting habitat quality due to dust, noise and human activities. These indirect effects to bird nesting habitat are considered low.

Clearing and Construction: Ravine Dam and Dry-Stacked Tailings Facility

Noise levels and human presence/activities will increase with the proposed clearing and construction activities at the ravine dam site and associated infrastructure.

Bird nesting habitat may be directly affected by clearing and construction of the ravine dam and dry-stacked tailings facility. A potential direct effect may include loss of 49.55 ha of subalpine bird nesting habitat. This relates to approximately 1.5% of available subalpine nesting habitat within the LSA. Direct effects by the removal of this limited amount of nesting habitat are considered low.

Bird nesting habitat may be indirectly affected by clearing and constructing the ravine dam and dry-stacked tailings facility. A potential indirect effect may include alteration of nesting habitat quality due to dust, noise and human activities. These indirect effects to bird nesting habitat are considered low.

Operation: Road, Aerodrome, and Associated Infrastructure

The operation of the access road, aerodrome and associated infrastructure will increase local noise levels, traffic and human presence. No potential direct effect to bird nesting habitat is expected during the operation of the road, aerodrome, and associated infrastructure. A potential indirect effect may include alteration of nesting habitat quality due to dust, noise and human activities. These indirect effects to bird nesting habitat are considered low.

Operation: Mine Site and Associated Infrastructure

The year round operation of the mine site and associated infrastructure will include an increase in noise levels and human presence and activities. No potential direct effect to bird nesting habitat is expected during the operation of the mine site and associated infrastructure. A potential indirect effect may include alteration of nesting habitat quality due to dust, noise and human activities. These indirect effects to bird nesting habitat are considered low.

Operation: Ravine Dam and Dry-Stacked Tailings Facility

The ravine dam and dry-stacked tailings facility will operate year-round. The operation phase of these proposed developments will include an increase in traffic, and to a lesser degree, human presence. No potential direct effect to bird nesting habitat is expected during the operation of the ravine dam and dry-stacked tailings facility. A potential indirect effect may include alteration of nesting habitat quality due to dust, noise and human activities. These indirect effects to bird nesting habitat are considered low.

Decommissioning, Reclamation, and Closure: Access Road, Aerodrome and Associated Infrastructure

Heavy equipment will be used for decommissioning and reclamation of the access road, which will continue to contribute to elevated noise levels; however, this will abate following reclamation and final closure.

Bird nesting habitat may be directly affected by decommissioning, reclamation and closure of the access road. Potential direct effects may include:

- increase in usable nesting habitat following decommissioning for a few bird species. These positive effects are considered low; and
- increase in usable nesting habitat following reclamation and closure for multiple bird species. These positive effects are considered moderate, but will take multiple years for early seral habitats to support a diverse nesting bird population.

Bird nesting habitat may be indirectly affected by decommissioning, reclamation and closure of the access road. Potential indirect effects may include:

- altering nesting habitat quality due to dust, noise and human activities until final closure. These indirect effects to bird nesting habitat are considered low; and
- increasing connectivity of nesting habitats. These positive effects are considered a low effect on bird nesting habitat quality, and will take multiple years for early seral habitats to blend with existing nesting habitats.

Decommissioning, Reclamation, and Closure: Mine Site and Associated Infrastructure

Noise levels and transportation of equipment and supplies will occur during the decommissioning, reclamation, and closure of the mine site and associated infrastructure.

Bird nesting habitat may be directly affected by the decommissioning, reclamation and closure of the mine site and associated infrastructure. Potential direct effects may include:

- increase in usable nesting habitat following decommissioning for a few bird species. These positive effects are considered low; and
- increase in usable nesting habitat following reclamation and closure for multiple bird species. These positive effects are considered low since the project footprint is limited in scale.

Bird nesting habitat may be indirectly affected by decommissioning, reclamation and closure of the mine site and associated infrastructure. A potential indirect effect may include alteration of nesting habitat quality due to dust, noise and human activities until final closure. These indirect effects to bird nesting habitat are considered low.

Decommissioning, Reclamation, and Closure: Ravine Dam and Dry-Stacked Tailings Facility

Noise levels are expected to increase during the ravine dam decommissioning phase. The dam will be breached and drainage patterns re-established with existing streambeds. The dry-stacked tailings facility will be capped and seeded.

Bird nesting habitat may be directly affected by decommissioning, reclamation and closure of the ravine dam and dry-stacked tailings facility. Potential direct effects may include:

- increase in usable nesting habitat following decommissioning for a few bird species. These positive effects are considered low; and
- increase in usable nesting habitat following reclamation and closure for multiple bird species. These positive effects are considered low.

Bird nesting habitat may be indirectly affected by decommissioning, reclamation and closure of the ravine dam and dry-stacked tailings facility. A potential indirect effect may include alteration of nesting habitat quality due to dust, noise and human activities until final closure. These indirect effects to bird nesting habitat are considered low.

Mitigation Measures Summary

Mitigation measures will be implemented to minimize potential direct and indirect negative effects on avian nesting habitat during all phases of the proposed project. The following is a summary of proposed mitigation measures:

- implement a no off-road policy for all mine employees and contractors while working at Mactung;
- speed limits will be posted and enforced, especially near sensitive wildlife areas;
- minimize vehicle and aircraft traffic, whenever possible;
- an employee training program will be conducted to describe and illustrate the importance of abiding by all wildlife mitigation measures;
- prohibit use of ATVs and snowmobiles at Mactung;
- precautions will be taken to ensure nesting on manmade infrastructure does not occur, to avoid threats to the birds and mine employees;
- roads and water crossings will be decommissioned and reclaimed to discourage access;
- infrastructure will be removed from the mine site and the footprint will be reclaimed to simulate the area's original habitat; and
- a nest survey will be conducted within the direct footprint of the access road prior to clearing to document all nests, nesting habitat and locations, species, and eggs/fledglings. Active nests identified within the construction footprint must not be disturbed or destroyed. Under the *Migratory Bird Convention Act* (1994), it is illegal to disturb or destroy a migratory bird or its nest without appropriate permitting.

Table 6.2.7-10 outlines potential avian nesting effects from various project activities and proposed mitigation measures.

TABLE 6.2.7-10 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: AVIAN NESTING HABITAT

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Clearing and Construction of Access Road	Habitat loss	-	• Reclamation through revegetation		✓	
	Mortality during nesting	-	• Restrict vegetation clearing to outside of the breeding season			✓

TABLE 6.2.7-10 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: AVIAN NESTING HABITAT						
Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Clearing and Construction of Mine Site	Habitat loss	-	• Reclamation through revegetation		✓	
	Mortality during nesting	-	• Restrict vegetation clearing to outside of the breeding season			✓
Water Retention Dam	Habitat loss	-	• Reclamation through revegetation		✓	
	Mortality during nesting	-	• Restrict vegetation clearing to outside of the breeding season			✓
Operations (including hauling)	-	Reduced quality and availability of breeding habitat	• Reclamation through revegetation			✓
Reclamation (includes decommissioning and abandonment)	Restored habitat	-	• None required			
	-	Increase in reproductive success and recruitment	• Positive effect, no mitigation required			

Residual Effects

Given the potentially low effect the proposed project will likely have on the overall quantity and quality of bird nesting habitat within the study area, and implementation of the proposed mitigative measures, the project is not expected to affect local bird populations. No potential residual effects are anticipated.

Table 6.2.7-11 summarizes the significance determination for avian nesting habitat.

TABLE 6.2.7-11 SUMMARY OF SIGNIFICACE DETERMINATION FOR AVIAN NESTING HABITAT				
Project Component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Clearing and Construction of Access Road	Negative	Low	Short-term	Low
Clearing and Construction of Mine Site	Negative	Low	Short-term	Low
Reservoir	Negative	Moderate	Short-term	Medium
Operation (including hauling)	Negative	Moderate	Short-term	Medium
Reclamation (includes decommissioning and abandonment)	Neutral	Moderate	Short-term	Low

Significance Determination

Potential project effects are likely to be low in magnitude, local geographical extent and medium-term in duration (Table 6.2.7-11). Any potential project effects are considered to have a low significance on bird nesting habitat with the application of mitigation measures, and reclamation and closure activities. There is the potential for minor residual effects if revegetation is only partially successful. However, any unsuccessful revegetation will be limited in spatial extent and not affect overall availability of nesting habitat.

6.2.7.6 Hoary Marmot

In the Yukon, hoary marmots are mostly found on rocky talus of mountains in alpine and subalpine zones. The species is closely associated with a microhabitat composed of a mosaic of outcrop, tundra rich meadows, and boulder-strewn slopes. The species density throughout the territory is not well known. Hoary marmots live in small colonies and rarely visit different territories. Dispersal occurs at sexual maturity (3 years old) but occasionally subadults remain with their birth group several years. The species has established territories, which are used year-round, on alpine and subalpine areas of the project area. However, hoary marmots are active only between May and September, depending on climatic conditions.

Identification of Valued Component

Hoary marmots were chosen as a VC for their socio-economic and cultural significance. Although the species is protected from hunting, the community of Ross River raised concerns regarding hoary marmot availability, as hoary marmot are occasionally trapped by First Nations people as a food source and for fur.

Summary of Baseline Information

Although hoary marmots were not a focal species in the wildlife baseline studies conducted between 2005 and 2008, several observations were made outside the hibernation period. The project study area contains highly suitable habitat around the mine site, where mountains with rocky talus slopes are intermixed with rich tundra meadows and boulders. A few colonies were observed where the dry-stacked tailings facility and the ravine dam will be constructed. The remainder of the project study area does not contain highly suitable habitat since the topography changes to less mountainous areas. However, the proposed access road can potentially encroach on hoary marmot habitat in higher elevations.

Since population densities and trends are unknown, it is difficult to determine potential population effects. At a local level, key monitoring indicators may include local distribution and feedback from the community on local harvest data.

Identification of Temporal and Spatial Bounding

Hoary marmots have a short, active life period of about 4 months in the Yukon. Depending on climate conditions, they will emerge from burrows in early May when the burrow seal thaws out. Clearing and construction of the access road, mine, and ravine dam are expected to overlap with this time period. Operations may affect the species outside the hibernation period, whereas reclamation activities can potentially affect hoary marmots year-round.

Hoary marmot are considered spotty in their range, which covers most of the Yukon Territory, except the northern coastal plain (Yukon Government 1969; Wilson and Ruff 1999). Their spatial distribution extends from the Mackenzie Mountains to Alaska on the western border. The northern limit of their range is not certain but is known to extend as far north as the Ogilvie Mountains and believed to be expanding northward. Hoary marmot densities throughout the territory are not very well known and depend greatly on annual changes in climatic conditions and social behaviour (Karels and Hik, 2004). No targeted surveys were completed on the species, but this species was observed in the alpine and subalpine zones of the project area.

Effects Characterization

A number of potential effects, both direct and indirect, on local hoary marmot populations were considered. Potentially, the most significant direct effect from project activities is habitat loss. Increased mortality from increased human access is a potential indirect effect.

Clearing and Construction: Access Road, Aerodrome Extension, and Associated Infrastructure

The majority of the road corridor, as well as the aerodrome, are both located in forested valleys ranging from 1,100 m to 1,400 m elevation. This habitat is considered low quality for the hoary marmot which utilizes habitat situated above the tree line. The upper portion of the road is located in subalpine and alpine habitat (between 1,400 m and 1,900 m elevation) and corresponds to most of the 2008 sightings. This road segment may be considered good quality habitat for the species.

Hoary marmot may be directly affected by clearing and construction of the access road and aerodrome extension. Potential direct effects may include:

- habitat loss along the access road during the clearing and construction phases. This potential effect is considered low, since the road is limited in extent; and
- increased mortality may potentially occur during clearing and construction operations.

Hoary marmot may also be indirectly affected by clearing and constructing the access road and aerodrome extension. Potential indirect effects may include:

- increased hunting pressure along the access road, and consequently a potential increase in mortality; and
- avoidance of constructions areas and displacement. Noise and disturbance from site construction may reduce use.

The following mitigation measures are proposed to avoid or minimize potential project effects:

- implement and strictly enforce a no hunting policy for all employees and contractors;
- prohibit use of ATVs and snowmobiles at Mactung; and
- roads and bridges will be decommissioned to prevent access.

The clearing and construction of the access road, aerodrome extension, and associated infrastructures is expected to have a potential negative effect of low magnitude. These effects will occur on a very local scale since the species uses microhabitats. It will be of short-term duration and of low frequency. Therefore, local habitat loss as well as potential accidental mortality related to clearing and construction of the access road and aerodrome is considered low.

Clearing and Construction: Mine Site and Associated Infrastructure

Potential effects on the hoary marmot are expected to occur in the area of the mine site, considering its location in alpine and subalpine areas. A portion of this area is known to be hoary marmot habitat.

Potential direct effects may include:

- habitat loss in the area of the mine site during the clearing and construction phases of the mine will likely occur; however, it is considered low and local in extent; and
- mortality may potentially occur during clearing and construction operations.

Hoary marmots may also be indirectly affected by clearing and construction of the mine site. Potential indirect effects may include:

- increased hunting pressure along the access road, potentially resulting in increased mortality; and

- avoidance of construction areas and displacement. Noise and disturbance from site construction may reduce use.

The following mitigation measures are proposed to avoid or minimize potential project effects:

- implement and strictly enforce no hunting policy for all employees and contractors;
- prohibit use of ATVs and snowmobiles at Mactung;
- decommission roads in three location; and
- remove water crossings in all locations.

No actions are required to mitigate avoidance as it is a neutral and the effect will be reversed once the activity has been discontinued. The project area allows for movement of the hoary marmot away from, or around, the area of disturbance.

The clearing and construction of the mine site and associated infrastructure are expected to have a potential negative effect on hoary marmot population of moderate magnitude on a local extent. It will take place on a medium-term scale at low frequency. The overall significance of this project activity is considered low.

Clearing and Construction: Ravine Dam and Dry-Stacked Tailings Facility

Potential effects on the hoary marmot are expected to occur in the area of the ravine dam and dry-stacked tailings facility, considering its location in alpine and subalpine areas (above 1,400 m elevation). A portion of this area is known to be used by hoary marmot.

A potential direct effect may include local habitat loss. This is considered low and limited in extent.

Potential indirect effects may include:

- avoidance and displacement from constructions areas. Noise and disturbance from clearing and construction may reduce use; and
- increased hunting pressure in the area, potentially resulting in increased mortality.

The following mitigation measures are proposed to avoid or minimize potential project effects:

- implement a no hunting policy for all employees and contractors;
- prohibit use of ATVs and snowmobiles at Mactung;
- decommission roads in three locations; and
- remove water crossings in all locations.

No actions are required to mitigate avoidance as it is neutral and the effect will be reversed once the activity has been discontinued. The project area allows for movement of the hoary marmot away from, or around, the area of disturbance.

The clearing and construction of the ravine dam and dry-stacked tailings facility are expected to have a potential negative effect on hoary marmot populations of low magnitude, but on a local extent due to microhabitat use. Potential effects will take place on a medium-term scale at medium frequency. The overall significance of the effect is, therefore, considered low.

Operation: Access Road, Aerodrome, and Associated Infrastructure

No potential direct or indirect effects were identified for the operation phase of the road and aerodrome due to their locations outside hoary marmot habitat areas.

Operation: Mine Site and Associated Infrastructure

Mine operations are expected to have minimal potential direct effects on local hoary marmot populations. A potential indirect effect from mine operations may include avoidance and displacement from areas in which mine operations occur. Noise and disturbance from mine operations may reduce use in area.

No actions are required to mitigate avoidance as it is neutral and the effect will be reversed once the activity has been discontinued. The project area allows for movement of the hoary marmot away from, or around, the area of disturbance.

The operation stage of the road, aerodrome and road is expected to have a neutral effect on hoary marmot communities. The operations are of low magnitude, on a local extent and may occur on short term basis. It is also expected to be of medium frequency. The overall significance of potential effects from operations at the mine site, the road and the aerodrome is rated as low.

Decommissioning, Reclamation, and Closure: Access Road, Aerodrome, Mine Site and Associated Infrastructure, Ravine Dam, and Dry-Stacked Tailings Facility

During decommissioning, reclamation and closure, the road will be re-contoured to discourage recreational use in the area and habitat returned to its natural state.

A potential direct effect may include an increase of usable habitat following closure and habitat restoration. A potential indirect effect may include access to previously inaccessible areas by hunters, potentially resulting in increased mortality.

The following mitigation measures are proposed to avoid or minimize potential project effects:

- implement and strictly enforce no hunting policy for all employees and contractors;
- prohibit use of ATVs and snowmobiles at Mactung;
- decommission roads in three locations; and
- remove water crossings in all locations.

The decommissioning of mine buildings, roads, aerodrome, ravine dam and reservoir and associated infrastructure is expected to have a neutral effect of moderate magnitude on a local extent. The duration is expected to be medium-term and of low frequency. Following the activities, some of the habitat previously affected will be restored. The significance of the associated effects on hoary marmot populations is rated as low.

Mitigation Measures Summary

Mitigation measures will be implemented to minimize the potential direct and indirect negative effects to hoary marmots during all phases of the proposed project. The following is a summary of all proposed mitigation measures:

- a no hunting policy for all mine employees and contractors will be enforced while working on or off-site North American Tungsten leases;
- the harassment of hoary marmot, as defined under the Wildlife Act (Yukon), will be prohibited;
- decommission roads in three locations; and
- remove water crossings in all locations.

Table 6.2.7-12 outlines potential effects on hoary marmot from various project activities and proposed mitigation measures.

TABLE 6.2.7-12 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: HOARY MARMOT

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Clearing and Construction of Access Road	Some habitat loss in upper areas	-	• Reclamation through revegetation		✓	
	Potential minimal mortality	-	• No mitigation feasible			
	-	Increased hunting pressures	• No hunting policy for all employees and contractors • Prohibit use of ATVs and snowmobiles at Mactung • Gated access			✓
Clearing and Construction of Mine	Habitat loss	-	• Reclamation through revegetation		✓	

TABLE 6.2.7-12 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: HOARY MARMOT

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Site	Potential minimal mortality	-	• No mitigation feasible			
	-	Increased hunting pressures	• No hunting policy for all employees and contactors • Prohibit use of ATVs and snowmobiles at Mactung • Gated access			✓
Water Retention Dam	Some habitat loss	-	• Reclamation through revegetation		✓	
	-	Increased hunting pressures	• No hunting policy for all employees and contactors • Prohibit use of ATVs and snowmobiles at Mactung • Gated access			✓
Operations (including hauling)	-	Decreased hunting pressure, likely resulting in an increase in population size	• No mitigation required		✓	
Reclamation (includes decommissioning and abandonment)	Restored and/or vacated habitat areas	-	• Neutral effect, no mitigation required			
	-	Increased hunting pressures	• No hunting policy for all employees and contactors • Prohibit ATVs and snowmobiles at Mactung • Gated access • Removal of infrastructure • Decommission roads, pull bridges in all locations.			✓

Residual Effects

Given the potentially low effect the proposed project may have on the local hoary marmot population, and implementation of the proposed mitigative measures, the project is not expected to affect local populations. No potential residual effects are anticipated.

Table 6.2.7-13 summarizes the significance determination for hoary marmot.

TABLE 6.2.7-13 SUMMARY OF SIGNIFICANCE DETERMINATION FOR HOARY MARMOT

Project Component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Clearing and Construction of Access Road	Negative	Low	Short-term	Low
Clearing and Construction of Mine Site	Negative	Moderate	Short-term	Low
Reservoir	Negative	Moderate	Short-term	Medium
Operation (including hauling)	Neutral	Moderate	Short-term	Medium
Reclamation (includes decommissioning and abandonment)	Neutral	Moderate	Short-term	Low

Significance Determination

Potential project effects are likely to be low in magnitude, local geographical extent and medium-term in duration (Table 6.2.7-13). Any potential project effects are considered to have a low significance on hoary marmot populations with the application of mitigation measures, and reclamation and closure activities. There is the potential for minor residual effects if reclamation is only partially successful. However, any unsuccessful reclamation will be limited in spatial extent and not affect overall populations.

6.2.7.7 Biodiversity

Identification of Valued Component

Biodiversity was selected as a VC for assessment as it provides a useful larger scale overview of the project effects as they relate to the integrity, complexity and functioning of local ecosystems, including all species within that ecosystem. This component allows us to view the evenness of effects across the biotic environment to determine whether effects are occurring in a representative fashion. Further, these effects may be indirectly targeting higher or lower value habitats. This value has also been identified for its importance as a community value by the Ross River Dena Council.

Summary of Baseline Information

Biodiversity is generally defined as the variety of species, communities, and ecosystems, as well as the structures, functions and processes within them.

Baseline studies focusing on ecological land classifications, wetlands, vegetation and rare plants, wildlife (including ungulates, breeding birds, waterfowl and raptors), fish and aquatic invertebrates, water quality, and hydrology were conducted from 2005 to 2008 and have been included in various appendices of this proposal. Other wildlife species were addressed in the baseline studies as part of incidental observations. A total of 240 species, including 145 plants, 12 mammals, 79 birds and 4 fish were recorded within the study area from 2005 to 2008 these have been discussed in section 4.1.9.

For the purposes of this proposal, the potential effects of the proposed development are assessed at the local community level and on the species within the study area. For the most part, the various components of biodiversity have already been considered through effects characterization of each environmental and socio-economic values (Section 6.2).

Since biodiversity encompasses multiple layers of biotic and abiotic interactions at the ecosystem and community levels, and since species distribution and habitat use has been discussed throughout this effects assessment, the scope of this section is limited to species biodiversity within habitat types. Species biodiversity takes into account various biotic and abiotic components at a community level that can be measured and presented in simplified terms.

The ecological land classification data collected from 2006 to 2008 indicates that the low valley systems have a higher number of different habitat types (i.e., seven defined habitat types) than the subalpine and alpine areas (i.e., five and four habitat types, respectively). The low valley areas include a greater number of different habitat types, so they are considered to possess a greater biodiversity. In addition, these low valley areas experience a number of ecological processes, including fire, flooding, erosion and avalanches, which promote habitat diversity. Subalpine and alpine areas also experience ecological processes, particularly avalanches and erosion. Due to the moist and cold climate of the study area, the fire interval in the low valley systems is expected at approximately every 234 years. Historical records indicate no major fire disturbance has occurred in the area of the proposed mine, which infers that late successional and/or mature habitat communities are likely present in the study area. These community types are characterized by lower habitat biodiversity.

Breeding birds were surveyed within the study area in June 2006 and 2007 using fixed radius point count stations (Appendix G2 and G3). A total of 102 breeding bird stations across all available habitat types were surveyed at this time. Breeding bird survey results within available habitat types across the study area were used as a proxy measurement of biodiversity in the study area. Breeding bird diversity within available habitat types is easily measurable and considered a reliable indicator of environmental change. Since birds are a diverse group, abundant, easy to identify and count, and require various habitats to fulfill their life requirements, they are used as indicators of biodiversity at a local community level.

Using the Shannon-Wiener Index, habitat types with the highest bird species diversity included: birch-lichen, fescue-willow, willow-sedge, spruce-moss and fir-moss (Table 4.1.9-29). These habitat types are located in both low and mid elevation valley habitats, and cover approximately 6%, 3.4%, 1.5%, 3.1%, and 1.0%, respectively, of the LSA. Whereas, fescue-sedge, fescue-willow: birch-moss complex, willow-bluebell and heath-lichen: fescue-sedge complex habitats had the lowest species diversity (Table 4.1.9-29). These habitats commonly occur in alpine and at the transition zone between the subalpine and alpine zones.

Effects to breeding bird species diversity can provide a surrogate measure of project effects on biodiversity, and will allow for reasonable potential effects predictions.

Identification of Temporal and Spatial Bounding

Potential effects to biodiversity at the local community level may occur throughout the life of the proposed development. All project activities have the potential to affect local biodiversity throughout all proposed development stages, including clearing and construction, operation, and decommissioning and reclamation. Therefore the temporal boundaries have been identified to be year-round from approximately 2010 to 2025.

Biodiversity incorporates all biotic and abiotic components and their interactions at an ecosystem and community level, including soil, water, air, flora, and fauna. The proposed project and its associated activities have a limited geographical footprint and, therefore, have the potential to affect biodiversity at the local community level during all project phases, including clearing and construction, operation, and decommissioning and reclamation.

Effects Characterization

The proposed Mactung project can directly and indirectly affect biodiversity throughout its construction, operation, decommissioning and remediation phases. However, the majority of expected potential direct effects will occur during the clearing and construction phases.

Biodiversity incorporates all biotic and abiotic components and their interactions, including geology, topography, soil, water, air, flora, and fauna. Therefore, all potential effects to these biotic and abiotic components, as outlined in Section 6.2, will directly or indirectly affect the biodiversity of the area. For simplicity, breeding bird species diversity is used to reflect potential projects effects on biodiversity at the local community level. Breeding bird diversity in habitat types not only reflects bird and plant community diversity, but integrates surface geology, topography, soils, water and ecological functions such as avalanches and floods.

Detailed accounts of potential breeding bird diversity as it relates to local community level biodiversity are described below.

Clearing and Construction: Access Road, Aerodrome Extension and Associated Infrastructure

Biodiversity at the local community level may potentially be directly affected by clearing and construction of the access road, aerodrome extension and associated infrastructure.

Potential direct effects include:

- loss of 120 ha of valley habitat types. These valley habitats cover a total of approximately 15% of the LSA. Low valleys support a diversity of habitat types, including willow-sedge, spruce-moss and fir-moss. These three habitat types were found to have the highest breeding bird diversity. Approximately 77.75 ha (or approximately 5.5% of the fir-moss habitats, 4% of the spruce-moss and less than 1% of the willow-sedge habitats) of these three habitat types may be directly affected by the proposed access road, aerodrome, and associated infrastructure. The loss of these low valley habitats will pose a low potential negative effect on local community biodiversity since the loss of these three habitat types within the LSA is low.
- loss of habitat that supports rare plant species. A single rare plant, Rubus arcticus spp acaulis was observed in the LSA, but outside the proposed development footprint. On the basis of the rare plant survey results, it is considered unlikely that any rare plants occur within the proposed project footprint and therefore any potential effects from the project to rare plants will be of low significance.
- loss of habitat that supports bird species with special conservation status (Table 6.2.7-9 and Table 6.2.7-14). The majority of bird species with special conservation status are supported by low valley habitats, and subalpine and alpine areas to a lesser extent. The loss of these habitats is limited in extent and is considered to pose low potential negative effects on these species and local community biodiversity.
- loss of approximately 71 ha of subalpine and alpine habitats. These subalpine and alpine areas cover approximately 15% and 67% of the LSA, respectively. In particular, birch-lichen and fescue-willow habitat types, two of the habitat types found to have high breeding bird diversity, occur in the subalpine and alpine areas. Approximately 45.95 ha of these two habitat types may be directly affected by the proposed development. The loss of these low valley habitats will pose a low potential negative effect on local community biodiversity since the potential loss of these three habitat types is low.

Local community biodiversity may be indirectly affected by clearing and construction of the access road, aerodrome extension and associated infrastructure. A potential indirect effect may include alteration of habitat types by the introduction of invasive or alien plant species and deleterious substances, changes to the natural drainage patterns, and other natural processes, such as avalanche hazards. This potential indirect effect is considered to pose moderate negative effects to local community biodiversity, without application of appropriate mitigation measures.

Clearing and Construction: Mine Site and Associated Infrastructure

Local community biodiversity may be directly affected by clearing and construction the mine site and associated infrastructure. Potential direct effects may include:

- loss of 2.95 ha of alpine habitat (or approximately 0.02% of the total alpine area in the LSA). Alpine areas cover approximately 67% of the total LSA. In particular, fescue-willow habitats, a habitat type found to have high breeding bird diversity, occur in the alpine. No fescue-willow habitats will be directly affected by the proposed mine site. Since direct effects to this habitat type is negligible in the project area, potential project effects to the local community biodiversity are considered low; and
- loss of habitat that supports two bird species with special conservation status (Tables 6.2.7-9 and 6.2.7-14). However, the loss of these habitats is limited in extent (approximately 0.02% of the alpine areas in the LSA affected) and is considered to pose low potential negative effects on these species and local community biodiversity.

Biodiversity may be indirectly affected by clearing and construction of the mine site and associated infrastructure. A potential indirect effect may be alteration of habitat types by the introduction of invasive or alien plant species and deleterious substances, changes to the natural drainage patterns, and other natural processes, such as avalanche hazards. This potential indirect effect is considered to pose low negative effects to local community biodiversity in the area.

Clearing and Construction: Ravine dam and Dry-Stacked Tailings

Local community biodiversity may be directly affected by clearing and construction of the ravine dam and dry-stacked tailings facility. Potential direct effects may include:

- loss of 49.55 ha of subalpine areas (or 1.5% of the total area in the LSA). In particular, birch-lichen habitats, a habitat type found to have high breeding bird diversity, covers approximately 7.5% of the LSA. No birch-lichen habitats will be directly affected by the proposed development. Since direct effects to this habitat type are negligible, potential project effects on local community biodiversity are considered low; and
- loss of habitats that may support a single bird species with special conservation status (Tables 6.2.7-9 and 6.2.7-14). However, the loss of these habitats is limited in extent (approximately 1.5% of the subalpine areas in the LSA affected) and is considered to pose low potential negative effects on these species and local community biodiversity.

Local community biodiversity may be indirectly affected by clearing and construction of the ravine dam and dry-stacked tailings facilities. Another potential indirect effect may be the alteration of habitat types by the introduction of invasive or alien plant species and deleterious substances, and changes to the natural drainage patterns. This indirect effect is considered to potentially pose moderate negative effects to local community biodiversity in the area, without application of appropriate mitigation measures.

Operation: Access Road, Aerodrome and Associated Infrastructure

Local community biodiversity may be indirectly affected by operation of the access road, aerodrome and associated infrastructure. A potential indirect effect may be the alteration of habitat types by the introduction of invasive or alien plant species and deleterious substances. This indirect effect is considered to potentially pose low negative effects to local community biodiversity in the area.

Operation: Mine Site and Associated Infrastructure

Local community biodiversity may be indirectly affected by operation of the mine site and associated infrastructure. A potential indirect effect may be the alteration of habitat types by the introduction of invasive or alien plant species and deleterious substances. This indirect effect is considered to potentially pose low negative effects to local community biodiversity in the area.

Operation: Ravine Dam and Dry-Stacked Tailings Facility

Local community biodiversity may be indirectly affected by operation of the ravine dam and dry-stacked tailings facility. A potential indirect effect may include:

> altering habitat types by the introduction of invasive or alien plant species and deleterious substances. This potential indirect effect is considered to pose moderate negative effects to local community biodiversity, without application of appropriate mitigation measures.

Decommissioning, Reclamation, and Closure: Access Road, Aerodrome and Associated Infrastructure

Local community biodiversity may be directly affected by decommissioning, reclamation and closure of the access road. A potential direct effect may include an increase in habitat types over time, particularly those in early seral stages, which are currently limited in area in the LSA to floodplains, avalanche chutes and other areas of natural and human-made disturbances. These habitats would support local biodiversity in the area. This potential direct effect is considered to pose low positive effects on local community biodiversity.

Local community biodiversity may be indirectly affected by decommissioning, reclamation and closure of the access road. A potential indirect effect may be allowing natural processes, such as flooding and avalanches. This potential indirect effect is considered to pose moderate positive effects to local biodiversity in the area as such phenomena are occurring naturally and without the influence of humans.

Decommissioning, Reclamation, and Closure: Mine Site and Associated Infrastructure

Local community biodiversity may be directly affected by decommissioning, reclamation and closure of the mine site and associated infrastructure. A potential direct effect may be an increase in habitat types over time by the revegetation of the mine site and associated footprint. These habitats would support local biodiversity in the area. This potential direct effect is considered to pose low positive effects on local community biodiversity.

Local community biodiversity may be indirectly affected by decommissioning, reclamation and closure of the mine site and associated infrastructure. A potential indirect effect may be allowing natural processes, such as avalanches to occur. This indirect effect is considered to pose low positive effects to biodiversity in the area.

Decommissioning, Reclamation, and Closure: Ravine Dam and Dry-Stacked Tailings Facility

The dam will be breached and drainage patterns re-established with existing streambeds. The dry-stacked tailings facility will be capped and seeded.

Local community biodiversity may be directly affected by decommissioning, reclamation and closure of the ravine dam and dry-stacked tailings facility. A potential direct effect may be an increase in habitat types. This potential direct effect is considered to pose low positive effects on local biodiversity.

Local community biodiversity may be indirectly affected by decommissioning, reclamation and closure of the ravine dam and dry-stacked tailings facility. A potential indirect effect may include restoration of natural drainage patterns. This indirect effect is considered to pose moderate positive effects to biodiversity in the area as the drainage patterns will no longer be influenced by human activity.

Mitigation Measures Summary

Mitigation measures will be implemented to minimize potential direct and indirect negative effects on biodiversity during all phases of the proposed project. All mitigation measures will be implemented as outlined in Section 6.2, for the maintenance of all biotic and abiotic components and their interactions. The following is a summary of proposed mitigation measures:

- wherever possible, alterations to natural drainage patterns, topography and avalanches will be minimized to maintain natural physical processes;
- wherever possible, local disturbance around the footprint will be minimized;
- introduction of deleterious substances will be avoided, including road dust by use of Best Management Practices;
- implement a no hunting policy for all mine employees and contractors while working at Mactung; and
- camp and mine wastes will be managed to avoid creating nuisance and dangerous wildlife that may lead to wildlife-human conflicts and/or wildlife mortality.

Table 6.2.7-14 outlines potential biodiversity effects from various project activities and proposed mitigation measures.

TABLE 6.2.7-14 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES: BIODIVERSITY						
Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Clearing and Construction of Access Road	Loss of habitat : -Low valleys (77.75 ha) (Supporting rare plant species and supporting bird species w/ conservation status) -in subalpine and alpine (77 ha)	Habitat type alteration through introduction of invasive and alien species or deleterious substances	• Avoid or minimize alteration of natural drainage patterns, topography and avalanches to maintain natural physical process • Implement and strictly enforce a no hunting policy for all employees and contactors		✓	
Clearing and Construction of Mine Site	Loss of alpine habitat (2.95 ha) Loss of habitat supporting bird species (2) w/ conservation status	Habitat type alteration through introduction of invasive and alien species or deleterious substances	• Avoid and minimize alteration of natural drainage patterns, topography and avalanches to maintain natural physical process • Implement and strictly enforce a no hunting policy for all employees and contactors • Proper camp management to avoid wildlife conflicts		✓	
Water Retention Dam	Loss of subalpine areas (49.55 ha) Loss of habitat supporting bird species (1) w/ conservation status	Habitat type alteration through introduction of invasive and alien species or deleterious substances	• Avoid and minimize alteration of natural drainage patterns, topography and avalanches to maintain natural physical process		✓	
Operations (including hauling)	Habitat type alteration through introduction of invasive and alien species or deleterious substances	Habitat type alteration through introduction of invasive and alien species or deleterious substances	• Implement and strictly enforce a no hunting policy for all employees and contactors • Avoid introduction of invasive and alien species or deleterious substances		✓	
Reclamation (includes decommission ing and abandonment)	Increase in habitat type in early serial stages	Occurrence of natural process (avalanches, floods) Natural drainage patterns	• Minimize footprint		✓	

Residual Effects

Given the expected potential low negative effects and implementation of the proposed mitigative measures, the proposed project is not expected to affect the overall local community biodiversity within the LSA. Potential residual effects are anticipated to be low. A wildlife monitoring program will evaluate the effectiveness of the adopted mitigation measures and adaptive management will be used to increase effectiveness where appropriate.

Table 6.2.7-15 summarizes the significance determination for biodiversity.

TABLE 6.2.7-15 SUMMARY OF SIGNIFICANCE DETERMINATION FOR BIODIVERSITY

Project Component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Clearing and Construction of Access Road	Negative	Moderate	Long-term	Low
Clearing and Construction of Mine Site	Negative	Moderate	Long-term	Low
Reservoir	Negative	Moderate	Long-term	Low
Operation (including hauling)	Negative	Moderate	Long-term	Low
Reclamation (includes decommissioning and abandonment)	Neutral	Moderate	Short-term	Low

Significance Determination

Potential project effects are likely to be low in magnitude, local geographical extent and medium-term in duration (Table 6.2.7-15). Project effects are considered to have a low effect on the productive capacity of habitats within the LSA, including those that support plant and bird species of special conservation status. The significance of the potential project effects on local community biodiversity within the LSA is considered low with the application of mitigation measures, including the completion of reclamation. There is the potential for minor residual effects if reclamation is only partially successful. However, any unsuccessful reclamation will be limited in spatial extent and not affect the overall local biodiversity.

6.2.7.8 Summary of Significance Determination for Wildlife Valued Components

Table 6.2.7-16 provides a summary of the significance of environmental effects for wildlife valued components.

TABLE 6.2.7-16 OVERALL SUMMARY OF SIGNIFICANCE DETERMINATION							
Project Activity	Caribou	Moose	Grizzly Bear	Wolverine	Avian Breeding Habitat	Hoary Marmots	Biodiversity
Clearing and Construction of Access Road	Low	Low	Low	Low	Low	Low	Low
Clearing and Construction of Mine Site	Low	Low	Low	Low	Low	Low	Low
Reservoir	Low	Low	Low	Low	Low	Low	Low
Operations (including hauling)	Low	Low	Low	Low	Low	Low	Low
Reclamation (includes decommissioning and abandonment)	Low	Low	Low	Low	Low	Low	Low

6.2.7.9 Proposed Wildlife Monitoring Program

The following section describes the proposed Wildlife Monitoring Program. The program will be further developed and implemented by NATC in consultation with appropriate Yukon government agencies and communities.

Objectives of the Wildlife Monitoring Program include:

- assessing the effects of the Mactung development on wildlife;
- evaluating the effectiveness of mitigation measures in avoiding or minimizing effects on wildlife;
- confirming compliance with regulatory requirements (e.g. Yukon Wildlife Act); and
- developing a framework to continually evaluate and adapt mitigation measures and best management practices.

The proposed Wildlife Monitoring Program focuses on key potential effects and specific wildlife Valued Components (VCs), such as caribou, moose, and grizzly bear.

NATC will be responsible for implementing the monitoring program, following appropriate Government of Yukon and community approvals. The monitoring program results will be provided to the appropriate agencies and communities on an annual basis, in the form of presentation(s) and or reports. Raw data will be maintained and managed by NATC and will be available to appropriate agencies and communities upon request.

Details of the proposed wildlife monitoring program are outlined in Table 6.2.7-17, while the VCs existing conditions and potential project effects are described in detail in Sections 4.1.9 and 6.2.1.7.

TABLE 6.2.7-17 SUMMARY OF PROPOSED WILDLIFE MONITORING ACTIVITIES

Valued Component	Background Information	Proposed Monitoring Activities
Caribou	Caribou are expected to occur in the vicinity of the Mactung project from late May to October when they will potentially encounter or be disturbed by local development-related noise and activities, and be exposed to road traffic and associated activities such as hunting. Potential avoidance effects from the Mactung project are considered the principal effect on caribou. The effects assessment concluded that both direct and indirect effects may occur, including potential avoidance from the Mactung mine and road areas. Mitigation measures to avoid or minimize potential caribou effects will be implemented, including but not limited to: posted speed limits, gated access to reduce hunting, reduced vehicle traffic, Wildlife Reporting Log, and a wildlife right-of-way policy. Mitigation measures proposed to avoid or minimize caribou effects are outlined in Section 6.2.1.7.1.5.	Potential caribou avoidance and direct mortality effects from the Mactung project will be monitored during the construction, operation, decommissioning, and reclamation project phases using two monitoring approaches: 1) A survey program will be established to monitor caribou distribution and abundance relative to the project infrastructure and activities in order to document whether changes to local caribou habitat use occur in conjunction with the project. NATC plans to develop the method schedule, and data reporting agreements in conjunction with territorial wildlife managers (Department of Environment) during the permitting phase of this project. Working with this agency will allow the monitoring program to be compatible with other ongoing management and monitoring programs in the local area or regions. 2) In addition to a survey program, a log of all reported wildlife contacts and sightings will be maintained by NATC during all phases of the project. Data from this program will help in monitoring interactions between caribou and the project by providing information on caribou occurrence in relation to the project, potential avoidance behaviors, and any cases of mortality. Data from this program will be monitored by NATC over the life of the project to determine whether a re-evaluation and potential alteration of existing mitigation measures or project activities are required.
Moose	Moose can be expected to occur in the vicinity of the Mactung project, particularly the access road and aerodrome year round, and will potentially encounter or be disturbed	Changes in moose behavior, or direct mortality effects from the Mactung project will be monitored during the construction, operation, decommissioning, and reclamation project phases using two monitoring approaches:

TABLE 6.2.7-17 SUMMARY OF PROPOSED WILDLIFE MONITORING ACTIVITIES		
Valued Component	Background Information	Proposed Monitoring Activities
	by local development-related noise and activities, including exposure to road traffic and potentially associated activities such as hunting. Potential mortality from hunting and vehicle collisions and habitat avoidance from the Mactung project are considered the principal effects on moose. The effects assessment concluded that direct and indirect moose effects from the Mactung mine would be local in geographical extent and low significance to the regional population. Mitigation measures to avoid or minimize potential moose effects will be implemented, including but not limited to: no-hunting policy, posted speed limits, gated access to reduce hunting, Wildlife Reporting Log, and a wildlife right-of-way policy. Moose mortality from hunting along the access road will be managed by the implementation of a no hunting policy for all mine employees and contractors and a gated access at a tributary of the Hess River Tributary. However, non-employee licenced and subsistence hunting can be expected along the access road outside the gated access.	1) A survey program will be established to monitor moose distribution and abundance relative to the project infrastructure and activities in order to document whether changes to local moose habitat use occur in conjunction with the project. NATC plans to develop the method, schedule, and data reporting agreements in conjunction with territorial wildlife managers (Department of Environment) during the permitting phase of this project. Working with this agency will allow the monitoring program to be compatible with other ongoing management and monitoring programs in the local area or regions. 2) In addition to a survey program, a log of all reported wildlife contacts and sightings will be maintained by NATC during all phases of the project. Data from this program will help in monitoring interactions between moose and the project by providing information on moose occurrence in relation to the project, potential avoidance behaviours, and cases of mortality. Data from this program will be monitored by NATC over the life of the project to determine whether a re-evaluation and potential alteration of existing mitigation measures or project activities are required.
Grizzly Bears	Grizzly bears, as well as wolverine, wolf and red fox, are potentially dangerous or nuisance wildlife that may be attracted to human developments. Under the Yukon *Wildlife Act*, it is unlawful to attract or encourage wildlife by leaving garbage or other attracting substances in a place accessible to wildlife, and reasonable precautions must be taken to prevent wildlife access or attraction to a site. Grizzly bears can be expected to occur in the vicinity of the Mactung project throughout the year, except during winter, and will potentially encounter	Grizzly bear occurrence or mortalities in relation to the Mactung project will be monitored during the construction, operation, decommissioning, and reclamation project phases. As noted above, a log of all reported wildlife contacts and sightings will be maintained by NATC during all phases of the project. It is anticipated that this log will provide NATC with grizzly bear observations (including signs and carcasses), vehicle collisions, or cases of nuisance bears. Data from this program will be monitored by NATC over the life of the project to determine whether a re-evaluation and potential alteration of existing mitigation measures or project activities are required.

TABLE 6.2.7-17 SUMMARY OF PROPOSED WILDLIFE MONITORING ACTIVITIES		
Valued Component	Background Information	Proposed Monitoring Activities
	or be disturbed by local development-related noise and activities, including exposure to road traffic and subsequent hunting, and may be attracted to activities occurring at the Mactung project site.	Additionally, any cases of nuisance bears, injuries or other encounters of concern between employees and grizzly bears, as well as vehicle collisions with grizzly bears will immediately be reported to the local Conservation Officer.

6.2.8 Water Resources

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

6.2.8.1 Hydrology

Identification of Valued Components

Two hydrology valued components (VC) have been identified for the project. These valued components are water quantity and flow timing (changes in the basin runoff hydrograph). These VCs have been identified due to the importance of water volumes and the temporal flow regime in supporting fish and benthic habitats.

Summary of Baseline Information

The hydrological regime for the project area is described in the 2006, 2007 and 2008 hydrometeorlogical reports (Appendix H1, H2 and H3 respectively), and in Section 4.1.10 of this proposal. The Mactung mine is situated in the upper headwaters of Tributary C (Figure 4.1.10-1). Tributary C flows into Tributary A. Tributary A flows approximately 1.5 km before joining the Hess River Tributary. Tributary A and the Hess River Tributary are known to have year round flows. The upper portion of Tributary C has seasonal flows with the lower portion immediately above the confluence with Tributary A having year round flows. Winter flows in these tributaries are sustained by groundwater recharge. The larger streams along the access road are believed to have year round flow based on their drainage areas and the occurrence of fish in some of the stream systems.

The Tributary C basin runoff response is quick, which is common for high elevation rocky basins with little mineral soil. The rapid basin response means that the seasonal peak flow event for this portion of Tributary C is expected to occur over a single 24 hour period. Tributary A also shows a rapid runoff response hydrograph. Peak flows for all streams in the project area typically occur during mid to late June, with the rise of the streamflow hydrograph starting in late April to early May as temperatures increase.

Identification of Temporal and Spatial Bounding

In order for the project to have an effect on a VC, both the VC and activity must be present in the same space and time. For hydrology related effects this is taken to mean the period during the year when there is flow within local streams including Tributary A, Tributary C, the Hess River Tributary, and streams that occur along the proposed access route. The Hess River Tributary and Tributary A in the project area are known to have year round flow from field observations. The larger drainages along the access road are believed to have year round flow based on the drainage basin size. Tributary C, above the ravine dam location, is thought to have seasonal flow (spring and summer), with the small drainages above this elevation in the watershed freezing up during the winter months. Tributary C below the location of the Warm Spring would have greater sustained flow above this point due to the constant year-round warm (37°C) groundwater contributions to the surface flow volumes.

Smaller sized drainages above the Warm Spring location are likely to freeze during the lowest flow winter months. The temporal occurrence of flow for the small drainages has been taken to be between April and October. Most of the small drainages crossed by the access road to the site will only have very minimal flows during the winter months and are expected to have a similar temporal occurrence (April to October) to the upper portion of Tributary C.

Effects Characterization

This section examines the potential direct and indirect effects of the construction, operation, and decommissioning phases on each of the identified VCs, including the effects of the mine and mine infrastructure, the DSTF, the ravine dam, reservoir, access roads, and the aerodrome expansion and associated camp.

Construction Phase

The construction phase is proposed to occur over a two-year period beginning in the summer 2010 and continuing until the end of 2012. The following activities have the potential for effects on hydrological processes during the Construction Phase:

- water withdrawals for aerodrome expansion
- water withdrawals for road construction;
- water withdrawals for road maintenance;
- water routed along built road surfaces;
- construction and operation of diversion channel;
- construction of the ravine dam; and
- water withdrawals for mine site use.

Withdrawals for Aerodrome Expansion Construction

Potential direct effects of water withdrawals may include increased sediment loading and stream de-watering. Potential indirect effects to fish and fish habitat may occur. The potential effects of dewatering activities described in this section are also applicable to subsequent sections such as road construction or road maintenance which potentially involve some water withdrawals. The effects on timing of flows are minor due to the low flow volume that will be withdrawn from the river during the period the activity is planned.

Water withdrawals for the aerodrome construction will be from the South Macmillan River which flows immediately adjacent to the facility. Water withdrawals for the construction phase will be required for sanitary systems (grey water) for the temporary 49-man construction camp, and for the civil earthworks. The South Macmillan River water will be treated and used for drinking water as well other camp uses. The freshwater demand at the camp is estimated to be less than 9800 litres per day.

The period of water withdrawals for this project component will be from June to October 2010, causing small sporadic reductions in the volume of streamflow in the South Macmillan River. Construction related to the aerodrome expansion will take approximately three months, while temporary camp activities at this location will occur throughout the identified time period. The potential effects of the water withdrawals will be sporadic for the aerodrome construction and constant for the temporary camp. The volume of water required for the civil earthworks component is minor and any potential negative effects can be mitigated through restrictions in the overall volume of water allowed to be withdrawn from a stream. Additional mitigation measures are discussed in Section 1.1.4.

The camp at the aerodrome will require a fairly constant source of non-potable water on a daily basis, which will be pumped from the river or an intake sump. Grey water will be discharged back into the environment through the sewage treatment facility and associated drainage field so there is virtually no net loss of water from the environment. The potential effects of this constant recirculation will be low, as typical water requirements for the construction camp will be less than 1 litre per second (L/s). This estimated withdrawal rate for the temporary construction camp (up to 49 persons) has been determined based on the estimated water demand for the permanent 150-person camp at the Mactung site (approximately 2 m^3/hr). The withdrawal rate will be less than 1% of the total flow within the South Macmillan River during the period of the water withdrawals; therefore the volume is within the natural variability for the local hydrological regime.

Withdrawals for Road Construction

Water withdrawals for road construction activities along the access road are expected to be required intermittently for compaction of earthworks and upgrade activities. The potential direct and indirect effects of road construction related water withdrawals on identified VCs are similar to those identified in the previous section. Water will be sourced from local streams close to the construction sites. Transportation of water will primarily be by water truck. The volume of water required for this component will be low but any potential downstream withdrawal related effects can be mitigated by controlling the rate of water withdrawal during each filling period. Additional mitigation measures are discussed in Section 1.1.4.

The periodic nature of this activity will not affect the timing of flows as it will occur during the open flow season (May to October) when higher stream volumes naturally occur. Withdrawal rates from the stream to fill water trucks would be pump controlled but are typically less than 2 m/s. Larger streams along the access road will be used for water withdrawals in order to maintain withdrawal rates at a low overall percentage of the total flow in the streams. It is expected that water withdrawals for this project activity will typically be less than 5% of the total streamflow for the pumping stations streams.

Withdrawals for Road Maintenance

Water withdrawals for road maintenance activities (primarily dust control) will be required during the construction phase of the project. NATC will use a water truck to transport and distribute this water. These withdrawals will be required only during the summer months when the road is not frozen. The effect from this activity has been assumed to potentially occur periodically at selected sites along the access road from May to October.

Water withdrawals will be from the major streams identified in the previous section where there is sufficient flow volumes to ensure that potential negative effects from lower water volumes do not occur. The volume of water required for this component cannot be estimated at this time but any potential downstream withdrawal related effects can be mitigated by controlling the rate of water withdrawal during each filling period. Additional mitigation measures are discussed in Section 1.1.4.

The periodic nature of this activity will not affect the timing of flows as it will occur during the open flow season (May to October) when higher water volumes naturally occur. Withdrawal rates from the stream to fill water trucks would be pump controlled but are typically from 3 - 5 L/s (0.003 - 0.005 m^3/s). It is anticipated that water withdrawals for this project activity will typically be less than 5% of the total streamflow for the pumping stations streams.

Water Routed Along Built Road Surfaces

There is the potential for effects on individual basin response hydrographs (flow timings from the construction and upgrading of the access road for this project. The construction of roads and ditches creates a shorter transit time for groundwater with the routing of the water through ditches, effectively shortening the response times from pre-development conditions. The new access road sections are near the valley bottoms and should not shorten groundwater transit times for water intercepted by road construction. Upgrading of the existing access road sections is not anticipated to result in effects to the pre-development conditions due to the existing cut slopes and ditches.

Diversion Channel

The construction of the northern diversion channel will allow for placement of the ravine dam by diverting approximately half (2.5 km2) of the existing 5.1 km2 drainage basin water volume around the ravine dam. The construction phase water balance data for this component are contained in Table 6.2.8-1. The table shows the majority of the flows occur between the months of May and October.

TABLE 6.2.8-1 CONSTRUCTION PHASE WATER BALANCE FOR TRIBUTARY C AT THE RAVINE DAM (M^3/S)

2012												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pre-Development Inflows to the Ravine Dam catchment (m^3/s)	0.012	0.008	0.007	0.009	0.162	0.414	0.261	0.154	0.117	0.069	0.030	0.018
Mean Natural Inflows to Diversion Channel (m^3/s)	0.012	0.008	0.007	0.009	0.162	0.103	0.131	0.077	0.059	0.035	0.015	0.009
Mean Natural Inflow to Ravine Dam and Reservoir (m^3/s)	0.012	0.008	0.007	0.009	0.162	0.310	0.131	0.077	0.059	0.035	0.015	0.009
Wastewater Treatment Discharge (m^3/s)	----	----	----	----	----	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
2013												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pre-Development Inflows to the Ravine Dam catchment (m^3/s)	0.012	0.008	0.007	0.009	0.162	0.414	0.261	0.154	0.117	0.069	0.030	0.018
Mean Natural Inflows to Diversion Channel (m^3/s)	0.006	0.004	0.004	0.005	0.081	0.207	0.131	0.077	0.059	0.035	0.015	0.009
Mean Natural Inflow to Ravine Dam and Reservoir (m^3/s)	0.006	0.004	0.004	0.005	0.081	0.207	0.131	0.077	0.059	0.035	0.015	0.009
Wastewater Treatment Discharge (m^3/s)	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Water Inflows from Hess Tributary (m^3/s)	----	----	----	----	----	----	----	----	0.0094	0.0094	0.0094	0.0094

This component of the mine will be one of the first activities conducted in order to minimize the volume of water flowing into the ravine dam work area. The diversion ditch construction has the potential for affecting the basin runoff response through reduction in the groundwater travel distances and transit times, and through changes to flow routing through a ditch as opposed to a natural channel.

The differences between ditches and natural channels are primarily the variations in gradient, channel roughness, with channel dimension for ditches being more effective at routing water. The distance between the diversion channel and the existing stream channel varies over the length of the channel, as do gradients and lengths. The diversion channel will result in an overall reduction in the time for flood response in Tributary C from this portion of the watershed due to a shorter flow path. This is not anticipated to have a negative downstream effect on flow timing as the overall shortening of the slopes is minor (50 to 100 m less than existing stream location) for most of the alignment. The ditch will be constructed in an uphill direction to provide for the gradual incorporation of the diversion channel into the hydrological regime.

The diversion channel is designed to route the Q100 flood event around the ravine dam. The diversion channel will direct flows into Tributary C through an existing drainage that will have armouring and rip-rap installed to ensure that it can withstand the additional flow volumes. The armouring and rip-rap design will meet applicable standards and will be designed during the ongoing detailed design and mine planning phase. Potential direct effects of construction may include increased sediment loading and stream de-watering. Potential indirect effects to fish and fish habitat may occur. A potential positive effect of the diversion channel will be to help maintain base flow conditions in Tributary C downstream of the ravine dam.

Ravine Dam

This section describes the potential hydrological effects from the ravine dam only during the construction phase. The longer term consideration of potential effects is described during the operation and decommissioning discussions. The ravine dam and associated reservoir are the lowest site infrastructure components on Tributary C. The DSTF is located within the un-diverted portion of the existing drainage area that flows to the reservoir. The footprint of the ravine dam will require de-watering to allow for stripping and placement of structural fill. The diversion channel located upslope of the DSTF will assist in de-watering that facility during construction.

The ravine dam has a catchment area of approximately 2.5 km^2 which is half of the Tributary C catchment upstream of the ravine dam. The construction phase water balance data are contained in Table 6.2.8-1. The table shows that the majority of the surface flows occur between the months of May and October with the remaining months providing water flow primarily from groundwater recharge. Potential direct effects of construction may include increased sediment loading and stream de-watering. Potential indirect effects to fish and fish habitat may occur.

An initial coffer dam will be constructed to allow for works to begin on the ravine dam structure and to provide a water source for mine site use. Discharges will be controlled from the coffer dam through pumping to a point downstream of the work site. The coffer dam and flow interception works will be conducted following freshet during the first year of construction (2012) with little to no potential effect on water volume during the peak flow period. The discharge rate to Tributary C from the ravine dam will be managed in accordance with the requirements of the Water Licence in order to minimize any potential negative effects on the basin response hydrograph.

Other water management features in the un-diverted catchment during this phase will consist of collection and interception ditches and settling ponds. All discharges to Tributary C from this activity will be required to meet the Water Licence discharge conditions. Water management required to meet discharge criteria will result in some short-term (<24 hour) potential negative effects to the basin runoff response from this site during this project phase in the event that water storage for settling of suspended sediment is required. Once the ravine dam and reservoir are ready to begin filling, the reservoir will be used as the primary sediment control pond for construction water.

The filling period for the reservoir is expected to occur during September and October 2012, when natural flow rates for the un-diverted catchment are 0.059 m^3/s and 0.035 m^3/s, respectively. The reservoir has a minimum operating capacity of 120,000 m^3 of water. Water for filling will be sourced from the un-diverted catchment and from the water intake structure on the Hess River Tributary to properly offset potential negative effects from reductions in Tributary C water volumes during the filling period. The use of the Hess River Tributary as a water source is discussed in greater detail below. Proposed mitigation measures for potential negative effects on the VCs from filling the reservoir are described in the mitigation section.

Withdrawals for Mine Site Use

The withdrawals for mine site use are not anticipated to have a negative effect on the timing of flows but will result in lower stream volumes. The potential direct effects of water withdrawals are the same as those identified in previous section (primarily increased sedimentation and temperature effects). Potential indirect effects may include reduced fish habitat quality. Water for mine site usage during construction activities will be varied in timing and overall demand. The construction camp will have a maximum year round water demand of approximately 50,000 L/day which is based on an average of 200 litres of water per person per day. The water demand for other uses will be primarily sporadic and will occur within the un-diverted catchment.

Water may be required for some surface drilling activities being conducted during this phase of the project. This water will be sourced from sumps and small drainages located within the un-diverted ravine dam catchment. Water for use in civil earthworks and concrete will also be from similar sources within the un-diverted ravine dam catchment. The overall volume of water that will be consumed during the construction phase by concrete usage will be minimal (<1% of overall flow volumes) compared with the natural run-off in this catchment. Any potential direct and indirect effects will be minimal and further mitigated as outlined in Section 1.1.4.

Some water will be sourced from the pond behind the initial coffer dam for most site requirements. This water will be located downgradient of the outflow of the proposed Waste Treatment facility so it would likely require water treatment prior to use as potable water. It is anticipated that once the water intake structure is constructed, water from the Hess River Tributary will be used to supply the construction camp and other site needs. The volume of water that would be required from the Hess River River during construction would be less than 1% of the estimated winter low flow volume (0.14 m3/s) within this tributary. Any potential direct and indirect effects will be minimal and further mitigated as outlined in Section 1.1.4.

Withdrawals from the Hess River Tributary

The construction of the water intake on the Hess River Tributary is scheduled to occur during the initial year of construction to supply water for mine site construction activities. The water demand for the construction camp is estimated to average approximately 2 m^3/hr.

Filling of the reservoir to the minimum storage capacity of 120,000 m^3 is expected to occur during September or October 2012. Water from the Hess River Tributary will be used as a source to minimize any potential negative effect from reduced Tributary C water volumes during this period. Pumping from the Hess River Tributary will be conducted at the estimated operation phase rate of 34 m^3/hr. Any potential direct and indirect effects will be minimized and mitigated as described in the following sections.

Potential Hydrological Effects from Accidents and Malfunctions during the Construction Phase

Potential accidents, malfunctions and natural disasters that would affect the flow volume or hydrograph during the construction phase are limited as most of the infrastructure being constructed will have a minimal effect on the hydrological VCs.

Potential instances of accident or malfunction that might effect the hydrology during this phase of the project include:

- blockage or failure of the diversion channel;
- excessive water withdrawals for emergency purposes (fire suppression); and
- failure of the ravine dam during the brief period between filling and commencement of operation.

Blockage of the diversion channel could result from landslides or snow avalanches. Failures of the ditch, as a result of blockage due to snow, are unlikely. The extent of landslides would determine whether the ditch breached and would be unlikely. Extreme flood events greater than the 1:100 year return period design event could allow for potential breaching or failure of the ditch once constructed. Ditch inspections will be conducted during the period immediately following diversion channel construction to ensure that the ditch is functioning according to design.

High volume withdrawals of water, in excess of amounts described in the mitigation section below, may occur during a fire emergency situation. All available water sources would potentially be used during this type of emergency. The period between the filling of the ravine dam and commencement of processing will involve the impoundment of approximately 120,000 m^3 of water.

The malfunction of the ravine dam during this would require an earthquake in excess of the 1000 year return period seismic design event. The potential effects of a dam breach during this period would be the release of some, or all, of the impounded water to the downstream receiving environment. Water would flow to both Tributary A and C, however; significant channel change as a result of such natural events would be expected to occur within Tributary C due to the relatively confined nature of the channel which is controlled by the topography. Tributary A has a wider floodplain so flood waters would be expected to overflow existing banks and cover a significant portion of the flat valley downstream of the confluence with Tributary C. This distribution of flood flows across the Tributary A valley could result in formation of new channels and a high likelihood of debris jams and coarse sediment deposition due to lower flow depths and velocities with increased flow width in Tributary A following the short duration flood surge.

Operation Phase

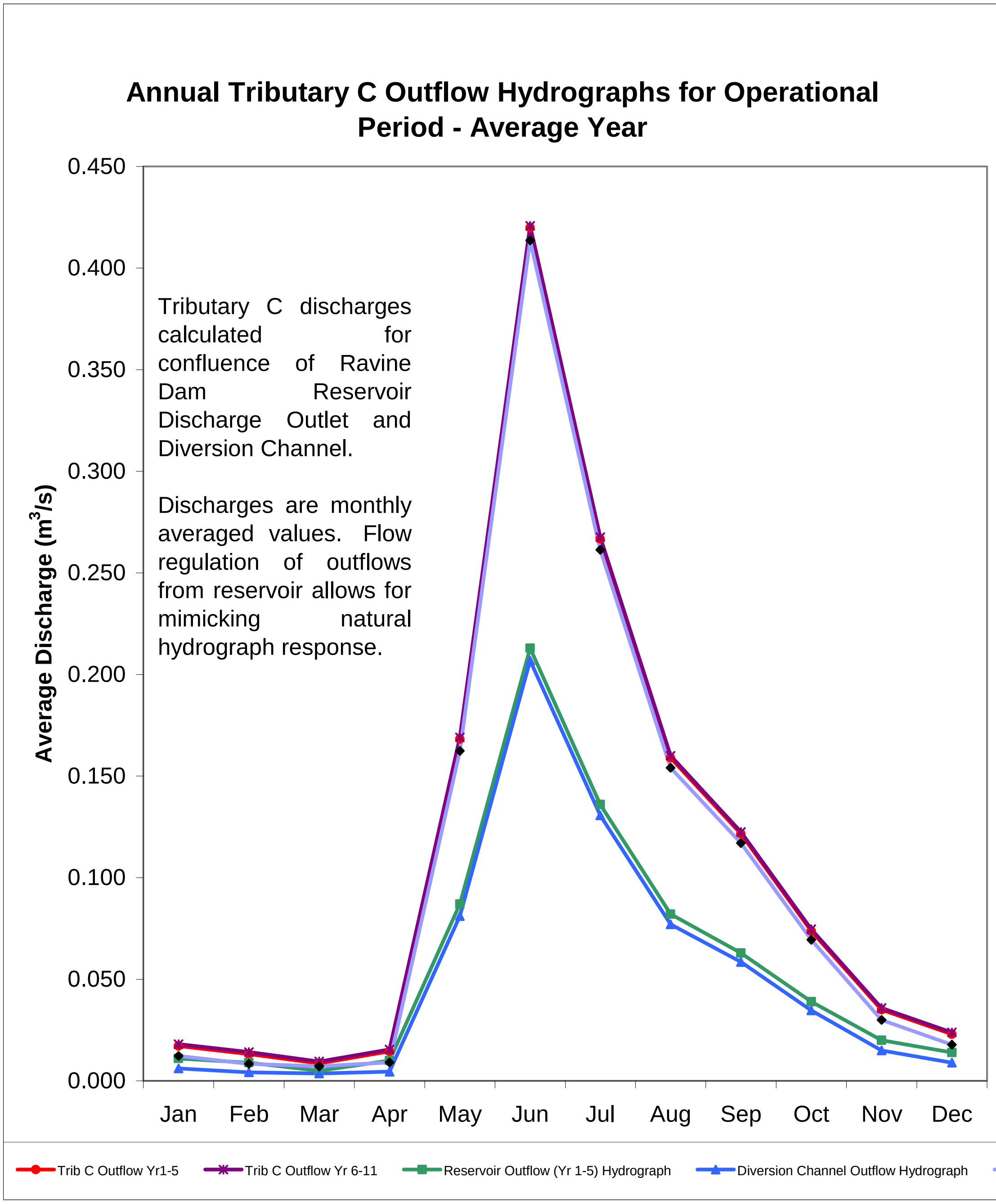
The operation phase of the project will run from early 2013 until the end of 2023. The operation phase water balance for a typical year is shown in Table 6.2.8-2, and presented in Figure 6.2.8-1. The potential direct effects on hydrology related VCs during the operation phase of the Project are predominantly associated with the following project activities:

- water withdrawals from Hess River Tributary;
- inflow to and outflow from the reservoir;
- seepage from the dry-stack tailings facility;
- stream diversions;
- discharges from underground workings;
- withdrawals for access road maintenance; and
- water routing along built road surfaces.

The potential direct effects of water withdrawals are the same as those identified for the construction phase of the project and may include sedimentation, stream de-watering and temperature increases.

TABLE 6.2.8-2 OPERATION PHASE AVERAGE YEAR WATER BALANCE BY MONTH (L/S)

	Process Water	Runoff	DSTF Seepage	Ground-water Discharge	Treated Effluent	UG Mine Dewatering	Process Water Reclaim	Ravine Dam Discharge	Ground water Seepage
	Inflow	Inflow	Inflow	Inflow	Inflow	Inflow	Outflow	Outflow	Outflow
January	46.9	6	0.3	6.6	0.5	1.0	-44.7	-10	-6.6
February	46.9	4	0.3	6.6	0.5	1.0	-44.7	-6	-6.6
March	46.9	4	0.3	6.6	0.5	1.0	-44.7	-5.4	-6.6
April	46.9	5	0.3	6.6	0.5	1.0	-44.7	-6	-6.6
May	46.9	81	0.3	6.6	0.5	1.0	-44.7	-87	-6.6
June	46.9	207	0.3	6.6	0.5	1.0	-44.7	-210	-6.6
July	46.9	131	0.3	6.6	0.5	1.0	-44.7	-171	-6.6
August	46.9	77	0.3	6.6	0.5	1.0	-44.7	-81	-6.6
September	46.9	59	0.3	6.6	0.5	1.0	-44.7	-61	-6.6
October	46.9	35	0.3	6.6	0.5	1.0	-44.7	-38	-6.6
November	46.9	15	0.3	6.6	0.5	1.0	-44.7	-18	-6.6
December	46.9	9	0.3	6.6	0.5	1.0	-44.7	-12	-6.6
Total Yearly Volume (m^3)	1479038	1665196	9461	208138	15768	31536	-1307612	-1862300	-129298



NOTES

Pre-development hydrology from regional flow analysis described in Section 4.1.10.
Process volumes from NATC.

ISSUED FOR USE

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Operations Phase
Tributary C
Outflow Hydrograph

PROJECT NO.	DWN	CHK	RE
W23101110.001	SDD	SD	0
OFFICE	DATE		
EBA-WHS	Dec 3, 2008		

Figure 6.2.8-1

Withdrawals from the Hess River Tributary

Water withdrawals from the Hess River Tributary will increase from the initial camp water demand during the construction phase to approximately 34 m^3/hr during full operation. The processing plant commissioning is scheduled to occur during the period from October to December 2012, followed by the 11 year continuous operation phase, which would run from January 2013 to December 2023. Flow withdrawals are expected to be continuous throughout the entire operation phase due to continued operation of the main camp even during periods of processing plant downtime.

The water flow rate during the winter low flow period in the Hess River Tributary is approximately 0.14 m^3/s (504 m^3/hr). During the mine operation phase, the fresh water demand will be approximately 6.7% of the available water during the low flow rate period (winter). On an annual basis the fresh water demand during full operation represents less than 1% of the total available water in the Hess River Tributary. Lower flows in the Hess River Tributary are augmented at the confluence with Tributary A, which is approximately 250 m downstream of the water intake infrastructure.

Hydrograph Effects from Ravine Dam and Reservoir Water Management

The ravine dam will be operated as a controlled discharge facility during the operation phase. The ravine dam is sized to retain the 100 year return period flood volume to allow for treatment in the event that the water does not meet discharge criteria. This design flood volume has been estimated to be approximately 520,000 m^3 and will be discharged from the facility into the receiving environment in a controlled manner throughout the open flow season.

The operation phase will see a year round positive increase in water volumes to Tributary C as a result of discharges of water sourced from the Hess River Tributary (Table 6.2.8-2). During the first five years of operation this amount of water is equal to 0.003 m^3/s which is the output of the waste water treatment plant (0.0003 m^3/s) plus water treatment plant outflows (0.0005 m^3/s) plus the difference between the estimated process plant water input and output rates (0.0022 m^3/s). After year five the average discharge rate will increase from underground dewatering inputs by approximately 0.001 - 0.004 m^3/s. This volume of water will result in winter low flows increases of 37% and 50% respectively at the ravine dam location. The overall increase in Tributary C flows at the mouth is less than 5%. The water volume increase is less during the open flow season when the majority of natural run-off occurs.

The effect of an increase in winter flow volumes would be to increase the base flow conditions for the duration of the eleven year operation phase. There may be some negative effects on the basin hydrograph response for individual storms due to the need to regulate the discharge of water from the ravine dam and reservoir.

No discharges to the receiving environment in exceedance of Water Licence flow rates will be allowed during the operation phase. Discharge rates from the ravine dam will exceed the natural flow rates that would be expected to occur in the pre-mining phase of the project as shown in Table 6.2.8-2. Discharges from the reservoir will be regulated with flow volumes in the diversion channel during operation. Discharges during the winter period will have the highest concentration of process water due to the low natural inflow rates.

Seepage from the Dry-Stacked Tailings Facility (DSTF)

Seepage volumes from the tailings in the DSTF are estimated at 74,000 m^3/yr. The process tailings are estimated to have a maximum moisture content of 20% prior to placement within the DSTF. The compaction of the tailings during placement will result in a moisture content of approximately 15%, with the seepage water being collected and routed to the reservoir. Some of this seepage will report to groundwater which will reduce the potential effects of overall surface water contributions from seepage of the DSTF. The DSTF seepage volume is minimal compared to surface run-off from the un-diverted ravine dam catchment during May to October and will not have any adverse effects outside of those described above for operation of the ravine dam during this project phase.

Hydrograph Effects from Diversion Channel

The effects of the diversion channel on the downstream basin response hydrograph are the same during the operation phase as during the construction phase. No negative changes in water volume along the diversion channel compared to pre-mining conditions are anticipated.

Water Discharges from Underground Workings

Dewatering of the underground workings will be required to some extent following year five of proposed mine operation when the workings extend below the area of frozen bedrock and the potential for groundwater inflows begins. Water from the underground workings will be routed to the reservoir where it will mix with the process water and other inflows to the reservoir. Underground dewatering is discussed in more detail in the hydrogeology effects section of this report.

The potential effects of the dewatering discharges would be a constant year-round positive transfer of regional groundwater to surface resulting in increased surface water volumes. The estimated average dewatering rate from the underground workings from year five of operation ranges from 5-125 m^3/day (0.05-1.5 L/s) with an average rate of 82 m^3/day (0.95 L/s). The dewatering contributions to the reservoir are low (less than 0.1%) during the mine operation.

Water Routed Along Built Road Surfaces

The effects on flow timing would be the same for this phase as for the construction phase. The effects would occur from May to October for the entire operation phase.

Potential Hydrological Effects from Accident and Malfunctions during the Operation Phase

Potential accidents, malfunctions and natural disasters that could affect the flow volume or hydrograph response during the operation phase are related to similar VC effects as during the construction phase of the project. The potential instances during this phase of the project may include:

- blockage or failure of the diversion channel;
- failure of the ravine dam; and
- excessive water withdrawals for emergency purposes (fire suppression).

Blockage of the diversion channel could result from landslides or snow avalanches. Failure of the ditch as a result of blockage due to snow is unlikely, while the specific extent of landslides would determine whether the ditch breached. Extreme flood events greater than the 1:100 year return period design could allow for potential breaching or failure of the ditch. Failure of the diversion channel during this project phase could result in some to all of the diversion water entering the ravine dam and reservoir until repairs to the channel could be conducted. Ditch inspections will be conducted during the period immediately following diversion channel construction in order to ensure that the ditch is functioning according to design.

The reservoir will have an operating volume of from 120,000 m3 to 620,000 m3. Failure of the ravine dam during this period would require an earthquake in excess of the 1000 year return period seismic design event. A spillway sized according to the Canadian Dam Safety Association guidelines and an appropriate consequence classification will be incorporated into the detailed design of the facility. A dam failure is extremely unlikely but the effects of a potential dam breach during this period would be the release of some, or all, of the impounded water to the downstream receiving environment.

Failure of the Ravine Dam may result in significant channel change within Tributary C where the channel is somewhat confined. Tributary A has a wider floodplain so flood waters would be expected to cover a significant portion of valley bottom downstream of the confluence with Tributary C and have little effect. This distribution of flood flows across the Tributary A valley flat could result in formation of new channels and also a high likelihood of debris jam formation.

High volume withdrawals of water, in excess of values described in the mitigation measures section, may occur during a fire emergency situation. All available water sources would potentially be used as a source during this type of emergency.

Decommission of the Project

The decommissioning phase of the project is scheduled to run from 2024 to 2025. The potential direct effects on hydrology related VCs during the decommissioning phase of the project are mainly associated with the following project activities:

- decommissioning of diversion channel;
- decommissioning of ravine dam;
- decommissioning of dry-stacked tailings facility;
- end of underground mining;
- end of Hess River Tributary withdrawals; and
- decommissioning of the access road.

Decommissioning of Diversion Channel

The stream diversion channel will remain in place until the end of the ravine dam decommissioning in order to minimize the volume of water entering the work area. It is expected that decommissioning activities will occur during summer 2025. Potential flow effects of the diversion channel for this project phase will be the same as the operation phase until decommissioning.

Re-contouring of the diversion channel will be conducted in a downstream direction once it is possible to re-divert flows into the original drainage patterns. Ditch re-contouring will not result in any negative effects on water volumes. The ongoing decommissioning of the diversion channel will result in the gradual re-establishment of pre-development natural drainage patterns and basin response. There may be the need to temporarily (<24 hours) store some water to treat construction related sediment being discharged to the receiving environment, which would result in a short-term transient effect for the period in which the re-contouring works are conducted.

Decommissioning of the Ravine Dam

The reservoir will be pumped down to below the minimum operating capacity of 120,000 m^3 to allow for commencement of decommissioning activities. Water flows will then be routed around the ravine dam with flow changes continuing until the diversion channel decommissioning is completed and all flows have been re-established to pre-development levels.

Decommissioning of the Dry-Stacked Tailings Facility (DSTF)

Decommissioning of the DSTF will be conducted during 2024. The positive addition of process water seepage to surface water volumes from the tailings stored in the DSTF will cease during 2024, which is the year after the end of the operation phase. The materials placed during the winter months of the final processing period will be allowed to thaw and drain prior to installation of the final cover system. No additional process water from seepage will be added to the Tributary C drainage following 2024.

The decommissioning of the DSTF will be conducted prior to decommissioning the ravine dam in order to have downstream control on any sediment that may be generated during the decommissioning of this facility. An impermeable liner will be placed over the surface of the DSTF and will act to limit oxygen and water access to the tailings materials. Borrows for the sourcing of cover material will be located within the undiverted ravine dam catchment. No potential negative effects from the decommissioning of the DSTF are anticipated.

End of Underground Mining

Underground mining activities are scheduled to end during 2023. It is anticipated that the underground workings will be sealed during 2024 or 2025. There will be no need to conduct dewatering activities following the end of underground mining so the positive contribution of the dewatering to surface flow volumes would cease at the end of 2023.

Decommissioning of the Access Road

The private sections of the access road to the mine site will be decommissioned at the end of this phase (2025 or 2026). Culverts will be removed from the road and there will be scarification and re-contouring to allow revegetation of the access road alignment. No potential direct or indirect negative effects to water volumes are anticipated during decommissioning of the access road.

There may be some minor site specific, short-term (<24 hour) negative effects to the timing of flows in drainages along the access road as a result of sediment management measures implemented to ensure that no sediment is released to the receiving environment. Check dams and pumps will be used to dewater culvert work areas with pump discharges being directed so that there are no exceedances of the Water Licence discharge criteria.

Potential Hydrological Effects from Accident and Malfunctions during the Decommissioning Phase

Potential accidents, malfunctions and natural disasters that could affect the flow volume or hydrograph response during the decommissioning phase are related to similar effects described for the operation phase of the project. The potential instances during this phase of the project may include:

- blockage or failure of the diversion channel;
- failure of the ravine dam; and
- excessive water withdrawals for emergency purposes (fire suppression).

Blockage of the diversion channel could result from landslides or snow avalanches. Failure of the ditch as a result of blockage due to snow is unlikely, while the specific extent of landslides would determine whether the ditch breached. Extreme flood events greater than the 1:100 year return period design could allow for potential breaching or failure of the ditch. Failure of the diversion channel during this project phase would result in some to all of the diversion water entering the ravine dam catchment until repairs to the channel are conducted. Ditch inspections will be conducted during the period immediately following diversion channel construction in order to ensure that the ditch is functioning according to design. The potential effect from failure of the diversion channel will decrease during decommissioning of this infrastructure component.

The ravine dam will be pumped down during 2024 to allow for sediment removal and start of the decommissioning activities on this facility. The potential effects from this activity are the same as during the previous project phases until storage volumes are reduced to below the minimum 120,000 m^3 volume. Potential effects from breach of this facility decrease as decommissioning activities progress until they are successfully mitigated through re-establishment of natural flow patterns.

High volume withdrawals of water, in excess of values described in the mitigation section, may occur during a fire emergency situation. All available water sources would potentially be used during this type of emergency.

Mitigation Measures

This section presents mitigation measures to minimize direct and indirect effects on the identified hydrological VCs during the various project phases. Some potential hydrological effects, such as those resulting from the diversion channel, cannot be mitigated until the decommissioning phase of the project is completed. However, all potential effects on hydrology are reversible and can be successfully mitigated within the first two years following the end of the operation phase. This section describes mitigation measures that will be employed during the various project phases to reduce any potential negative effects associated with the project.

Water Withdrawal Management - Access Road and Construction

- Water withdrawals from the areas of the aerodrome, access road, and diverted portions of the Tributary C catchment will be managed to partially mitigate potential effects resulting from lowered streamflows.
- Water withdrawals will not exceed 10% of the overall channel flow during the period of the withdrawal.
- Water withdrawals will be sourced from the major streams where there are sufficient flow volumes to ensure that potential negative effects from lower water volumes do not occur. Water withdrawal station locations will be determined during the detailed design phase for the road with the locations included in the Water Licence application for the project.
- Screening of water intakes will be conducted in accordance with appropriate legislated requirements to prevent fisheries effects.

Ravine Dam Discharges

- Discharges from the ravine dam will be regulated in order to prevent unwanted downstream channel erosion due to excessive flow volumes. The regulation of flows using gates or pumps will allow for the mimicking of natural flow conditions based on flows within the diversion channel. Flows will be monitored to assist in regulation of the ravine dam discharges.

- Pump discharge scenarios involve a regulated discharge that is based on the total pumping capacity. The maximum pumping capacity considered for the ravine dam would be on the order of 8,000 USGPM (0.51 m^3/s) which is less than the estimated 10-year peak run-off (Q10) of 1.34 m^3/s for the ravine dam catchment. Downstream effects from pumping at this rate would not be expected to result in downstream channel changes from changes to the Tributary C water volumes. The maximum pumping capacity will only be in effect during large return period storm events and as a result there is not anticipated to be downstream effects from water volumes being discharged from the reservoir as they would be lower than natural flows.
- A gated discharge system for the reservoir would be used in the same manner as a pumped discharge system.

Accidents and Malfunctions

- The primary mitigation measure for accidents and malfunctions is the use of applicable design standards, which provide a factor of safety, and the use of industry best management practices. Mitigation of potential accidents and malfunctions during all project phases would be identified through the monitoring and inspection programs that form part of the operating procedures for mine related infrastructure like the ravine dam and diversion channel.
- The hydrological effects from accidents and malfunctions related to the diversion channel can be partially prevented. Equipment from the DSTF construction fleet can be used to respond to situations on the diversion channel.
- Failure of the ravine dam under an earthquake in exceedance of the design seismic event cannot be mitigated; however there would be other substantial environmental effects occurring as a result of an event of this magnitude. Failure of the ravine dam as a result of other potential failure mechanisms will be evaluated using instrumentation installed within the dam structure along with a schedule of regular inspections by qualified personnel under the direct supervision of a registered professional engineer.

A summary of potential hydrological effects from the project and proposed mitigation measures are provided in Table 6.2.8-3

TABLE 6.2.8-3 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR HYDROLOGY

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Construction Phase							
Construction of Ravine Dam, Reservoir and Roads	Water Volume and Flow Timing	Altered, reduced flows on Lower Tributary C due to bypassing of construction site; increased sediment loading	Reduced fish habitat quality	• Erosion control and sediment management practices during construction. • Discharges around the work area to maintain flow			✓
Filling of Reservoir		Lowers Tributary C flows during filling	Reduced fish habitat quality	• Use of Hess River Tributary to supplement un-diverted inflows			✓
Stream Diversions		Altered, reduced flows from rainfall events. Unlined/armoured sections of diversions sediment mobilization	Reduced fish habitat quality	• Construction sequencing to minimize flow interruptions. • Erosion control and sediment management practices during construction.			✓
Water Withdrawals (Construction, Aerodrome)		Reduced flow during filling of water trucks	Reduced fish habitat quality	• Set maximum water withdrawal rates. • Screen pump intakes			✓
Operation Phase							
Withdrawals from Hess River Tributary during Low Flow Period	Water Volume and Flow Timing	Lower stream flows	Reduced fish habitat quality	• Withdrawals less than 6% for all but two months. • Additional fresh water storage in site water tank. • Screen water intake		✓	

TABLE 6.2.8-3 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR HYDROLOGY

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success: None	Anticipated Success: Partial	Anticipated Success: Complete
Discharges from Ravine Dam		Modified streamflows	Reduced fish habitat quality	• Ravine dam discharge flows managed in accordance with Water Licence.		✓	
Withdrawals for Road Maintenance		Lower streamflows	Reduced fish habitat quality	• Development of a water withdrawal strategy			✓
Flow Attenuation from Reservoir		Changes to timing of flows	Reduced fish habitat quality	• Ravine dam discharge flows managed in accordance with Water Licence.			✓
Runoff Diversion (Diversion Channel)		Very minor change to flow timing	Very minor changes to flow timing	• None			✓
Seepage from Dry-Stack Tailings Facility		Flows to reservoir during operation	-	• Discharges collected in ravine dam and reservoir.			✓
Discharges from Underground Workings		Increased streamflows	-	• Discharges collected in the reservoir.			✓
Decommissioning Phase							
De-commissioning of Stream Diversions	Water Volume and Flow Timing	Natural flows partially re-established in Tributary C	Positive effect on fish and benthics	• Decommissioning methods to minimize flow interruptions			✓
De-commissioning of Ravine Dam		Natural flows regime re-established in Tributary C	Increased erosion and riparian area sediment production until natural stream equilibrium is attained, temporarily affecting fish habitat.	• Ravine Dam Discharge Regulation • Decommissioning Plan			✓
Withdrawals for Road Watering		Lower flows during filling of water truck	-	• Set maximum water withdrawal rates.			✓

TABLE 6.2.8-3 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR HYDROLOGY

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Seepage from Dry-Stack Tailings Facility		Additional water volume liberated during placement.	Metals to Tributary C, indirect effect to fish and benthics	• Impermeable cover to isolate tailings			✓
End of Underground Mining		No additional discharges from underground workings	Lower metal loadings to Tributary C, positive indirect effect on fish and benthics	• None required.			✓
End of Hess River Tributary Withdrawals		Natural flows re-established in Hess River Tributary	Positive effect on fish and benthics	• None required			✓

Significance Determination

The potential direct and indirect effects of project activities on hydrology can be mostly mitigated during construction and operation by implementing the mitigation measures noted above. The potential direct and indirect effects would all be successfully mitigated by the final decommissioning of the mine and its associated infrastructure. The reversal of any potential effects on the hydrological VCs will be deemed complete once natural flow patterns have been re-established in the project area following decommissioning. Table 6.2.8-4 provides the significance determination summary of potential effects for the project activities that are not considered to be fully mitigated.

TABLE 6.2.8-4 SUMMARY OF SIGNIFICANCE DETERMINATION FOR HYDROLOGY

Project Component	VC	Direction	Magnitude Extent Duration	Reversibility	Frequency
Discharges into Tributary C from reservoir during low flow period (February and March)	Water Volume	Positive	Moderate	Short-term	High
Withdrawals from the Hess River Tributary during low flow period (February and March)	Water Volume	Negative	Moderate	Short-term	High
Diversion channel	Flow Timing	Negative	Low	Short-term	Medium

Discharges from the ravine dam may locally increase flows in Tributary C by approximately 3 L/s to 4 L/s which is up to a 50% increase in pre-development flows during the winter low flow period. This increase in flows is as a result of the water withdrawals from the Hess River Tributary being discharged into Tributary C from the ravine dam. The positive addition of water during the winter low flow period would increase the depth of water in Tributary C. The effect of flow increases from the ravine dam during the winter months is judged to be of low significance due to the lack of potential adverse effects and the periodic nature of the increased discharge.

Water withdrawals from the Hess River Tributary will have moderate effect on hydrology in this stream during the winter low flow period, which would result in an approximately 6% reduction in the total streamflow. For months outside of the low flow period the water withdrawal rate would be less than 5% of the total streamflow with the annual average being less than 1% of the streamflow. The effect of the low flow period withdrawals would persist downstream 250 m until the confluence with Tributary A.

There is approximately 128 m^3 of freshwater storage in the site water tank that could be used to supplement water demand during periods of low stream flow. The lack of any identified sensitive habitat in the effected area of this stream makes the overall significance of these water withdrawals low.

Flow timing effects as a result of the diversion channel are judged to be of low significance. The routing of flows through this structure will closely mimic the natural basin response and the timing of runoff response should not be significantly affected. The effects would be short-term and occur periodically in response to precipitation or snowmelt events. The effects will cease on decommissioning of the diversion channel.

6.2.8.2 Surface Water Quality

Identification of Valued Components

Surface water quality has been identified as a valued component (VC) due to its importance, both directly and indirectly, in supporting life. Water quality is regulated under both territorial and federal legislation and is considered significant to all people.

Summary of Baseline Information

Water quality sampling was conducted in the Mactung project area between June 2006 and May 2008. A total of seven water sampling stations were located along Tributary C, Tributary A, the Hess River Tributary and the South Macmillan River (see Figure 4.1.10-11 in the water quality existing conditions section). The locations of the sampling stations are summarized below:

- WQ1 - Tributary C
- WQ1A - Tributary C
- WQ2 – Tributary A
- WQ2A – Tributary A
- WQ3 – Upper Hess River Tributary
- WQ4 – Lower Hess River Tributary
- WQ9 – South Macmillan River

First order tributary sampling locations (WQ1, WQ1A, WQ2 and WQ2A) receive direct runoff from neighbouring mountains, while second order tributary sampling stations (WQ3, WQ4 and WQ9) are located in larger valley systems.

Collected water samples were shipped to an accredited laboratory for analysis of standard physical and chemical parameters. Physical parameters such as total suspended solids (TSS), turbidity, pH, electrical conductivity (EC), nutrients (i.e., ammonia – N, nitrate, and total phosphorus), major ions (i.e., calcium, potassium, magnesium, sodium, and iron) and total organic carbon (TOC) were requested for analysis. These parameters were selected as they typically demonstrate early signs of anthropogenic disturbances.

The Mactung property is located in an area of high natural mineralization with large mineral deposits below and at the surface, which influences natural water quality conditions. There are also natural thermal springs at various locations, further influencing surface water quality. Section 4.1.11 noted that there are natural exceedances for several water quality parameters including; nickel, selenium, zinc, and pH. The observed concentrations at the water quality monitoring stations vary from month-to-month, and year-to-year.

Water quality results at station WQ2, located at the base of Tributary A, consistently exceeds Canadian Council of Ministers of the Environment (CCME) guidelines for total nickel, total selenium, and total zinc. Since Tributary C is also subject to seasonal exceedance of the CCME guidelines, this stream warrants consideration of site specific water quality objectives. The naturally occurring exceedances of water quality guidelines are most likely attributed to exposed natural metal deposits that are slowly leaching into the watercourse within the Tributary A drainage.

In general, station WQ9 (South Macmillan River) has the highest electrical conductivity and total metal concentrations. Tributary A (WQ2), has the highest nutrient, major ion and total metal concentrations and therefore has the lowest baseline water quality. Station WQ3 (Hess River Tributary) has the lowest total metal concentrations, and station WQ1 (Tributary C) generally has the lowest major ion concentrations and physical properties. Stations WQ2A (Tributary A) and WQ9 (South Macmillan River) recorded pH values below the lower CCME range for this parameter. These low pH values are attributed to natural acid rock drainage occurring within each of these drainages. The high metal concentrations within the Macmillan River support this assertion.

Previous studies by AMAX (1974) stated that generally the water quality of the various tributaries of the Hess River was typically good and clear, with low turbidity values. They also state that the water quality of the feeder tributaries is generally lower than that of the main Hess River Tributary. Baseline water quality in the Mactung study area appears to have remained relatively constant since the studies performed by AMAX in the 1970s.

Identification of Temporal and Spatial Bounding

Following the start of construction, it is anticipated that there will year-round surface activities in the project area that will persist into the decommissioning phase. Flow within local streams and rivers including Tributary A, Tributary C, Hess River Tributary, and South Macmillan River can occur year-round. A number of the project activities are in, around, or directly involve water at the Mactung property and along the proposed access road. As a result, there will be overlap between the project activities and water quality on a year round basis.

Effects Characterization

A detailed examination of the potential water quality effects by project phase is provided in the following sections. Project activities can be grouped based on the commonality of potential effects on water quality. Potential water quality effects include:

- adverse effects - from the introduction of a contaminant or deleterious substance, into the surface water environment. The Yukon *Environment Act* defines a contaminant as:

  a solid, liquid, gas, smoke, odour, heat, sound, vibration, pathogen or radiation or any combination thereof that is foreign to the normal constituents of the natural environment, or that exceeds normal quantities or concentrations in the environment, and that results directly or indirectly from human activity that may cause or contribute to causing adverse effect.

The federal *Fisheries Act* defines a deleterious substance as:

A substance is deleterious if it is harmful to fish, if it limits the use of fish by humans, or if by going through some process of degradation, it harms the water quality (for example, oxygen-depleting wastes). A substance is also deleterious if it exceeds a level prescribed by regulation.

- indirect effects - that result from a specific project activity, e.g., potential effects on fish habitat.

Potential adverse effects have been subdivided into sediment and chemical related effects for the purpose of discussion.

Sediment Related Contaminant Effects

Increased sediment loading to watercourses may occur when there are activities that involve personnel or equipment working in and around watercourses. Project activities where potential sediment related effects may occur include:

- construction and upgrading of access roads;
- construction of mine site water retention and diversion structures;
- access road maintenance activities;
- maintenance of the diversion channel;
- discharges from the ravine dam;
- decommissioning of mine site water retention and diversion structures; and
- decommissioning of access roads.

Chemical Related Contaminant Effects

Chemical, nutrient and organic additions to the water course may result from specific project activities or as a result of accidents or malfunctions. Potential effects are of concern due to sensitive receptors in the receiving environment (e.g., fish, and wildlife).

Examples of project activities where potential chemical effects may occur include:

- mineral processing;
- mixing and use of concrete;
- discharges of mine effluent from the reservoir; and
- accidents and malfunctions.

Indirect Water Quality Effects

Water quality may be indirectly affected by project activities. Activities involving water withdrawals could result in lower streamflow. Sediment that would normally be transported through the system may potentially deposit on streambeds as a result of this type of activity. Activities that result in positive increases to streamflow would increase sediment transport capability and could lead to erosion causing degradation of water quality.

Accidents and Malfunctions

Accidents and malfunctions may occur during any project phase and the potential effects on water quality would be primarily as a result of contaminant related causes. Potential accidents and malfunctions that may occur during the project life include:

- spills to the receiving environment from vehicle or bulk transport accidents along the access road to and from the site;
- spills during fuel dispensing activities;
- accidental release of concrete mixing water into the receiving environment;
- increased sediment loading from poorly maintained sections of access road (i.e., plugged ditches and culverts); and
- plugged diversion channel caused by landslides or snow avalanches.

Water Quality Predictive Modeling

A conceptual site geochemical model was created to identify the possible interactions between the effluent from various mine and processing components and how these effluents would react within the reservoir. Development of a more detailed model for the site is not warranted at this stage as the current level of assessment should provide an indication of whether there would be anticipated effects from the operations. The conceptual model identified the following considerations:

- natural surface and groundwater geochemistry;
- metal loading from waste rock used in surface infrastructure;
- metal loading from tailings stored on surface or backfilled underground in the unfrozen bedrock zone; and
- metal loading from residual process water in the reservoir.

Ongoing data collection during the construction and operation phases will allow for the development of a comprehensive predictive model for the final site closure plan that would be submitted during the latter portion of the operation phase. The modeling software Phreeqc Interactive 2.15.0 MIX model and database software "wateq4f" were used for the reservoir mixing predictions (Parkhurst and Appelo 1999). The groundwater flows from the underground workings were determined to represent less than 1% of the overall flows to the reservoir during low flow conditions. The predictive model was coupled to the site water balance to determine the proportion of loadings from the individual mine components.

Model Assumptions

To develop a predictive geochemical model, it was necessary to identify data gaps and potential sources of data to fill these gaps. A geochemical comparison (Appendix C2) of the Cantung and Mactung deposits has shown that the two deposits are similar in nature. Data from the Cantung mine was used to complete data requirements for the predictive model based on this comparative study. The model will be updated as results from the Mactung metallurgical testing program become available. The following assumptions and data transfers from Cantung were made for the predictive modeling:

- process water chemistry from Cantung mine was used to represent chemistry of Mactung mine process water;
- metal loading rates from the Cantung mine tailings humidity cell were used to represent the potential loadings for tailings materials;
- shake flask testing results for Mactung waste rock were used to reflect leaching from surface infrastructure pads;
- mineralogy of the Mactung ore grade materials was used to estimate the mineralogy of the tailings;
- surface water sampling from Mactung (August 2008) was used to represent surface water chemistry;
- groundwater collected from downgradient of the area of the Mactung underground workings was used to represent groundwater geochemistry;
- surface hydrology from the Mactung baseline programs were used to determine runoff from mine components; and
- groundwater flow rates were determined from detailed hydrogeological assessment conducted on the Mactung property.

The predictive model included the assumption that effluents were oxygenated and that there was sufficient time in the reservoir to allow for chemical precipitation to occur. A reduction in actual turbulence of the reservoir may be achieved through installation of booms to decrease wave action. A copy of the input data for the predictive model are contained in Appendix C2.

Conceptual Model Results

The results of the predictive modeling for discharges from the ravine dam during operations are contained in Table 6.2.8-5. Two different model scenarios are shown in the table. The results were based on the conservative use of the maximum recorded metal loading rates for each metal from the first 66 weeks of operation from the Cantung mine tailings humidity cell. The Cantung humidity cell is constructed from a series of composite monthly samples and is meant to represent the bulk response from more than a single processing period.

The results of the predictive modeling show that there are no anticipated exceedances of the federal Metal Mining Effluent Regulation (MMER) discharge criteria. The CCME guidelines for the protection of aquatic life may be potentially exceeded for aluminum, copper and cadmium. The cadmium concentrations for the natural surface water quality are naturally elevated above the CCME guidelines. This material is not subject to precipitation within the reservoir and is not significantly influenced by the processing activities at the site. Copper concentrations in the reservoir were below the MMER criterion but are approximately 10 times above the CCME guidelines, while aluminum in the reservoir is only slightly elevated above CCME guidelines but falls below CCME thresholds following dilution with discharges from the diversion channel.

TABLE 6.2.8-5 PREDICTED RESERVOIR CHEMISTRY BALANCE

Parameter	Unit	Before Precipitation	After Precipitation	Metal Mining Effluent Regulations	CCME Guideline for the Protection of Aquatic Life
pH		8.3	8.3	6.5 – 9.0	6.5 – 9.0
Pe		14.3	14.3		
Cl	mg/L	0.0009	0.0009		
S(6)	mg/L	116.8	116.8		
Al	mg/L	0.62	**0.14**		0.1
As	mg/L	0.0018	0.0018	0.5	0.005
Ba	mg/L	0.014	0.014		
Ca	mg/L	38.28	38.28		
Cd	mg/L	0.00021	0.00021		0.00024
Cu	mg/L	0.030	**0.030**	0.3	0.002
Fe	mg/L	2.44	0.00006		0.3
K	mg/L	6.99	6.99		
Li	mg/L	0.08	0.08		
Mg	mg/L	6.53	6.53		
Mn	mg/L	0.115	0.115		
Ni	mg/L	0.0043	0.0043	0.5	0.065
Na	mg/L	109.4	109.0		
P	mg/L	0.66	0.66		
Pb	mg/L	0.00075	0.00075	0.2	0.002
Se	mg/L	0.00080	0.00080		0.001
Si	mg/L	4.90	3.41		
Sr	mg/L	0.089	0.089		
Zn	mg/L	0.016	0.016	0.5	0.03

Note: **bold** numbering indicates potential exceedances of stated guidelines.

Mitigation Measures

This section presents mitigation strategies to minimize potential water quality effects during the various project phases. All potential water quality effects can be successfully mitigated at the end of the decommissioning phase. This section describes mitigation strategies that will be employed to reduce the potential for negative effects associated with project activities based on the earlier grouping of potential water quality effects.

Sediment Related Effects

The mitigation of sediment related effects will be implemented through use of best management plans and practices for construction activities and engineered design. Mitigation measures for sediment related effects include:

- inclusion of erosion and sediment management controls into detailed infrastructure designs;
- engineered design for all rip-rap and bank armouring designs;
- appropriate sizing and design of all culverts and bridges along the access road;
- revegetation of disturbed areas to minimize sediment mobilization from erosion; and
- encapsulation of operation phase reservoir related sediments in dry-stacked tailings facility.

Chemical Related Effects

The mitigation of chemical related effects will be conducted through use of best management plans and practices for construction activities (such as concrete pouring) that occur in and around watercourses. Mitigation measures for chemical related effects include:

- locate processing plant and other infrastructure within the undiverted reservoir catchment area, to prevent uncontrolled discharges to the receiving environment;
- comply with Water Licence criteria;
- employ approved process treatment chemicals and operate the plant efficiently to minimize contaminants;
- treat reservoir discharge water, if required;
- conduct environmental construction monitoring during activities, such as concrete pouring for the water intake facility, to ensure that the waste water from concrete mixing is disposed of in an acceptable manner;
- maintain a minimum 30 m re-fuelling distance from watercourses, where possible. Where re-fuelling activities are to occur within 30 m of a watercourse, then a spill kit is required to be available at this location for the duration of the re-fuelling activities;
- properly design and maintain containment measures for bulk fuel storage facility;

- prepare, and have available, spill kits containing appropriate amount and type of materials where project activities occur in and around a waterbody;
- progressively remediate hydrocarbon contaminated soils in an on-site land treatment facility (LTF) during operation and into decommissioning; and
- include LTF operations, Phase II Environmental Site Assessment (ESA), and Phase III ESA in decommissioning plan (Appendix M1).

Indirect Water Quality Effects

Indirect effects on water quality have been identified as potentially occurring as a result of water withdrawals for project activities through all phases. The potential for indirect water quality effects will be mitigated as follows:

- water withdrawal station locations will be identified in the Water Licence application. These stations will be used for water withdrawal during the construction, operation and decommissioning phases.
- water withdrawal rates will be <10% of total flow except where terms and conditions of the Water Licence allow for a higher proportional rate.

Accidents and Malfunctions

Potential effects on water quality from accidents and malfunctions will be minimized through the use of accepted design standards and construction practices, and the development of operating procedures for mine site infrastructure components. Periodic inspections and routine maintenance are also used to minimize the potential occurrence of accidents and malfunctions. If accidents or malfunctions occur, the Emergency Response Plan and Spill Contingency Plan (Appendix M2) will provide personnel with the proper response and notification procedures. Spill kits and spill response training will also be in place at the mine to ensure that potential effects from accidents and malfunctions are managed in an appropriate manner.

Table 6.2.8-6 summarizes the direct and indirect effects and the anticipated success of proposed mitigation measures for each primary activity.

TABLE 6.2.8-6 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR SURFACE WATER QUALITY						
Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Construction Phase						
Temporary Camp sewage (Aerodrome)	Potential for increased nutrient, metal or pathogenic loadings.	Potential risk to human health	• Sewage Treatment system • Qualified operations and maintenance personnel			✓
Water withdrawals: Construction, aerodrome, temporary camp and access road	Increased potential for sedimentation Potential temperature effects depending on season	Potential aquatic effects and habitat degradation	• Water withdrawals kept to less than 10% of total flow			✓
Road construction and upgrades	Introduction of a deleterious substance into the receiving environment	Potential aquatic effects and habitat degradation	• Equipment, instream, earthworks best management practices and scheduling.			✓
Construction of Water Intake Infrastructure (2010)	Introduction of a deleterious substance into the receiving environment	Potential aquatic effects and habitat degradation	• Equipment, instream, earthworks best management practices and scheduling. • Spill Contingency Plan			✓
Construction of Diversion Channel	Introduction of a deleterious substance into the receiving environment	Loss of stream energy, altered hydrograph response	• Equipment, instream, earthworks best management practices and scheduling.			✓
Construction of Ravine Dam	Introduction of a deleterious substance into the receiving environment	Potential aquatic effects and habitat degradation	• Equipment, instream, earthworks best management practices and scheduling. • Sediment management practices for construction phase permitting			✓
Operation Phase						
Water Withdrawals including Hess River Tributary	Decrease in streamflow and sediment transport potential	Potential aquatic effects and habitat degradation	• Water withdrawals to be kept to less than 10% of total flow • Site water tank sized to provide some freshwater requirement for processing.			✓

TABLE 6.2.8-6 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR SURFACE WATER QUALITY

				Anticipated Success		
Discharges from the ravine dam	Introduction of a deleterious substance into the receiving environment (increase in copper greater than CCME)	Potential aquatic effects and habitat degradation	• Development of site specific Water Quality Objectives based on natural exceedances • Treat water, if required • Compliance with Water Licence criteria			✓
Discharges from Underground Workings and Dry-Stacked Tailings	Increased metal and nutrient loadings		• All discharges report to the reservoir			✓
Mine Maintenance activities in and around water bodies	Introduction of a deleterious substance into the receiving environment	Potential aquatic effects and habitat degradation	• Equipment, instream, earthworks best management practices and scheduling. • Suitable design and construction of access roads. • Erosion control and sediment management best practices.			✓
Road Maintenance activities in and around water bodies	Introduction of a deleterious substance into the receiving environment		• Ravine dam operations manual to include a section on introduction of deleterious substances. • Pre-freshet inspections and snow clearing • Annual engineering inspections			✓
Decommissioning Phase						
Discharges from Ravine Dam	Potential additional metals, nutrient and sediment		• Ability to stop discharges during periods of potential non-compliance with Water Licence			✓
Decommissioning of on-site Infrastructure and roads	Introduction of a deleterious substance into the receiving environment	Potential aquatic effects and habitat degradation	• Works located within the ravine dam to use sediment management controls			✓
Decommissioning of Water Intake Infrastructure	Introduction of a deleterious substance into the receiving environment	Potential aquatic effects and habitat degradation	• No instream closure works required.			✓
Decommissioning of Diversion Channel	Introduction of a deleterious substance into	Increased sediment erosion until	• Equipment, instream, earthworks best management practices and scheduling.			✓

TABLE 6.2.8-6 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR SURFACE WATER QUALITY

				Anticipated Success		
	the receiving environment	natural stream is reached	• Erosion control and sediment management practices. • No water discharge to environment unless it meets Water Licence criteria			
Decommissioning of Ravine Dam	Introduction of a deleterious substance into the receiving environment	Altered hydrograph effects in response to rainfall	• Equipment, instream, earthworks best management practices and scheduling. • Erosion control and sediment management practices. • No water discharge to environment unless it meets Water Licence criteria			✓
Decommissioning of Tailings Area	Introduction of a deleterious substance into the receiving environment		• Works located within the reservoir catchment • Decommissioning this facility prior to ravine dam			✓

Significance Determination

Based on the applied mitigation measures described above, the effects of the proposed project on water quality are determined to be of low significance. Therefore, no further significance analysis is required.

6.2.8.3 Hydrogeology

Identification of Valued Components

Groundwater is a significant element of the local ecological system and therefore groundwater quality and quantity form valued components (VC) within this environmental effects assessment. Both groundwater quality and quantity may be described as special elements of the local ecosystem.

There are no aquifers of regional or territorial significance, and no water well users in the vicinity of the project area.

Summary of Baseline Information

Below is a summary of relevant baseline information previously presented in the existing conditions section (Section 4.1.10.3) of this project proposal:

- The regional groundwater flow divide coincides with surface water divides to the north, east, and south of the project area. Groundwater from the project area discharges to the valley of Tributary C south of Mt. Allan.
- The groundwater flow direction generally mimicks the slope of surface topography. Deep groundwater flows from the highest areas of Mt. Allan southwards, turning southwesterly or westerly in the valley of Tributary C. Shallow groundwater flow within the overburden is characterized by local, small-scale flow cells, with its flow direction closely following local topography.
- Groundwater recharge typically occurs at higher elevations with groundwater ultimately discharging to surface water bodies at lower elevations in valleys. The presence of permafrost in the upland areas tends to reduce and/or inhibits infiltration to groundwater. At lower elevations where permafrost is discontinuous or absent, groundwater recharge to the deep aquifer occurs where a hydraulic connection exists between the shallow overburden and underlying bedrock aquifers.
- The horizontal hydraulic gradient in the bedrock aquifer ranges from about 0.02 (i.e., 2 m vertical per 100 m horizontal) in the upland areas of Mt. Allan to about 0.5 in locations south of the proposed mill site. The hydraulic gradient in the valley south of Mt. Allan appears to be fairly constant at 0.1-0.15. Based on the hydraulic conductivities obtained from hydraulic tests, the hydraulic gradients inferred from groundwater level measurements, and assuming a bedrock porosity of about 0.05-0.15, the mean flow velocity of the deep groundwater is estimated to range from about a few metres to several tens of metres per year.
- Shallow and deep groundwater samples obtained from the site had low to moderate concentrations of total dissolved solids, and correspondingly low to moderate electrical conductivities. The pH values ranged widely (from 7.0 to 9.4) and hardness ranged from 78 to 267 mg/L. Dissolved oxygen concentrations were generally low suggesting reducing chemical conditions, except for the shallow groundwater samples which had dissolved oxygen concentrations of about 11.5 mg/L. The groundwater temperature varied between 1.2 and 3.1°C.
- Calcium is a dominating cation in all groundwater samples from the project area. Magnesium was only dominant in the sample from observation well MW-MT-08-05. Bicarbonate and sulfate were the dominating anions in all samples, except for the sample collected from observation well MW-MT-08-08 in which sulfate was the only dominating anion.
- Natural background concentrations for aluminum, cadmium, iron, selenium, and zinc slightly exceeded the CCME guideline values for the protection of aquatic life. However, all concentrations were below the Yukon Contaminated Sites Regulation aquatic life standards.

Identification of Spatial and Temporal Bounding

From a hydrogeological perspective, potential effects related to groundwater occur at locations where there is a spatial and temporal overlap of mine infrastructure or activities resulting in a potential change to groundwater quality or quantity. These conditions can exist where surface water exfiltrates from or drains through surface or subsurface mine facilities, where groundwater is extracted from or added to the subsurface, and where chemicals are released to the ground surface or subsurface. The groundwater quality and quantity in these areas of spatial overlap are in fact the specific valued components. A summary of the specific VCs and the associated temporal overlap are summarized below:

- **Underground workings:** groundwater (quantity and quality) within the mine area and draining to the mine workings while the ore is extracted; and, groundwater seepage through the backfilled workings after ore extraction. These effects may occur during the later stages of mining (years 5 to 11), and post closure.
- **Dry-stacked tailings facility (DSTF):** groundwater quality beneath the DSTF is influenced by surface water draining through or from the dry-stacked tailings. NATC will place a geomembrane over the DSTF at the end of operation. This will greatly reduce or eliminate the risk of infiltrating water transporting acidic drainage or dissolved metals post closure. Some of these effects will occur during operation and after closure.
- **Potential spill locations**: groundwater quality throughout the mine footprint that could potentially be affected by spills or chemical releases. Chemical spills and releases could occur anywhere in the mine footprint, and at any time during construction, operation, and decommissioning. The risk of chemical spills and releases will be carefully managed during the operation phase and eliminated during closure.
- **Temporary surface waste rock storage areas:** groundwater quality in the vicinity of temporary waste rock storage areas may be affected by recharge from precipitation infiltrating through the temporary waste rock storage areas. This temporal overlap occurs during construction, and operation.
- **Groundwater seepage from reservoir:** groundwater quality may be affected by underflow from the water retention reservoir (upstream of the ravine dam). This effect may occur during construction and operation. Since the dam will be decommissioned following mine operation, this effect will not occur following decommissioning.

Effects Characterization

The effects characterization has been conducted through consideration of the individual project components and the effects that may result to groundwater quantity and quality. This section characterizes the magnitude and extent of effects and identifies the need and rationale for further mitigative action.

<u>Underground Workings</u>

Measurements of static piezometric levels in observation wells installed during the detailed hydrogeologic assessment (Appendix H8) indicate that a portion of the underground workings will occur below the existing static piezometric water level (Figure 4.1.10-18). Hydraulic testing (packer tests) results suggest that the rock mass where underground workings be advanced has a low to moderate hydraulic conductivity ($< 1\times10^{-8}$ m/s to 1×10^{-6} m/s). It may be expected therefore that there will be some drainage into the mine from the surrounding rock mass, and a resulting requirement for dewatering during later mining. Further, because a portion of the mine will be wet, the interaction of sulphide minerals in the open drifts and adits of the mine may create the potential for acidic mine drainage and metals leaching.

Groundwater seepage is anticipated to occur in the underground workings below an elevation of about 1,775 m asl (above sea level). Mining at these depths will occur only on the west end of the deposit and will take place only from Year 5-11 of mine operation. One consequence of groundwater seepage into the mine is that through the dewatering process, the groundwater pressure in the surrounding rock mass will decrease. This loss of groundwater pressure will lower static piezometric levels in the adjacent rock mass leading to a potential loss of groundwater discharge to the headwaters of local creeks on the flanks of Mt. Allan. A second consequence is that water flowing into the mine may create waters with elevated metals concentrations that must be handled. These potential effects are described in more detail below.

To semi-quantitatively predict the magnitude of groundwater drainage into the mine, EBA assumed that the underground workings below 1,775 m asl can be represented as a cylindrical volume with an approximate diameter of 300 m and a mean height of about 50 m (based on the mine geometry, and the difference between the estimated piezometric level and the working level at the outside perimeter of the mine). Inflow to the underground workings was estimated using the Theis formula applied to this geometry (e.g., Domenico and Schwartz 1998). The Theis formula considers that groundwater flow occurs within a strictly confined aquifer (i.e. does not receive recharge from overlying geologic units). EBA has inferred, based on data collected during the DHA in the area of the mine, that permafrost occurs to a maximum depth of 200 m to 250 m below ground surface (bgs). Permafrost in the rock overlying the underground workings greatly reduces the hydraulic conductivity of the rock and consequently greatly decreases recharge of groundwater to the underground workings: a condition comparable to the hydraulic behaviour of a confined aquifer (at least in the vicinity of the mine).

The Theis formula for estimation of the groundwater discharge rate is:

$$Q = \frac{4 \cdot \pi \cdot T \cdot s}{W(u)}$$

Where:

Q [m^3/s] is the discharge;

T [m^2/s] is the transmissivity (the product of hydraulic conductivity times aquifer thickness);

s [m] is the drop in water level or potentiometric level; and

W(u) is the "well function" (exponential integral).

Transmissivity values were found to range over three orders of magnitude in hydraulic tests completed during the DHA. A conservative (high) range of transmissivity estimates applied to inflow volumes is 10^{-5} to 10^{-6} m^2/s; consistent with higher hydraulic conductivity values observed in tests completed in drill holes on Mt. Allan. Calculations were performed for storativity values ranging from 10^{-4} to 10^{-7} (typical of fractured rock). Applying this estimate to the underground workings produced a relatively low range of inflow to the underground opening of between 5 and 125 m^3/day; or about 1 to 20 Igpm (Figure 6.2.8-2 and Table 6.2.8-7).

Because recharge of the bedrock draining to the mine will be limited due to the overlying permafrost, the zone of depressurization induced by drainage to the mine will expand laterally until such time as the recharge from areas of discontinuous or no permafrost equals the discharge, or until the outward expanding zone of depressurization meets the ground surface or base elevation of the mine. When the outward expanding cone of depression intersects ground surface, or meets the base of the mine there will be a decline in the water draining to the mine.

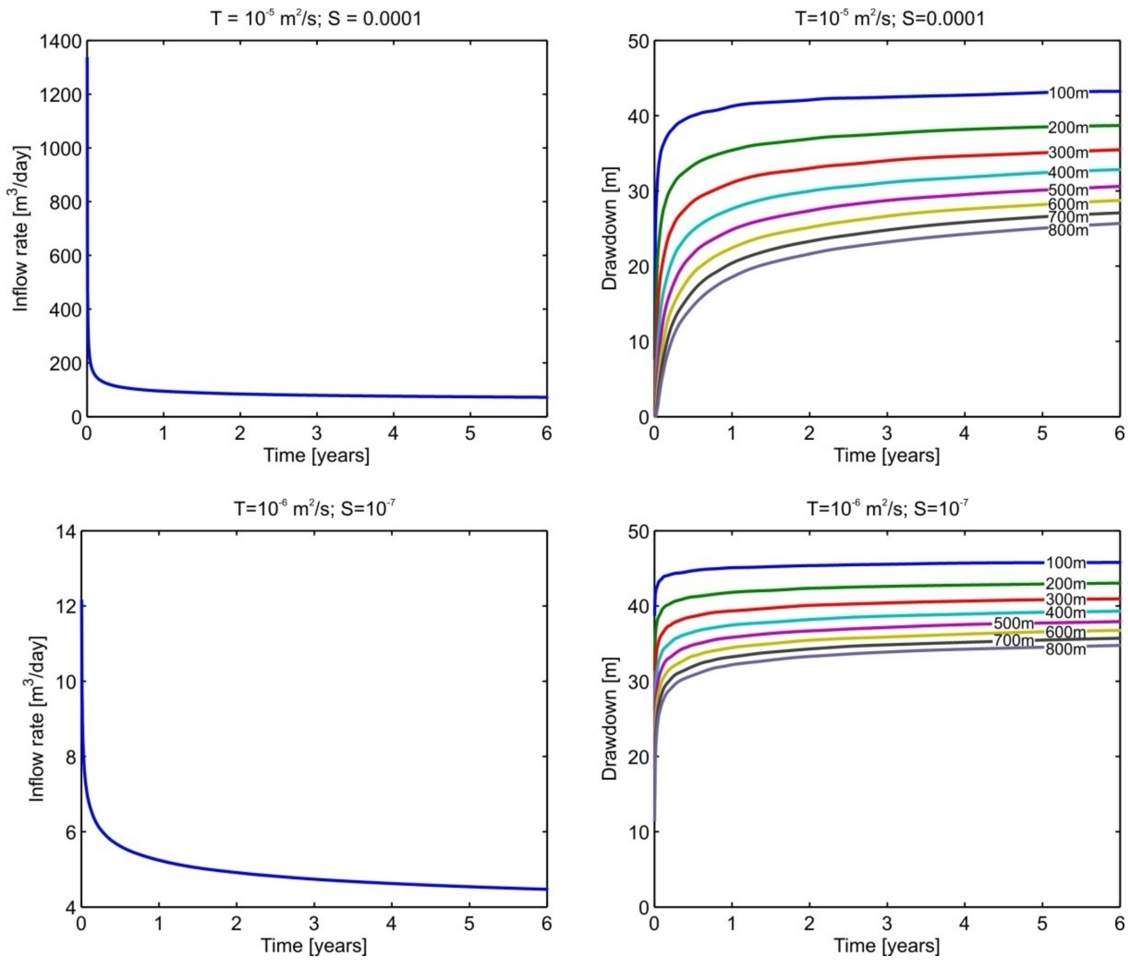


Figure 6.2.8-2: Estimated inflow rates and drawdown at distances from the underground workings using the Theis formula.

TABLE 6.2.8-7 ESTIMATE OF INFLOW TO UNDERGROUND WORKINGS				
Time	Scenario 1: T = 10^{-5} m^2/s, S = 10^{-4}		Scenario 2: T = 10^{-6} m^2/s, S = 10^{-7}	
	Total Inflow	Mean Inflow Rate	Total Inflow	Mean Inflow Rate
[year]	[m^3]	[m^3/day]	[m^3]	[m^3/day]
1	45,525	125	2,145	6
2	32,361	89	1,844	5
3	29,751	82	1,759	5
4	28,315	78	1,707	5
5	27,309	75	1,671	5
6	26,591	73	1,643	5
Total	189,853	-	10,769	-

During mine dewatering, the base flow to some creeks with headwaters on Mt. Allan (Tributaries C, C-2, C-3, and C-4) will also be diverted towards the underground workings. Figure 6.2.8-3 presents a site plan with a predicted hydraulic head map during dewatering (Year 5 to 11). Figure 6.2.8-4 presents the conceptual hydrogeology schematic for a cross section through Mount Allan and the underground workings during dewatering.

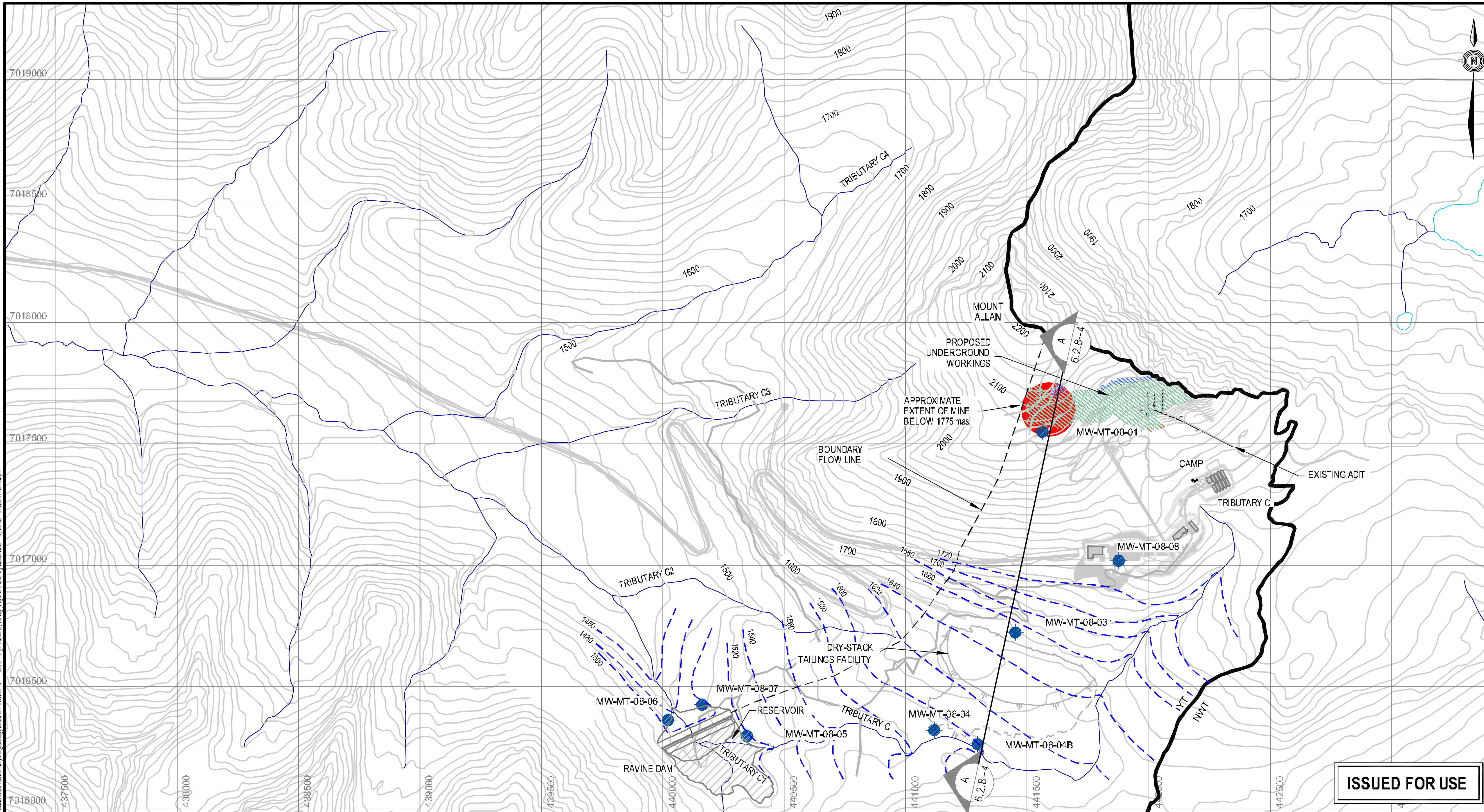
The quantity of water extracted from the mine is estimated to range from 6×10^{-5} to 0.001 m^3/s. The extracted water will be transported via discharge pipe to the surface reservoir. The reservoir will also receive process water from the mill (estimated at 0.047 m^3/s) and diverted from upslope catchment areas (mean catchment area runoff in mean year, estimated at 0.053 m^3/s). Comparison of these volumes to the estimated flow into the mine suggests that the mine drainage water will amount to less than 1% of the volume in the reservoir (annually), and less than 2% in low flow (winter months). Further, because the reservoir will largely be infilled with oxygenated, near neutral pH surface water diverted from the catchment areas upslope, dissolved metals will precipitate as/or adsorb onto mineral surfaces (e.g., iron oxyhydroxides), and further metal transport through surface water movement from the reservoir will be mitigated. With this change in redox conditions and pH, precipitation of some metals would likely occur within the timeframe that the water is retained within the reservoir. As part of the mine closure, once the dam is decommissioned, sediments that had settled out from the base of the reservoir and containing high metals concentrations will be relocated and disposed of on the DSTF.

Dry-Stacked Tailings Facility

A dry-stacked tailings management approach is being used as an alternative to construction of a tailings dam and berms typically needed to contain conventional wet tailings. Based on information collected in the DHA, the proposed area for the DSTF is in a transition zone from groundwater recharge to discharge. Overburden deposits of gravel (38-59%) and sand (30 to 38%), with some silt (10-22%) and trace clay (<2%) overly the bedrock in this area. The topography of the area slopes to the south towards Tributary C; and the groundwater flows to the south and discharges to Tributary C.

Acidic rock drainage (ARD) caused by oxidation of sulphides in tailings, and/or leaching of metals can potentially affect groundwater quality and ultimately surface water quality. There are three possible mechanisms of leachate production that could result in effects to groundwater quality:

- groundwater flow through the DSTF;
- infiltration of precipitation through the tailings; and
- loss of process water from the tailings after placement.



LEGEND
- GROUNDWATER OBSERVATION WELL LOCATION
- INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR DURING MINING (YEARS 6-11) (m-asl)

NOTE:
1. 20 m CONTOUR INTERVAL
2. BOUNDARY FLOW LINE DEPICTS WESTERN MOST FLOW LINE FROM MINE, MILL, DSTF, AND CAMP.

0 500
Scale: 1: 15 000 (metres)

NORTH AMERICAN TUNGSTEN CORPORATION LTD

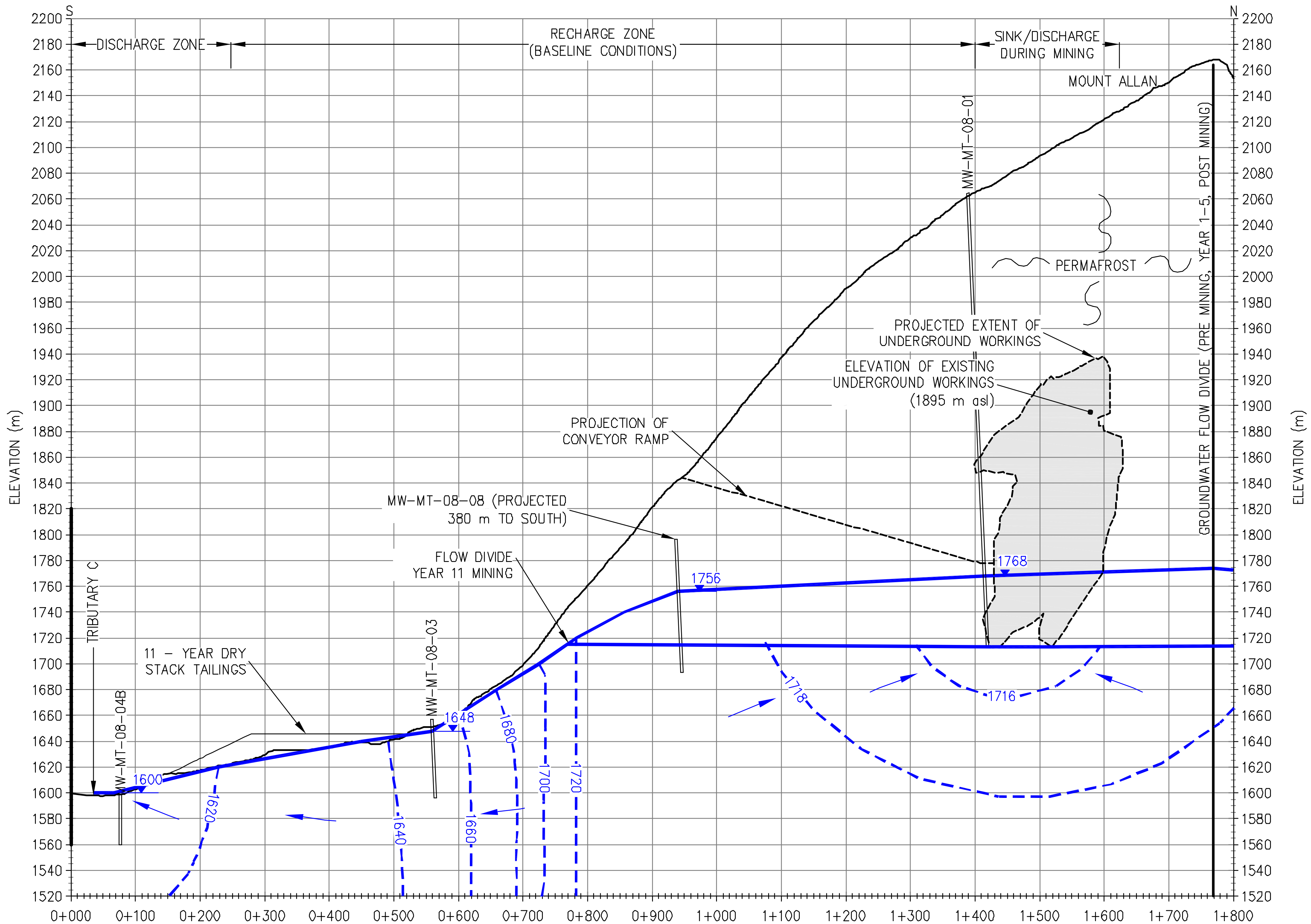
EBA Engineering Consultants Ltd.

MACTUNG

Predicted Hydraulic Head Map and Boundary Flow Line During Mining Operation

PROJECT NO	DWN	CKD	REV
W23101110.001	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	DECEMBER, 2008		

Figure 6.2.8-3



A
6.2.8-3

SECTION A - LOOKING EAST-NORTHEAST

SCALE 1:7,500H 1:3,750V

ISSUED FOR USE

LEGEND

▼ 1490 HYDRAULIC HEAD MEASUREMENT OBSERVED (SEPT 2008) IN DEEP INSTALLATIONS (m asl)

— — INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR (m asl)

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Conceptual Hydrogeology Schematic During Mining Cross Section A

PROJECT NO	DWN	CKD	REV
W23101110.001	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	DECEMBER, 2008		

Figure 6.2.8-4

Groundwater discharge or flow up into the base of the tailings and through the DSTF could potentially result in ARD or metals leaching. This effect if unmitigated could occur during placement of the tailings, or after closure when the tailings are covered. Geotechnical investigations completed by EBA in 2007 in the DSTF area indicate that the overburden varies from 1 m to 5 m in thickness. The hydraulic conductivity of the overburden material in this area is estimated based on lab testing and grain size analyses to vary from 3×10-5 m/s to 5×10-6 m/s. Based on hydraulic conductivity calculations from grain size analyses, the tailings are predicted to have a lower hydraulic conductivity (in the order of 7×10-7 m/s) due to compaction. A comparison of the grain size distribution of the tailings to the underlying overburden indicates that the overburden will be an effective blanket underdrain filter, and will be suitable for keeping the tailings from migrating down into the overburden and hence affecting the transmissivity of this unit. This preferential pathway for groundwater transport will prevent groundwater from flowing up into the tailings.

The dry-stacked tailings will be placed at 18 to 20% moisture content. It is expected that the moisture content will eventually drop to about 15% and some seepage of process water will occur during compaction, and during seasonal melting. Infiltration of precipitation (snow melt and rain) during active mining and tailings placement may also result in leachate and potential effects on shallow groundwater. The freezing of the surface of the DSTF that is expected to occur during the winter months will help to limit oxygen and moisture ingress into the tailings, however; some infiltration by oxygenated water to the active layer of the tailings is expected to occur. Compactive efforts to maximize use of the DSTF reduces the vertical infiltration and creates a horizontal pathway for lateral seepage along contacts between the tailings lifts. This lateral drainage through the active layer of the tailings during the warmer months may affect shallow groundwater quality during tailings placement.

The primary interface between leachate (process water, and/or precipitation that has infiltrated the dry-stacked tailings) and groundwater at the DSTF occurs primarily at the south slope of the DSTF where water leaching from the active layer of the tailings has the potential to mix with groundwater. Further, the southern part of the DSTF area is a groundwater discharge area with an upward groundwater gradient expected. The upward gradient is expected to limit percolation of leachate from the tailings to the shallow groundwater flow system.

The potentially acidic and metals-rich water generated within the tailings will also flow preferentially to the south end of the DSTF through the active layer at the upper surface of the stack. Any seepage or leachate discharging from the DSTF will flow on surface, or in shallow groundwater towards Tributary C, and during operation, will ultimately discharge to the reservoir. The overall water balance for the site (Section 6.2.8.1), has accounted for 9,500 m^3/year of seepage from the DSTF to the Reservoir. This seepage is expected to have chemistry similar to the process water. Water quality effects within the reservoir are considered in Section 6.2.8.2.

NATC will place an impermeable geomembrane over the DSTF at the end of operation. This will greatly reduce or eliminate the risk of infiltrating water transporting acidic drainage or metals leachate post closure (after year 11).

Chemical Spills and Releases

Release of hazardous chemicals (e.g. hydrocarbons, process water etc.) to the surface or subsurface can result in effects to groundwater and ultimately effects to surface water. The NATC's spill contingency plan (Appendix M2) is designed to limit the potential effects of any chemical releases. As well, the Decommissioning and Closure Plan for the site (Appendix M1) will include Phase 2 environmental site assessments in any areas where potential contamination of soils and groundwater may have occurred to determine if chemicals exist at concentrations above regulated standards. This potential effect is addressed in the Decommissioning and Closure Plan.

Temporary Surface Waste Rock Storage Area

Waste rock that is placed on ground surface is exposed to oxygen and water. When waste rock contains sulphides and high metals content, it can result in acid production and/or metals leaching over time.

A geochemical and mineralogical comparison between the Mactung and Cantung deposits was conducted by EBA (Appendix D2). This comparison was completed to determine whether data from the Cantung operation could be used to understand the potential effects of the proposed Mactung project These deposits were found to have comparable mineralogy and metals contents; however, the Mactung deposit has higher copper and selenium content than the Cantung deposit.

At the Mactung site, waste rock that is not potentially acid generating will for the most part be used for construction purposes (e.g., roads, enbankments, fill or foundations). If waste rock material is classified as potentially acid generating (PAG) it will ultimately be used to backfill stopes and drifts, and will be stored only temporarily (less than 5 years) on ground surface near the mine portal. Eventually all PAG waste rock will be placed underground where the potential effects will be reduced by removing this PAG rock from sources of water and oxygen. However, residual PAG rock left on surface will be exposed to oxygen and moisture and may create acidic drainage affecting shallow groundwater quality. Visible oxidation of waste rock surfaces will indicate that this process is occurring. Infiltration to the groundwater will only occur seasonally when snow melt and precipitation are available to percolate through the waste rock storage area.

As a result of the proposed use of non-acid generating rock, there will be ample room within the mine's underground workings to accept all of the PAG waste rock as backfill. Storage on the surface exposes the waste rock to weathering by snowmelt and rain. Due to the coarse nature of the waste rock, percolation will occur rapidly through the waste rock and surface water runoff will be small.

Core samples collected from historical exploration drill holes and observation of the waste rock stored at the sister mine, Cantung, demonstrate that a significant time lag (greater than 10 years) may occur between exposure to weathering and generation of acid by-products (iron oxides and sulphate). Tailings from the nearby Cantung Mine are estimated to have a time to acidity of slightly over 9 years based on humidity cell test work. Waste rock would require longer exposure before initiating acid production than would tailings. Therefore, over the time frame that waste rock is stored on the surface (not exceeding 5 years), it is not expected that water infiltrating through the waste rock will generate acidic seepage. However, as a mitigative option, should oxidation by-products be observed (through recommended monitoring program), it is possible to accelerate placement of the waste rock underground.

Seepage from the Reservoir

The reservoir will collect groundwater discharge, mine drainage water, mill process water, and water directed to the reservoir from selected surface water catchments. The location of the proposed reservoir is currently a groundwater discharge area, and will remain a groundwater discharge area during the time that the reservoir exists. The reservoir dam will be constructed upon fractured bedrock which will allow some groundwater seepage under the dam (through bedrock discontinuities, fractures and faults). This underflow will mix with the underlying groundwater and potentially change the quality of the shallow groundwater.

Seepage from the reservoir will occur throughout the year, and will increase in times of increased water retention behind the dam.

Water retention behind the ravine dam will result in an increased hydraulic head and thus increased groundwater flow through discontinuities in the bedrock that underlies the dam. The rate of dam "underflow" has been predicted by EBA using a scoping 2D flow model to be in the order of 500 to 750 m^3/day based on the following assumptions:

- The bulk hydraulic conductivity (K) of the bedrock underlying the rock will be in the order of 5×10-6 m/s based on the highest observed K values from packer tests completed at four diamond drill hole locations in the vicinity of the ravine dam;
- Dam construction details and hydraulic properties based on feasibility study (EBA, 2008); and,
- Reservoir stage levels ranging from 1505 m asl (low level – during 9 months of operation in normal years) to 100 year peak high levels (1513 m asl).

It is assumed that groundwater underflow will be very similar in chemistry to the surface water quality contained within the reservoir. In the event that the reservoir water quality does not meet discharge criteria, mitigation to prevent the uncontrolled discharge of seepage water has been formulated and is included in the mitigation section below.

Proposed Mitigation Measures and Monitoring

Mitigation of the identified potential effects will be undertaken to eliminate or reduce negative effects on groundwater quality and quantity. As groundwater ultimately discharges to surface water, these mitigation measures will also reduce or eliminate the potential indirect effects to receiving surface waterbodies.

Underground Workings

Dewatering of the lower portions of the mine is necessary for resource extraction. As dewatering will be stopped after mine closure, effects to groundwater quantity will fully be reversed through the natural recharge of the aquifer. Because water levels will be allowed to recover in the vicinity of the underground mine workings once mining stops, the groundwater discharge to the headwaters of Tributaries C, C-2, C-3, and C-4 will be fully restored after the piezometric level recovered to pre-mining conditions. No mitigation for the anticipated limited effects is proposed.

The chemistry of water extracted from the mine will be monitored monthly during active dewatering (years 5-11). As well, over this period, NATC will keep water balance records to track the volumes of water discharged to the reservoir.

Following mine closure, groundwater flowing into or through backfilled workings from the surrounding rock mass will have low dissolved oxygen concentrations and therefore further oxidation of the backfill will be negligible. Bulkheads and concrete seals will prevent surface water entry and oxygen migration to the underground. The low quantity of acid drainage potentially generated within the mine will mix with the surrounding groundwater by dispersive and advective processes within the rock mass. As such, any acid by-products in down-gradient groundwater discharging to surface water will likely be negligible.

However, there is a lack of metals testing data for the tailings. Even with a low risk for acid production, there might be effects to groundwater from metals leaching. To reduce, or eliminate these potential effects, an adaptive approach will be used as described below.

As described in Section 6.2.2 (Acid Rock Drainage and Metals Leaching), additional metals testing of the tailings (shake flask, humidity cell) will be conducted to determine whether there is a risk of metals leaching from tailings backfill in the lower portion of the mine. Because backfilling of the mine workings below the expected post-closure groundwater elevation will not begin until after year five of the operation phase, there will be ample time to do more testing on the tailings, and determine whether mitigation is required. Tailings characterization information will also be available from the monthly composites that will be tested during operation. Seepage will be monitored in closed out portions of the backfilled workings in the lower portion of the mine during the later operating years.

After mine closure, the groundwater quality downstream of the underground workings will be monitored at groundwater observation wells to confirm that no degradation of water quality occurs due to acid mine drainage and/or metals leaching. The same observation wells will also be used to monitor the recovery of the piezometric level after dewatering ceased. Groundwater samples will be collected biannually (for 10 years post closure) and analyzed for major ions and dissolved metals. Analytical results will be compared with baseline hydrogeochemical data and applicable groundwater guidelines.

Dry-stacked Tailings Facility

As a mitigation strategy to prevent the possibility of groundwater seepage through the tailings pile, the granular materials that are naturally present in the area will be left in place to serve as blanket underdrain to ensure that seepage from the tailings pile travels laterally downslope rather than mounding up into the tailings. Removal of borrow materials will be limited to ensure that an adequately thick (> 1 m) unsaturated natural blanket drain is maintained in this area.

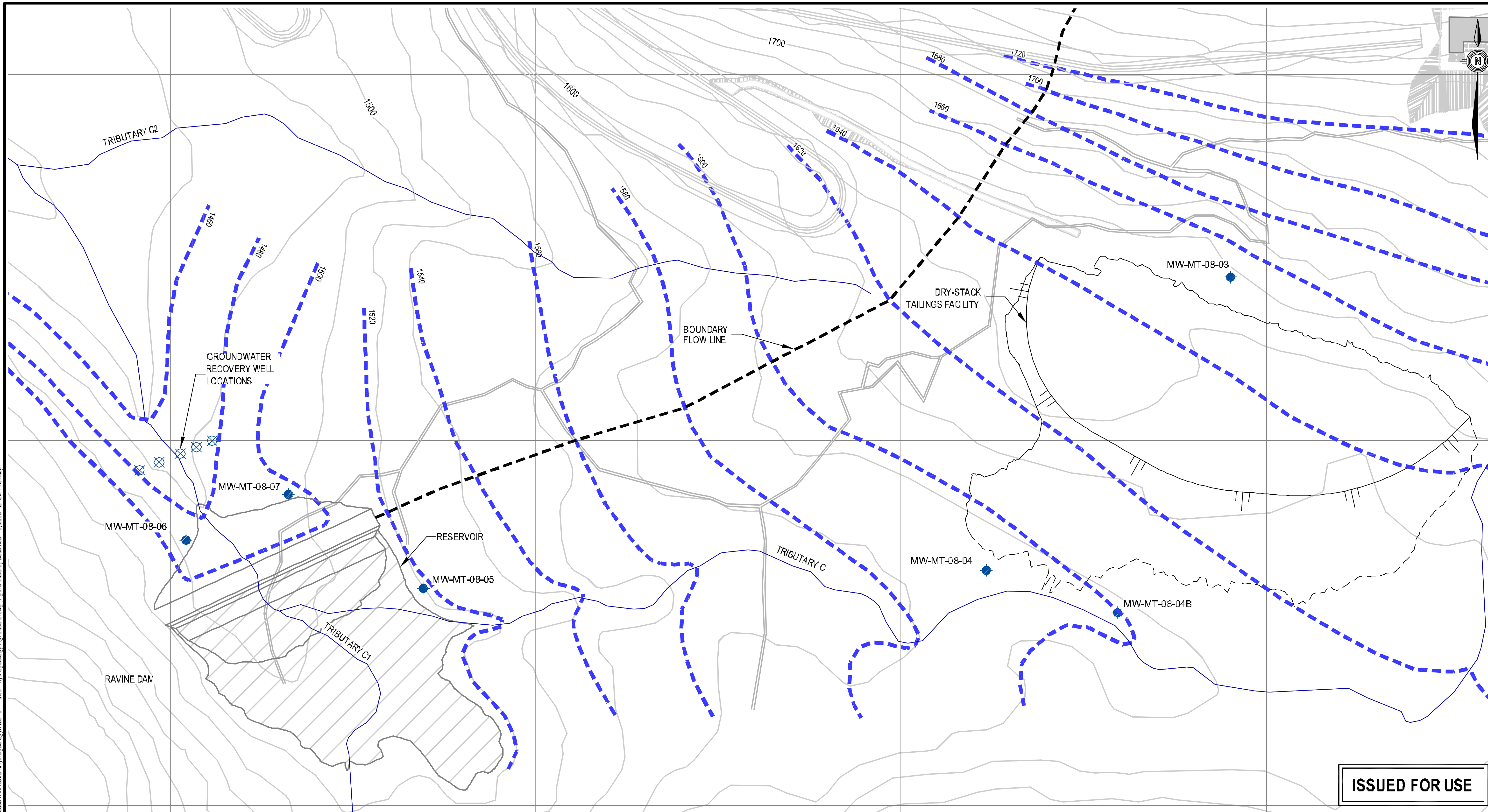
Another mitigation to prevent effects to groundwater at the DSTF will include grading to encourage overland flow of any seepage from the DSTF directly to the reservoir dam, where water quality will be monitored and controlled, if necessary. This will minimize the effects to groundwater, and delayed effects to surface water in post closure times.

During tailings placement at the DSTF (year 1 to 11), any lateral seepage from the seasonally active layer of the DSTF will be observed by weekly visual inspection of the tailings storage area. When seepage is observed, it will be directed overland (using swales and ditches) to the reservoir via Tributary C. As the total surface and subsurface runoff from the DSTF will amount to less than 1% of the total volume of the reservoir, the potentially acidic drainage and any elevated metals concentrations will be considerably diluted, and not significantly affect reservoir water quality.

As indicated in Section 6.2.2 (ARD-ML), the tailings materials are estimated to have the potential to become acid-generating during the operation phase. This is based on the humidity cell data from the Cantung Mine which has an estimated time to acidity of about 9 years. Seepage from the DSTF facility will be monitored quarterly in order to better understand the behaviour of the tailings materials and to determine whether there are any indications of ARD generation.

Once mining operations cease, the DSTF will be covered with an impermeable geomembrane and further infiltration of oxygen-rich snowmelt and precipitation will not occur.

The existing groundwater observation wells MW-MT-08-04, and MW-MT-08-04B downgradient of the DSTF will be monitored for groundwater quality during the operational phase to confirm groundwater chemistry in this area (Figure 6.2.8-5). Monitoring will continue post mine closure for five years to ensure that the geomembrane cover effectively prevents ongoing seepage through the DSTF. Groundwater samples should be collected annually for the first three years following mine closure and biannually thereafter if necessary. The samples should be analyzed for major ions and dissolved metals. Analytical results will be compared with baseline hydrogeochemical data, and applicable guidelines and standards.



LEGEND

- GROUNDWATER OBSERVATION WELL LOCATION
- PROPOSED GROUNDWATER RECOVERY WELLS
- INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR DURING MINING (YEARS 6-11) (m-asl)

NOTE:

1. 20 m CONTOUR INTERVAL
2. BOUNDARY FLOW LINE DEPICTS WESTERN MOST FLOW LINE FROM MINE, MILL, DSTF, AND CAMP.

0 250

Scale: 1: 5 000 (metres)

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Site Plan Showing Hydrogeological Mitigations and Monitoring in Vicinity of DSTF and Ravine Dam

PROJECT NO.	DWN	CKD	REV
W23101110.001	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	DECEMBER, 2008		

Figure 6.2.8-5

Temporary Surface Waste Rock Storage Areas

Groundwater recharge through the PAG waste rock stored at surface near the mine portal will only occur seasonally. Since these materials will only be stored on surface for less than five years, acidic recharge is not expected. Therefore, groundwater quality will be protected. If acidification of the waste rock occurs more rapidly than expected, then accelerated placement as mine backfill is the most prudent mitigative option to limit the exposure of the PAG source to oxygen and moisture. With this mitigative strategy, the potential effect on shallow groundwater quality will be minimal.

NATC will visually inspect and record the waste rock piles on a monthly basis. If the monthly visual inspection indicates the onset of acidification, monitoring of the shallow groundwater quality downgradient of the waste rock storage areas may become necessary. Samples should be taken quarterly – if necessary based on visual inspection – from a shallow observation well to be installed approximately 10 m downgradient of any proposed PAG waste rock storage areas prior to mine construction, and any springs immediately downgradient of the waste rock storage area during spring, summer, and early fall when the active layer is unfrozen. Shallow groundwater samples should be analyzed for major ions and dissolved metals. Analytical results should be compared with baseline hydrogeochemical data and applicable standards.

Dam Underflow

Mitigation will be required to prevent the uncontrolled release of dam undeflow. Dam underflow is expected to daylight within a few hundred metres of the downstream side of the dam. Groundwater seepage will be captured and controlled if the surface water quality in the reservoir is unsuitable for discharge to Tributary C. This will be achieved through the use of pumping wells to be situated downstream of the dam. If reservoir water quality exceeds discharge standards, groundwater samples will be collected monthly from downstream pumping wells (located approximately 100 m downgradient of the toe of the dam) to determine groundwater quality downgradient of ravine dam (see Figure 6.2.8-5 for approximate location of pumping wells). The results will be used by NATC to determine whether pumping should be initiated to capture the dam underflow. If groundwater quality at the control point (recovery well system), is in exceedence of discharge criteria, the pumps will be activated, and water will be pumped back to the reservoir.

Based on the bedrock hydraulic properties from discrete test intervals in four drill holes in the in the vicinity of the dam, and the predicted dam underflow volume, three to five wells would be required to capture the predicted dam underflow volumes. This will be verified through pumping tests at the time of the well installation. Information on the approach to monitoring and handling surface water in the reservoir is presented in Section 6.2.8.2 (Surface Water Quality).

Potential direct and indirect effects, proposed mitigation measures, and anticipated success of these mitigation measures are summarized in Table 6.2.8-8.

TABLE 6.2.8-8 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR HYDROGEOLOGY

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Under-ground workings	Groundwater quality and quantity within area of underground workings	Drainage and seepage into the mine workings may effect ground-water quality	Drainage with potentially affected water quality removed from mine workings	• Dewatering of mine (from year five) and discharge of mine inflow into the reservoir			✓
		Drainage and seepage into the mine workings may effect groundwater quantity	Drainage and seepage into the mine workings may effect groundwater quantity	• No mitigation (natural recovery of water levels post mining replaces baseflow to stream)	✓		
		Groundwater flow through the mine workings post closure may effect water quality	Potential ARD and/or metals leaching from mine backfill, affecting the down-gradient groundwater quality	• Backfilling, and sealing of underground workings reduces exposure to oxygen limiting oxidation in mine workings and generation of acidic rock drainage. Additional testing will confirm whether neutral metals leaching is a concern		✓	
PAG waste rock storage area	Groundwater quality beneath and downgradient of temporary surface waste rock storage area	Acidification of waste rock creates acid recharge to groundwater; which may effect water quality	Contamination of groundwater downgradient of the waste rock storage areas	• Keep PAG waste rock on surface less than five years. Monitor and accelerate disposal of waste rock nderground if acidification is observed			✓

TABLE 6.2.8-8 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR HYDROGEOLOGY							
Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Reservoir	Groundwater quality downgradient of reservoir; underflow at ravine dam	Groundwater mixed with seepage water from the reservoir creates the potential for changes in groundwater quality	Potential effect on water quality in downgradient receiving surface water bodies (Tributary C)	• Monitoring of water quality in reservoir. Collection of seepage using a series of groundwater extraction wells downgradient of the ravine dam and discharge back into reservoir			✓

Significance Determination

The following points are drawn from the hydrogeological effects assessment in consideration of the proposed mining activities at the Mactung property:

- For the project areas where potential effects were identified, three can be fully mitigated, one will be dealt with through spill contingency and post closure assessment, and three remaining potential effects require further residual effects significance determination (see Table 6.2.8-8).
- As indicated on Figures 6.2.8-3 and 6.2.8-5, the boundary flow line, which depicts the westernmost flow line for potential effects on groundwater quality (other than potential spills in locations which at this time cannot be determined), all have discharge above the Ravine Dam. The significance of this fact is that because the reservoir water quality can be monitored and controlled, there is control over groundwater discharge to surface water during the period of mine operation.

Table 6.2.8-8 summarizes the mitigation requirements for each of the potential hydrogeological effects identified at the Mactung site. A significance ranking was performed for those effects where the mitigation is not expected to be complete (residual effects) in Table 6.2.8-9. Consistent with the approach and criteria suggested by YESAB through the guidance documents, significance rankings were performed for dewatering of the proposed underground workings and its effects on the local groundwater flow regime, as well as the potential effects of groundwater flow through the underground workings post-mine closure, and the effects on groundwater quality from the DSTF.

Conservative assumptions were used to predict the significance of the potential hydrogeological effects by the proposed project activities. Significance determinations are therefore conservative and represent the maximum anticipated spatial and temporal extent of any effects which are not completely mitigated, accounting for uncertainty and natural heterogeneity.

Dewatering Effects on Groundwater Quantities

As indicated previously, mine dewatering in the lower portions of the mine (below the permafrost zone) will have an effect on base flow to some creeks with headwaters on Mt. Allan. However, at these headwater locations, the natural base flow from the upper section of Mt. Allan will be small. Most of the flow in the upper reaches of these creeks is recharged by snowmelt and surface water runoff. Therefore, the effect to these creeks is not expected to be noticeable over the seasonal and year to year variations in precipitation. Furthermore, base flow loss in the headwaters of Tributaries C will ultimately return to the main Tributary C in the form of dewatering water pumped from the underground workings and discharged into the reservoir.

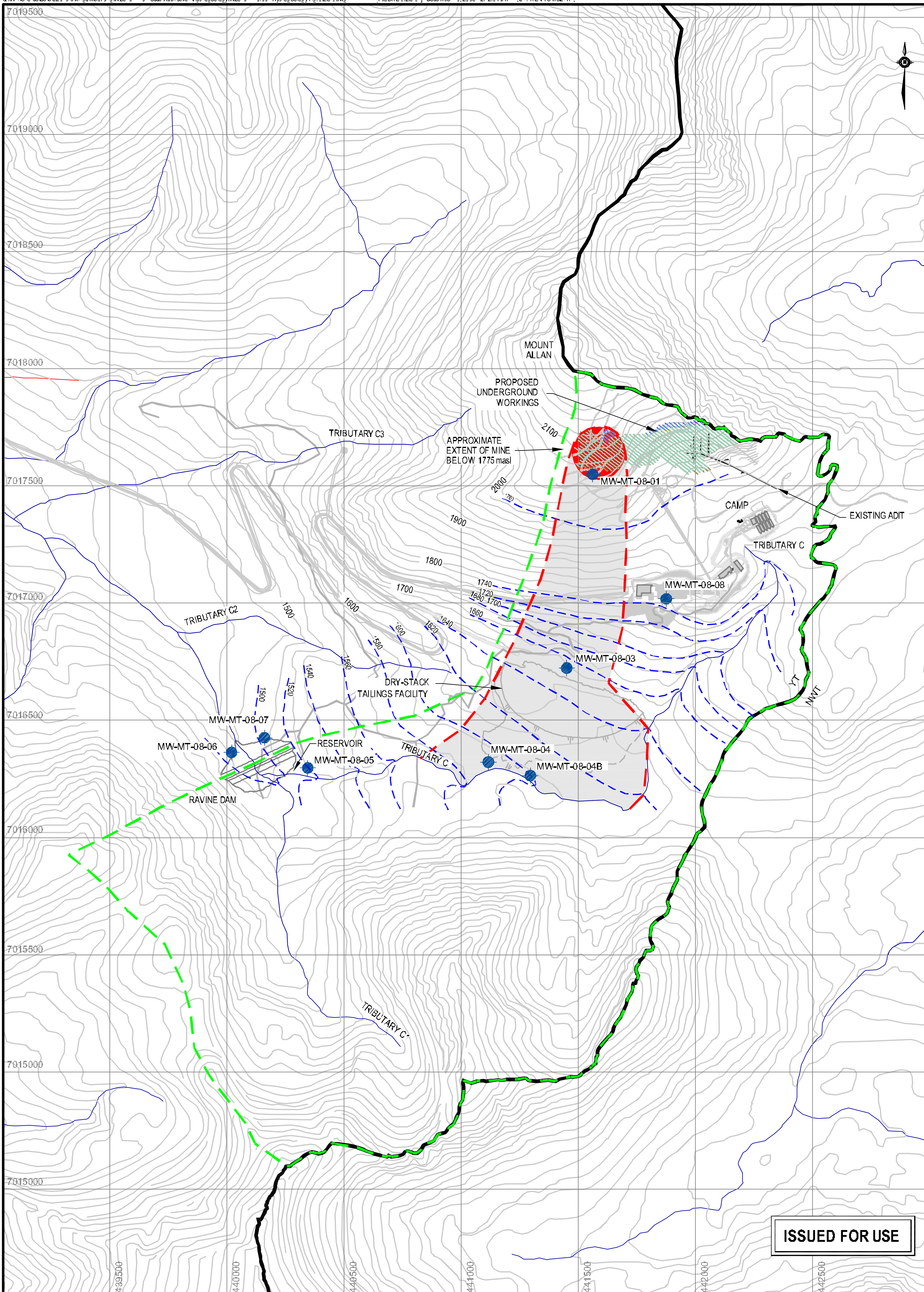
When mine dewatering (groundwater extraction) is stopped following completion of ore extraction and mine backfilling, the water level in the surrounding rock mass will re-equilibrate and groundwater discharge to the creeks will be returned to pre-mining levels. Based on the assumed recharge rates and recharge model, this is predicted to occur in less than 10 years following the end of mining, and less than 16 years from start of project. Therefore, by YESAA definition, this is a fully reversible effect as it will be fully reversed within 26 years.

The magnitude of the effect of dewatering on groundwater base flow to creeks with headwaters on Mt. Allan is low, the extent is regional, and the effect is medium-term in duration; and fully reversible within 10 years of mine closure. The overall significance of the effect of dewatering on groundwater quantity has been determined as being low because the water removed from the headwaters is returned to Tributary C above the point of use by aquatic life.

Post Closure Water Seepage Through Mine Workings

Mined-out stopes and drifts will be backfilled with dry tailings. After dewatering has ceased, the piezometric level will start to recover to its natural condition. As a result, the lowest part of the underground workings below an elevation of about 1,775 m asl will flood and groundwater will move through the abandoned underground workings following the natural hydraulic gradient to the south towards Tributary C. Stope and drift walls as well as backfill materials will have been exposed to atmospheric oxygen during the operation phase and sulphide minerals may have started to oxidize. This provides the potential for the generation of acid rock drainage at least during the initial phase of flooding when oxygen will be available. However, after flooding, oxygen availability will be very limited due to the fact that all underground workings will be sealed off with bulkheads preventing any air circulation from atmosphere. Furthermore, the groundwater flow through the mine will contain no significant amounts of oxygen and chemical conditions will be reducing. Therefore, potential acid generation and associated metals leaching will widely be restricted to the initial phase of flooding of the underground workings. If acid generation and metals leaching does occur, there may be effects to groundwater that will flow southwards and ultimately discharge into Tributary C upstream of the ravine dam. The portion of the watershed of Tributary C that may be affected by groundwater flowing through the underground workings is shown in Figure 6.2.8-6. To determine the significance of the effect of groundwater with potentially affected quality by seepage through the abandoned underground workings, an estimate of the relative contribution of the discharge of this groundwater to the overall discharge of Tributary C is provided below:

Q:\Whitehorse\Data\0201drawings\MacTung\W23101110 Yessa Application\Hydrogeology\W23101110.001 Hydrogeology Fig.6.2.8-6.dwg [FIGURE 6.2.8-6] December 16, 2008 - 2:12:54 pm [BY: KEN TOMCZYK]



LEGEND

- GROUNDWATER OBSERVATION WELL LOCATION
- INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR PRE AND POST MINING (m-asl)
- AREA DOWN GRADIENT OF MINE WORKINGS BELOW STATIC GROUNDWATER ELEVATION AND AREA DOWNGRADIENT OF DSTF
- EXTENT OF UPPER TRIBUTARY C AND C1 CATCHMENT AREA (ABOVE RAVINE DAM LOCATION - AFTER DAM REMOVAL)

NOTE:

20 m CONTOUR INTERVAL

0 500

Scale: 1: 15 000 (metres)

CLIENT

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Upper Tributary C and C1 Catchment and Area Downgradient of Mine and DSTF

PROJECT NO.	DWN	CKD	REV
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EBA-WHSE	DECEMBER 2008		

Figure 6.2.8-6

The cross-sectional area of backfilled underground workings perpendicular to the flow direction is about 300 m × 60 m = 18,000 m^2 (conservative estimate). The flow through the backfilled underground workings can be calculated using Darcy's Law:

$$Q = K \cdot i \cdot A$$

Where:

Q is the flow rate [m^3/s];

K is the hydraulic conductivity [m/s];

i is the hydraulic gradient [unitless]; and

A is the cross-sectional area [m^2].

Based on the assumptions provided, and using the Darcy equation, the flow rate through the underground workings was calculated to be 2.2×10^{-4} m/s (0.22 L/s). The conceptual outflow hydrograph for the ravine dam and reservoir (refer to Hydrology Section (Section 6.2.8.1)) in post mining conditions (no diversion) indicates that the lowest flow in Tributary C at the ravine dam location will be approximately 8 L/s. Therefore, the estimated groundwater discharge from the underground workings corresponds to about 3% of the total estimated base flow discharge of Tributary C. Note that this only applies during the time of minimum base flow in Tributary C in late winter. At other times of the year, when there is significant surface water runoff, the contribution of the groundwater that might be affected by seepage through the underground workings will be much lower (<1%) by volume.

The magnitude of the effect of groundwater flow is low through the abandoned underground workings which might be subject to acid rock drainage and metals leaching, the extent is local, and the effect is long-term in duration. The overall significance has been identified as being low because:

- acid generation and metals leaching will be very limited due to the low oxygen content in water within the flooded underground workings;
- the potentially affected groundwater represents only a small percentage (<1% to 3%) of the total discharge of Tributary C at the point of surface water discharge; and

Post Closure Groundwater Seepage from the DSTF

As mentioned above, the mobile portion of the process water after compaction of the tailings amounts to about 9,500 m^3/year (0.3 L/s) during the 11-year operational phase. During operation, most of this process water will flow as surface or shallow subsurface runoff to the south end of the tailings pile and will be diverted into the reservoir during the non-frozen season. However, a small portion of the mobile process water may infiltrate to the shallow groundwater and discharge into Tributary C after mine closure.

As a conservative estimate, it is assumed that 20% of the mobile process water (about 1,900 m^3/year) may infiltrate into the shallow groundwater which corresponds to a typical estimate of groundwater recharge being 20% of the precipitation. Because the mean groundwater flow velocity in the area of the DSTF is in the order of magnitude of 50-100 m/year and because most of the process water will flow to the south end of the tailings pile, the greater portion of the infiltrating process water will discharge to Tributary C in considerably less than 10 years (i.e. during the operation phase). Some of the infiltrated process water, however, may daylight in Tributary C after mine closure and may affect the water quality of Tributary C downstream of the DSTF. Since there is a lack of data regarding anticipated Mactung process water chemistry, it is assumed that it will have similar chemistry to Cantung mine process water Assuming a maximum annual process water discharge to Tributary C of 1,900 m^3, the percentage of the process water in Tributary C during low flow conditions in March (~ 8 L/s) is about 0.8% of the total flow, i.e., the metals concentrations in the daylighting process water will be diluted by a factor of at least 100 to 150 throughout the year. The portion of the watershed of Tributary C that may be affected by groundwater flowing through the underground workings is shown in Figure 6.2.8-6. Note that dilution is much higher during other months when the discharge in Tributary C is considerably larger. As a result, all concentrations in Tributary C will most likely fall below CCME guideline values throughout the year, except for those metals that are naturally elevated above CCME guideline values (e.g., cadmium, selenium; see Section 6.2.8.1 (Hydrology).

In conclusion, the magnitude of the effect of process water seepage from the DSTF on the water quality of Tributary C after mine closure is low, the geographic extent is local and the duration is medium-term, resulting in a moderate significance. However, as shown above, the water quality in Tributary C will not be affected significantly and the effect is unlikely to represent any threat for fish habitat further downstream in Tributary C where dilution will be much greater than indicated above. As well, the effects on groundwater are reversible due to the natural flushing of groundwater that will occur through the area of the DSFT after closure. Based on the observed groundwater conditions, and assuming that the geomembrane cover over the tailings will limit future leaching, this flushing should occur within 5 to 10 years of the end of mining operation. Therefore the overall significance of the effect of water seepage from the DSTF on the water quality of Tributary C after mine closure is low.

TABLE 6.2.8-9 SUMMARY OF SIGNIFICANCE DETERMINATION FOR HYDROGEOLOGY					
Project Component	VC	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Underground workings	Groundwater quantity in the area of underground workings	Negative	Moderate	Short-term	High
	Groundwater quality downgradient of the underground workings	Negative	Moderate	Long term	High
Dry-stacked tailings facility	Groundwater quality beneath and downgradient of dry-stacked tailings facility	Negative	Moderate	Short-term	High

TABLE 6.2.8-10 PROPOSED MONITORING FOR POTENTIAL HYDROGEOLOGIC EFFECTS

Project Activity	Effect	Mitigation	Monitoring Location and Sampling	Monitoring Required During Operation	Frequency	Monitoring Required After Closure	Frequency	Parameters	Comparison of Monitored Parameters
Underground workings	Drainage with potentially affected water quality	Discharge into reservoir for dilution and possible treatment	Groundwater sample from observation well downgradient of underground workings (post closure). Water sample from dewatering discharge during mining.	Water quality and quantity during mine operation	Monthly	Yes	Annually for up to 10 years; longer monitoring may become necessary if recovery of piezometric level should be very slow (>5-10 years)	Major ions, total and dissolved metals	Applicable groundwater guidelines; local baseline data
Dry-stacked tailings facility (DSTF)	Potentially acidic and metals-rich seepage from DSTF into the groundwater	Drainage system of DSFT, and discharge of surface and subsurface runoff from tailings into reservoir	Groundwater sample from observation wells downgradient of DSTF. Visual inspection for seepage	Yes	Visual inspection for seepage: weekly - Groundwater sampling: every six months	Yes	Every 6 months for first 3 years following mine closure, annually thereafter if necessary; total monitoring time frame: 5 to 10 years depending on results	Major ions, total and dissolved metals	Applicable groundwater guidelines; local baseline data
Temporary surface waste rock storage	Potential seepage with affected water quality from waste rock storage areas into shallow groundwater	Temporary storage on surface and use as backfill material for underground workings; accelerated placement underground if onset of acidification is observed	Visual inspection of waste rock; shallow groundwater sampling from downgradient observation well and springs immediately downgradient of the waste rock storage areas when beginning acidification is observed	Yes (during pre-production and early production until underground placement	Visual inspection: monthly - Groundwater sampling: quarterly, if necessary	No	--	Visual inspection for beginning oxidation of sulphide minerals - Major ions, total and dissolved metals in shallow groundwater, if necessary	Applicable groundwater guidelines; local baseline data

TABLE 6.2.8-10 PROPOSED MONITORING FOR POTENTIAL HYDROGEOLOGIC EFFECTS

Project Activity	Effect	Mitigation	Monitoring Location and Sampling	Monitoring Required During Operation	Frequency	Monitoring Required After Closure	Frequency	Parameters	Comparison of Monitored Parameters
Reservoir and ravine dam	Seepage of potentially poor quality water beneath ravine dam	Extraction of potentially contaminated groundwater by a series of pumping wells downgradient of ravine dam if necessary	If reservoir water quality exceeds discharge standards, groundwater samples from pumping wells will be collected and analyzed monthly to determine groundwater quality downgradient of ravine dam. The results will be used as a determination as to whether pumping should be initiated.	Yes	Monthly	No	--	Major ions, total and dissolved metals	Applicable groundwater guidelines; local baseline data

6.2.9 Aquatic Ecosystems and Fisheries Resources

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

6.2.9.1 Identification of Valued Component

Fish and fish habitat were selected as valued components to represent both fisheries resources and the biological aquatic environment. Fish and fish habitat have biological values, which serve as tangible indicators of aquatic environmental quality, reflecting conditions imposed by instream and terrestrial physical, chemical, and biological characteristics. Recent baseline studies and existing information have shown that fisheries and aquatic resources in the region are highly variable, strongly linked to local geological features, and of generally poor to moderate quality due to the seasonal influences of local groundwater inputs, which were found to degrade stream water quality. The following criteria were considered in the selection of fish and fish habitat as a VC:

- both fish and fish habitat are federally protected under the *Fisheries Act*;
- fish habitat is defined in the *Fisheries Act* to include areas and processes on which fish directly or indirectly depend to carry out their life processes;
- fish and fish habitat can be readily monitored to identify changes due to anthropogenic influences;
- although fish habitat value is not of high quality in the region, the project study area is thought to contain a representative example of regional fisheries resources;
- there is potential for recreational and traditional uses of fish downstream from the project area (the Hess River or South Macmillan River); and
- the assessment and protection of fish habitat, including physical/chemical components of water quality, metals uptake and accumulation, and biological health including productivity and diversity will in turn protect key characteristics of the entire aquatic environment.

Individual species level VCs were not chosen for the Mactung project, as baseline study, background research and consultation did not identify particular species within the project study area or road study area that are of significant regional or territorial value.

6.2.9.2 Identification of Temporal and Spatial Bounding

Temporal Bounding

As identified during project baseline studies, Dolly Varden and slimy sculpin are considered to occur year-round in several tributaries located within the study area (Tributaries C, D13, and D9) and Hess River Tributary, respectively (Refer to Section 4.1.11 and Figure 4.1.11-4 for a description of watercourses). Arctic grayling and round whitefish are found only seasonally in the Hess River Tributary. Consequently, potential effects to fish and fish habitat may occur throughout the year, based on the distribution of project activities and types of effects that could occur (i.e., surface runoff from precipitation, resulting in sedimentation or erosion).

Spatial Bounding

For the purpose of this effects assessment, areas considered for potential effects include fish-bearing watercourses as well as watercourses that flow into fish-bearing waters. When considering both direct and indirect potential effects, this includes Tributary C, Tributary A, and the lower Hess River Tributary as the receiving environment (being downstream from the processing and primary mine infrastructure). The upper Hess River Tributary and South Macmillan River could be influenced by other project related infrastructure (pumping facility and aerodrome upgrades), while the South Macmillan River and Tributaries A through E could be influenced by the proposed access road. All watercourses are detailed in Figure 4.1.11-2.

Fish habitat located upstream of development areas is within the zone of influence and could potentially be affected by restricting fish movement. The downstream zone of influence for works in or around watercourses are considered according to criteria outlined in the Alberta *Guide to the Code of Practice for Watercourse Crossings, Including Guidelines for Complying with the Code of Practice* (AENV, 2001). The guide defines the zone of influence as the area of the bed and banks to be altered, and the area downstream where 90% of released sediment will be deposited.

Criteria for high slope, high energy streams were selected from the previously noted Code of Practice, as they provide the most conservative estimates for project area streams. Details on zone of influence are provided below in Table 6.2.9-1.

TABLE 6.2.9-1 DOWNSTREAM ZONES OF INFLUENCE FOR SEDIMENTATION IN THE PROJECT AREA

Category	Width (m)	Slope	Energy	Dominant Substrate	Velocity	Habitat	Length of Effected Zone
H1	< 10	Moderate / High	High	Coarses (boulders, cobbles and gravels)	Moderate / High	Riffle, Cascade, and fast runs	300 m
H2	> 10 < 20	Moderate / High	High	Coarses (boulders, cobbles and gravels)	Moderate / High	Riffle, Cascade, and fast runs	1000 m
H3	> 20	Moderate / High	High	Coarses (boulders, cobbles and gravels)	Moderate / High	Riffle, Cascade, and fast runs	> 1000 m

Note: Table Adapted from Alberta Environment (2001).

The zone of influence for deleterious substances, metals, and other aspects of water quality can be considerably different from those considered for physical properties, and cannot be considered according to the same criteria as those for sediment above. Specific potential effect zones are discussed within the following individual effect sections.

6.2.9.3 Summary of Baseline Information

Several watercourses within the project and road study areas that may be potentially affected by project activities are fish-bearing or are located upstream of fish-bearing waters.

Tributary C, the primary receiving environment of the proposed development, has non-fish-bearing headwaters that extend into the mine footprint area (Figure 4.1.11-4). The lower reaches of Tributary C support a resident dwarf population of Dolly Varden (refer to section 4.1.11 for more detailed information on Tributary C). While Tributary A (into which Tributary C flows) has the potential to only support the migration of fish intermittently, the Hess River Tributary (into which both tributaries flow) supports Dolly Varden, Arctic grayling, slimy sculpin, and round whitefish (Figure 4.1.11-4). Baseline studies suggest that slimy sculpin are resident year-round in the Hess River Tributary, while the other species retreat to main stem areas annually.

From a regional perspective, the fisheries resources in the receiving environment appear to be restricted by low overall primary productivity as well as by poor water quality as influenced by local geochemistry. Natural acid rock drainage and abundant dissolved metals are commonplace in the region (refer to Section 4.1.4 for further information).

Of the watercourses located adjacent to the proposed road route, only Tributaries C and D support fish (i.e., Dolly Varden). Only three individual watercourses crossed by the proposed road route are fish-bearing (i.e., Tributaries D3, D9, and D13; see Figure 4.1.11-4).

6.2.9.4 Effects Characterization and Mitigation Measures

The following definitions were used during the aquatic environments effects assessment:

Fish: For the purpose of this assessment, fish are assumed to include the eggs, milt, larvae, juvenile stages, and adults of fish species;

Fish Habitat: For the purpose of this assessment, fish habitat refers to any biological, physical or chemical components of the aquatic environment that are used by fish for spawning, nursery, rearing, feeding, or migration during any life stage, and on which they depend, directly or indirectly, in order to carry out their life processes.

Effects: For the purpose of this assessment, effects are defined as any change in the abundance, quality, functionality, or sustainability of fish populations or their habitat. As an example, an effect could be the loss of the local Dolly Varden population in one stream due to water quality reductions, or an increase in seasonal habitat use in a main tributary due to water level increases.

Construction Phase

A number of construction phase project components have the potential to affect fish and fish habitat in the project and road study areas and their downstream zones of influence. These project components have the potential to result in both direct and indirect effects. The following project activities are considered:

- clearing, grubbing, and preparation of the mine footprint area infrastructure sites, including the diversion of several unmapped first order tributaries (non fish-bearing) to Tributary C in the footprint area;
- construction of the ravine dam;
- upgrading and construction of the mine access road from the North Canol Road to kilometre 35.5, including the installation of 17 watercourse crossing structures. Activities include clearing and grubbing, road works, material borrow and transport, and temporary camp setup;
- widening and upgrading the access road from kilometre 35.5 to kilometre 45 (i.e, the mine site). However, watercourse crossings along this portion will not require widening or upgrade.
- expansion (widening and lengthening) of the Macmillan Pass Aerodrome, including clearing and grubbing, material borrow, and temporary camp setup;
- installation, testing, and operation of the water extraction infrastructure in the Hess River Tributary, and installation of water delivery and return pipelines from the water extraction infrastructure to the footprint area; and,
- increased access potential to the project area via upgraded road systems.

A summary of the potential effects and mitigation measures for the construction phase is outlined in Table 6.2.9-2.

<u>Erosion/Sedimentation</u>

Erosion and sedimentation are common indirect effects related to land development activities. Sediment is a naturally occurring component of all watercourses; however, when concentrations exceed a threshold that are not typical of natural conditions, sediment can create conditions that are harmful to both fish and fish habitat. Any activities that include the removal of vegetation or other ground cover, or the disturbance or exposure of mineral or organic soils can result in erosion of unconsolidated materials. Consequently, transport of eroded materials by surface runoff, wind, or other means to local watercourses can result in negative effects to fish and fish habitat. High concentrations of sediment can result in negative direct and indirect effects to fish (Birtwell 1999, DFO 2000). Effects may include:

- smothering eggs or larvae, thereby reducing their survival;
- clogging and abrading fish gills, leading to disease or respiratory distress;

- infilling critical streambed habitat (i.e., the porous streambed), thereby degrading the quality of spawning habitats or reducing the abundance of critical food resources such as benthic invertebrates;
- reducing visibility and thus the location of food items and predator detection through increased turbidity; and
- inhibiting or reducing migration due to the avoidance of turbid waters.

As noted above, sediment occurs naturally in most watercourses, and periods of elevated suspended solids can occur in conjunction with such events as landslides, bank erosion, and high flows (e.g., storms or freshet). However, the addition of sediment to watercourses via human activities can be considered a deleterious substance under the *Fisheries Act*, and is the focus of many common mitigation measures and best management practices.

Effects Characterization

Construction activities have the potential to result in erosion and sedimentation; however, with proper mitigation these potential effects are expected to be minimal.

Access road construction will require the installation of 17 watercourse crossing structures (i.e., culverts or bridges), 3 of which span fish-bearing waters. Four additional crossings have a zone of influence that extends into fish-bearing water (i.e., Tributary D). The construction of most watercourse crossings will require works below the high water mark. Such activities have the potential to release sediment into the watercourse and must be isolated from the active channel during construction.

There are six additional watercourse crossings between kilometres 35.5 and 45, along Tributary C. These crossings are to be constructed under a separate Class III mining exploration permit that NATC is currently applying for (2008-0289). NATC will engineer and construct these crossings to accept all future anticipated use, and subsequent further upgrading or widening of these crossings will not be necessary as part of the current project.

Erosion and sedimentation may occur from widening and upgrading the access road surface. As noted previously, clearing, grubbing, materials movement, and other associated road construction activities create unconsolidated materials in the right-of-way. This poses a risk in the vicinity of watercourses (particularly fish-bearing) where surface runoff could transport those materials to the watercourse. Retaining existing vegetation cover along the majority of the access road will limit the potential for sediment transport, as will retaining riparian vegetation at watercourse crossings.

From the mine footprint area, sedimentation could occur in Tributary C, leading to effects in lower reaches of that watercourse that are fish bearing. Most notably, temporary instream activities during the construction of the ravine dam and the associated diversion channel to route runoff around the reservoir area may temporarily increase the potential for erosion and sediment transport. Similarly, site preparation and construction of maintenance roads, mine and tailings facilities, and water source pipeline will all involve ground disturbance and vegetation removal that can result in sediment deposition to local watercourses, unless properly mitigated.

The Macmillan Pass Aerodrome upgrade and pumping infrastructure installation in the Hess River Tributary will also involve works near or within the stream. In the Hess River Tributary, construction and equipment installation could result in the introduction of sediment, which will require specific mitigation. In the aerodrome area, potential effects to fish or fish habitat in the South Macmillan River are predicted to be low due to the low fish habitat potential within the zone of influence. However, the risk of effects in fish-bearing reaches further downstream does still exist, although these risks are remote. To address these risks, appropriate mitigation measures will be employed, as outlined in the following sections.

Mitigation Measures

Mitigation measures to minimize potential effects from construction activities will focus on two primary objectives: minimizing the risk of erosion by properly managing sites, and minimizing the risk of surface runoff or wind transport of eroded sediment to local watercourses. Mitigation measures will include:

- conducting a permitting review with the Department of Fisheries and Oceans (DFO) prior to any works. All works will adhere to the terms of either the *Fisheries Act* Authorization or Letter of Recommendation resulting from that review;
- all instream works will be conducted in isolation from the active channel to reduce the potential risk to fish habitat; these activities will be monitored by environmental professionals;
- an environmental management plan (EMP) will be developed and employed by NATC and its contractors for all works. This plan will outline best management practices for construction, control of activities on site, site stabilization, environmental monitoring, and instream works, based on the following literature:
  - DFO Standard Operational Procedures;
  - *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO and BCMOE 1993);
  - *A Users' Guide to Working In and Around Water* (BC Ministry of Land Water and Air Protection, 2005);
  - *Standards and Best Management Practices for Instream Works* (BC Ministry of Land Water and Air Protection, 2004);
- clearing limits and riparian reserve areas will be adhered to during construction activities;.
- wherever possible, instream works and works in the vicinity of fish-bearing watercourses will be conducted at low flow periods; and

- fords will not be installed or used as watercourse crossings due to the abundance of sediment fines and the high precipitation microclimate in the footprint area.

Significance Determination

Following the implementation of mitigation measures, effects of erosion and sedimentation on fish and fish habitat during construction are predicted to be negative, low to moderate in magnitude, local in extent, short term in duration and reversible, and of low frequency (Table 6.2.9-3). The significance of effects is estimated to be low (Table. 6.2.9-10).

Riparian Vegetation Loss

Riparian vegetation refers to vegetation that occurs along the margins of watercourses and interacts functionally with that watercourse in a number of ways. This vegetative boundary commonly consists of a mixture of low herbaceous, grass, or moss ground cover, a shrub layer of low to medium height (e.g., alder, willow, or birch), and an upper layer that can consist of tall shrubs or tree cover. This vegetation buffer contributes significantly to the structure and function of the stream in the following ways:

- provides physical cover and shade that aids in regulating stream temperature;
- provides physical cover and protection for fish from potential predators;
- the root mass associated with riparian vegetation stabilizes the stream from lateral channel movements and bank erosion;
- absorbs and slows the velocity of surface runoff, thereby reducing sediment introduction to watercourses and slowing the response time of runoff from precipitation events; and,
- attracts insects and provides a source of important organic materials from outside of the watercourse (allochtonous inputs), such as leaves, woody debris, and other materials.

Effects Characterization

During the project construction phase, the road upgrade, the Macmillan Pass Aerodrome expansion, the Hess River Tributary pumping infrastructure installation, water retention dam, and footprint stream diversion will all require works near to or in riparian areas. The removal of riparian vegetation will be minimized.

The degree of riparian habitat loss during the access road construction and upgrade is expected to be relatively minor. The total road allowance along the access road is planned at 15 m, which will provide 4 m of cleared right-of-way on each side of the 7 m road surface. For the section of existing access road that will be upgraded, the right-of-way only requires a 5 m expansion. A total of 23 watercourse crossings will be located along the length of the road route, three of which are confirmed to be, or have potential to be, fish-bearing. The resulting loss at crossing areas is approximately 570 m of linear riparian vegetation cover (total length), of which only approximately 100 m is located adjacent to fish-bearing waters.

While the majority of the Macmillan Pass Aerodrome expansion is planned to occur on the southeast side of the existing structure, engineering specifications may require stabilization of river banks nearest to the southwest corner of the aerodrome where erosion is currently occurring. Baseline studies determined that this section of the river is non fish-bearing and that riparian vegetation cover is limited due to ongoing channel migration and substrate types. Therefore, stabilization works are not expected to result in any negative effects in comparison to current conditions.

The installation of the water withdrawal infrastructure on the Hess River Tributary requires removal of riparian vegetation prior to cutting a 4 m by 10 m long trench into the rock wall. The existing vegetation cover (i.e., sparse dwarf birch) located above the rock wall does not provide high value fish cover; however, the construction of the trench will result in a minor loss of ground stabilizing moss and herbaceous cover. This effect is expected to be minor and localized in scale.

Finally, as noted previously, numerous infrastructure components in the footprint area will encroach on upper Tributary C and its feeder streams. However, negative effects from riparian vegetation loss in the footprint area are expected to be minimal as all watercourses within the footprint area are non fish-bearing. Downstream effects from riparian habitat loss are expected to result in low risk to fish and fish habitat.

Mitigation Measures

Mitigation of the effects of riparian habitat loss resulting from construction activities is proposed through several means that include proper planning, careful management of construction sites, and ongoing reclamation efforts. Measures will include:

- minimizing the amount of cleared areas during the road upgrade process through careful planning and delineation;
- applying DFO Standard Operation Procedures as and where appropriate;
- applying the standards outlined in the British Columbia *Riparian Management Area Guidebook* (MOF 1995) when designing clearing limits around fish-bearing waters;
- reviewing riparian vegetation removal plans for three fish-bearing watercourses along the access road with DFO as part of the permitting process;
- revegetating disturbed riparian areas, as part of the progressive reclamation process, to maintain structure and function; and
- conducting works within riparian areas according to recognized environmental best management practices.

Significance Determination

Following the implementation of mitigation measures, residual effects of riparian vegetation loss on fish and fish habitat during construction are predicted to be negative, low in magnitude, local in extent, potentially long term in duration but reversible in the short term, and of low frequency (Table 6.2.9-3). The significance of effects is estimated to be low (Table. 6.2.9-10).

Fish Habitat Loss

The Federal *Fisheries Act* defines fish habitat as those parts of the environment that fish depend on directly or indirectly to carry out their life processes. Section 35 (2) of the *Fisheries Act* prohibits the harmful alteration, disruption or destruction of fish habitat (HADD) unless authorized by Fisheries and Oceans Canada (DFO).

Effects Characterization

The installation of watercourse crossings in the project area has the potential for losses of fish habitat where they span fish-bearing waters. The placement of crossing structures (particularly culverts) and re-alignment of channels, or other similar works, can directly reduce the available habitat area at a local scale. With respect to the construction of the mine access road, the risk of direct habitat loss relates only to three known fish-bearing watercourses (Tributaries D3, D9, and D13).

In addition to the access road construction, minor fish habitat loss may occur as a result of the pump infrastructure installation in the Hess River Tributary. This habitat loss is anticipated to be limited to the pump and related equipment footprints, as no changes will be made to the channel.

No direct habitat losses will result from the mine infrastructure or reservoir, as the uppermost reaches of Tributary C, near where these activities occur, are non fish-bearing.

Mitigation Measures

Mitigation measures will be implemented to minimize or eliminate fish habitat loss and to replace lost habitat with other acceptable habitat. As previously described, the destruction and/or compensation of fish habitat must be authorized by DFO prior to any activities taking place. The DFO typically become engaged in reviewing habitat losses during the detailed engineering and permitting phase. When an acceptable plan for compensation is developed by the proponent, the DFO may issue an Authorization for Works or Undertakings Affecting Fish Habitat pursuant to the *Fisheries Act*.

The following mitigation measures will be employed by NATC to minimize the effects of habitat loss:

- utilize clear span bridges or open bottom culverts, where feasible, to span fish-bearing streams in accordance with DFO Operational Procedures;
- engage with DFO for a permitting review prior to any works, and prepare an acceptable fisheries habitat compensation plan. All works will adhere to the terms of either the *Fisheries Act* Authorization or Letter of Recommendation resulting from that review; and
- limit the area of instream works, where possible.

Significance Determination

Following the implementation of mitigation measures, residual effects of direct habitat loss on fish and fish habitat during construction are predicted to be negative, low to moderate in magnitude, local in extent, long term in duration, reversible in the short term, and of low frequency (Table 6.2.9-3). The significance of effects is estimated to be low (Table 6.2.9-10).

Restriction of Fish Passage at Watercourse Crossings

Effects Characterization

The installation of watercourse crossing structures, particularly culverts, or other changes in stream morphology have the potential to reduce or limit the ability for fish to migrate freely between areas upstream and downstream of crossing sites. This can potentially limit access to spawning areas, feeding areas, overwintering areas, or other seasonal or routine movement needs. Any such works that are installed in fish-bearing waters must provide adequate conditions to maintain fish passage and migration capability though the crossing structure, comparable to that within the parent channel.

Mitigation Measures

As with other undertakings in fish-bearing waters, fish passage capacity also falls under the requirements of the *Fisheries Act*, and comprise general conditions for *Fisheries Act* Authorizations. Three fish-bearing tributaries along the road route (i.e., D3, D9, and D13) are the only watercourses where potential fish passage concerns exist. NATC will employ the following mitigation measures to minimize the potential for fish passage restrictions:

- integrate fish passage requirements for crossings over fish-bearing watercourses during engineering design of crossing structures; and
- engage with DFO for a permitting review during the design and permitting of these structures, and prepare criteria for passage to the satisfaction of both parties. All fish passage criteria outlined in *Fisheries Act* Authorization or Letter of Recommendation will be adhered to.

Significance Determination

Following the implementation of mitigation measures, residual effects of watercourse crossings on fish passage during construction are predicted to be negative, low in magnitude, local in extent, long term in duration, reversible in the short term, and of low frequency (Table 6.2.9-3). The significance of effects is estimated to be low (Table 6.2.9-10).

Deleterious Substances

Construction activities and equipment requires the use of fuels (i.e., hydrocarbons), concrete, and other potentially deleterious substances. Consequently, potential risks to fish and fish habitat exist in relation to construction activities, particularly those within the vicinity of watercourses.

Effects Characterization

Hydrocarbon products such as gasoline, diesel, lubricating oil, aviation fuels, and hydraulic oil likely pose the greatest potential contamination threat due to their commonplace use during construction. In particular, there is potential for spills, leaks, and other surface contamination to occur while using mechanical equipment in and around watercourses. When released to fish-bearing waters, hydrocarbons have the potential to result in direct toxicity and secondary effects from surface films, buildups, or reductions in productivity.

When used in works in or near watercourses, concrete has the potential to affect water quality due to its alkalinity and high toxicity to fish and other aquatic organisms. Concrete leachate may be generated during the curing/drying process. The use of concrete in construction activities will be restricted to camp, mill, and adit infrastructure, and to watercourse crossing structures. Most of these activities are set back from local watercourses, and waste water from concrete works will be diverted to specifically assigned areas for treatment or disposal. As such, the potential effects of concrete use to fish and fish habitat are expected to be low.

Other deleterious substances used during the construction process may include industrial solvents or adhesives, and paints. Waste water and sewage from construction sites can also be considered a deleterious substance of both chemical and biological nature. Each of these substance categories will be managed and controlled according to acceptable and strictly enforced industry guidelines.

Mitigation Measures

Overall, the risk of effects on local fish and fish habitat resulting from the potential releases of deleterious substances from construction activities is low due to the marginal nature of fisheries resources within the project and road study areas. However, the following mitigation measures will be implemented:

- All works will be conducted according to industry best management practices, with diligent monitoring, reporting, and reclamation practices.
- An anticipated environmental management plan and Emergency Response Plan (Appendix M2) will be implemented during construction. Together, these plans describe procedures for fuel storage and transfer, waste management, equipment management in and around watercourses, concrete works, spill response and reporting.

Significance Determination

Taking into account the potential effectiveness of proposed mitigation measures, effects of deleterious substances on fish and fish habitat during construction are predicted to be negative, low to moderate in magnitude, local in extent, short term in duration and reversibility, and of low frequency (Table 6.2.9-3). Following the implementation of mitigation, the significance of effects is estimated to be low (Table. 6.2.9-10).

Changes in Watercourse Flow

Effects Characterization

Numerous temporary and permanent flow diversions are planned for the upper reaches of Tributary C and several of its tributaries due to the construction of the ravine dam and associated infrastructure. While temporary fluctuations to flow are predicted during these works, the overall water balance is expected to remain constant as surface flows are redirected around the reservoir area using a diversion channel. Approximately 10% of the total Tributary C catchment area will be affected by the construction of the ravine dam. Construction works will be completed by redirecting water or pumping water from that section of the catchment area during construction. As such, downstream flows are not predicted to change significantly. Effects to the seasonal runoff pattern of Tributary C are described in the operation section.

Stream flows are not expected to change as a result of road upgrading, as no changes to existing watercourse crossing structures will be made. Similarly, the installation of water extraction infrastructure at the Hess River Tributary is not expected to result in flow changes, as infrastructure will be installed in existing deep pool areas, and the amount of water extracted via pumping will be limited to that used for pressure testing, line filling, or similar activities.

Mitigation Measures

While the anticipated effects of construction activities on local watercourse flows are minimal, temporary water diversion and pumping, and staged construction schedules will be used, where appropriate, to minimize changes in downstream flow delivery to Tributary C.

Significance Determination

Following the implementation of mitigation measures, residual effects of construction on surface water flows are predicted to be neutral, low in magnitude, local in extent, short term in duration, reversible in the short term, and of low frequency (Table 6.2.9-3). The risks to fish and fish habitat are estimated to be low (Table. 6.2.9-10).

Increased Angling Pressure

Effects Characterization

Fish populations (i.e., primarily Dolly Varden) within Tributaries D3, D9, and D13 and the Hess River Tributary are at moderate risk from angling pressure as their capacity to recover from harvest is likely limited due to the relatively unproductive nature of the watercourses they inhabit. However, moderate angling pressure may greatly reduce or extirpate one or more populations, as Dolly Varden population size and growth rates are low.

Mitigation Measures

- Mitigation measures will include installing educational materials, such as signage, at accessible watercourses to outline the sensitivity of local populations to over fishing.

Significance Determination

Following the implementation of mitigation measures, residual angling effects during the construction phase are predicted to be negative, low to moderate in magnitude, regional in extent, short term in duration, reversible in the short term, and of medium frequency (Table 6.2.9-3). The significance of effects on fish and fish habitat are anticipated to be low (Table 6.2.9-10).

TABLE 6.2.9-2 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR AQUATIC ECOSYSTEMS AND FISHERIES RESOURCES (CONSTRUCTION PHASE)

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Clearing and Construction of Access Road	-	Erosion/ Sedimentation	• Appropriate action in accordance with DFO requirements • Instream works conducted in isolation from active channel. • Development of an environmental management plan (EMP) for construction, site control, site stabilization, environmental monitoring, and instream works. • Protection of riparian areas and limited clearing. • Instream works in fish-bearing watercourse conducted at low flow periods. • No fords to be used as crossings.		✓	
		Riparian Vegetation Loss	• Minimize cleared areas. • Appropriate action in accordance with DFO requirements • Revegetation of disturbed areas. • Application of best management practices within riparian zones.		✓	
	Fish Habitat Loss		• DFO permitting through *Fisheries Act* Authorization or Letter of Advice • Preparation of compensation plan		✓	
	Fish passage	-	• Appropriate action in accordance with DFO requirements		✓	

TABLE 6.2.9-2 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR AQUATIC ECOSYSTEMS AND FISHERIES RESOURCES (CONSTRUCTION PHASE)

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
	Restrictions		• Fish passage in accordance with *Fisheries Act* Authorization or Letter of Advice			
	-	Deleterious Substances	• Adherence to best management practices • Environmental management plan and monitoring		✓	
	Angling pressure	-	• Education			✓
Clearing and Construction of Mine Site	-	Erosion/ Sedimentation	• Appropriate action in accordance with DFO requirements • Instream works conducted in isolation from active channel. • Development of an environmental management plan (EMP) for construction, site control, site stabilization, environmental monitoring, and instream works. • Maximized protection of riparian areas and limited clearing. • Instream works in fish-bearing watercourse conducted at low flow periods. • No fords to be used as crossings.		✓	
Construction of Reservoir	-	Deleterious Substances	• Adherence to best management practices • Environmental management and emergency response plans, and monitoring		✓	
	-	Changes in Watercourse Flow	• Low effect anticipated, no mitigation necessary.			
	-	Erosion/ Sedimentation	• Appropriate action in accordance with DFO requirements • Instream works conducted in isolation from active channel • Development of an environmental management plan (EMP) for construction, site control, site stabilization, environmental monitoring, and instream works • Maximized protection of riparian areas and limited clearing • Instream works in fish-bearing watercourse		✓	

TABLE 6.2.9-2 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR AQUATIC ECOSYSTEMS AND FISHERIES RESOURCES (CONSTRUCTION PHASE)						
Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
			conducted at low flow periods • No fords installations to limit fines runoff and sedimentation			
		Deleterious Substances	• Adherence to best management practices • Environmental management and emergency response plans, and monitoring		✓	

TABLE 6.2.9-3 SUMMARY OF SIGNIFICANCE DETERMINATION FOR AQUATIC ECOSYSTEMS AND FISHERIES RESOURCES (CONSTRUCTION PHASE)				
Project component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Fish habitat loss	Negative	Moderate	Short term	Low
Riparian vegetation habitat loss	Negative	Moderate	Short term	Low
Fish passage restriction	Negative	Moderate	Short term	Low
Erosion/Sedimentation	Negative	Low	Short term	Medium
Deposition of deleterious Substances	Negative	Low	Short term	Low
Angling pressure	Negative	Low to Moderate	Short term	Medium

Operation Phase

The operation phase for the Mactung project involves a number of components that have the potential to adversely affect fish and fish habitat. As with the construction phase, most project activities will occur upstream from fish-bearing waters; therefore, effects will be indirect and downstream in nature. The following components are considered:

- withdrawal of 6.6 litres per second from the Hess River Tributary and transport of that water to the mill site;
- operation of the mine and mill facility, including the deposition and preparation of tailings in the dry-stacked tailings facility;

- transfer of 2.2 litres per second of excess balance process water from the mill facility to the reservoir;
- release of excess water from the reservoir to Tributary C;
- movement of supplies, staff, and product along the access road between the mine site and North Canol Road;
- maintenance traffic from the mine site to the Hess River Tributary pumping facility and reservoir; and
- increased access to the project area via upgraded road systems.

It is also expected that several effect components will continue from the construction phase, although their mechanisms and scope may differ. Operation phase effects and mitigation measures are described in Table 6.2.9-6.

Erosion and Sedimentation

Details regarding the effect of erosion and sedimentation on fish and fish habitat are discussed in detail in the construction phase. Effect pathways for the construction phase are similar for the operation phase.

Effects Characterization

The mine access and pumping station spur road have the potential for limited, ongoing levels of erosion and sedimentation in the vicinity of watercourse crossings. Storm events, road washouts, and other construction and maintenance works can create sedimentation risks that must be adequately mitigated and monitored. Most notably, site stabilization and reclamation undertaken as part of the construction efforts (e.g. revegetation of stream bank areas next to watercourse crossings) will be maintained throughout the operation phase. Dust problems resulting from road traffic are not anticipated due to frequent local precipitation and slow traffic speeds. Sedimentation to watercourses in the footprint area is not anticipated as riparian vegetation will be maintained or revegetated if disturbed during construction, and runoff from tailings and other high risk areas will be diverted to the reservoir.

Mitigation Measures

Mitigation measures to minimize potential effects from construction activities will focus on two primary objectives: minimizing the risk of erosion by properly managing sites, and minimizing the risk of surface runoff or wind transport of eroded sediment to local watercourses. Mitigation measures will include:

- developing an environmental management plan (EMP) for use by NATC and its contractors for all works. This plan will outline best management practices for construction, site control, soil stabilization, environmental monitoring, and instream works, based on the following literature:
  - DFO Standard Operational Procedures;

  - *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO and BCMOE 1993);
  - *A Users' Guide to Working In and Around Water* (BC Ministry of Land Water and Air Protection, 2005);
  - *Standards and Best Management Practices for Instream Works* (BC Ministry of Land Water and Air Protection, 2004); and
- Maintain clearing limits and riparian reserve areas during construction activities.

Significance Determination

Following the implementation of mitigation measures, residual effects of erosion and sedimentation on fish and fish habitat during operations are predicted to be negative, moderate in magnitude, local in extent, short term in duration and reversibility, and of medium frequency (Table 6.2.9-7). The significance of effects of erosion and sedimentation on fish and fish habitat are estimated to be low (Table 6.2.9-10).

Surface Water Discharge Rates

Seasonally consistent discharge rates in watercourses that contain fish or flow into fish-bearing waters are an important component of sustainable fish and fish habitat. Suitable water levels are essential for all components of fish life cycles, including supporting developing eggs, fry and food, delivering oxygen, and allowing movement. Depending on the season, abnormally high or low discharges can be detrimental for fish survival, health, or reproduction.

Effects Characterization

A positive water balance in the Tributary C drainage will result from water pumped to the on-site processing plant from the Hess River Tributary. Secondary effects are related to the controlled release of water from the reservoir.

The most significant flow effects are expected to occur at the furthest potential upstream extent of fish distribution in Tributary C, located at the lower of two recognized fish barriers on that watercourse (herein referred to as the discharge point). Further downstream, effects on flow will be reduced as other tributaries flow into Tributary C and increase the overall flow. Flow estimates for process plant water and groundwater seepage are provided in Section 4.1.10 (Water Resources).

Overall, no effects are anticipated from any potential reductions in flow resulting from the reservoir operation, as estimated flow reductions for Tributary C are estimated to be roughly 10% on an average yearly basis (Table 6.2.9-4). Further, the bulk of suitable overwintering habitat occurs in the lowest reaches of Tributary C, near the junction with Tributary A, where deep pools and habitat structure are more suitable to overwintering and where these habitats are buffered from discharge fluctuations.

NATC plans to gradually release water from the reservoir throughout the ice-free season (approximately June through September), particularly surface water accumulated during freshet. Depending upon annual volume of surface runoff, planned pumping from the reservoir to the upper reaches of Tributary C will range from 190–380 L/s, and will span up to 90 days. Stepped reductions in flow will be possible toward the latter part of the season if deemed favourable to fish habitat. Water release from the reservoir is predicted to decrease peak freshet flows by roughly 75% at the release area (Table 6.2.9-4), while the resulting decrease in lower reaches of Tributary C are predicted to be approximately 6.5%. The overall result will be a less variable summer hydrograph, with freshet flows being distributed more evenly through the summer season. In consideration that the affected watershed portion is roughly 10% of the total Tributary C drainage and reductions in peak flow are limited, effects on fish habitat quality or availability (e.g., from low flows or reduced sediment flushing capacity) are expected to be minimal.

TABLE 6.2.9-4 SUMMARY OF TRIBUTARY C FLOWS, RAVINE DAM AREA AND LOWER C

	Natural (Pre-development) Estimates			Operation Phase
Return Period*	Mean Low Flow Discharge at Pond Area/ Lower Tributary C (March)	Peak Flow Estimate at Discharge Pond Area (June)	Peak Flow at Lower Tributary C, near Tributary A (June)	Estimated Retention Pond Discharge Rate (June 1-August 31)
Mean (Q_2)	3.77 / 36.16	--	--	--
Q_{10}	--	818	9,779	190 L/s.
Q_{20}	--	1,028	10,964	270 L/s
Q_{100}	--	1,600	13,333	380 L/s.

– * Return period (Q value) refers to the estimated maximum flows for a specific time period (e.g. Q refers to the estimated maximum 100 year flood value).

During the ice-free season, the presence of infrastructure and stream diversion in the footprint area may act to increase the flow response peak from precipitation events. While this may occur, the footprint diversion area contributes approximately 50% of the total watershed area at the discharge point, and approximately 10% of the total discharge area. Consequently, negative effects are not predicted.

Within the footprint area and upper Tributary C drainage, the potential for a minor reduction of groundwater discharge resulting from adit construction and dewatering was also considered. Baseline hydrogeological studies have revealed that permafrost persists through the majority of the resource area, and it is anticipated that this permafrost will be maintained throughout mining operations. No changes in groundwater flow regimes are anticipated, and any groundwater removed during minor adit dewatering will be routed through the process water system, reservoir, and ultimately the Tributary C system (described further in hydrogeological effects section, Section 6.2.8.3).

Water withdrawal from the Hess River Tributary is planned at 6.6 L/s on a year-round basis to meet production water requirements. During the summer season, flows in the Hess River Tributary range from roughly 12,000 –16,000 L/s, and withdrawal represents 0.04% to 0.06% of the total water discharge. Consequently, no effects of water reductions are anticipated.

During winter months, flows in the Hess River Tributary are reduced to roughly 140 L/s, at which time the maximum water intake needs could represent roughly 5% of the total flow in the 550 m section between the pumping station and the junction of the Hess River Tributary. Consequently, the potential for effects of flow reduction were considered for an area downstream of the withdrawal site. The poor natural water quality attributes in Tributary A, which enters the Hess River Tributary 550 m downstream of the pumping location, consequently affects the water quality of the Hess River Tributary below that junction. As a result, the lower Hess River Tributary is not considered to support fish overwintering from the junction with Tributary A until further downstream, where other tributaries can dilute the negative effects of Tributary A. As such, potential effects are limited to only the 550 m segment of channel below the pumping area.

As noted in Section 4.1.11, baseline studies indicate fall and early winter fish presence and habitat use to be extremely low in all areas of the Hess River Tributary surveyed. Additionally, no indications of spawning by Dolly Varden, salmon, whitefish, or any other fall spawners were found locally or upstream of the project area. The conclusion from these findings is that overwintering habitat needs, or water/flow requirements for redds, larvae, or juveniles are not a concern for areas downstream of the pumping infrastructure, nor for the Hess River Tributary in the greater project area. Therefore, the use of water from the tributary is not expected to affect overwintering fish or fall spawning.

Mitigation Measures

The following mitigation measures will be implemented:

- a water release regime plan for the reservoir will be subjected to regulatory review by both the Yukon Water Board and DFO;
- winter low flow levels in Tributary C will be maintained as necessary according to the terms of the Water Licence or other regulation;
- early summer discharges can be regulated if deemed necessary to approximate natural freshet flows; and
- Pumping intakes will be properly fitted with screens to ensure that no fish will be harmed or taken into pumps (as per DFO's *Freshwater Intake End-of-Pipe Fish Screen Guidelines*).

Significance Determination

Following the implementation of mitigation measures, residual effects of operations on surface water flows are predicted to be negative, low in magnitude, local in extent, short term in duration, reversible, and of medium frequency (Table 6.2.9-7). The significance of risk to fish and fish habitat from operational flow modifications in surface flows is estimated to be low (Table. 6.2.9-10).

Surface Water Quality

The maintenance of surface water quality as it relates to fish and fish habitat within the project and road study areas have been considered in the design of the proposed Mactung project facilities. Numerous project components were identified and assessed for their potential to reduce the quality of surface water and other aspects of fish habitat capacity, including:

- spill or discharge of process plant effluent balance to Tributary C via the reservoir;
- spill or discharge of treatment plant effluent to Tributary C via the reservoir;
- potential changes to downstream metal concentrations resulting from operation activities;
- potential acid rock drainage effects (ARD) resulting from disturbed rock and tailings; and
- release of hydrocarbons or related substances during regular on-site operations.

Effects Characterization

Hydrocarbons such as fuels, lubricants, and industrial chemicals pose a small ongoing risk for contamination threat due to their extensive use in operation activities. However, the presence of supporting infrastructure, such as designated fuelling and maintenance areas, will reduce environmental risk.

Following the start of operation, mining and milling will operate for 24-hours per day. This process uses number of reagents, including flocculents, frothers, separation, and other reagents such as KAX, DF250, caustic soda, quebracho, emcol, and pamak, as described in Section 5. The process closely parallels that used at NATC's existing Cantung mine, which has similar geological and mineral composition to the Mactung site. Following milling, the tailings will be de-watered for placement in the dry-stacked tailings facility, and process water will be directed to the reservoir. While the majority of process water will be recycled to the process facility following roughly 30 days of residence time, (allowing the breakdown of fatty acid components as required for use in the process), excess process water will be discharged to upper Tributary C with excess runoff water. NATC recognizes that this discharge has the potential to cause effects on fish and fish habitat, although the precise details of discharge water makeup and resulting risk cannot be fully understood at this early stage, experience at the Cantung mine indicates that no negative effects to downstream biota will occur.

As described previously, both the process and local mineral characteristics at the proposed Mactung site are similar to those at NATC's Cantung mine. Process water at the Cantung mine is released from a wet tailings facility to the environment via subsurface percolation to the neighbouring Flat River. The tailings decant water from the Cantung process, collected at the MMER prescribed effluent point (i.e., a monitoring well), have consistently proven safe to fish and aquatic life through direct bioassay (results shown in Appendix I4). While this data does not provide a sufficient basis on which to design or prescribe a regulatory water release regime for the proposed Mactung mine, it does provide a basis by which the potential effects can be classified and considered in the context of mitigation measures. No effects to fish or fish habitat are expected due to the plant operations.

During the milling and dewatering stages of the operation, process water will contact ore providing the potential for the uptake of metals that can, upon release of process water, result in potential chronic or toxic effects on downstream fish and fish habitat. NATC will extract water for mill processing from the upper Hess River Tributary, which has lower total and dissolved metals concentrations than water in Tributaries C and A (see Water Quality Section 4.1.10). A modelled estimate of the decant metals balance, following precipitation, suggests that the majority of metals levels will be lower in decant water than the receiving environment (Section 6.2.8.2 – Surface Water Quality). This scenario is shown for five key metals in Table 6.2.9-5.

TABLE 6.2.9-5 COMPARISON OF RESERVOIR CHEMISTRY BALANCE WITH BASELINE LEVELS

Parameter	Unit	Projected Reservoir Chemistry	Comparison of Reservoir to Background	Highest Recorded Baseline Value (2007 -2008)†			
				Tributary C	Tributary A	Upper Hess River Tributary	Lower Hess River Tributary
As	mg/L	.0018	<	.0036	.0026	.0014	.0021
Cd	mg/L	.00021	<	.00269	.00795	.0002	.00234
Cu	mg/L	.030	<>	.019	.0442	.004	.0135
Se	mg/L	.00080	<	.0044	.0035	.0007	.0013
Zn	mg/L	.0016	<	.262	0.48	.011	.125

†Shaded boxes denote baseline levels that exceed CCME levels.

Consequently, the concentration and bioaccumulation of metals in the receiving environment is not considered to pose a significant risk.

The use of ammonium nitrate fuel oil (ANFO) for on-site blasting is predicted to result in the deposit of nitrate residue on process ore, waste rock, and other materials that will be deposited on-site or be processed. Consequently, nitrate levels are predicted to be elevated in the receiving environment; the potential effect may be a slight increase in primary productivity that may in turn increase the quality and productivity of fish habitat in

Tributary C. However, such an effect would only be realized in the case that nitrate is a limiting nutrient in the system, which is not necessarily the case considering the location and baseline environment conditions.

Other water used on site for non-process needs and the camp will be treated and released to the reservoir at a rate of 0.5 L/s. Treatment of this water (described in Section 5) will be to CCME standards for aquatic life, and no additional risk to fish or fish habitat are expected as a result.

A complete discussion on ARD effects are presented in Section 6.2.2. ARD is not predicted during the operational life of the mine, and thus effects on fish of fish habitat are not anticipated.

Mitigation Measures

Numerous mitigation measures will be employed to reduce or prevent potential effects. These measures include:

- Regulating and monitoring the use of hydrocarbons and other industrial substances under NATC's environmental management plan for the mine, and spill response will be conducted according to the spill contingency plan.
- The release of excess water from the reservoir will be regulated under the Territorial *Waters Act*, the *Fisheries Act*, and MMER. As the precise makeup and effects of this process water will not be known until operation, process water release will only proceed according to allowable regulation.
- NATC will work with DFO, the Territorial Water Board, and other regulatory groups to establish acceptable protocols (i.e., timing, dilution, location, etc.) for release of excess process water.
- NATC will have the capacity to retain excess process water during startup for the time required to establish safe release protocols.
- Water will be subjected to direct acute toxicity testing and other tests prior to discharge, as required, to establish the direct anticipated aquatic health effects.

NATC does not expect that CCME standards will be attainable in the receiving environment, as naturally occurring baseline conditions exceed these standards.

- NATC will work with regulatory agencies during the permitting process to develop site specific environmental standards for parameters such as water, sediments, nutrients, pH, and others;
- Discharges from the reservoir will be subject to the Metal Mining Effluent Regulations (MMER) and territorial Water Licence criteria. NATC is in the early stages of planning a fisheries and aquatic environment monitoring program (an anticipated requirement for MMER and the Water Licence); and

- Water quality will be monitored routinely under the scope of the water quality program (Section 6.2.8.2).

Significance Determination

Following the implementation of mitigation measures, residual effects of operations on surface water quality are predicted to be negative, low to moderate in magnitude, local in extent, long term in duration, reversible in the short term, and of high frequency (Table 6.2.9-7). The risks to fish and fish habitat due to changes in surface water quality from the mine operation are expected to be low (Table. 6.2.9-10).

Angling Pressure

Effects Characterization

As during the construction phase, increased angling pressure will continue to pose a risk during the operation phase of the project. Watercourses potentially accessible for angling during operations of the project include Tributaries D3, D9, and D13, and Hess River Tributary. Significant fishing pressure is not predicted due to the small size of these watercourses and small size of fish within them, making them less attractive to anglers.

Mitigation Measures

Mitigation measures will be implemented, including:

- Incorporating educational material, such as signage, at accessible watercourses to describe the sensitivity of local populations to overfishing; and
- Installing a gate to prevent unauthorized access to Tributary E to limit fishing pressure at the Hess River Tributary.

Significance Determination

Following the implementation of mitigation measures the risk to fish and fish distribution from potentially increased angling pressure is estimated to be low (Table. 6.2.9-6). Following the implementation of mitigation measures, residual effects from angling pressure during the mine operation are predicted to be negative, low to moderate in magnitude, regional in extent, short term in duration, reversible in the short term, and of medium frequency (Table 6.2.9-7).

TABLE 6.2.9-6 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR AQUATIC ECOSYSTEMS AND FISHERIES RESOURCES (OPERATION PHASE)

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Hauling on access road (concentrate, supplies, staff)	-	Erosion/ Sedimentation	• Implementation of an environmental management plan (EMP) for construction, site control, site stabilization, environmental monitoring, and instream works. • Protection of riparian areas and limited clearing. • No fords to be used as crossings.		✓	
	-	Deleterious Substances	• Adherence to best management practices • Environmental management and emergency response plans and monitoring		✓	
	Angling Pressure	-	• Education		✓	
Mining, milling, and Concentration of ore (including water management)	-	Surface Water Quality	• Acceptable release protocols for process water to be developed with Federal agencies and Territorial Water Board. • Process water to be held during low flows if necessary • Toxicity testing of decant water to be conducted on an ongoing basis. • Environmental management and emergency response plans and monitoring		✓	
	-	Changes in surface water flows	• Supplement winter flows if necessary to maintain minimums. • Supplement early summer flows if necessary to approximate natural freshet.		✓	
Water withdrawal from the Hess River Tributary	-	Reduction of surface water flows	• Neutral effect, no mitigation necessary.			
	Fish uptake or mortality from pumps	-	• Installation of screens according to DFO fish screen guidelines.			✓

TABLE 6.2.9-7 SUMMARY OF SIGNIFICANCE DETERMINATION FOR AQUATIC ECOSYSTEMS AND FISHERIES RESOURCES (OPERATION PHASE)				
Project Component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Erosion/Sedimentation	Negative	Low	Short term	Medium
Deposition of deleterious Substances	Negative	Low	Short term	Medium
Angling pressure	Negative	Moderate to High	Short term	Medium
Surface water quality	Negative	Moderate	Short term	High
Surface water flows	Neutral	Low	Short term	Medium
Fish uptake into pumps	Neutral	Moderate	Short term	Medium

Decommissioning Phase

Following the anticipated 12 year operating lifespan of the Mactung mine, a two year decommissioning and reclamation phase will be undertaken. Decommissioning will include the following components, which have the potential to affect fish and fish habitat:

- decommissioning of the mine access road, including the removal of watercourse crossing structures and restriction of access to the site;
- decommissioning of the ravine dam and reservoir diversion channel structures in order to return natural flow regimes to the area;
- re-contouring of the mine infrastructure areas in the footprint;
- removal of pumping infrastructure from the Hess River Tributary; and
- abandonment of the site.

Erosion and Sedimentation

Effects Characterization

Following the end of mine operations, NATC plans to decommission part or all of the private access road, contingent on Yukon government's request to assume ownership of the road. The removal of watercourse crossings and re-contouring of road surfaces near watercourses poses erosion and sedimentation risks similar to those identified for the construction phase. Similarly, the decommissioning of the reservoir, footprint water diversion, and general mine site re-contouring will require extensive works in or near watercourses that form the headwaters to fish-bearing waters. Consequently, moderate downstream effects on fish and fish habitat have the potential to occur.

Following reclamation of the watercourses in the footprint area and decommissioning of watercourse crossings, erosion and sediment transport are expected to quickly equilibrate to naturally expected levels, and effects post-closure are not anticipated.

Mitigation Measures

Mitigation measures to minimize the potential for sedimentation and erosion in conjunction with decommissioning activities closely parallel those outlined for construction, and focus on two primary objectives: minimizing the risk of erosion and minimizing the transportation of sediments by water or wind. The following mitigation measures will be employed to minimize erosion and sedimentation effects:

- NATC will engage with DFO for a permitting review prior to any works. All works will adhere to the terms of either the *Fisheries Act* Authorization or Letter of Recommendation resulting from that review;
- all instream works will be conducted in isolation from the active channel where the potential for fish habitat risks exist, and these activities will be monitored by environmental professionals;
- an environmental management plan (EMP) will be developed and employed by NATC and its contractors for all works. This plan will outline best management practices for construction, soil stabilization, environmental monitoring, and instream works, based on the following literature:
  - *Land Development Guidelines for the Protection of Aquatic Habitat* (DFO and BCMOE 1993).
  - *A Users' Guide to Working In and Around Water* (BC Ministry of Land Water and Air Protection, 2005).
  - *Standards and Best Management Practices for Instream Works* (BC Ministry of Land Water and Air Protection, 2004).
- clearing limits and riparian reserve areas will be adhered to during construction activities;
- wherever possible, instream works and those in the vicinity of fish-bearing watercourse will be conducted at low flow periods when surface runoff is limited; and,
- fords will not be installed or used as watercourse crossings due to the abundance of sediment fines and the high precipitation microclimate in the footprint area.

Significance Determination

Following the implementation of mitigation measures, residual effects of erosion and sedimentation on fish and fish habitat during construction are predicted to be negative, moderate in magnitude, local in extent, short term in duration and reversible in the short term, and of low frequency (Table 6.2.9-9)., the risks to fish and fish habitat resulting from sedimentation and erosion are expected to be low (Table. 6.2.9-10).

Maintenance of Surface Water Quality

Effects Characterization

During reclamation and closure of the mine site, no significant changes in surface water chemical quality are predicted. Following closure, surface flows originating from the site will be re-established, and surface runoff will assume pre-development patterns. Chemical composition and predicted ageing of these tailings and process water have suggested no resulting increases in Tributary C metals levels, due to the high background levels originating from local groundwater sources. The shift from process water to natural surface runoff at closure is expected to result in a net increase in water quality.

Acid rock drainage effects have been considered during the planning of the closure phase of the mine, as they are considered as a long-term effect. Such effects have also been considered for the road and footprint areas. Along the access road, all areas of disturbance, material borrow, and cut/fill will occur in previously fractured bedrock and surface soil areas. The majority of fill removal and all borrow areas will take place in granular glaciofluvial deposits that are previously broken and weathered, and minimal blasting will remove previously fractured surface rock only. Tailings may contain some potentially acid generating (PAG) content, and will be located within the upper drainage of Tributary C. However, these tailings will be covered in dry-stack form and properly prepared at closure with impermeable liners and proper sealing processes. Due to their location, the tailings are also predicted to, over time, develop permafrost year-round. The complete footprint of tailings at closure will be less than 10% of the Tributary C watershed area.

The future ARD effects from the mine and road infrastructure are not considered to be significant.

Mitigation Measures

During reclamation and closure, no significant negative effects on surface water quality are predicted, and consequently no mitigation measures are deemed necessary other than those proposed under the ARD effects assessment section (Section 6.2.2).

Significance Determination

Residual effects on surface water quality and on fish following closure are predicted to be neutral, low in magnitude, local in extent, short term in duration and reversibility, and of low frequency (Table 6.2.9-9). Risks to fish and fish habitat due to effects on surface water quality following mine closure are estimated to be low (Table. 6.2.9-10)

Fisheries Habitat Gains

Effects Characterization

During the reclamation and closure processes, infrastructure such as culverts, clear span bridges and pumping infrastructure that were placed into watercourses will be removed in part or whole, depending on the road use status. During the construction phase, fish habitat compensation, developed as part of a *Fisheries Act* Authorization, will have resulted in the creation of new habitat areas. Once those original structures causing the losses are removed, the re-establishment of these areas will result in an overall long-term gain.

Mitigation Measures

Since a net increase in habitat over time are predicted, no mitigation measures are deemed necessary.

Significance Determination

The effect of re-establishing previously lost fish habitat is expected to result in fish habitat effects that are positive, low in magnitude, local in extent, long term in duration and reversibility, and of low frequency (Table 6.2.9-9). Overall, the risk to fish and fish habitat due to the removal of instream or near stream infrastructure is estimated to be very low (Table. 6.2.9-10).

Fish Passage Restrictions

Effects Characterization

As with the re-established fish habitat areas, the removal of watercourse crossing structures in conjunction with road decommissioning is predicted to improve fish passage capacities to pre-development levels. The decommissioning plans, which will be developed in coordination with regulatory bodies, will outline the techniques to be used and efforts will be made to re-establish disturbed channel segments with similar slopes, substrates, and flows to those identified at the baseline state. In some cases, fish passage ability may be improved over baseline states.

Mitigation Measures

In general, re-establishment of original channel characteristics and fish passage capacity during reclamation is predicted as a result of watercourse crossing removal. The following mitigation measures will be implemented:

- DFO will be consulted during preparation for reclamation; and
- Watercourse crossings will be removed, returning fish passage characteristics to baseline levels at minimum.

Significance Determination

The effect of reclaiming watercourse crossing areas is expected to allow baseline-level fish passage capabilities, resulting in an effect that is neutral, low in magnitude, local in extent, long term in duration and reversibility, and of low frequency (Table 6.2.9-9). Following the implementation of mitigation measures, the significance of effects is estimated to be low (Table. 6.2.9-10).

Angling Pressure

Effects Characterization

Following the closure and reclamation of the mine and road infrastructure, vehicular traffic will be restricted from using the access road and accessing fish-bearing watercourses, with the exception of all-terrain vehicles and snowmobile traffic that can access Tributary D at pre-development phase. Due to the remote nature of the site and low fish presence, angling pressure is predicted to remain at low levels.

Should the access road be deemed a value to government and not decommissioned, the potential for continued fishing pressure will have to be considered as part of the transfer of maintenance responsibility. At that time, the new proponent will assume the responsibility for preventing increased fishing pressure, should it be deemed important to do so.

Mitigation Measures

The following mitigation measures will be implemented during the decommissioning phase:

- The access road will be decommissioned, unless the Yukon government agrees to take over management of the road. Decommissioning the road will remove all access capacity to the Hess River Tributary, and will limit access to Tributaries D3, D9, and D13 (the only fish-bearing watercourses on the road) to pre-development levels.

Significance Determination

Following the implementation of mitigation measures, residual effects of angling pressure on local fish resources during reclamation and post-closure are predicted to be negative, low to moderate in magnitude, regional in extent, long term in duration, reversible in the short term, and of medium frequency (Table 6.2.9-9). Risks to fish and fish distribution from angling following site closure is estimated to be very low (Table. 6.2.9-10).

TABLE 6.2.9-8 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR AQUATIC ECOSYSTEMS AND FISHERIES RESOURCES (DECOMMISSIONING PHASE)

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
Decommissioning of Access Road (includes removal of bridges/culverts and limiting access	Fish passage Restrictions		• Fish passage conditions at closure will meet baseline conditions.			✓
	-	Erosion/ Sedimentation	• DFO Letter of advice to be sought for removal of crossings. • Instream works conducted in isolation from active channel. • Implementation of an environmental management plan (EMP) for removal of crossings, site stabilization, environmental monitoring, and instream works. • Protection of riparian areas. • Instream works in fish-bearing watercourse conducted at low flow periods. • No fords to be used as crossings following removal of crossing structures.		✓	
	-	Deleterious Substances	• Adherence to best management practices • Environmental management and emergency response plan and monitoring		✓	
	Habitat gains	-	• No mitigation necessary.			
Decommissioning of reservoir and footprint diversions	-	Erosion/ Sedimentation	• Instream works conducted in isolation from active channel. • Implementation of an environmental management plan for instream works. • Instream works in fish-bearing watercourse conducted at low flow periods. • No fords to be used as crossings following culvert removals.		✓	

TABLE 6.2.9-8 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR AQUATIC ECOSYSTEMS AND FISHERIES RESOURCES (DECOMMISSIONING PHASE)

Project Activities	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
				None	Partial	Complete
	-	Deleterious Substances	• Adherence to best management practices • Environmental management and emergency response plans and monitoring		✓	
Re-contouring of mine infrastructure areas.	-	Erosion/ Sedimentation	• Instream works conducted in isolation from active channel. • Implementation of an environmental management plan (EMP) for instream works. • Instream works in fish-bearing watercourse conducted at low flow periods. • No fords to be used as crossings following culvert removals.		✓	
	-	Deleterious Substances	• Adherence to best management practices • Environmental management and emergency response plans and monitoring		✓	
Abandonment	Angling Pressure	-	• No access to the Hess River Tributary following decommissioning.		✓	

TABLE 6.2.9-9 SUMMARY OF SIGNIFICANCE DETERMINATION FOR AQUATICS AND FISHERIES RESOURCES (DECOMMISSIONING PHASE

Project component	Direction	Magnitude/ Extent/ Duration	Reversibility	Frequency
Fish passage restrictions	Neutral	Moderate	Short term	Low
Erosion/ Sedimentation	Negative	Low	Short term	Low
Deposition of deleterious Substances	Negative	Low	Short term	Low
Angling pressure	Neutral	Moderate to High	Short term	Low

6.2.9.5 Significance Determination

Table 6.2.9-10 summarizes the significance determination identified for each residual effect in the previous section.

TABLE 6.2.9-10 SUMMARY OF SIGNIFICANCE DETERMINATION FOR AQUATICS AND FISHERIES RESOURCES (ALL PROJECT PHASES)

Effect	Construction	Operation	Reclamation/ Closure
Fish habitat loss	Low	Low	Low
Fish passage restrictions	Low	Low	Low
Erosion/Sedimentation	Low	Low	Low
Deposition of deleterious Substances	Low	Low	Low
Angling pressure	Low	Low	Low
Surface water quality	-	Low	-
Surface water quantity	Low	Low	Low

6.2.10 Archaeology

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

6.2.11 Identification of Valued Component

Archaeological resources, also described as "heritage resources" were identified as a valued component due to their importance to society. These resources have been recognized for their value to First Nations as well as society in general. Heritages resources are protected through a number of legal instruments including *YESAA*, the *Historic Resources Act* (Yukon) and the individual Final Agreements of Yukon First Nations, specifically, the First Nation of Nacho Nyak Dun Final Agreement.

According to *YESAA*, heritage resources are defined as:

(a) *a moveable work or assembly of works of people or of nature, other than a record only, that is of scientific or cultural value for its archaeological, palaeontological, ethnological, prehistoric, historic or aesthetic features;*

(b) *a record, regardless of its physical form or characteristics, that is of scientific or cultural value for its archaeological, palaeontological, ethnological, prehistoric, historic or aesthetic features; or*

(c) *an area of land that contains a work or assembly of works referred to in paragraph (a) or an area that is of aesthetic or cultural value, including a human burial site outside a recognized cemetery.* *(YESAB, 2003)*

6.2.11.1 Summary of Baseline Information

For the purpose of collecting baseline heritage resources information, archaeological investigations were completed. For these studies, archaeological sites are described as "locations that contain physical evidence (i.e., artefacts or features) of past human activity and are integral to understanding the cultural history of the Mactung area. These sites are non-renewable resources and as such are susceptible to damage from any land altering activity. Within the Mactung project area, archaeological sites would likely be prehistoric and consist of the remains of camps, stone tools and stone tool making debris" (Points West, 2008).

Site investigations to identify archaeological potential were completed by Points West Heritage Consulting Ltd. (Points West) in 2006, 2007, and 2008. All field studies were conducted with the presence and participation of a Ross River Dena Council representative. For the initial site investigations conducted in 2006, Points West preformed a preliminary assessment of the proposed mine site to identify areas with archaeological potential.

Field work was completed in 2007 to further the initial conclusions from the 2006 site investigations. The 2007 report indicated that the proposed mine facilities, located in a high west facing alpine valley, would be situated in an area with very low archaeological potential.

In 2008, site investigations were undertaken for the new access road, from the North Canol Road to the Mine site, as well as the aerodrome expansion area. One archaeological site was discovered adjacent to the proposed access road alignment in the Macmillan Pass. Points West stated in its report that the site is unlikely to yield additional information that would significantly add to the understanding of the prehistory of the area (Points West, 2008). Further, the report indicated that the proposed mine site area and pumping station, access road, and aerodrome extension were of low archaeological potential.

The archaeological reports completed by Points West are appended to this project proposal in Appendix K1, K2 and K3.

6.2.11.2 Identification of Temporal and Spatial Bounding

Heritage resource sites are typically located in areas that have been used in the past for living, hunting, gathering or traveling. These areas are commonly identified through their proximity to waterbodies, high terraces and harvested resources (Points West, 2008). The spatial boundary for this effects assessment is reflective of those areas requiring earth works, including the proposed access road, staging areas, quarries, borrow pits, mine site, and aerodrome expansion.

The temporal scope of this assessment is limited to the construction years 2010 to 2012, as the potential for conflict between heritage resources and project activities would occur during this time.

6.2.11.3 Effects Characterization

Identified project activities that may potentially affect heritage resources include:

- clearing of land for the construction or roads, site facilities, aerodrome expansion and staging areas; and

- excavation of areas for the development of borrow pits and quarries.

Heritage resources are valued in association with the area in which they rest (i.e., *in situ*). The clearing and excavation of land can result in the disruption and/or destruction of heritage resources. Damage to heritage resources may result in effects to society through the loss of scientific and cultural value.

No archaeological sites were encountered during the 2006 and 2007 investigations in the areas of the proposed mine site development. Within this area, the studies reported little to no archaeological potential and identified no previously recorded sites. During the studies conducted in 2008, one archaeological site was discovered adjacent to the proposed access road alignment in the Macmillan Pass area.

Table 6.2.10-1 presents a summary of the effects characterization and application of mitigation measures.

TABLE 6.2.10-1 SUMMARY OF POTENTIAL EFFECTS AND MITIGATION MEASURES FOR ARCHEAOLOGY

Project Activities	VC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Clearing of land for the construction.	Heritage Resources	Loss of cultural and scientific resources.		• Assessment of areas not previously identified for clearing and excavating. • Heritage resources encountered will be protected and reported to authorities. • NATC will communicate heritage resource terms and conditions listed in authorizations to employees and contractors.			✓
Excavation of areas to obtain aggregate.							✓

6.2.11.4 Mitigation Measures

Due to the importance of heritage resources as well as the legal requirements associated with their protection, NATC will ensure the following standard mitigation measures are applied:

- if the footprint of the project should change to require land-altering activities outside of the previously assessed area, a qualified professional will be retained to conduct an assessment for archaeological resources. The results of this assessment will be submitted for review and approval to the Government of Yukon - Heritage Resources.
- if heritage resources are discovered during operations, NATC will mark and protect the site from disturbance. NATC will contact the appropriate authorities to report the discovery, and will not carry out any activities in the vicinity of the heritage resource until permission to resume activities has been granted.
- NATC will communicate the terms and conditions of their authorizations, specific to the protection of heritage resources, to both their employees and contractors.

6.2.11.5 Significance Determination

Given the results of the archaeological assessments, project planning, and the application of identified mitigation measures, the effects of the project on heritage resources are identified to be of low significance.

A formal significance determination using magnitude, frequency, duration, and biological and physical considerations is not required.

6.2.12 Effects of the Environment on the Project

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

The project may be affected by various environmental occurrences, including rockfalls, landslides, avalanches, earthquakes, high winds, flooding, fire, and permafrost.

6.2.12.1 Rockfalls, Landslides, and Avalanches

Discussions regarding the potential effects of rockfalls, landslides, and avalanches have been previously described in Section 6.2.1. The effects of these terrain hazards are mitigated by locating infrastructure in areas of low risk and developing and implementing management plans (e.g. Avalanche Hazard Management Plan).

6.2.12.2 Earthquakes

The project area is located in an area of moderate seismic hazard, rated 3 on a scale of 5 (GSC 2005). The maximum ground accelerations associated with 1:475 and 1:1000 year return earthquakes are 0.137 g and 0.179 g respectively. The seismic hazard for the area has been incorporated into the design of major infrastructure components such as the ravine dam and the dry-stacked tailings facility. Procedures and protocols to be followed in the event of an earthquake are included in the Emergency Response Plan (Appendix M2).

6.2.12.3 High Winds

The proposed Mactung mine site is located in a mountainous area above the treeline. The on-site meteorological station recorded a maximum wind gust speed of 23 m/s (82.85 km/hr) between 2005 and 2007. There is a potential for buildings to be damaged as a result of high winds, but the likelihood of this occurring is considered low. Buildings will be designed according to Government of Yukon building standards and will be mostly steel framed structures with cladding. Potential direct wind effects include minor structural damage to buildings that would be repaired as required. The indirect effect of wind on the project is the drifting of snow that can influence avalanche activity following storm events.

6.2.12.4 Flooding

Flooding has the potential to disrupt surface access to the site through road wash-outs and potential failure of stream crossing structures. All drainage structures are designed to accommodate a 100-year storm event (i.e., Q100). Bridges and culverts will be subject to frequent inspections to ensure timely response to potential flooding.

6.2.12.5 Fire

Natural fires are not considered to have a significant potential effect on the project due to absence of trees and shrubs around the mine site and sparse or low-growing vegetation along the proposed access road and Macmillan Pass Aerodrome. Any natural fires are anticipated to be small and isolated, causing only temporary disruptions to operations, likely occurring along the proposed access road.

6.2.12.6 Permafrost

Permafrost is discontinuous in the project area and may be encountered during access road construction. Road construction activities in areas of permafrost and associated mitigation measures have been described in Section 6.2.1. Permafrost at the mine site is not anticipated to have an effect on buildings and other infrastructure as foundations will be constructed on waste rock pads.

6.2.13 Effects of Accidents and Malfunctions

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

Potential effects of accidents and malfunctions are addressed in the individual environmental effects assessment subsections, where applicable. Accidents and malfunctions are also addressed in the Emergency Response Plan in Appendix M2.

6.3 POTENTIAL SOCIO-ECONOMIC EFFECTS

6.3.1 Introduction

In the *Guide to Socio-economic Effects Assessments* (YESAB, 2006), seven principles provide direction on how a proponent is to conduct a socio-economic effects assessment:

1. Achieve a broad understanding of the local and regional settings potentially affected by the proposed action;
2. Focus assessment on key aspects of the human environment;
3. Provide valid and relevant information for use in decision-making;
4. Identify methods and assumptions and define significance;
5. Ensure that effect equity issues are described and analyzed;
6. Consider and recommend suitable mitigation and include in the assessment mechanisms to improve the likelihood of mitigation success; and
7. Determine the best development alternative(s) rather than merely serving as an arbiter between socio-economic benefit and social cost (YESAB 2006).

In addition to these principles, YESAB's six-step process for conducting socio-economic effects assessments was used throughout the Mactung socio-economic effects assessment:

1. Determine scope of project;
2. Determine scope of assessment;
3. Compile the socio-economic baseline information;
4. Characterize potential effects;
5. Mitigation/enhancement; and
6. Significance determination.

Both YESAA and YESAB's guides emphasize the importance of engagement with the affected communities to establish and validate valued socio-economic components (VSECs), to characterize potential effects, to evaluate potential mitigation and enhancement strategies, and finally, to determine the significance of the potential effects on the VSECs. The last three tasks require an iterative process, which involves substantial contact and consultation with the affected communities, First Nations, and other identified interests. From the very beginning of the assessment process, NATC and its consulting team have engaged with the Yukon communities most likely to be affected by the Mactung mine, with First Nation governments, with Yukon government, and with others that have an interest in the project.

6.3.2 Project Scope

The scope of a socio-economic assessment is determined by identifying the primary and secondary projects and their corresponding components and activities, as well as describing the rationale used to determine the scope (YESAB 2006).

Based on the location of the project, the route to be taken by project-related traffic and the foreseeable environmental, economic and social effects of the project, NATC identified the following communities as being directly affected by the Mactung project.

- The community of Ross River; and
- The community and Council for the Municipality of the Town of Faro (Town of Faro).

Also, the Mactung project is located within the traditional territories of the following three First Nations:

- Ross River Dena Council;
- Liard First Nation; and
- First Nation of Nacho Nyak Dun.

6.3.2.1 Project Description

NATC plans to construct an underground mine and mill at its Mactung property to produce tungsten. The Mactung property is located near Mt. Allan, in the Selwyn Mountain Range, approximately eight kilometres northwest of Macmillan Pass. The nearest settlement accessible by road is Ross River, approximately 250 km to the southwest along North Canol Road. The drive takes approximately six hours. The property is located at latitude 63º17' N and longitude 130º10' W.

The mine's is projected to produce 2,000 tonnes of ore per day over an approximate 11 year mine life. Most of the ore (89%) will be mined using long hole blasting methods with the remaining 11% mined through mechanized cut-and-fill techniques. The ore will be processed at the on-site plant through a combination of magnetic separation, sulphide flotation, and gravity separation. Approximately 82% of the ore is recoverable. The tailings will be thickened and filtered with approximately 50% used as backfill underground and 50% dry-stacked on the property to eliminate the need for a permanent tailings dam.

The construction of the mine, process plant and related infrastructure is scheduled to take 27 months. Construction will require an estimated 1.1 million person-hours of work, excluding mine pre-development and engineering. At the peak of the construction phase there will be a maximum of 250 people on-site.

The mine will operate 365 days per year over the approximate 11 year mine life. Employees will be flown in and out of camp, working on a three week in, three week out rotation. There will be two 10 hour underground shifts per day, 7 days per week, while those working on the surface and in the mill will work 12 hour shifts 7 days per week during their rotation. A total of 253 employees will be needed during operations. Fuel and other supplies will be trucked to the site and the processed ore will be trucked out.

Following mine closure, the site will be decommissioned and reclaimed. NATC plans to engage in progressive reclamation activities during operation operations wherever possible in order to reduce site liability; however, most of the site infrastructure and the tailings area will be reclaimed once operation is complete. At closure, all site buildings and other structures will be removed with salvageable parts resold or recycled and the remainder disposed of following approved methods. Some disposal may occur in the underground workings most of which will already have been back filled during operations. Openings to the underground workings will be sealed. All hazardous material will be removed from the site and disposed of at approved sites. The dry-stack tailings will be capped and natural run-off channels re-established. The access road will be decommissioned unless other arrangements are agreed upon with the Yukon government.

6.3.2.2 Secondary Projects: New Access Road and Aerodrome Expansion

NATC is applying to extensively upgrade an existing mining exploration road, construct a new section of access road to improve site access, and construct a maintenance road to the water pumping station. In total, 48 km of road improvement and construction is included in the socio-economic effects assessment.

NATC plans to improve and upgrade the Macmillan Pass Aerodrome, located approximately 21 km to the southeast along North Canol Road. The runway will be expanded from the existing 700 m to 1,375 m in length, allowing larger passenger aircraft to use the runway.

6.3.2.3 Components and Activities

Table 6.3.2-1 summarizes the major components and activities of North American Tungsten's Mactung project that will form the basis for the socio-economic effects assessment over the three major phases of the project: construction, operation, and decommissioning.

TABLE 6.3.2-1 PROJECT SCOPE: COMPONENTS AND ACTIVITIES

	Construction	Operation	Decommissioning
Camp	Install camp to house a maximum of 250 people.	Modify to house operations personnel.	Remove for salvage and reclaim area.
Potable water	Install water tank, hypo-chlorinator, 2 distribution pumps and distribution pipes in insulated utilidors.	Maintain system.	Remove for salvage or disposal.
Waste water	Install sewage treatment plant.	After treatment, wastewater will be placed in the mine reservoir.	Remove for salvage or disposal.
Garbage	Install propane incinerator.	Incinerate all domestic garbage. Bury large waste items in dry-stack tailings.	Remove for salvage or disposal.

TABLE 6.3.2-1 PROJECT SCOPE: COMPONENTS AND ACTIVITIES			
	Construction	Operation	Decommissioning
Mine	Develop approx. 6,500 m underground workings, install crusher and conveyors.	Produce 2,000 tonnes/day ore.	Backfill with dry tailings during operations. Seal all openings.
Process plant	Construct process plant and install systems.	Process 2,000 tonnes/day.	Remove for salvage or disposal.
Tailings area	Clear and prepare area. Build ravine dam and reservoir.	Dry-stack approximately 50% of tailings not used for underground backfill.	Cap dry-stack tailings, breach ravine dam, restore drainage patterns.
Infrastructure			
Access road	Build new 40 km access road.	Maintain road. Use to truck in fuel and supplies and truck out processed ore.	Decommission/ turn over to the Yukon government as a public asset.
Aerodrom e	Upgrade to accommodate larger passenger aircraft.	Maintain runway. Use to fly crews in and out.	Turn over to Yukon government as public asset.
Power plant	Install 5 diesel generators with total capacity of 13 MW.	Maintain.	Remove for salvage.
Water pipeline	Install 10 km of insulated pipeline to provide potable and fire-fighting water to site.	Maintain.	Remove for salvage or disposal.
Ancillary facilities	Build truck shop, warehouse, admin building, mine dry, assay lab, cold storage warehouse. Install water tanks, fuel storage tanks, and explosive storage facilities.	Maintain.	Remove for salvage or disposal.
Transportatio n	Required to construct access road, expand aerodrome and construct and prepare mine site.	Transport fuel, supplies, and ore.	Decommissioning may result in a temporary increase in road traffic.

6.3.3 Scope of Assessment

According to YESAB (2006), determining the scope of the socio-economic effects assessment includes:

- understanding of the socio-economic setting;
- identifying which communities, governments, organizations, and individuals have an interest in the proposed project;
- identifying what those interested parties value in the socio-economic context (i.e., their valued socio-economic components or VSECs);
- determining whether the project is likely to have a significant effect on those VSECs; and

- establishing the spatial and temporal boundaries for the assessment and documenting the rationale for choosing those boundaries.

6.3.3.1 Socio-economic Setting

In accordance with YESAB (2006) guidelines, NATC has made a concerted effort to understand the background social and economic conditions against which the project is proposed to take place. In order to identify VSECs and potential effects, NATC has attempted to identify the historical trends and current status of:

- societal relationships with the biophysical environment;
- political and social resources;
- culture, attitudes, social-psychological conditions;
- economic and financial conditions; and/or
- relevant population or demographic characteristics (e.g. age, gender, education and employment distributions).

The following subsections describe these conditions according to the region, community, or organizations affected by the project.

Yukon

The Yukon Territory has a relatively small population (33,294) for the large land area. Similar to other relatively remote jurisdictions, the Yukon has a variety of economic and industrial sectors, yet the government sector is the largest.

Mining has traditionally been the mainstay of the Yukon's private sector industry. In fact, the territory owes its separate existence to the Klondike gold rush of 1896-1898. The dependence on mining gave rise to boom-and-bust cycles typical of economies dependent on natural resources. Until this century, the size of the non-aboriginal population fluctuated with the fortunes of the mining industry.

Whitehorse, the territorial capital, has become increasingly important. Containing more than three-quarters of the territorial population, Whitehorse dominates the territorial economy and most services are only available in Whitehorse. Rural communities like other rural and First Nation communities across Canada, suffer disproportionately from a number of social and economic problems, including generally high unemployment, low income, alcohol and drug abuse, and relatively low educational levels. Rural communities, where the First Nation population is concentrated, are not keeping up with the high incomes and economic prosperity of the capital.

In 1992, the Council for Yukon Indians (today the Council of Yukon First Nations) and the federal and territorial governments signed an Umbrella Final Agreement (UFA) to serve as the template for individual land claims agreement. Among the many provisions of that agreement is the creation of a new system of environmental and socio-economic assessment, the current YESAA, as well as the development of a self-government regime giving signatory First Nations a number of additional powers. Most Yukon First Nations, including the Nacho Nyak Dun, have signed land claims and self-government agreements. However, significantly for this project, the Ross River Dena and the Liard First Nation have not and remain bands administered under the federal *Indian Act*.

Yukon Demographics and Labour Force

The population has fluctuated over time. Population peaked in 1997 at 33,519 residents, then declined to 30,776 in 2000 and as of June 2008, had increased to 33,294, up 3.4% from a year earlier according to the Yukon Bureau of Statistics. More than 75% of Yukon residents live in Whitehorse or its immediate vicinity, with the remainder primarily distributed in 16 small, widely scattered communities.

There are an approximately even proportion of men and women in the population. In the 2006 federal census, just over 25% of respondents identified themselves as aboriginal.

According to the 2006 census (Statistics Canada), the median age of the population is 38.4, slightly younger than the federal median age of 39.5 and older than the 2001 territorial median of 35.8. The territory therefore does not have an unusually young population. However, there are proportionately far fewer seniors aged 65 and older in the territory (7.5%) than the Canadian average (13.7%), with a similar disproportion of the population aged 14 and younger. The population structure in the Yukon has a greater proportion of working-aged adults aged 25 to 64 years (59.9%) compared to the federal average (55.3%).

The educational attainment levels in the Yukon are similar to the federal levels. The 2006 census found no significant differences between the territory and the country as a whole in the percentage of population aged 15 and over who had not finished high school, held high school diplomas, had apprenticeships or trades certifications, or held university degrees. Yukon residents, however, are somewhat more likely than Canadians as a whole to hold college certificates or diplomas.

As a result of the lower proportion of seniors, the Yukon has a labour force participation rate of 78.1% according to the 2006 census, much higher than the federal rate of 66.8%,. However, the territory's unemployment rate of 9.4% (Statistics Canada, 2006), undertaken during the same time period as the 2006 federal census, was considerably higher than the federal rate of 6.6%. In August 2008 the Yukon Bureau of Statistics reported that the Yukon had an unemployment rate of 5.6%, less than the federal rate of 6.1%, but higher than the unemployment rate for the western provinces of British Columbia (4.3%), Alberta (3.5%), Saskatchewan (4.5%), and Manitoba (3.9%).

Incomes are generally higher in the Yukon than in Canada as a whole. According to the 2006 census, the median income in the Yukon was $31,352 compared to federal median income of $25,615. Earnings are generally higher in the Yukon as is the proportion of income derived from work rather than government transfers or other income.

Yukon Economy and Industrial Structure

The Yukon's real (i.e., adjusted for inflation) Gross Domestic Product (GDP) totalled $1.298 billion in 2006, up from $1.260 billion in 2005. Real GDP growth has been strong, up 4.1% in 2005.and 3.0% in 2006.

The territory's 2006 GDP by industry is summarized in Table 6.3.3-1.

TABLE 6.3.3--1 YUKON INDUSTRIES AS A PERCENTAGE OF GDP (2006)

Industry	Percentage of GDP
Public administration	23.7%
Finance, insurance and real estate	18.4%
Construction	8.2%
Health care and social assistance	7.8%
Retail trade	6.4%
Educational services	6.3%
Other services (except public administration)	4.7%
Accommodation and food services	4.3%
Information and cultural industries	3.3%
Mining and oil and gas extraction	3.0%
Wholesale trade	3.0%
Transportation and warehousing	2.7%
Professional, scientific and technical services	2.5%
Utilities	2.5%
All others	3.2%

Source: Yukon Bureau of Statistics, 2006. Yukon GDP by Industry

The territorial economy is dominated by public sector industries. The public sector contribution to GDP tends to be in the range of 40% of the Yukon's overall economic activity, compared to the Canadian average of about 15%. Federal government transfers to the Yukon government have been increasing, in part because of the devolution of some powers to the territorial government. Federal transfers account for approximately 70% of the Yukon government's budget. The federal government also spends directly in the Yukon and provides some funding to First Nation governments.

Although the Yukon has traditionally relied on mining as an economic mainstay, the industry entered into a prolonged slump following the closure of the Faro lead-zinc mine in January 1998. By 2002 there were no operating hard-rock mines in the Yukon, mineral exploration spending had declined steeply, and even placer gold production had fallen to a 23-year low. The total value of mineral production in the territory fell from $225 million in 1997 to $82 million in 2003. In 2004 the value of total mineral production rose to $96 million and mineral exploration expenditures have continued to rise, being estimated at

$140 million in 2007. In October 2007 Sherwood Copper officially opened the Minto mine, ending a five year stretch of no operating hard-rock mines in the Yukon.

Inflation, as measured by the consumer price index, has been somewhat higher in Whitehorse than in Canada as a whole since mid-2007 (note: inflation is measured for the City of Whitehorse rather than the Yukon Territory). The July 2008 data indicate a 4.2% annual inflation rate in Whitehorse, 0.8% above the federal rate of 3.4%, whereas between 2002 through 2004, Whitehorse's inflation rate was, on average, 1.1% below the federal rate.

Ross River

Ross River is the community closest to the Mactung mine. Ross River is located on the south bank of the Pelly River near the confluence of the Ross and Pelly Rivers. The South Canol Road runs through the community with a seasonal ferry providing access to North Canol Road during the summer. The community is approximately 10 km from the Campbell Highway.

A trading post was initially established in Ross River in 1901 at a traditional First Nations gathering spot. During World War II and the years immediately following, substantial changes occurred in Ross River with the building of the Canol Road and pipeline. The late 1940s and early 1950s also saw the permanent closure of most of the region's fur trading posts including Pelly Banks, Sheldon Lake, Rose Point, Frances Lake and Macmillan River. The construction of the South Canol Road shifted the commercial centre of the community to the south bank of the Pelly River and the federal government pressured the First Nation to move south across the Pelly River from the Old Village.

Mining exploration increased in the region around Ross River through the 1950s and an exploration and mining boom occurred in the 1960s and 1970s with the discovery and development of the Faro lead-zinc mine. Although some Ross River Dena people did work in mining exploration, the mining boom did little to benefit most of the First Nation. The re-opening of the Faro mine and a smaller mining exploration boom in the mid-1990s brought more economic benefits to the First Nation and its people than in the 1960s and 1970s, but those benefits remained relatively small and social problems remained large. The more recent increase in exploration activity in the region has benefited Ross River residents; employment levels have increased to the point that, in 2007, mining exploration projects had difficulty finding local residents to work.

The Ross River Dena Council (RRDC) is the First Nation government in Ross River. The RRDC is a member of the Kaska Tribal Council along with the Liard First Nation based in Watson Lake. Other Kaska people live in northern British Columbia. The Ross River Dena has developed a mining strategy to guide their relationship with mining companies.

Ross River Demographics and Community Economy

According to the Yukon Bureau of Statistics the population of Ross River was 383 (June 2008). The 2006 census reported a community population of 310, with over 87% identifying themselves as aboriginal.

Statistics on the GDP of individual Yukon communities are not kept, but a reasonably good indicator of the size of the local monetary economy is aggregate personal income. According to the latest data (from 2005), residents of Ross River reported a total of $5.36 million in income from all sources. It is important to note that this represents only the formal, monetary economy; the value of subsistence activities and other unpaid work are not captured by monetary measures of the economy.

The Yukon Bureau of Statistics does not keep a spatial price index for Ross River. It is therefore difficult to compare the cost of living in Ross River to that of living in Whitehorse.

The 2006 census found that Ross River has a relatively high labour force participation rate (73.3%) compared with other rural communities, but this rate is less than that of the Yukon (78.1%). Unemployment in Ross River, however, was found to be very high at 21.2%.

Various levels of government provide employment and an economic base for residents of Ross River. In 2006, the census found that 53% of the labour force was employed in public administration, education, health care, and social assistance. The most common jobs are in the trades and in the transportation occupational cluster, which includes most construction workers, equipment operators and truck drivers (many of whom are employed by governments). Sales and service occupations are equally common jobs for Ross River residents and include those working in retail, child-care, restaurants, hotels, and others.

Average incomes in Ross River are far below the territorial average. The 2006 census found the average family income in Ross River was $50,585, approximately 60% of the Yukon average of $86,085.

Ross River Social Infrastructure and Issues

Ross River is a predominantly aboriginal community, home community of the Ross River Dena, a Kaska First Nation. The Ross River Dena Council is not recognized as a self-governing First Nation by the federal government under the UFA, but does see itself as exercising inherent self-government rights over its traditional territory. The First Nation delivers a variety of services to its citizens in the community. Ross River has no form of local or municipal government.

The Royal Canadian Mounted Police (RCMP) maintains a detachment in the community. Fire and ambulance services are provided by volunteer organizations. The Yukon government maintains a health centre in the community, staffed with nurse practitioners. The Ross River School offers Kindergarten through Grade 10, with youth attending

Grades 11 and 12 in Whitehorse. A total of 67 students were enrolled in all grades as of June 2008. The community has some recreational facilities, including a hockey rink.

While developing an Integrated Community Sustainability Plan in 2006, Ross River residents identified substance abuse as a serious health and social problem in the community and made the elimination of such abuse a long-term community goal. Another community health issue identified in the plan was the need for clean, high quality potable water and better sewage treatment.

RCMP crime statistics indicated that between 1995 and 2003 Ross River averaged 249 reported crimes annually. On a per capita basis Ross River tends to have one of the highest levels of reported crime in the Yukon. In 2003, for example, there were 68.1 reported crimes per 100 residents, almost double the Yukon average of 32.4 per 100 residents. Ross River appears to have a particularly high level of reported violent crime with 17.6 reported incidents per 100 residents in 2003, more than four times the Yukon rate of 4.1 per 100 residents.

Faro

Faro, located above the north bank of the Pelly River approximately 70km from Ross River, is the Yukon's newest community. It was built in 1969 to house the Faro mine workers and their families. The community's relatively short history has been marked by massive population fluctuations as the mine has opened and closed.

The Anvil Mining Corporation (later Cyprus Anvil) made the decision to go into production in 1967 and construction of the town began in the fall of 1968. In June 1969 a forest fire roared through the area, destroying 48 of the 50 newly built houses. However, three months later, the first families moved into the new town. The 1970s were boom times for Faro. The mine was profitable, wages were high, and housing was heavily subsidized, causing the population to grow. In 1981, Faro was the highest income community in Canada and reached a peak population of over 2,000 people.

In the early 1980s metal prices dropped, Cyprus Anvil began losing revenue and building up debt. A temporary shutdown was announced in June 1982 and continued as metal prices remained very low. A stripping operation, heavily subsidized by government, provided some work from mid-1983 to October 1984. In May 1985 the company announced it was closing the mine.

By July 1985, Faro was virtually deserted except for the less than 100 residents who remained, believing that there was potential for future employment in the area. In November 1985, Curragh Resources Inc. took over the mine, mill and housing with substantial help from the government in the form of loan guarantees, subsidized power and highway upgrades. In spring 1986, the Faro mine and mill were back in operation and the mine was profitable. By 1992 however, the company was mired in financial difficulties that eventually drove the company to bankruptcy. The Faro mine was shut down for the second time in April 1993, causing the town's population to decline, although remaining above 400.

Anvil Range Mining Corporation bought the property in 1994 with no direct government assistance. Production began again in August 1995 and full commercial production was achieved by November 1995. In November 1996, however, Anvil Range suddenly announced that there would be a temporary closure of the mine by the end of the year. The mill would continue to operate until March 1997 using stockpiles of ore. Lower metal prices and a higher Canadian dollar were given as the reasons for the shutdown. Anvil Range declared bankruptcy in April 1998, leaving the property in the hands of a receiver.

Faro Demographics and Community Economy

Since 2000, the town's population has remained relatively stable at less than 400 residents. In June 2008 the Yukon Bureau of Statistics stated the population of Faro at 385. The 2006 census reported a population of 340, with 16% identifying themselves as aboriginal.

As described in the previous Ross River subsection, statistics on the GDP of individual Yukon communities are not kept, but a reasonably good indicator of the size of the local monetary economy is aggregate personal income. According to the latest data (from 2005), residents of Faro reported a total of $9.24 million in income from all sources. It is important to note that this represents only the formal, monetary economy; the value of subsistence activities and any other unpaid work are not captured by monetary measures of the economy.

The Yukon Bureau of Statistics keeps a spatial price index for Faro and the latest available figures (for October 2006) show that the cost of living in the community is 16.7% higher than in Whitehorse.

The 2006 census found a relatively low labour force participation rate in Faro (64.3% versus 78.1% for the Yukon) and an unemployment rate of 13.9%. Although Faro's unemployment rate is higher than the Yukon's unemployment rate, Faro has a lower unemployment rate than many other rural communities in the territory.

Various levels of government provide a substantial number of the jobs in Faro. In 2006, the census found that 39% of the labour force was employed in public administration, education, health care, and social assistance. About 14% of the labour force reported that they worked in mining. Sales and service occupations are the most common for Faro residents and include those working in retail, child-care, restaurants, hotels, and others. Almost as numerous are those who work in the trades and in the transportation occupational cluster, which includes most construction workers, equipment operators and truck drivers (many of whom are employed by governments).

Average incomes in Faro are somewhat lower than the territorial average. The 2006 census found the average family income in Faro was $68,599, approximately 80% of the Yukon average of $86,085.

Faro Social Infrastructure and Issues

Faro has been an incorporated municipality since 1970 and the Town collects property taxes, delivers a variety of municipal services, and has the authority to pass local bylaws. The Yukon government provides other community infrastructure and services including a school and a health centre.

The RCMP maintains a local detachment. Fire protection, ambulance, and search and rescue services are provided by volunteer organizations.

The RCMP keeps detailed records of reported incidents of crime for all Yukon communities. Between 1995 and 2003 the average number of reported crimes in Faro was 95 per year. However, because of the abrupt drop in population following the closure of the mine in 1998, the average is not necessarily representative. For example, 26 crimes were reported in 2003 following the mine closure. On a per capita basis, the reported crime rate in Faro has tended to be the lowest in the Yukon. In 2003, for example, Faro had 7.2 reported crimes per 100 residents, far below the Yukon average of 32.4. As with overall crime, the level of reported violent crime in Faro is the lowest in the Yukon at 1.1 per 100 residents in 2003 compared with the Yukon average of 4.1 per 100 residents.

The Yukon government maintains the Faro Community Health Centre that is staffed by nurse practitioners. The territorial government also provides education through the Del van Gorder School, which offers classes from Kindergarten through to Grade 12. In June 2008 total enrolment was 44 for all grade levels. Yukon College operates a satellite community campus in Faro, providing academic upgrading courses, graduation equivalency diplomas (GEDs), computer training, and various occupation-related courses. The community is currently lobbying for the establishment of a mine training centre in Faro.

Faro has a municipal recreation centre that offers a variety of programs and recreation opportunities, including an indoor hockey rink, a four sheet curling rink, summer swimming pool, squash court, and weight room. In addition, there is a golf course that winds its way through the center of the community.

Watson Lake

Watson Lake is situated in the south-eastern corner of the Yukon at the junction of the Alaska Highway and the Campbell Highway. The Stewart Cassiar Highway connects Watson Lake with Stewart, British Columbia. The community is considered to include not only the Town of Watson Lake, but also the adjoining Kaska First Nation Settlements of Upper Liard along the Alaska Highway, and Two and One-Half Mile Village and Two Mile Village on the Campbell Highway. The settlement of Lower Post just across the border in British Columbia is also often considered part of Watson Lake.

Although there were a number of trading posts and First Nations settlements in the area, notably Lower Post which had a residential school, Watson Lake itself was only established during World War II when an airfield was built and the Alaska Highway was routed through this area. Watson Lake became an accommodation and supply centre servicing the highway and airfield construction.

The economy of the Watson Lake area has depended on being a transportation hub and a supply centre for operational mines in the area, including Cassiar asbestos mine, Sa Dena Hes lead-zinc mine, and Cantung tungsten mine. There has also been forestry and sawmills operating in the area. The Yukon's one producing natural gas field, Kotaneelee, is located in the territory's south-eastern tip.

Watson Lake, along with neighbouring Upper Liard, Two Mile and Two and One-Half Mile Villages, is the home community of the Liard First Nation. In June 2008 the total population) of Watson Lake (including all of the aforementioned communities) was 1,596 residents.

Mayo

Mayo is located in the central Yukon approximately 410 km north of Whitehorse. Mayo is the home community of the First Nation of Nacho Nyak Dun. In June 2008 the community's population was 460.

Mayo is another Yukon community that owes its existence to mining. Shortly after the Klondike Gold Rush, placer gold deposits were found in the Mayo area, and, more significantly, large and rich silver deposits were found in the Keno Hill area to the north. Mayo served as the transhipment point for the silver ore from Keno and Elsa until the United Keno Hill mine's closure in 1989. There continues to be active placer mining and exploration for gold in the Mayo area, particularly in Keno Hill and Dublin Gulch, and exploration for uranium in the Wind River area to the north.

6.3.3.2 Identified interests

Communities, governments, organizations, and individuals have an interest in a proposed project when the project may have an effect, positive or negative, on a part of the social and economic system that they, or those they represent, value. It is important to note that though the project may have an effect on an interest, it will not necessarily do so.

The proposed mine at Mactung will likely have effects on matters valued by a variety of interested parties. Table 6.3.3-2 contains a summary list of entities that likely have a socio-economic interest in the Mactung mine. The following subsections discuss the potential nature of these interests.

TABLE 6.3.3-2 MACTUNG MINE: IDENTIFIED SOCIO-ECONOMIC INTERESTS
Government of Canada
Indian and Northern Affairs
Human Resources and Social Development Canada
Health Canada
Natural Resources Canada
Yukon Government
Department of Economic Development
Department of Education
Department of Energy, Mines and Resources
- Emergency Measures Organization
Department of Health and Social Services
- Environmental Health Services Branch
Department of Tourism
- Heritage Branch
Department of Highways and Public Works
Department of Justice
Women's Directorate
Yukon Workers' Compensation Health and Safety Board
Department of Environment
Yukon College
First Nations Government
Ross River Dena Council
Liard First Nation
First Nation of Nacho Nyak Dun
Municipal Government
Town of Faro
Community Members
Ross River
Faro
Watson Lake
Groups, Businesses and Individuals
Traditional land stewards
Ross River trapper's group
Koser Outfitters Ltd.
Gregory Keating and Neilson Sisson, Trapline 112
Rick Charlebois and Rainer Russman, Trapline 111
Yukon Mine Training Association

Government of Canada

The government of Canada has few areas of responsibility in the Yukon. Possible areas of interest for the federal government include:

Indian and Northern Affairs Canada (INAC)

- Through its Northern Affairs Program, INAC has a mandate for the sustainable development of the northern communities and natural resources.
- INAC also has the primary responsibility for meeting the federal government's duties and responsibilities to First Nations. This responsibility has particular bearing on the Ross River Dena Council and the Liard First Nation, neither of which has settled land claims and continue to be administered under the *Indian Act*.

Human Resources and Social Development Canada (HRSDC)

- HRSDC has a very broad mandate that includes managing the Employment Insurance program and a variety of training initiatives.

Health Canada

- Health Canada is responsible for funding the delivery of health services to First Nations.

Natural Resources Canada (NRCan)

- Among its other responsibilities, NRCan has a regulatory role in enforcing Canada's *Explosives Act*.

Yukon Government

The Yukon government represents all residents and provides a wide variety of services to the population. The following Yukon government departments, branches, and directorates have been identified as having an interest in the Mactung mine.

Department of Economic Development

- Economic Development's interests include: increasing the Yukon's GDP, increasing government revenues, increasing opportunities for Yukon businesses, and increasing Yukon First Nations' participation in economic development.

Department of Education

- Education's interest in the project will likely be focussed on providing for any increase in the number of school-age children brought to the area by the project, and providing appropriate adult training and education programs to help Yukon residents take advantage of employment opportunities.

Department of Energy, Mines and Resources

- Apart from its regulatory role in the mining sector, EMR has an interest in the effects that large mining projects may have on forest resources, including clearing activities and forest fires.
- Emergency Measures Organization will play a role if there is a large emergency.

Department of Health and Social Services

- The interests of the Health side of the Department include any effect on its community nursing stations and its provision of emergency medical services, including medivacs.
- The interests of the Social side of the Department are likely to include effects the project may have on: alcohol and drug services, social assistance, child and family services, and youth justice services.

Environmental Health Services Branch (Department of Health and Social Services)

- The Environmental Health Services branch of the Department of Health and Social Services is concerned with the prevention and suppression of disease and enforces legislation involving drinking water, sewage, food services, and other public nuisance issues. The branch's interest will be in the supply of potable water and sewage services to any camp planned for the project.

Department of Tourism

- Tourism's broad interests are to recognize tourism as an industry with economic value, and that potential effects from the Mactung mine on any particular tourism operator or event be mitigated.

Heritage Resources Branch

- The interests of the Heritage branch of the Department of Tourism are the protection of any archaeological or heritage resources that may be affected by the project.

Department of Highways and Public Works

- Highways' broad interests in the Mactung project arise from the department's core role in the construction and maintenance of safe and efficient transportation infrastructure. Specific interests will likely include the additional volume of traffic generated, the routes selected, and any additional maintenance that may be required as a result.

Department of Justice

- Justice's interest in the Mactung mine will be any effect the project has on crime, justice, and policing.

Women's Directorate

- The Women's Directorate's role is to support the Yukon government's commitment to the economic, legal, and social equality of women. Its interests in the Mactung project include potential effects on family violence, and employment and training opportunities for women.

Yukon Workers' Compensation Health and Safety Board (WCHSB)

- The YWCHSB has an interest in all large projects in the Yukon through their role in workplace safety.

Department of Environment

- The Department of Environment's socio-economic interest in the Mactung project will be the project's potential effect on hunting, fishing, and trapping in the region.

Yukon College

- Yukon College has an interest in any project that may affect demand for general or specific training courses.

Yukon Energy

- Yukon Energy will have an interest if the project hooks up to the electricity grid and becomes a significant customer.

First Nations Government

The following First Nations have identified interests in the socio-economic effects assessment of the Mactung mine.

Ross River Dena Council

- The mine site is within the traditional territory of the Ross River Dena Council; Ross River is the closest community to the site and all road traffic to Mactung must pass through the community.
- The First Nation's socio-economic interests in the project are wide-ranging and include: economic development (i.e., employment and business opportunities), potential health, cultural and social issues resulting from increased income (i.e., alcohol and drug abuse, crime, and family violence), cultural integrity and continuity of the First Nation, and potential effects on health or economic aspects of subsistence activities.

Liard First Nation

- The Liard First Nation has an interest in the Mactung project because the project is located on Kaska traditional territory.
- Socio-economic effects are likely to be limited due to the project's distance from the community.
- The Liard First Nation's likely socio-economic interests in the project include: business and employment opportunities, the social issues that may arise from increased incomes, and perhaps, the economic aspects of subsistence activities.

First Nation of Nacho Nyak Dun

- The First Nation of Nacho Nyak Dun has an interest in the Mactung project because it is located on the First Nation's traditional territory.
- It is anticipated that there will be little to no socio-economic effect on the First Nation and the community of Mayo given the project's distance from Mayo (by road).

Municipal Government

Municipality of the Town of Faro

- Socio-economic interests in the Mactung project include a potential increase in population if mine workers and their families settle there, and increased tax base from growth in population and businesses, and increased use of local infrastructure and services (i.e., water, sewer, solid waste disposal, roads and recreation facilities) provided by the municipality.

Community Members

Local residents were consulted and identified the following interests in the Mactung mine project:

Ross River

- Ross River is the closest community to the site and all road traffic to Mactung must pass through the community. The community as a whole has wide-ranging socio-economic interests in the project, such as direct employment and increased business opportunities.

Faro

- Faro, like Ross River, is located relatively close to the project. The community as a whole has wide-ranging socio-economic interests in the project, especially if some of the mine's new employees choose to make their home in the community.

Watson Lake

- Watson Lake is likely to see an increase in road traffic as a result of the Mactung mine. The community's current relationship with NATC's Cantung mine may result in continuing employment and business relationships with the new Mactung mine.

Groups, Businesses and Individuals

Groups, businesses, and individuals that appear to have interests in the Mactung mine are:

- The traditional land stewards of the area affected;
- The Ross River trappers who use the group trap line that incorporates much of the North Canol Road area between the mine site and Ross River;
- Koser Outfitters Ltd., the area's outfitter;
- Gregory Keating and Neilson Sisson, the registered owners of Trapping Concession 112;

- Rick Charlebois and Rainer Russman, the registered owners of Trapping Concession 111;
- NorthwesTel, the regional telephone company;
- Faro Real Estate Ltd; and
- The Yukon Mine Training Association.

6.3.3.3 Valued Socio-economic Components

Valued socio-economic components, or VSECs, are defined by YESAB (2006) as those parts of the socio-economic fabric that are valued because of their importance to the community. Specifically, VSECs are valued because of their:

- integral connection to, or reflection of, the socio-economic system;
- commercial or economic value; and/or
- role in maintaining quality of life in a community.3

Some VSECs are specific to a particular community or interest, but many overlap among communities and interests. The VSECs identified for the Mactung project have been grouped into three clusters:

- Sustainable livelihood;
- Community vitality; and
- Health and socio-cultural well-being.

The VSECs have been identified through a variety of means:

- Existing community plans and strategies including the Integrated Community Sustainability Plans for Faro and the Ross River Dena Council;
- Community meetings/workshops held to identify and validate VSECs for the Mactung mine held in Faro and Ross River;
- Meetings between NATC and representatives of the Nacho Nyak Dun and Liard First Nations;
- Community meetings/workshops held to identify and validate VSECs for the Ketza mine held in Faro and Ross River in 2007; and
- Responses by many interests (and especially government interests) to YESAB's assessment of the Carmacks Copper mine project.

– [3] Yukon Environmental and Socio-economic Assessment Board. *Guide to Socio-economic Effects Assessments*. June 2006. p.36.

Sustainable Livelihood

The sustainable livelihood cluster of VSECs includes several factors normally considered part of the economic sphere, including components related to people making a living or enabling that to happen. The following is a summary of the VSECs:

- Traditional economic activities — hunting, fishing, gathering, trapping
- Employment
- Employability
  - Education
  - Training
  - Experience
- Infrastructure
  - Transportation
  - Power and communication
  - Municipal services
- Economic development
  - Economic growth
  - Participation in economic development
  - Government revenues
- Economic diversification
  - Minimizing boom and bust cycles
- Healthy business sector
  - Business opportunities, immediate and long-term
  - Business capacity.

Community Vitality

The community vitality cluster VSECs are those that speak directly to life in the community and how to make it better. The following is a summary of the VSECs:

- Community population
  - Demographics
  - Housing and land availability
- Safety and security
  - Reduced crime level
- Social cohesion
  - Social/community events
  - Volunteerism
  - Reduced discrimination and racism

- Quality of life
  - Recreation opportunities
  - Recreation facilities
- Community infrastructure and aesthetic
  - Municipal services
  - Decent place to live
- Governance, political structure
  - Decision making capacity

Health and Socio-cultural Well-being

The health and socio-cultural well-being VSEC cluster covers a broad range of issues that, although frequently raised as important or fundamental, are often very difficult to measure. The following is a summary of the VSECs:

- Best possible health
  - Individual and family
  - Sense of purpose in life
- Reducing alcohol and drug abuse
- Reducing domestic abuse and violence
- Public health and safety
- Workplace health and safety
- Family resilience and self-sufficiency
  - Food security
- Cultural continuity
  - Heritage sites
  - Land-based social and cultural activities
  - Language preservation and restoration
  - Sharing traditional knowledge and stories

6.3.3.4 Preliminary Determination of Potential Effects

This section identifies VSECs that may be potentially affected, either positively or negatively, by the Mactung mine. Deciding on a preliminary determination for some VSECs is straightforward, particularly if the effect can be measured quantitatively, e.g. the opening of the mine will result in a clear and measurable increase in the Yukon's GDP. For other VSECs that rely on qualitative measures, however, such a determination is not straightforward. The preliminary determination of potential effects is summarized in Table 6.3.3-3.

TABLE 6.3.3-3 PRELIMINARY DETERMINATION OF POTENTIAL EFFECTS OF MACTUNG PROJECT ON SUSTAINABLE LIVELIHOOD OF VSECs

VSEC	Potential Effect
Traditional economic activities — hunting, fishing, gathering, trapping	Potential direct effect if the increased industrial activity in the region reduces the ability of people to pursue activities. Trapping will likely be most affected as wildlife movements may change due to use of the North Canol Road in winter. Indirect effect of the project is increasing the size and importance of the local wage economy.
Employment	Direct effect through all phases of the project. Job opportunities will be available.
Employability	
Education	Potential indirect effect if employees come to live in the Yukon with their families.
Training	Direct effect as NATC will employ apprentices and provide other forms of training to employees, likely in partnership with other organizations.
Experience	Direct effect as employment on the Mactung project will provide work experience.
Infrastructure	
Transportation	Direct effect on road transportation infrastructure, especially the North Canol Road, through all phases of the project. The Campbell Highway will also have an increase in traffic.
Power and communication	No significant effect anticipated.
Municipal infrastructure	No significant effect anticipated unless large increase in local population in Faro or Ross River.
Economic development	
Economic growth	Directly effect on economic growth in the Yukon and nearby communities.
Broad participation in development	Direct effects through providing job and business opportunities to the entire cross-section of Yukon society.
Government revenues	Direct effect on government revenues through various taxes and royalties.
Economic diversification	
Minimizing boom and bust cycles	Direct effect on Yukon and regional economic diversification of skills and services.
Healthy business sector	
Business opportunities, short and long term	Direct effect by providing a wide variety of business opportunities through all phases of the project.
Business capacity	Indirect effect to business capacity through the business opportunities that will occur during all of the project phases.

TABLE 6.3.3-3 PRELIMINARY DETERMINATION OF POTENTIAL EFFECTS OF MACTUNG PROJECT ON COMMUNITY VITALITY VSECS	
VSEC	Potential Effect
Community population	Potential effect if a significant number of employees choose to move to communities in the region.
Demographics	
Housing and land availability	
Safety and security	
Reduced crime levels	Potential indirect effect on crime levels through the increase in incomes provided by employment and business opportunities.
Social cohesion	
Social/community events	NATC may have an effect through the sponsorship of community events.
Volunteerism	No significant effect anticipated.
Reducing discrimination and racism	NATC will develop and strictly enforce a policy that prohibits discrimination and racism in the work place.
Quality of life	
Recreation opportunities	No significant effect anticipated with the possible exception of hunting along North Canol Road.
Recreation facilities	No significant effect anticipated unless Faro or Ross River population increases significantly.
Community infrastructure and aesthetic	
Municipal services	No effect anticipated unless Faro or Ross River population increases significantly.
Decent place to live	No significant effect anticipated.
Governance, political structure and decision-making capacity	No significant effect anticipated.

TABLE 6.3.3-3 PRELIMINARY DETERMINATION OF POTENTIAL EFFECTS OF MACTUNG PROJECT ON HEALTH AND SOCIO-CULTURAL WELL-BEING VSECS	
VSEC	Potential Effect
Best possible health	
Individual and family	Potential indirect effects on individual and family health through offering employment and increasing incomes. Local health infrastructure will be directly affected by the project.
Sense of purpose in life	Employment has an effect on people's sense of purpose in life.
Reducing alcohol and drug abuse	Potential indirect effect on alcohol and drug abuse through an increase in employment and incomes.
Reducing domestic abuse and violence	Potential indirect effect on domestic abuse and violence through an increase in employment and incomes.
Public health and safety	Potential direct effects on public health and safety through all phases of the project including: increased traffic, especially through Ross River,

TABLE 6.3.3-3 PRELIMINARY DETERMINATION OF POTENTIAL EFFECTS OF MACTUNG PROJECT ON HEALTH AND SOCIO-CULTURAL WELL-BEING VSECS	
VSEC	Potential Effect
	the possibility of off-site accidents and spills, and camp operations.
Workplace health and safety	Potential direct effects on the health and safety of its own workforce.
Family resilience and self-sufficiency	Potential indirect effect from increased employment.
Food security	Potential indirect effect from increased employment reducing requirement for subsistence activities.
Cultural continuity	
Heritage sites	Effects dependent on whether heritage sites are discovered or disturbed by the project.
Land-based social and cultural activities	Potential effect from increased employment reducing opportunities for these activities.
Language preservation and restoration	No significant effect anticipated.
Sharing traditional knowledge and stories	No significant effect anticipated.

6.3.3.5 Summary: Scope of the Socio-economic Assessment and Rationale

As noted in Section 6.4.3.4, some VSECs are specific to a particular community or interest, but many overlap among communities and interests. Within the socio-economic assessment, VSECs are grouped according to geographic scale or location, and the rationale used to determine whether VSECs are within the scope of the assessment is presented.

Canada

The Mactung project will not produce socio-economic effects that are significant on a Canada-wide scale. Employment during operation estimated at 253 jobs, the project will be statistically imperceptible in a $1.6 trillion economy with 17.2 million people employed.

Canada as a whole, outside of the Yukon, is therefore not included in the assessment of the Mactung project.

Yukon

The Yukon as a whole will be affected by the Mactung project. Of particular importance will be the territory-wide effects on economic growth, employment, transportation infrastructure (i.e., the North Canol Road and the ferry crossing at Ross River), territorial tax revenue, and public and workplace health and safety.

Ross River Dena Council (RRDC) and Ross River

The social and economic effects of a mining project tend to be more concentrated in the communities located nearest to the mine, particularly those communities located close to main roads. Ross River is the closest community to the Mactung project and all road traffic to the site will pass directly through the community. Nearly all of the VSECs described in

Section 6.4.3.4 above will be included in the socio-economic effects assessment of Ross River and the RRDC.

Faro

Like Ross River, Faro is located relatively close to the Mactung project by road, although it is not directly on the route to it. The Town of Faro has the housing and infrastructure to accommodate a significant population increase and continues in its efforts to attract new residents (and especially families with children). Faro is therefore more likely than any other community to see a population increase as a result of the project and, if that increase is significant, experience more socio-economic effects.

Liard First Nation and Watson Lake

The Liard First Nation and Watson Lake are located far from the Mactung project but are included in the scope of the socio-economic assessment for the following reasons. The Liard First Nation have an interest in the project as the project is located on Kaska traditional territory. The First Nation and community have ongoing employment and business relationships with NATC's Cantung mine, which may result in additional employment and business relationships with the new Mactung mine.

For the Liard First Nation and Watson Lake, likely socio-economic interests in the project include: business and employment opportunities, social issues that arise with an increase in incomes, and perhaps, the economic aspects of subsistence activities.

First Nation of Nacho Nyak Dun and Mayo

As described in Section 6.4.3.2, the First Nation of Nacho Nyak Dun has an identified interest in Mactung due to the project's location in their traditional territory. It is anticipated that there will be little to no socio-economic effect on the First Nation and the community of Mayo given the project's remoteness from Mayo by road and because the transportation routes used to access Mactung do not pass through Mayo.

However, NATC and representatives of the Nacho Nyak Dun met in Mayo and identified three socio-economic interests: employment opportunities, help for substance abuse among those working on the project, and worker safety.

Specific Groups, Businesses and Individuals

Other groups, businesses and individuals with identified interests in the Mactung project are identified in Section 6.4.3.2 and are reiterated here:

- The traditional land stewards of the area affected;
- The Ross River trappers who use the group trapline that incorporates much of the North Canol Road area between the mine site and Ross River;
- Koser Outfitters Ltd., the area's outfitter;
- Gregory Keating and Neilson Sisson, the registered owners of Trapping Concession 112;

- Rick Charlebois and Rainer Russman, the registered owners of Trapping Concession 111;
- NorthwesTel, the regional telephone company;
- Faro Real Estate Ltd.; and
- The Yukon Mine Training Association.

Each of these groups, businesses or individuals is wholly or partly Yukon-based and, therefore, effects will fall within the Yukon.

Temporal Scope of Assessment

As described in Section 6.4.2.4, the temporal scope of the project is approximately 18 to 20 years, allowing for the current estimated construction schedule of 27 months, an approximate 11 year mine life, a 2-3 year decommissioning period, and a minimum three year monitoring period following final closure and reclamation. Therefore the temporal scope of the socio-economic assessment will cover 20 years, from the beginning of construction through to the end of the post-closure monitoring period.

6.3.3.6 Summary and Rationale for Spatial and Temporal Scope

The rationale for determining this project scope in the context of the socio-economic effects assessment is straightforward. The scope includes all of project components and activities from the beginning of construction through to the post-closure monitoring period.

The project's spatial scope includes the mine site, access roads, aerodrome and other associated facilities. Given the construction schedule (3 years), planned mine life (11 years), decommissioning (2-3 years) and minimum 3 year monitoring period following closure and reclamation, the temporal scope of the project is approximately 18 to 20 years.

6.3.4 Socio-economic Baseline Information

In an effects assessment, the baseline information provides the necessary indicators for answering the question; what effects will the project have on the community or other interests? The baseline indicators are what anticipated changes are measured against. In YESAB's (2006, p. 49) *Guide to Socio-economic Effects Assessments,* the following direction on selecting baseline indicators is given:

> The social and economic assessment indicators are derived from the VSECs and point to measurable change in human population, communities and social and economic relationships resulting from a proposed project. The delineation of socio-economic assessment indicators defines categories of social and economic change and selects the most suitable measures from which to describe current conditions and predict change. It achieves the goals of scoping by focusing on the most important categories of change and on useful and meaningful indicators.

Baseline community and territorial data provide useful indicators for measuring the anticipated effects on each of the identified VSECs for the proposed development, operation and closure of Mactung mine. The baseline indicators also provide the means for longer term socio-economic effects monitoring as the project proceeds. By identifying anticipated effects, effective mitigation and enhancement measures may be devised during the effects assessment itself.

However, there is not always a clear or quantifiable indicator for each of the VSECs. Where this is the case, indicators have been selected that, individually or together, provide indirect or proxy means of measurement. In these cases the VSEC is acknowledged and any indirect or anecdotal evidence are described in order to predict any potential effects from the Mactung project. However, in some cases, quantifiable indicators are not provided at all, where there is no value in doing so. Providing an indicator that has only a tenuous or tangential relationship to the VSEC will not assist in the assessment and may distract from what is actually valued. All attempts are made to include only data to this assessment.

Table 6.3.4-1 summarizes the linkages between the VSECs, the interests associated with each VSEC, and the baseline indicator. The detailed baseline indicator, including explanations for why each indicator was chosen, can be found in Appendix J1.

TABLE 6.3.4-1 SUMMARY OF VSECS, INTERESTS AND INDICATORS

VSEC	Interest	Indicator
Sustainable livelihood		
Traditional economic activities — hunting, fishing, gathering, trapping	Yukon Environment Ross River Dena Council Liard First Nation Traditional land stewards Ross River group trappers Gregory Keating and Neilson Sisson Rick Charlebois and Rainer Russman,	Trapping harvest data (Source: YE)
Employment	Yukon Economic Development Ross River Dena Council/ Ross River Town of Faro/ Faro Liard First Nation/ Watson Lake Nacho Nyak Dun/ Mayo	Employment rate Unemployment rate Participation rate (Source: 2006 Census)
Employability		
Education	Yukon Education Yukon Women's Directorate Ross River Dena Council/ Ross River Town of Faro/ Faro	Highest level of education (Source: 2006 Census)
Training	HRSDC Yukon College Yukon Women's Directorate Ross River Dena Council/ Ross River Town of Faro/ Faro Liard First Nation Yukon Mine Training Association	Number of courses and completion rates for selected training courses (Source: YMTA)

TABLE 6.3.4-1 SUMMARY OF VSECS, INTERESTS AND INDICATORS

VSEC	Interest	Indicator
Experience	Ross River Dena Council/ Ross River Town of Faro/ Faro	Occupational breakdown (Source: 2006 Census)
Infrastructure		
Transportation infrastructure	Yukon Highways Ross River Dena Council/ Ross River	Description Traffic count data (Source: YHPW)
Power and communication infrastructure	Yukon Energy NorthwesTel	Description
Municipal infrastructure	Town of Faro	Description
Economic development		
Economic growth	INAC Yukon Economic Development Ross River Dena Council/ Ross River Town of Faro/ Faro Liard First Nation/Watson Lake	Yukon GDP (Source: YBS) Personal income by community (Source: CRA)
Broad participation in economic development	Yukon Economic Development Yukon Women's Directorate Ross River Dena Council/ Ross River	Women's and First Nation's employment, participation rates, and incomes (Source: 2006 Census) Availability of daycare spaces
Government revenues	Federal government Yukon government Ross River Dena Council Liard First Nation Town of Faro	Municipal YTG property taxes by community Federal and YTG income taxes by community GST data by community (Source: CRA)
Economic diversification	INAC Yukon Economic Development Yukon Tourism Ross River Dena Council/ Ross River Town of Faro/ Faro Liard First Nation/Watson Lake Koser Outfitters Ltd.	Employment by industry (Source: 2006 Census) Description
Minimizing boom and bust cycles	Ross River Dena Council/ Ross River Town of Faro/ Faro	Personal income by community over time (Source: CRA)
Healthy business sector	Yukon Economic Development Ross River Dena Council/ Ross River Town of Faro/ Faro	GST data by community (Source: CRA) Description
Business opportunities, short and long term	Yukon Economic Development Ross River Dena Council/ Ross River Town of Faro/ Faro Liard First Nation/Watson Lake	Description
Business capacity	Ross River Dena Council/ Ross River Town of Faro/ Faro Liard First Nation/Watson Lake	Description

TABLE 6.3.4-1 SUMMARY OF VSECS, INTERESTS AND INDICATORS

VSEC	Interest	Indicator
Community vitality		
Community population	Ross River Dena Council/ Ross River Town of Faro/ Faro	Community population and growth pattern (Source: YBS)
Demographics	Ross River Dena Council/ Ross River Town of Faro/ Faro	Demographic profile (families, children) Ethnicity (Source: 2006 Census)
Housing and land availability	Ross River Dena Council/ Ross River Town of Faro/ Faro Faro Real Estate Ltd.	Dwelling units (occupied and available) Housing prices (Real estate listings) Available lots (Source: YEMR)
Safety and security		
Reduced crime levels	Yukon Justice Ross River Dena Council/ Ross River Town of Faro/ Faro	Community crime rates (broad all, violent, property) (Source: YBS)
Social cohesion		
Social/community events	Ross River Dena Council/ Ross River Town of Faro/ Faro	Description
Volunteerism	Ross River Dena Council/ Ross River Town of Faro/ Faro	Description
Reducing discrimination and racism	Ross River Dena Council	Income differentials between FN and others and over time (Source: 2006 Census)
Quality of life		
Recreation opportunities	Ross River Dena Council/ Ross River Town of Faro/ Faro	Description
Recreation facilities	Ross River Dena Council/ Ross River Town of Faro/ Faro	Description
Community infrastructure and aesthetic		
Municipal services	Town of Faro	Description
Decent place to live	Ross River Dena Council/ Ross River Town of Faro/ Faro	Description
Governance, political structure and decision-making capacity	Ross River Dena Council/ Ross River Town of Faro/ Faro	Description
Health and socio-cultural well-being		
Best possible health		
Individual and family	Health Canada Yukon Health and Social Services Ross River Dena Council/ Ross River Town of Faro/ Faro	Yukon morbidity rates Smoking rates Diabetes rates (Source: YHSS and HC)
Sense of purpose in life	Ross River Dena Council/ Ross River Town of Faro/ Faro	Description
Reducing alcohol and drug	Yukon Health and Social Services	Description

TABLE 6.3.4-1 SUMMARY OF VSECS, INTERESTS AND INDICATORS

VSEC	Interest	Indicator
abuse	Yukon Women's Directorate Ross River Dena Council/ Ross River Town of Faro/ Faro	
Reducing domestic abuse and violence	Yukon Health and Social Services Yukon Women's Directorate Yukon Justice Ross River Dena Council/ Ross River	Domestic violence statistics (Source: YBS)
Public health and safety	Natural Resources Canada Yukon Energy, Mines and Resources Yukon Environmental Health Ross River Dena Council/ Ross River	Traffic accident rates (Source: YHPW)
Workplace health and safety	Yukon WCHSB Ross River Dena Council/ Ross River Nacho Nyak Dun	Mining accident rate (Source: YWCHSB)
Family resilience and self-sufficiency	Ross River Dena Council/ Ross River	Ratio of lone-parent families to all families (Source: 2006 Census)
Food security	Ross River Dena Council/ Ross River	Inflation rate, food (Source: YBS)
Cultural continuity		
Heritage sites	Yukon Heritage Branch Ross River Dena Council	Description
Land-based social and cultural activities	Ross River Dena Council Traditional land stewards Ross River group trappers	Description
Language preservation and restoration	Ross River Dena Council	Description
Sharing traditional knowledge and stories	Ross River Dena Council	Description

Notes:
CRA – Canada Revenue Agency
FN – First Nations
YBS – Yukon Bureau of Statistics
YE – Yukon Department of Environment
YEMR – Yukon Department of Energy, Mines and Resources
YHSS – Yukon Department of Health and Social Services
YHPW – Yukon Department of Highways and Public Works
YMTA – Yukon Mine Training Association
HC – Health Canada
YWCHSB – Yukon Workers' Compensation Health and Safety Board

6.3.5 Effects Assessment and Mitigation/ Enhancement

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

This section of the report includes:

- characterization and assessment of the potential effects that the Mactung mine project will have on the identified VSECs;
- mitigation measures for negative effects or enhancement measures for positive effects; and
- a description of the rationale and methods used to characterize and assess effects and identify mitigation and enhancement measures.

The anticipated effects of the Mactung project are grouped into three clusters of VSECs, as described in Section 6.4.3.3. Where VSECs overlap among the identified interests, the potential affect to each of those interests is characterized. For each VSEC, mitigation or enhancement measures planned by NATC to maximize the social and economic benefit of the project and minimize social and economic costs are described. Where applicable, the effects are identified according to the primary project phases (i.e., construction, operation, and closure/reclamation) that they may occur in.

6.3.5.1 Project Effects on Sustainable Livelihood VSECs

The following subsections describe the potential project effects on Sustainable Livelihood VSECs.

Traditional Economic Activities — Hunting, Fishing, Gathering, Trapping

The traditional economic activities VSEC is of particular importance to the Ross River Dena Council, the Liard First Nation, the traditional land stewards of the area, the Ross River group trappers, and the registered owners of Trapping Concessions 111 and 112. Yukon Environment also has an interest through its responsibilities and activities connected to hunting, fishing, and trapping in the area.

The construction and operation of the Mactung mine, the construction of the access road, expansion of the Macmillan Pass Aerodrome, and the resulting winter use and maintenance of the North Canol Road is likely to have a number of effects on traditional economic activities, particularly hunting and trapping. Potential effects include:

- improved access to a remote area through new road construction and improved maintenance of existing roads can make pursing traditional economic activities, such as hunting, easier for First Nation people.
- increased ease of access, however, can also lead to increased hunting pressures from people outside the region and thereby limit the ability of local residents to continue these activities.
- if mine employees hunt in the region, they play a role in increasing hunting pressures and possibly reducing traditional economic activities.

- opportunities to pursue traditional economic activities are reduced in proportion the amount of time spent in the paid labour force, especially if shifts and shift rotations do not allow for sufficient time off.
- the use and maintenance of the North Canol Road by mine staff during winter will have a negative effect on Trapline 112 and the Ross River trappers who use the group trapline. There may also be a small effect on Trapline 111. Currently, trappers use the existing North Canol Road and an unmaintained former exploration road as a means of accessing their traplines by snow machine and as a trapping trail in itself.
- the planned improvement of an old mining road and construction of a new road from the aerodrome into the mine site will disrupt a portion of Trapline 112, whose owner currently traps in the valley through which the new road will pass.
- Trapline 111, located to the north and east of the Mactung mine, is not expected to be affected by the project.
- the Mactung project is not expected to have any significant effect on the Yukon Department of Environment's responsibilities and activities connected to hunting, fishing, and trapping in the area.

It is important to recognize that for First Nations in particular, trapping is not just an effort to earn part of an individual's income. Instead it also plays an important role in continuing the individual and collective connection to, and stewardship of, the land in all seasons. Therefore the value of trapping is not just the dollar value of the fur harvested.

Data from the Yukon Department of Environment shows that the region around the project area has had trapping activity in each of the past ten years with total fur harvest varying from 105 to 1,612 pelts annually. The wide variation in harvest levels is likely the result of a combination of factors: variation in animal populations (especially lynx, as they go through their population cycle), variation in fur prices, and varying levels of trapping effort for other reasons.

Mitigation Measures:

- NATC will have a strictly enforced policy forbidding employees to bring firearms into camp and will have a no hunting rule for employees. This, combined with the fly-in nature of the project, will ensure that no employees will be hunting in the region during their rotations.
- NATC plans a standard 3-week in, 3-week out rotation for all employees. The three week period of time off will likely provide sufficient time for First Nation employees to pursue traditional economic activities.
- NATC will install a gate on the new portion of the access road to the mine site (approximately 17 km from the North Canol Road). The new road section will be a private road on leased land leased from the Yukon government. This will limit access into the area around the site itself and limit the increase in hunting pressure.

- NATC will enter into talks with representatives of the users of the Ross River group trapline and with the registered owners of Trapline 112 to establish a level of compensation for the expected disruption of trapping that will result from the construction of the new access road, the winter maintenance of North Canol Road, and the increase in traffic through all phases of the project.

Employment

Employment is often seen as the single most important potential benefit of mining development, especially at the community level. However, it is no longer required for mine employees to live near the mine. With fly-in camps and long rotations now being standard in the industry, mine employees can and do live almost anywhere and commute almost entirely by air. This has advantages for mining companies; they can recruit their workforce from all over Canada (if feasible) and are not constrained by local labour pools or the need to build towns, such as Faro, in the mine's vicinity. The biggest disadvantage of relying on a workforce that has no ties to the mine's region is that a local workforce tends to have lower employee turnover. If a millwright lives in Vancouver, it makes little difference to them which northern mine they work at. A worker living in a nearby community (or at least in the territory) appears less likely to switch to a job in another territory because of the substantial increase in travel time if nothing else. Employee turnover rates in mines tend to be high and these high rates come with very high costs in recruiting, training, and a loss of efficiency.

NATC's Cantung mine near Watson Lake employs approximately 200 people on a rotating shift basis. A January 2008[4] analysis of the payroll showed that 57 of the 200 employees, or 28%, were Yukon residents. Of those 57 employees based in the Yukon, 12 were Liard First Nation members, 12 were non-First Nation residents of Watson Lake, 27 were from Whitehorse, and the remaining 6 from other Yukon communities. These ratios are used to estimate the number of Yukon and nearby community residents that may work at the Mactung mine during operation.

Construction and Pre-Operation

The great majority of the surface construction of the Mactung mine will be carried out by contractors. The underground construction will be done by NATC using its existing underground crews. The construction of the mine, process plant and related infrastructure is scheduled to take approximately 27 months. Construction will require an estimated 1.1 million person-hours of work, excluding mine pre-development and engineering. At the peak of the construction phase there will be maximum 250 people on-site.

Due to the remote location of the Mactung project, current industry-wide labour shortages and a relatively short construction schedule, NATC plans to use existing personnel and equipment from its Cantung mine to do all of the required pre-operation underground mine development at Mactung. Two teams of two shifts of experienced drift miners and one team of mine construction workers will develop the underground portions of the operation

[4] As of November 2008, there are 221 full time employees at Cantung.

(6,358 m of ramps, ventilation raise, crusher station and other underground excavations) in approximately 20 months.

Table 6.3.5-1 summarizes in the labour required for the construction of the Mactung project, including the aerodrome and access road projects. As noted in previous sections, the 120 person years of underground mining work will be largely carried out by the existing crews at Cantung and will not create much new employment. In total, it is estimated that all other construction work will create 420 person-years of new employment distributed unevenly over the three calendar years of construction.

TABLE 6.3.5-1 CONSTRUCTION EMPLOYMENT

Type of Work	Person years	%
Underground mining	120	22
Heavy civil construction	140	26
Civil construction	80	15
Structural construction	55	10
Mechanical construction	35	6
Electrical construction	35	6
General and administrative	25	5
Camp services	50	9
Total	**540**	**100%**

It is estimated that 50% of the 420 person-years (or 210 person-years total) of new employment in the construction phase will likely be filled by Yukon residents for two main reasons:

- over 20% of the Yukon's labour force work in occupations that will make up the bulk of the work, including the trades, transport and equipment operators, and occupations unique to primary industry; and
- NATC is planning to tender construction contracts in increments small enough to make many Yukon construction firms competitive in the bidding process.

Operation Phase

During operation, NATC plans to operate the mine and mill, and provide administrative and surface services using its own employees, as is currently done at the Cantung mine. Employees will be flown in to the Macmillan Pass Aerodrome using a charter plane for their rotations.

NATC will require a total of 253 employees to operate the Mactung mine and mill. In addition, a contractor will require approximately 20 employees to provide catering and camp services. During operation, therefore, a total of 273 people will be employed at the Mactung mine. Employee shifts and rotations are summarized in Table 6.3.5-2.

TABLE 6.3.5-2 SHIFTS AND ROTATIONS			
Area of Operation	Shift length (hrs/day	Rotation	Shifts per day
Senior management	12	3 weeks on 3 weeks off	1
Mining	10	3 weeks on 3 weeks off	2
Process plant (mill)	12	3 weeks on 3 weeks off	2
Surface services	12	3 weeks on 3 weeks off	2

NATC is aware that long rotations (i.e., 3 weeks in camp, living away from home) can be onerous for employees, and especially those with families. However, given the remoteness of the project, short rotations (e.g., 4 days on and 4 days off) are simply not feasible; there is evidence (Storey *et al* 1989) that longer rotations with equal time on and off are more sustainable for families in the long term.

A detailed breakdown of the mine labour required, according to position, during operation is shown in Table 6.3.5-3 below. A total of 101 employees will be required for the mine.

TABLE 6.3.5-3 MINE PERSONNEL: OPERATION PHASE				
Mine Operation Positions	No.		Hourly Mine Crew Positions	No.
Mine superintendent	1		Production drillers	8
Mine general foreman	1		Jumbo operators	8
Mine shift supervisor	4		Rock bolter	8
Chief geologist	1		Ground support	8
Senior geologist	1		Scoop loader operators	12
Geologist technician	2		Truck drivers	16
Chief mining engineer	1		Dozer/grader operators	4
Senior mine engineer	1		Service crew	4
Mine engineer	2		Mine nippers	2
Mine technician	2		Mine general labourer	4
Senior geotechnical engineer	1		Diamond driller	1
Surveyor	2		Diamond driller helper	1
Surveyor helper	2		Blaster	2
			Blaster helper	2
Total	**21**		**Total**	**80**
TOTAL – All Staff	101			

A total of 44 employees will be required for the mill facility during operations as shown in Table 6.3.5-4.

TABLE 6.3.5-4 MILL PERSONNEL: OPERATION PHASE				
Mill Staff	No.		Mill Operations and Surface	No.
Mill superintendent	1		Crusher operator	4
Mill general foreman	1		Secondary crusher operator	4
Mill shift foreman	4		Control room/grind/gravity operator	4
Chief chemist	1		Flotation operator	4
Senior chemist	1		Filter and reagent operator	4
Chief metallurgist	1		Mill helper/labourer	4
Senior metallurgist	1		Tailings Surface Operator	4
Total	**10**		**Total**	**28**
Plant Metallurgical and Assay Lab	No.			
Metallurgical Technician	2			
Assayer	2			
Sample Bucker	2			
Total	**6**			
TOTAL – All Staff	44			

General and administrative work will require a total of 22 employees during operation as shown in Table 6.3.5-5.

TABLE 6.3.5-5 GENERAL AND ADMINISTRATIVE PERSONNEL: OPERATION PHASE				
Administrative staff	No.		Environment	No.
General manager	1		Environmental superintendent	1
Assistant mine manager	1		Environmental technician	2
Receptionist	2		**Total**	**3**
IT network technician	2			
Total	**6**		Human resources and training	No.
			Human resources superintendent	1
Purchasing/Warehouse	No.		Assistant HR superintendent	1
Warehouse superintendent	1		**Total**	**2**
Purchasing agent/ Warehouse supervisor	2			
			Health and safety	No.
Warehouse shipper and receiver	4		Head supervisor	2
Total	**7**		EMT	2
			Total	**4**
TOTAL – All Staff	22			

Finally, the operation phase will require a total of 86 maintenance personnel as summarized in Table 6.3.5-6.

TABLE 6.3.5-6 MAINTENANCE PERSONNEL: OPERATION PHASE

Mill maintenance	No.	Surface maintenance	No.
Mill maintenance foreman	2	Maintenance superintendent	1
Electrician	4	Surface general foreman	1
Instrument technician	2	Surface maintenance foreman	2
Millwright	8	Electrical foreman	2
Millwright apprentice	2	Maintenance planner/clerk	2
Oiler	2	HD mechanic	4
Total	**20**	Automotive mechanic	2
		Machinist	2
Mine maintenance	No.	Welder	2
Mine maintenance foreman	2	Tireman	2
Mine electrical foreman	2	Plumber/pipe fitter	2
Mine maintenance HD mechanic	10	Equipment operator	4
HD mechanic apprentice	2	Labourer	2
Mine maintenance welder	4	Electrician	2
Millwright	2	Powerhouse operator	4
Mine maintenance helper	2	HD mechanic powerhouse	2
HD electrician	4	**Total**	**36**
Electrician apprentice	2		
Total	**30**		
TOTAL – All Staff	86		

Approximately 28% of the workforce at NATC's existing Cantung mine is made up of Yukon residents. Based on this ratio, it is estimated that approximately 30% (or 82) of the 273 employees and contractors needed at Mactung will be recruited from the Yukon's existing workforce. In addition, it is estimated that a total of 20 more employees will be recruited from outside of the Yukon that will relocate to the Yukon, 10 in Faro and 10 in Whitehorse (see Section 6.4.5.2 for more details). Therefore, total operation phase employment is estimated to include 102 Yukon residents, or 37% of the total.

Yukon-based employees will likely reside according to similar distribution patterns as Cantung mine. For Cantung, Yukon-based employees reside in Whitehorse (50%), Watson Lake (40% total, including 20% Liard First Nation), and other communities (10%). Using this ratio as a rough guide it is estimated that Yukon-based staff at Mactung mine project (including those anticipated to relocate to the Yukon) will reside in the following communities, as shown in Table 6.3.5-7.

TABLE 6.3.5-7 ESTIMATED EMPLOYMENT DISTRIBUTION BY COMMUNITY: OPERATION PHASE	
Community	No. of Employees and Contractors
Ross River	6
Faro	12
Watson Lake	27
Mayo and other rural communities	6
Whitehorse	51
Outside the Yukon	171
TOTAL	**273**

The estimates shown in Table 6.3.5-7 include the following assumptions apart from the use of the existing distribution of Cantung employees:

- Ross River has a very small existing labour force of 165 people and, although unemployment and underemployment are high, it is not realistic to anticipate a large number of employees from the community.
- Faro's 12 employees include the estimated 10 who will be recruited from outside the Yukon but will relocate to Faro.
- Watson Lake is assumed to supply a fairly high proportion of Mactung employees in part because of the community's existing relationship with NATC's Cantung mine.

Enhancement Measure:

- NATC will continue its efforts to recruit as many of its employees from the Yukon as possible with a particular focus on the communities of Ross River, Faro, Watson Lake, and Mayo. The locations of the pick up points for employees will be worked out when the number of employees is known for each of the communities.

Decommissioning Phase

It is estimated that approximately 20 people will be employed for four month periods over two summer work seasons to complete the closure and reclamation of the Mactung mine. NATC will undertake progressive reclamation activities during the operation phase wherever possible.

Employment during closure and reclamation will primarily include equipment operators and related trades to re-contour and cover the dry-stack tailings, breach the ravine dam, scarify roads, and plug adits. A smaller number of construction and transportation-related jobs will be created to demolish and remove buildings and other infrastructure.

It is anticipated that all, or almost all, of the jobs in the decommissioning phase will go to Yukon residents. Given the high level of experience and expertise in such work by firms and individuals at the Faro mine site, there is opportunity for many of the positions to be filled by residents of Ross River and Faro.

Employability: Education, Training and Experience

Education

As described in previous sections, there is little need for people to live near the mine site anymore. With fly-in camps and longer rotations now standard in the industry, mine employees can and do live almost anywhere and commute almost entirely by air. Therefore, it is expected that only a few Mactung employees will relocate to the Yukon (see Section 6.4.5.2). Given that few employees (and their families) will relocate, there will not be a noticeable increase in the number of children and, therefore, no significant effect on the education system in the nearby communities or the Yukon as a whole.

The Mactung project will have a positive effect on education by offering a scholarship to students from the communities of Ross River, Faro, Watson Lake or Mayo.

Enhancement Measure:

- Upon opening of the Mactung mine, NATC will offer an annual scholarship to a qualified student, or students, from Ross River, Faro, Watson Lake or Mayo who are pursuing a post-secondary education, particularly in a mining related field.

Training and Experience

The training VSEC and those with an interest in training will be directly effected by the project as NATC will employ apprentices and provide other forms of training to employees, in partnership with organizations, such as Yukon Mine Training Association and Yukon College.

For employees of the Cantung mine, NATC provides a variety of training, either directly or through assistance, for:

- Life skills/literacy/language;
- Basic training;
- Health and safety training;
- Training in equipment operations; and
- Training for surface and underground mine work.

Enhancement Measures:

- NATC will implement the training programs currently used at Cantung, especially its underground training in partnership with the Yukon Mine Training Association.
- To facilitate employee career advancement, NATC will implement its policy of initially posting all employment positions internally, and, with a particular focus on First Nation candidates, help create individual training and succession plans.

Infrastructure

Transportation

Mactung will have a direct effect on road transportation infrastructure, especially the North Canol Road and the ferry at Ross River, by increasing traffic through all phases of the project. The Campbell Highway will also have an increase in traffic.

The North Canol Road is currently a lightly used, minimally maintained, and seasonal road. In summer, the ferry crossing over the Pelly River operated by the Yukon government provides the only vehicle access to the portion of the road on the north side of the Pelly River. Traffic data from 1983 to 2007 reveal that an average 28 vehicles per day use the ferry over the average 145 day season. From 2000 to 2007, average daily use was lower, ranging from 19 to 24 vehicles per day. An ice "bridge" over the Pelly River provides vehicle access to the North Canol Road during winter; however, the "bridge" is not maintained. During spring thaw and fall freeze, neither the ferry nor the ice bridge is operational.

It is estimated that the project will require an average of 10 round trips per day by transport trucks during the construction phase. This will result in a total average of 20 trucks per day passing through Ross River, over the North Canol Road.

During the much longer operation phase, there will be less truck traffic. An average of 4 round trips per day by transport trucks will be needed, resulting in 8 trucks per day passing through Ross River during operations.

During the decommissioning phase there will be no significant increase in truck traffic. An estimated average of one truck per day will be needed during the summer and even less during winter.

During spring and fall, when there is no access over the Pelly River, there will be no truck traffic through Ross River.

Mitigation Measure:

- NATC is aware that the Mactung project will increase the volume of heavy truck traffic through Ross River, particularly during the construction phase of the project. The company will prepare a traffic plan, with input from the community, to minimize negative effects.

The Mactung project will have a direct effect on the Yukon Department of Highways (YDOH). The North Canol Road will require additional summer and winter maintenance and possible upgrades. YDOH has committed to providing the required level of maintenance to the North Canol Road, in both summer and winter to handle the increased use of the road by the Mactung project. The department has also committed to providing adequate ferry service during summer and adequate ice bridge during winter.

Power and Communication

The Mactung project will have no effect on the Yukon's power infrastructure as the mine will generate its own power and not connect to the electrical grid. The territory's communications infrastructure will also not be affected as Mactung will rely on its own satellite communications system for voice and data communication.

Mitigation/ Enhancement Measure:

- NATC is identifying the feasibility of reducing its reliance on diesel generators by using wind or geothermal generation. This may benefit the company through reducing its operational costs but will also have the wider benefit of reducing greenhouse gas emissions.

Municipal Infrastructure

Mactung will have no effect on municipal infrastructure, such as water or sewer systems, unless the project results in a substantial increase in the population of either Ross River or Faro. Such large increases are highly unlikely (see Section 6.4.5.2).

The project will not use the solid waste disposal facilities at Ross River or Faro. Instead, large waste items will be buried in dry-stack tailings and all garbage and small items will be incinerated in an on-site propane incinerator.

Economic Development: Growth, Participation, Government Revenues, Diversification and Minimizing Boom and Bust

Economic growth: Yukon and community GDP

The Mactung mine's broad effect on the Yukon's economy can be measured by the gross value of its anticipated output. Based on the size of the deposit as well as the average grade, NATC has estimated that the development of a tungsten mine could produce tungsten concentrate over an 11-year mine life.

The tungsten will be sold in two forms of concentrate, gravity and ammonium para tungstate (APT). The price of APT has been holding steady at approximately US$255/metric tonne unit (mtu) since 2006 after reaching a high of US$300/mtu in 2005[5].

The base case prices are estimated by Goodall Business and Resource Management Pty Ltd (GBRM), based on a detailed analysis of the supply and demand of tungsten. GBRM forecasts that demand will increase between 2008 and 2012 but that there are no confirmed new mining projects set to meet that demand. Within these parameters, APT prices are forecast to reach US$300/mtu by 2012.

GBRM forecasts that the price will increase somewhat over the life of the mine given the current trend of increasing demand with likely no new sources of supply; however, the

– [5] The price of APT reached a low of US$50/mtu in 2002 and began rising sharply in 2004.

predicted price increase is not factored into the forecast value of Mactung's production shown in Table 6.3.5-8.

TABLE 6.3.5-8 GROSS VALUE OF CONCENTRATE PRODUCTION			
Year	Gravity Concentrate Production (mtu)	APT Concentrate Production (mtu)	Gross Value (C$ millions)
Average (11.2 years)	428,000	210,000	$182.0

Note: Based on exchange rate of C$1.10 to US$1.00

In 2006 the Yukon's GDP was $1.55 billion. Statistics Canada's 2003 Input-Output model for the Yukon (the latest available) gives a multiplier of 0.77 for calculating the effect of metal mining on the Yukon's GDP. Mactung's average annual gross production value of $182.0 million translates into an annual effect of $140.1 million on the Yukon's GDP. The mine can therefore be expected to increase the size of the economy by a significant 9.0%.

No data are kept on the size of community economies. As such, the total declared income data from Revenue Canada is used as a proxy for the size of a community's monetary economy. The effect of additional incomes of community residents for the three most affected communities during the operation phase of the Mactung project are shown in Table 6.3.5-9.

TABLE 6.3.5-9 INCREASE IN COMMUNITY GDP: OPERATION PHASE					
	2005 Total Declared Income	No. Employees	Average Salary	Additional Income	% Effect
Ross River	$5,361,000	6	$69,000	$414,000	7.7%
Faro	$9,235,000	12	$69,000	$828,000	9.0%
Watson Lake	$31,892,000	27	$69,000	$1,863,000	5.8%

Some points on the estimates shown in Table 6.3.5-9:

- Data from the 2005 tax year is the latest available from Revenue Canada;
- The number of employees by community is based on estimates shown in Table 6.3.5-7; and
- Average salary is the average across all categories of employee during the operation phase.

Government Revenues

The Mactung project will directly increase government revenues through various taxes, fees, royalties, and other payments. However, the bulk of the project's effect on government revenues will be indirect, through income taxes and property taxes paid by employees.

The Town of Faro will see a modest increase in the amount of property taxes collected if approximately 10 Mactung employees relocate from outside the Yukon to Faro (see Section 6.4.5.2). The town collects an average of $1,600 annually in property taxes per single family dwelling. The increased revenue would therefore be an additional $16,000 per year, with only a marginal cost of providing infrastructure and services to the additional residents.

The Ross River Dena Council (RRDC) and the Liard First Nation (LFN) may gain additional revenue, but this is entirely dependant on their negotiations of Socio-Economic Participation Agreements (SEPAs) with NATC. Once finalized, SEPA terms tend to be confidential; therefore, it is not possible to estimate the amount that may be raised from these agreements. As neither the RRDC nor the LFN are self-governing First Nations under the Umbrella Final Agreement, they are not entitled to the First Nation share of income taxes paid by residents on settlement land.

The Yukon government collects mining royalties under the *Quartz Mining Act*. The royalty is a proportional annual tax on mining profits that exceed $10,000. The profit subject to the royalty is the amount by which the value of annual output from mining (revenues) exceeds eligible deductions (costs) for the year. The royalty rate begins at 3% for profits between $10,000 and $1 million, increases to 5% for profits of $1 million to $5 million, increases to 6% for $5 million to $10 million and continues to step up by 1% for each $5 million thereafter. Calculating the profit for the purposes of collecting the royalty is a very complex undertaking on both the revenue and cost side.

Historically, the actual amount of royalty collected under the *Quartz Act* in the Yukon has been very modest. For example, the average annual sum of *Quartz Act* royalties collected form 1992 to 1997 was approximately $400,000. Over the same period, various fees and lease payments collected under the *Quartz Act* averaged $1.3 million annually. During more recent years, the Yukon government reported a total of $236,000 in royalties plus land and mineral lease payments for 2006/07, with a forecast drop to $178,000 total for 2007/08 and $178,000 total for 2008/09 despite the Minto mine being in full operation as of late 2007. Given these very modest numbers, and the great difficulty in projecting just what royalty the Mactung project will be subject to, an estimate is not provided.

The largest Mactung-related source of government revenues for both the federal and territorial governments is the income tax paid by the project employees (Table 6.3.5-10).

TABLE 6.3.5-10 ESTIMATED INCOME TAXES BY PROJECT PHASE				
Project Phase	Federal Income Tax (Annual)	Yukon Income Tax (Annual)	Total Federal Income Tax	Total Yukon Income Tax
Construction phase	$1,526,280	$335,685	$4,578,840	$1,007,055
Operation phase	$2,976,246	$489,141	$33,333,955	$5,478,379
Closure and reclamation	$65,412	$28,773	$130,824	$57,546
Total	**$4,567,938**	**$853,599**	**$38,043,619**	**$6,542,980**

The income tax estimates shown in Table 6.3.5-10 are based on the following:

- The average annual income across all jobs in all phases is $69,000. This income is based on the known operation phase jobs' annual average income, which is assumed to be roughly correct for the other phases.
- Based on 2006 Revenue Canada data, the average tax payer earning between $60,000 and $70,000 annually paid 15.8% of their total income in federal income tax and 6.95% of their total income in Yukon income tax.
- It is assumed that Yukon residents will get 210 person-years of the 420 person-years of new employment created during a 27 month period of construction.
- It is assumed that 102 out of the total of 273 people employed during the 11.2 year operation phase will be Yukon residents.
- It is estimated that the decommissioning phase will require a total of 12 person-years of employment over two years, all for Yukon residents.

Economic Diversification

Although it is a common perception that mining is a big part in the Yukon's economy, this has not been the case for some time. In 2006, the latest year for which GDP statistics are available, mining and oil and gas extraction made up only 3.0%, or approximately $46.5 million of the Yukon's GDP of $1.55 billion. It is anticipated, however, that the GDP and particularly the percent share from mining and oil and gas activities will be significantly higher when the data for 2007 and especially 2008 are released, as the Minto mine began full operation in the fall of 2007.

The 3.0% mining and oil and gas share of the economy puts these industries on par with wholesale trade (3.0%) and information and cultural industries (3.3%). The Yukon's economy is clearly not over-reliant on the extraction of non-renewable resources. Similarly, the region centered on Ross River and Faro, where the largest effects of the Mactung project are likely to occur, has no operating mines. Mactung will therefore have a direct positive effect on the Yukon and regional economic diversification.

Koser Outfitters Ltd. operates the outfitting concession that covers all of the Mactung project area and the North Canol Road region. The Mactung project will have a relatively small but direct negative effect on the outfitting business as Peter Koser, owner-operator of the outfit, has conducted occasional hunts in the immediate area of the mine site in the past and will not be able to do so over the life of the mine if the project proceeds. In addition, any improvements to the North Canol Road and the existing portion of the access road, as a result of the project, will increase ease of access that may lead to increased hunting pressures in the area.

However, during a discussion about the project, Peter Koser was clear that the negative effects will be small and not particularly significant to the business. Koser Outfitters has experienced similar increases in mining activity in the past, especially in the mid 1970s when Koser's father operated the outfit, and was able to adapt. Road improvements also create a small positive benefit to the business, making the transportation of supplies and horses to the trailheads easier. One point raised during discussion was a strong preference that any roads newly built for the project be entirely removed once the mine is closed and reclaimed.

Mitigation Measure:

- NATC's will install a gate along the new access road (approximately 17 km from the North Canol Road) to help mitigate the effects of increased hunting pressure in the region.

Minimizing Boom and Bust

By its very nature mining has a tendency toward creating a boom and bust cycle, particularly in a small local economy. Any mine is fundamentally limited by its ore reserves and cannot continue operation when the ore supply is depleted. However, the construction and operation of a mine can be designed to extend its life and extend the period over which economic benefits flow to local communities.

As already noted, the construction of the Mactung mine is planned to occur in a 27 month period. Given the project's remote location, the need to concentrate much of the surface construction in the summer months and the financial need to complete construction as quickly as possible, it is not feasible to extend the construction phase in order to provide longer-term economic benefits.

Mactung has a planned operation phase of approximately 11.2 years at a mining rate of 2,000 tonnes of ore per day. Reducing the mining rate to 1,500 tonnes per day would extend the mine life to approximately 14 years. A lower rate of production would mean fewer employees would be needed over a longer period of time.

One of the greatest challenges in opening a mine is financing its construction. Reducing the production rate also reduces the internal rate of return on investment and lengthens the payback period on the capital required for start-up. It, therefore, substantially increases the risks to those investors who provide the capital. NATC calculates that reducing the mining rate at Mactung to 1,500 tonnes per day would reduce the internal rate of return on investment and lengthen the payback period by more than the 25% reduction in the mining rate. Under these conditions the project will be prohibitively difficult to finance and become economically unfeasible.

Healthy Business Sector: Business Opportunities, Short and Long Term and Business Capacity

Mactung will provide a wide variety of business opportunities through all phases of the project.

Business Opportunities: Construction Phase

The construction contracting strategy for the Mactung project will be designed to maximize use of the local labour force and create a responsible and sustainable relationship with the nearby communities and First Nations. Current plans call for the following separate construction contracts:

- Aerodrome construction;
- Access road upgrade and construction;
- Camp construction (both temporary and permanent);
- Plant site preparation and tailings facility (includes tailing extension work during operation phase);
- Design/build 13.8 kV transmission lines to pump stations/site facilities;
- Design/ build truck fuel station;
- Design/ build truck shop and warehouse;
- Design/ build pre-engineered administration complex;
- Concrete supply;
- Concrete installation;
- Structural steel installation;
- Cladding and roofing;
- Mechanical and piping;
- Insulation;
- Design/ build flotation cells;
- Electrical and instrumentation;
- Process control; and,
- Architectural finishes.

Enhancement Measures:

- As shown in the contract lists above, NATC is committed to offering scaled down construction contracts that will encourage Yukon-based firms to bid on the project.

- As part of ongoing discussions with the Ross River Dena Council and the Liard First Nation, NATC is exploring ways of maximizing First Nation participation in the construction phase business opportunities.

Business Opportunities: Operation Phase

The Cantung mine currently purchases approximately $8.55 million worth of goods and services annually from Yukon contractors and suppliers. In general, these goods and services include:

- transportation -$750,000;
- parts and supplies - $1.7 million; and
- services - $6.1 million.

The Mactung project will likely provide even more opportunities as it will be a somewhat larger operation. During the operation phase, the following goods and services will potentially be contracted out:

- transportation – expediter and cargo;
- food services;
- camp maintenance services;
- vehicle maintenance services;
- environmental monitoring services;
- fuel supply; and
- propane supply.

Enhancement Measure:

- As part of ongoing discussions with the Ross River Dena Council and the Liard First Nation, NATC is exploring ways of maximizing First Nation participation in the project's operation's phase business opportunities.

Business Opportunities: Closure and Reclamation

During the decommissioning phase there will likely be a number of business opportunities including:

- building demolition contracts;
- earth moving contracts;
- reseeding and revegetation contracts; and,
- environmental monitoring.

Enhancement Measure:

- As part of ongoing discussions with the Ross River Dena Council and the Liard First Nation, NATC is exploring ways of maximizing First Nation participation in the project's decommissioning business opportunities.

Business Capacity

The project may have a positive effect on business capacity through the business opportunities offered during all project phases. Firms located in nearby communities or in the territory will have the opportunity to increase their experience and capacity by working at Mactung.

6.3.5.2 Project Effects on Community Vitality VSECs

Community Population

Both Ross River and Faro have identified community population as a VSEC, but for different reasons. One of Faro's primary goals as a community is to increase its population in order to make the community more vibrant, achieve and maintain a population large enough to support more business services, make more efficient use of its existing infrastructure, and increase the tax base sufficiently to allow the municipality to maintain and upgrade its infrastructure. An influx of newcomers to Faro is desired by the community. Most residents of Ross River, on the other hand, expressed strong reservations about an influx of newcomers, wanting the community to grow slowly instead.

Demographics

Community demographics are important to both Faro and Ross River. Faro wishes to attract families and especially families with children, as new community residents. The Del Van Gorder School is operating far below its capacity. As the number of children in the community declines, the incentive grows for parents of school age children to move to communities where there are more children, and consequently, more extracurricular activities and a broader social environment. Families with children are also perceived as more active participants in the community and more likely to volunteer to create more community activities and events.

One of the reasons given by some Ross River residents for not wishing to see an influx of outsiders into the community was the desire to see Ross River remain a majority First Nation, and particularly a Kaska, community.

Housing and Land Availability

The availability of housing and land (to build housing) is a key determinant of whether a community can increase its population in the short to medium term.

Faro has both the immediate capacity to house new residents and is actively seeking them. NATC recognizes the value to the company of drawing as much of its workforce from local communities as possible to minimize its employee transportation costs and decrease turnover. As of November 2008, the Yukon government has four country residential lots for sale and there are approximately 35 homes listed for sale or rent through real estate agents or private listings.

Ross River does not have capacity to house new residents. In November 2008 there were no houses listed for sale or rent in Ross River, either through a real estate agent or through private sale. Further, the Yukon government listed no residential lots for sale in the community. It appears that the community will not see a significant influx of new residents in the short to medium term, as there is no available housing or land to construct new houses on.

Enhancement Measure:

- NATC will consider relocation incentives for new employees of Mactung who reside outside of the Yukon. The company will work with the Town of Faro and Faro Real Estate Ltd. to make Faro a preferred place for employees to relocate.

With a relocation incentive in place, it is expected that some employees will choose to relocate and become Yukon residents. We are estimating that up to 10 new employees and their families will choose to make Faro their new home, increasing the population of the community by 20 to 25 people. These additional residents would not add stress to the available infrastructure or services in the community, rather, they would be considered a positive effect.

Safety and Security: Reduced Crime Levels

People feeling safe and secure in a community, and especially safe from excessive or pervasive crime, plays a large role in community vitality. The Mactung project will have only indirect effects, if any, on reducing crime levels. If increased incomes lead to increases in alcohol and drug abuse then crime levels are likely to rise rather than fall.

Social Cohesion

Social/Community Events and Volunteerism

The Mactung project will likely have no significant effect on volunteerism in the community. However, NATC is considering sponsoring at least one community event in Ross River annually once the operation phase begins. NATC currently donates approximately $70,000 annually to social/ community events and organizations.

Enhancement Measure:

- NATC, in consultation with each community, is planning to sponsor at least one community event in Ross River and Faro once the operation phase begins.

Reducing Discrimination and Racism

NATC will attempt to have a positive effect on reducing discrimination and racism by not tolerating discrimination and racism in the workplace.

Mitigation Measure:

- NATC will strictly enforce a workplace policy prohibiting any form of discrimination or racism in the workplace. Complaints will be treated seriously and dealt with immediately.

Quality of Life: Recreation Opportunities and Recreation Facilities

Community quality of life, and particularly recreation opportunities and facilities will not be directly affected by the Mactung project.

Community Infrastructure and Aesthetic: Municipal Services, Decent Place to Live

The Mactung project will likely have no significant effects on community infrastructure and aesthetic, including municipal services in Faro and Ross River. Overall, the project will not affect whether a community is a decent place to live.

Governance, Political Structure and Decision-Making Capacity

The construction, operation and closure of Mactung will likely have no significant effect on local, First Nation, or territorial governance, political structures or decision making capacity.

6.3.5.3 Project Effects on Health and Socio-cultural Well-being VSECs

Information contained within this section has been updated or expanded within the Addenda. Please refer to the Table of Clarification for specific guidance.

Best Possible Health: Individual and Family Health, Sense of Purpose in Life

Better individual health is clearly associated with higher incomes and higher education levels. Statistics Canada (2003) states:

> Health can be influenced by income and education. People with higher incomes can generally expect to live longer and healthier lives than those earning less. In 1996–97, only 47% of Canadians at the lowest income level rated their health as very good or excellent, compared with 73% in the highest income group. … Only 19% of people who had not graduated from high school said their health was excellent, whereas more than 30% of university graduates claimed they enjoyed excellent health.

In general, steady employment and increased incomes are strongly correlated with a greater sense of self-worth, better individual health, and better family stability and health. By offering relatively long-term, steady, and well-paid employment, and offering education and skills development through apprenticeship and training, the Mactung project will likely have an overall positive effect on individual health and family health.

However, the combination of a sudden increase in income and the absence of the employed spouse/ parent during each three week rotation can have negative effects on family health and well-being. Studies done in the Northwest Territories indicate that the development of a resource-based industry near a small community can cause disruptions to family life. Increased income in families and communities that are already experiencing stress (related to rotational employment, commuting, single parenting, and integrating an absent parent back into the family) can lead to increased substance abuse, behavioural issues for children, and sometimes, family violence.[6]

Enhancement Measure:

- To help employees and their families maintain good health, NATC will be offering a dental and extended health plan to all employees at Mactung, as they currently do at Cantung.

Reducing Alcohol and Drug Abuse

The Mactung project will not have any direct effect on domestic abuse and violence. However, by providing relatively long-term and generally well-paid work the project may have indirect effects, both positive and negative.

Employment opportunities may provide incentive for potential employees to stop abusing alcohol and drugs prior to applying for employment. As well, increased income may lead to increased self esteem and sense of self-worth, reducing a person's reliance on alcohol and drugs. Alternatively, it can lead to increases in drug and alcohol abuse, as drugs and alcohol become relatively more affordable and attainable. Although NATC cannot be responsible for any employee's actions while on their own time, it is of utmost importance to the company to reduce drug and alcohol abuse among its employees to help ensure a safe worksite, reduce employee turnover, and help protect the general health and well-being of its employees.

Mitigation Measure:

- The camp will be dry through all phases of the project, no alcohol or non-prescription drugs will be permitted.
- NATC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter.
- Workplace safety is priority for NATC. Employees will be terminated if found to be possessing or consuming drugs or alcohol on site.

Reducing Domestic Abuse and Violence

The Mactung project will not have any direct effect on domestic abuse and violence. However, by providing relatively long-term and generally well-paid work the project may have indirect effects, both positive and negative.

[6] Review of Diavik Diamonds Project Socio-Economic Environmental Effects Report: Impacts on Women and Families. NWT Status of Women Council. March 1999.

Steady employment and increased incomes lead to a greater sense of self-worth and allow people to provide more for their family's material well-being. This should lead toward reducing the amount of domestic abuse and violence in the community. However, a large increase in income can also lead to a greater degree of alcohol and drug use as these items become more affordable. This in turn can lead to increases in domestic abuse and violence. In research from other jurisdictions and similar projects, it has been shown that an increase in income in the community, in-migration, and shifts in family life are often linked to an increase in violence against women (NWT Status of Women Council 1999; Brockman and Argue, nd).

Public Health and Safety

There are three major areas of public health and safety that the Mactung project may affect: traffic safety, spills or major accidents, and environmental health concerns around the disposal of sewage and garbage at the mine site camp.

As outlined previously, the project will substantially increase the amount of truck traffic through Ross River and up the North Canol Road during the construction phase, have a much smaller effect during operations, and have no significant effect during the decommissioning.

It is estimated that the project will require an average of 10 round trips per day by transport trucks during the construction phase. This will result in a total average of 20 trucks per day passing through the community and over the North Canol Road. During the much longer operation phase, there will be far less truck traffic. An average of 4 round trips per day by transport trucks will be needed; therefore, 8 trucks a day will pass through during operations. During the decommissioning phase there will be no significant increase in truck traffic. An estimated average of one truck per day will be needed during the summer and even less during winter. For all project phases, there will be no truck traffic during spring and fall, when neither the ferry nor the ice bridge is operational.

Mitigation Measure:

- NATC is aware that the Mactung project will increase the volume of heavy truck traffic through Ross River, particularly during the construction phase of the project. The company will prepare a traffic plan, with input from the community, to minimize negative effects.

Because the Mactung project will require the transport of substantial quantities of diesel fuel, gasoline, propane, explosives, and a variety of mill reagents, there is a possibility of a spill or accident that will have a potential public health or safety effect and/or a negative environmental effect.

Mitigation Measure:

- NATC will have a trained emergency response team, along with an assortment of relevant equipment available to respond to accidents and spills. The company will, prior to commencing the project, have worked out a protocol with the Yukon government's Emergency Measures Organization that outlines roles and responsibilities in the event of an accident or spill (see Appendix M2).

Public health will not be compromised at the Mactung site as NATC will follow all relevant regulations concerning potable water, food safety, and the disposal of sewage and garbage under the oversight of the Environmental Health Services Branch of the Yukon government.

Workplace Health and Safety

The health and safety of those working for NATC on the Mactung project is a top priority. The company will rigorously follow all applicable safety laws and regulations in all aspects of its operations. All employees will receive the safety training (see Section 6.4.5.1) they require to do their jobs properly and safely.

There will be a fully trained emergency medical technician (EMT) on site at all times with all required medical supplies and equipment. An on-call air medivac service will be available at all times and anyone needing medical care will be flown to Whitehorse. This will greatly reduce the likelihood of the Mactung project putting undue stress on the Ross River or Faro nursing stations.

Underground mining can pose its own unique workplace safety risks. Overall, the ground conditions in the mine appear to be competent, that is, the rock is inherently stable. About 89% of the mining will use long hole blasting techniques. Specific plans to ensure maximum worker safety underground include, where required:

- all underground excavations will be supported with rock bolts;
- main haulage ramps will be reinforced with galvanized steel mesh;
- fault area crossings will be reinforced with shotcrete or synthetic liners and grouting as required;
- back (roof) of sill levels will be reinforced with rock bolting and cable bolting;
- all major mine infrastructure (e.g., crusher station, ramps and raises) will be located in the geotechnically-competent rock of the footwall;
- no heat will be added to the mine to preserve permafrost;
- drilling equipment will by dry-operated to avoid ice accumulation on ramps and working areas; and,
- although ground conditions are reported to be competent, ground support is planned at all permanent openings.

Mitigation Measures:

- NATC will follow all applicable safety laws and regulations in every aspect of its operations;
- NATC will provide every employee with the training required to safely do their work; and
- NATC will have a fully qualified EMT on site with all required medical supplies and equipment and have an on-call air medivac service available at all times.

Family Resilience and Self-sufficiency: Food Security

NATC is aware that longer rotations (i.e., 3 weeks in camp, living away from home) can be onerous for employees, and especially those with families. However, the available literature demonstrates that longer rotations, with an extended period at home, decreases the stress on family relationships overall and increases family resilience. Similarly, the three week periods at home should allow adequate spans of time for those who wish to increase their food security through hunting, fishing and gathering to do so.

Cultural Continuity

Heritage Sites

NATC has conducted three seasons of archaeological fieldwork on and around the Mactung site searching for heritage sites. Two seasons of study were conducted around the mine site itself and one season of study was conducted examining the aerodrome, the pump house site, and along the proposed new access road. Thus far, no heritage sites have been identified and none have been inadvertently discovered or disturbed by mine-related work on the site.

Mitigation Measure:

- If at any point during the construction and operation of the mine and its accessory projects a heritage site is discovered or disturbed, NATC will immediately cease work in the immediate vicinity and contact both the Ross River Dena Council and the Yukon Heritage Branch. No work in the immediate vicinity will resume until the site is assessed.

Land-based Social and Cultural Activities

The Mactung project will not have any direct effect on land-based social and cultural activities. Depending on whether First Nation people are already employed full-time, the project may or may not affect the amount of time available for the First Nation to pursue these activities. However, the 3-week in, 3-week out rotation should allow sufficient consecutive days off to pursue most activities.

Mitigation Measure:

- In addition to the regular rotation and annual holiday time, NATC will have a flexible time-off policy in place allowing all employees to book further unpaid time off assuming qualified replacement employees can be scheduled to cover the absence. This will further mitigate any negative effect the project may have on First Nation social and cultural activities.

Language Preservation and Restoration

As with land-based social and cultural activities, the Mactung project will not have any direct effect on language preservation and restoration. Depending on whether First Nation people are already employed full-time, the project may or may not affect the amount of time available for the First Nation to pursue these activities. While English will be the operating language at the mine, employees (including First Nations) are free to speak in any language during personal conversations. However, the 3-week in, 3-week out rotation should allow sufficient consecutive days off to pursue most activities.

Sharing Traditional Knowledge and Stories

As with land-based social and cultural activities and language preservation and restoration, the Mactung project will not have any direct effect on the sharing of traditional knowledge and stories. Depending on whether First Nation people are already employed full-time, the project may or may not affect the amount of time available for the First Nation to pursue these activities. However, sharing of traditional knowledge and stories is permitted while at the mine site and the 3-week in, 3-week out rotation should allow sufficient consecutive days off to pursue most activities.

6.3.6 Significance Determination

Table 6.3.6-1 outlines the value attributed to each criteria, as per the definitions stated previously in the Environmental Assessment Methods section (Section XX), which were used to determine the residual effect significance on each VSEC.

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Sustainable Livelihood													
Traditional economic activities	Potentially reduced opportunity to pursue traditional economic activities.	NATC plans a standard 3-week in, 3-week out rotation for all employees.	-	3	NA	1	1	2	2	3	NS	3	3
Traditional economic activities: hunting	Easier access to area for hunting; hunting reduces big game population.	NATC will install a gate along the private road section of the access road. NATC will strictly enforce their policy forbidding employees to bring firearms into camp and from hunting.	-	3	5	2	3	2	3	3	NS	2	2
Traditional economic activities: trapping		NATC will enter into talks with representatives of the Ross River group trapline and registered owners of Trapline 112 to determine compensation for potential trapline disruption.	-	3	5	2	2	3	4	3	NS	4	3
Employment: construction phase	An estimated 50% (or 210 person-years) of construction phase employment will be to Yukon residents.	NATC is planning to tender construction contracts in increments small enough to make many Yukon construction firms competitive in the bidding process.	+	1	NA	3	NA	2	NA	3	P	4	1

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Employment: operation phase	An estimated 37% of total operation phase employees (or 102 employees) will be Yukon residents.	NATC will continue its efforts to recruit as many of its employees from the Yukon as possible with a particular focus on the communities of Ross River, Faro, Watson Lake, and Mayo. Pick-up locations will be worked out once employee residence locations are known.	+	3	NA	3	NA	2	NA	4	P	4	1
Employment: decommis-sioning and reclamation phase	It is estimated that approximately 20 people (likely from the Yukon) will be employed for four month periods over two summer work seasons.	NATC will tender decommissioning and reclamation contracts in increments designed to make Yukon firms competitive in the bidding process.	+	1	NA	2	NA	2	NA	3	P	4	1
Employability: education	No noticeable increase in the number of children relocating due to parent employment at the mine; therefore, no significant effect on the local/ territorial education system.	Upon opening of the mine, NATC will offer an annual scholarship to a qualified student(s) from Ross River, Faro, Watson Lake or Mayo who are pursuing a post-secondary education, particularly in a mining related field.	+	3	NA	2	NA	2	NA	3	P	4	1

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Employability: training and experience	The training VSEC and those with an interest in training will be directly effected by the project as NATC will employ apprentices and provide other forms of training to employees, in partnership with organizations, such as Yukon Mine Training Association and Yukon College	NATC will implement the training programs currently used at Cantung, especially its underground training in partnership with the Yukon Mine Training Association. To facilitate employee career advancement, NATC will implement its policy of initially posting all employment positions internally, and, with a particular focus on First Nation candidates, help create individual training and succession plans.	+	3	NA	2	NA	2	NA	4	P	4	1
Infrastructure: transportation	Increased traffic along North Canol Road, the Campbell Highway, and the ferry crossing at Ross River through all phases of the project, may require additional maintenance and upgrades to road infrastructure.		-	3	5	3	1	2	2	4	NS	4	1

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Infrastructure: power and communication	No effect as Mactung will generate its own power and will rely on its own satellite communications system for voice and data communication.	NATC is identifying the feasibility of reducing its reliance on diesel generators by using wind or geothermal generation. This may benefit the company through reducing its operational costs but will also have the wider benefit of reducing greenhouse gas emissions.	NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Infrastructure: municipal	No effect on municipal infrastructure, such as water or sewer systems. No effect on solid waste disposal facilities at Ross River or Faro as Mactung will manage of its own waste.		NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Economic growth: Yukon	$182.0 million average annual gross production value translates into annual effect of $140.1 million on the Yukon's GDP, or 9.0% increase in the size of the economy.		+	3	NA	3	NA	2	NA	4	P	4	1

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Economic growth: communities	Increased incomes expected to increase the size of community economies (Ross River +7.7%, Faro +9.0%, and Watson Lake +5.8%).		+	3	NA	3	NA	2	NA	4	P	4	1
Government revenues	Increased government revenues through various taxes, fees, royalties, and other payments. Majority of effects will be indirect — through income taxes and property taxes paid by employees.		+	3	NA	2	NA	2	NA	4	P	4	1
Economic diversification	Increased economic diversification through expanded industry presence in the territory. Easier access to the region will have a mixed effect on Koser Outfitters.	NATC's plans to install a gate along its new access road to help mitigate the effects of increased hunting pressure in the region.	+/ -	3	NA	2	1	3	2	2	NS	3	2
Minimizing boom and bust	By its very nature, mining has a tendency toward creating a boom and bust cycle, particularly in a small	Construction, operation and decommissioning phases total approximately 16-18 years.	-	3	NA	2	1	3	2	2	NS	3	2

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
	local economy.												
Business opportunities: construction phase	Construction will provide a wide variety of contract opportunities, from aerodrome construction to architectural finishes.	NATC is committed to offering scaled down construction contracts that will encourage Yukon-based firms to bid on the project. As part of ongoing discussions with the RRDC and the LFN, NATC is exploring ways of maximizing First Nation participation in the project's construction phase business opportunities.	+	1	NA	2	NA	2	NA	2	P	4	1
Business opportunities: operation phase	Opportunities for Yukon firms to supply goods and services (approximately $8.5 million annually).	As part of ongoing discussions with the RRDC and the LFN, NATC is exploring ways of maximizing First Nation participation in the project's operation phase business opportunities.	+	3	NA	3	NA	2	NA	3	P	4	1
Business opportunities: decommis-sioning and reclamation phase	There will likely be contracts for building demolition, earth moving and environmental monitoring.	As part of ongoing discussions with the RRDC and the LFN, NATC is exploring ways of maximizing First Nation participation in the project's decommissioning phase business opportunities.	+	1	NA	2	NA	2	NA	2	P	4	1

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Business capacity	Increased business capacity through the business opportunities offered in all phases.		+	3	NA	1	NA	3	NA	2	P	4	2
Community Vitality													
Community population: Faro	Faro desires an increased population, particularly families. Estimated increase to Faro's population is 20 to 25 people (up to 10 employees plus their families).	NATC will consider offering relocation incentives to new employees to relocate to the Yukon and will encourage employee relocation to Faro.	+	3	NA	2	NA	2	NA	4	P	3	2
Community population: Ross River	Ross River expressed strong reservations about an influx of newcomers, wanting the community to grow slowly instead.	There is currently no housing or land available in Ross River.	NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Safety and security: reduced crime levels	Indirect effects, if any, on reducing crime levels. If increased incomes lead to increases in alcohol and drug abuse then crime levels are likely to rise	See mitigation measures in "Reduced alcohol and drug abuse."	+/-	3	NA	1	1	3	3	4	NS	3	2

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
	rather than fall.												
Social and community events & volunteerism	NATC currently donates approximately $70,000 annually to social/ community events and organizations.	NATC, in consultation with each community, plans to sponsor at least one community event in Ross River and Faro once the operation phase begins.	+	3	NA	1	NA	2	NA	4	P	3	1
Reducing discrimination & racism	NATC will attempt to have a positive effect on reducing discrimination and racism by working to eliminate discrimination and racism in the workplace.	NATC will strictly enforce a workplace policy prohibiting any form of discrimination or racism in the workplace. Complaints will be treated seriously and dealt with immediately.	-	3	NA	1	1	3	3	4	NS	3	2
Quality of life: recreation opportunities & recreation facilities	No effect unless NATC sponsors recreation activities or facilities.	NATC, in consultation with each community, plans to sponsor at least one community event in Ross River and Faro once the operation phase begins.	+	3	NA	1	1	2	2	4	NS	2	2

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Community infrastructure & aesthetic: municipal services, decent place to live	No significant effects on community infrastructure and aesthetic, including municipal services at Faro and Ross River.		NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Governance, political structure and decision-making capacity	No significant effect on local, First Nation, or territorial governance, political structures or decision making capacity.		NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Health & Socio-cultural Well-being													
Best possible individual health	By offering relatively long-term, steady, and well-paid employment, and offering education and skills development through apprenticeship and training, the Mactung project will likely have an overall positive effect on individual health.	To help employees and their families maintain good health, NATC will offer a dental and extended health plan to all Mactung employees.	+	3	NA	2	1	3	3	2	NS	3	2

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Best possible family health	The combination of a sudden increase in income and the absence of the employed spouse/ parent during each three week rotation can have negative effects on family health and well-being.	Mactung will implement a 3-week in, 3-week out rotation. Available literature indicates that longer rotations (with extended periods at home) decrease the overall stress on family relationships.	-	3	NA	2	1	3	3	2	NS	3	2
Reduced alcohol and drug abuse	Substantial increases in income can lead to increases in drug and alcohol abuse as these substances become relatively more affordable.	The camp will be dry through all phases of the project, no alcohol or non-prescription drugs will be permitted. NATC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter. Workplace safety is priority for NATC. Employees will be terminated if found to be possessing or consuming drugs or alcohol on site.	-	3	NA	2	1	3	3	2	NS	2	2

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Reduced domestic abuse and violence	No direct effect on domestic abuse and violence. However, increased income can lead to increased drug and alcohol use as these substances become more affordable. This in turn can lead to increased domestic abuse and violence.	See “reducing alcohol and drug abuse.”	-	3		2	1	3	3	2	NS	3	2
Public health and safety: traffic	Increased truck traffic through Ross River, along the North Canol Road. Anticipated effects during construction phase and operation phase. No significant effect during decommissioning phase.	The company will prepare a traffic plan, with input from the community, to minimize negative effects.	-	3	NA	2	1	3	2	3	NS	3	2
Public health and safety: spills & accidents	As with any project, there is always the possibility of a spill or accident that will have a potential public health or safety effect along with a negative environmental effect.	NATC will have a trained emergency response team and necessary equipment available to respond to accidents and spills. The company will, develop a protocol with the Yukon government’s Emergency Measures Organization that outlines roles and responsibilities in the event of an accident or spill.	-	3	NA	3	3	2	2	2	NS	2	2

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Public health & safety: water and sewer	Public health and safety will not be compromised at the Mactung site.	NATC will follow all relevant regulations concerning potable water, food safety, and the disposal of sewage and garbage under the oversight of the Environmental Health Services Branch of the Yukon government.	-	3	2	1	1	2	1	2	NS	1	1
Workplace health & safety	Workplace health & safety will not be compromised at the Mactung site.	NATC will follow all applicable safety laws and regulations in every aspect of its operations. NATC will provide every employee with the training required to safely do their work. NATC will have a fully qualified EMT on site with all required medical supplies and equipment and have an on-call air medivac service available at all times.	-	3	NA	2	1	2	3	2	NS	2	2
Family resilience & self-sufficiency: food security	Long rotations can be onerous for employees, especially if they have a family.	Mactung will follow a 3-week in, 3-week out rotation. Available literature indicates that longer rotations (with an extended period at home) decreases the overall stress on family relationships and increases family resilience. Similarly, the 3-week period off rotation allows for employees to increase their food security through hunting, fishing and gathering, if	-	3	NA	2	1	3	2	3	NS	3	2

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
		desired.											
Cultural continuity: heritage sites	No heritage sites have been identified or disturbed at the site, aerodrome, pump house, or access road.	If at any point during the construction and operation of the mine and its accessory projects a heritage site is discovered or disturbed, NATC will immediately cease work in the immediate vicinity and immediately contact both the Ross River Dena Council and the Yukon Heritage Branch. No work in the immediate vicinity will resume until the site is assessed.	-	3	5	1	3	2	1	2	NS	2	2
Land-based social and cultural activities	No direct effect on land-based social and cultural activities.	In addition to the regular rotation and annual holiday time, NATC will have a flexible time-off policy in place allowing all employees to book further unpaid time off. This will further mitigate any negative effect the project may have on First Nation social and cultural activities.	NA	3	NA	1	NA	2	NA	NA	NS	NA	NA

TABLE 6.3.6-1 SUMMARY OF SIGNIFICANCE DETERMINATION FOR SOCIO-ECONOMIC EFFECTS ASSESSMENT

VSECs	Potential Effects	Proposed Mitigation or Enhancement Measures	Residual Effects								Significance	Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency		Probability	Uncertainty
Language preservation & restoration	No direct effect on language preservation and restoration.	The 3-week in, 3-week out rotation should allow sufficient consecutive days off to pursue most activities.	NA	3	NA	1	NA	3	NA	NA	NS	NA	NA
Sharing traditional knowledge and stories	No direct effect on the sharing of traditional knowledge and stories.	The 3-week in, 3-week out rotation should allow sufficient consecutive days off to pursue most activities.	NA	3	NA	1	NA	3	NA	NA	NS	NA	NA

Note:

Numeric ranking definitions for each criteria are stated in Table 6.3.6-1 in Environmental Assessment Methods (Section 6.1.2).

NA – not applicable

NS – no significant adverse socio-economic effect

P- positive socio-economic effect

S – significant socio-economic adverse effect

6.4 SUMMARY OF EFFECTS

This section provides a summary of the key potential environmental and socio-economic effects of the project, and the proposed mitigation and enhancement measures for these effects.

The key environmental effects of the project and their proposed mitigation measures are identified in Table 6.4-1 below:

TABLE 6.4-1 SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION

Key Environmental Effects	Proposed Mitigation Measures
Natural Landscape	
Reduced aesthetic value	• Minimum road widths to be used • Cleared slopes to be revegetated. • Aesthetics will be considered for borrow pit site selection. • Minimum size borrow pits will be used
Loss of habitat	• Adopt an adaptive management approach, e.g., re-vegetate as required • Salvage of organic and mineral top soils for future reapplication during reclamation and revegetation • Prohibit the use of all-terrain vehicles, and limit the use of motorized vehicles and equipment to established roads • Educate employees regarding the removal of any local plants or plant parts for consumption • Educate employees regarding the sensitive nature of alpine vegetation. • Application of dust suppressants (water), if required, during summer operation of roads and the dry-stacked tailings facility • Restrict the placement of snow and sand piles to areas that are less sensitive to mineralization • Ensure any re-contouring, scarification, and reclamation of disturbed areas is conducted with appropriate and approved native seed mixes • Ensure revegetation measures are applied in a timely manner • Monitor potential accumulation of trace elements at established monitoring stations
Soil Stability	• Revegetate disturbed areas with native vegetation • Seeding, armouring or other mitigative techniques. • Relevant cut slope ratios will be used • Conscientious drainage management • Engineered cut and fill slopes • A slope stability assessment will be conducted. • A geotechnical evaluation will be conducted as part of the detailed road design • Specific design parameters will be applied to sections identified with permafrost • Adequately-sized culverts to be used and additional culverts placed where necessary • Sections of road with inadequate culvert frequency will be identified and additional ditches and culverts will be added as required. • Armoured outlets of culverts where no natural stream channel exists.
Human Safety	• Reporting system in place for potential rockfalls and actual fallen rocks • Development of an avalanche management and safety training program

TABLE 6.4-1 SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	
Key Environmental Effects	Proposed Mitigation Measures
Fish & Wildlife	
Increased Pressure on Key Wildlife Species	• Post speed limits and traffic signs in sensitive wildlife areas • Enforce that wildlife has the right of way • Prohibit the use of ATVs and snowmobiles at Mactung • Removal of infrastructure at decommissioning will return site to pre-development conditions • Roads and bridges to be decommissioned at the end of the project • Limit extent of clearing required for all infrastructure • Minimize clearing and construction activities during late winter (low energy reserves and high snow depth) • Reclamation through revegetation • Limit snow bank height at known travel corridors • A strictly enforced no hunting policy for all employees and contactors at Mactung • Installation of a gate on the new portion of the access road • Keep worksite clean • Manage garbage to avoid attracting bears and other wildlife • An environmental management plan will addresses the protocol for dealing with bear issues • Restrict vegetation clearing to outside of the bird breeding season • Develop and implement a Wildlife Monitoring Program in consultation with appropriate Yukon Government agencies and communities.
Biodiversity	• Avoid or minimize alteration of natural drainage patterns, topography and avalanches to maintain natural physical process • Proper camp management to avoid wildlife conflicts • Avoid introduction of invasive and alien species or deleterious substances • Minimize footprint
Effects on Aquatic and Fisheries Resources	• DFO permitting via *Fisheries Act* Authorization or Letter of Advice. • Screen all pump intakes to prevent fish fatalities • Instream works conducted in isolation from active channel. • Development of, and adherence to an environmental management plan (EMP) and emergency response plan, and monitoring for construction, site control, site stabilization, and instream works. • Protection of riparian areas and limited clearing. • Instream works in fish-bearing watercourse conducted at low flow periods. • No fords to be used as stream crossings • Minimize cleared areas and revegetation of disturbed areas • Application of best management practices within riparian zones • Preparation of compensation plan • Integration of DFO requirements for fish-bearing watercourse crossings • Education of employees regarding aquatic resources at Mactung • Acceptable release protocols for process water to be developed with federal agencies and territorial Water Board • Process water to be held during low flows if necessary • Toxicity testing of decant water to be conducted on an ongoing basis • Supplement winter flows if necessary to maintain minimums • Supplement early summer flows in Tributary C, if necessary, to mimic those during freshet

TABLE 6.4-1 SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	
Key Environmental Effects	**Proposed Mitigation Measures**
	• Fish passage conditions at closure will meet baseline conditions • DFO Letter of advice to be sought for removal of crossings • Restriction of access to Hess River Tributary following closure
Water Resources	
Effects on Water Quality	• Use of silt fences • Ditch filters and settling ponds/sumps at culvert inlets • Scheduled inspections of access roads and diversion channel to allow for timely removal of snow • Geochemical characterization to understand long-term acid rock drainage and metal leaching behaviour of tailings in order to minimize any acid generation • Underground disposal of potentially acid generating (PAG) material within frozen bedrock zone • Construction design to minimize drill and blast (avoidance) • Encapsulation of PAG materials • Encapsulation and isolation of PAG tailings • Isolation of underground materials from water and oxygen • Install Sewage Treatment system with qualified operations and maintenance personnel • Water withdrawals from all streams to kept to less than 10% of total flow • Instream work and earthworks best management practices and scheduling to be used. • Spill Contingency Plan available (Appendix M2) • Sediment management practices to be used for construction • Site water tank sized to provide some freshwater for processing • Development of site specific water quality objectives based on natural baseline information • Treat discharge water from the ravine dam, if required • Compliance with territorial Water Licence criteria • All discharges report to the reservoir • Best practice design and construction methods used for all access roads. • Erosion control and sediment management best practices to be used • Ravine dam operations manual to include section on the potential introduction of deleterious substances • Annual engineering inspections • Ability to stop discharges during periods of potential non-compliance with Water Licence • Main mine infrastructure is within the reservoir catchment • No water discharge to environment unless it meets Water Licence criteria • Decommission tailings facility prior to ravine dam • Monitoring of water quality in reservoir. • Collect seepage from the ravine dam, if required, using a series of groundwater extraction wells downgradient of the ravine dam and discharge back into the reservoir
Effects on Groundwater	• Dewatering of mine (from year five) and discharge of mine inflow into the reservoir • Backfilling and sealing of underground workings to reduce exposure to oxygen, thereby limiting oxidation in mine workings and generation of acidic rock drainage.

TABLE 6.4-1 SUMMARY OF KEY ENVIRONMENTAL EFFECTS AND PROPOSED MITIGATION	
Key Environmental Effects	Proposed Mitigation Measures
	• Keep PAG waste rock on surface less than five years. Monitor and accelerate disposal period of waste rock underground if acidification is observed
Effects on Surface Water Flow	• Erosion control and sediment management practices during construction. • Discharges around the work area to maintain flow • Use of Hess River Tributary to supplement un-diverted inflows • Construction sequencing to minimize flow interruptions • Maximum water withdrawal rates to be set for streams (no more than 10% of available flow) • Withdrawals from the Hess River Tributary are less than 6% for all but two months of the year • Additional fresh water storage in site water tank • Ravine dam discharge volumes will be managed in accordance with Water Licence • Discharges from the tailings and underground workings will collect in the reservoir • Decommissioning methods to be developed to minimize flow interruptions • Ravine dam discharges will be regulated • Decommissioning of infrastructure at the end of the project • Impermeable cover to isolate tailings at decommissioning

The key socio-economic effects of the project and their proposed mitigation or enhancement measures are identified in Table 6.4-2 below:

TABLE 6.4-2 SUMMARY OF KEY SOCIO-ECONOMIC EFFECTS AND PROPOSED MITIGATION/ ENHANCEMENT MEASURES	
Key Socio-economic Effects	Proposed Mitigation/Enhancement Measures
Sustainable Livelihood	
Traditional Economic Activities	***Mitigation:*** • No firearms permitted in camp and a no hunting at Mactung (this will reduce hunting pressure in the area) • Standard three-week in, three-week out rotation for all employees (allows for pursuit of traditional activities). • Install a gate on the new portion of the access road to reduce hunting pressure • Enter into talks with representatives of the users of the Ross River group trapline and with the registered owners of Trapline 112 to establish a level of compensation for the anticipated disruption of trapping
Employment and Employability	***Enhancement:*** • Recruitment of as many employees from the Yukon as possible with a particular focus on the communities of Ross River, Faro, Watson Lake, and Mayo. • Upon opening of the Mactung mine, NATC will offer an annual scholarship to a qualified student, or students, from Ross River, Faro,

TABLE 6.4-2 SUMMARY OF KEY SOCIO-ECONOMIC EFFECTS AND PROPOSED MITIGATION/ ENHANCEMENT MEASURES

Key Socio-economic Effects	Proposed Mitigation/Enhancement Measures
	Watson Lake or Mayo who are pursuing a post-secondary education, particularly in a mining related field. • NATC will implement the training programs currently used at Cantung, especially its underground training in partnership with the Yukon Mine Training Association. • To facilitate employee career advancement, NATC will implement its policy of initially posting all employment positions internally, and, with a particular focus on First Nation candidates, help create individual training and succession plans.
Infrastructure	***Mitigation:*** • Prepare a traffic plan, with input from the community, to minimize negative effects ***Mitigation/ Enhancement:*** • NATC is identifying the feasibility of reducing its reliance on diesel generators by using wind or geothermal generation
Economic Growth/ Healthy Business Sector	***Enhancement:*** • Offer scaled down construction contracts that will encourage Yukon-based firms to bid on the project. • As part of ongoing discussions with the Ross River Dena Council and the Liard First Nation, NATC is exploring ways of maximizing First Nation participation in the construction phase business opportunities.
Community Vitality	
Community Population	***Enhancement:*** • NATC will consider some form of relocation incentives to new employees of Mactung who reside outside of the Yukon. The company will work with various bodies, e.g., Faro Town Council, to help make the Yukon a preferred place for employees to live.
Social Cohesion and Quality of Life	**Enhancement**: • NATC, in consultation with each community, will sponsor at least one community event in Ross River annually once the operation phase begins. ***Mitigation:*** • NATC will strictly enforce a workplace policy prohibiting any form of discrimination or racism in the workplace.
Health and Socio-cultural Well-being	
Best Possible Health	***Enhancement:*** • To help employees and their families maintain good health, NATC will be offering a dental and extended health plan to all employees at Mactung, as per current practice at Cantung.
Reducing Alcohol and Drug Abuse	***Mitigation:*** • The camp will be dry through all phases of the project, no alcohol or non-prescription drugs will be permitted. • NATC will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter.

TABLE 6.4-2 SUMMARY OF KEY SOCIO-ECONOMIC EFFECTS AND PROPOSED MITIGATION/ ENHANCEMENT MEASURES	
Key Socio-economic Effects	**Proposed Mitigation/Enhancement Measures**
	• Workplace safety is priority for NATC. Employees will be terminated if found to be possessing or consuming drugs or alcohol on site.
Public & Workplace Health and Safety	***Mitigation*:** • NATC will have a trained emergency response team, along with an assortment of relevant equipment available to respond to accidents and spills. • Develop a protocol with the Yukon government's Emergency Measures Organization that outlines roles and responsibilities in the event of an accident or spill.
Workplace Health and Safety	***Mitigation:*** • NATC will follow all applicable safety laws and regulations in every aspect of its operations; • NATC will provide every employee with the training required to safely do their work; and • NATC will have a fully qualified Emergency Medical Technician (EMT) on site with all required medical supplies and equipment and have an on-call air medivac service available at all times.
Cultural Continuity	***Mitigation:*** • Implement a flexible time-off policy, allowing all employees to book further unpaid time off assuming qualified replacement employees can be scheduled to cover the absence. • If a heritage site is discovered or disturbed, NATC will immediately cease work in the immediate vicinity and contact both the Ross River Dena Council and the Yukon Heritage Branch.

6.5 SUMMARY OF RESIDUAL EFFECTS

Section 6.5 provides a summary of the residual environmental effects of the project that are expected to remain after the application of mitigation measures, and a summary of significance determination of the environmental and socio-economic effects.

Table 6.5-1, below, provide summaries of the anticipated residual effects and the significance determination for the key environmental effects that are identified in Section 6.4.1. Other topics, such as noise, were determined to have no residual effects and therefore low significance; and no further significance analysis was required. Such topics have not been included in the below table.

TABLE 6.5-1 SUMMARY OF KEY ENVIRONMENTAL RESIDUAL EFFECTS AND SIGNIFICANCE		
Key Environmental Effects	Anticipated Residual Effects	Significance
Natural Landscape		
Reduced aesthetic value	• Some visual effects will remain from clearing, stripping and excavating of road corridor, mine footprint, and borrow pit and quarry sites	• Moderate
Loss of habitat	• Clearing of alpine riparian and wetland ecosystems • Clearing of other vegetation communities	• Moderate • Low
Soil Stability	• No anticipated residual effects	• Low
Human safety	• No anticipated residual effects	• Low
Fish & Wildlife		
Increased pressure on key wildlife species	• Caribou, Moose: hunting, vehicle accidents, and restrictions in foraging and movement patterns • Bear: loss of foraging habitat, human conflicts, avoidance. • Wolverine: Avoidance, risk of increased trapping • Avian nesting habitat; some habitat loss but residual effects • Hoary marmot: some habitat loss but no residual effects	• Low • Low • Low • Low • Low
Biodiversity	• Some loss or alteration of habitat	• Low
Effects on fisheries resources	• Fish habitat loss • Fish passage restrictions • Erosion/Sedimentation • Deposition of deleterious Substances • Angling pressure • Surface water quality • Surface water quantity and alteration of flow timing	• Low • Low • Low • Low • Low • Low • Low
Water Resources		
Effects on surface water	• Some increases in sediment and metal concentrations	• Low
Effects on groundwater	• Potential ARD and/or metals leaching from mine backfill affecting the downgradient groundwater quality • DSTF: Seepage to the local groundwater and potential negative effect on groundwater and surface water quality	• Low • Low
Effects on surface flow	• Discharges into Tributary C from reservoir during low flow period (February and March) • Withdrawals from the Hess River Tributary during low flow period (February and March) • Diversion channel	• Low • Low • Low

Table 6.5-2, below, provides a summary of the significance determination for the key socio-economic effects that are identified in Section 6.4.1. Significance is described as either positive effect, no significant adverse effect ("not significant"), or significant adverse effect.

TABLE 6.5-2: SUMMARY OF SOCIO-ECONOMIC EFECTS AND SIGNIFICANCE	
Key Socio-economic Effects	Significance
Sustainable Livelihood	
Traditional Economic Activities	Not significant
Employment and Employability	Positive effect
Infrastructure	Not significant
Economic Growth/ Healthy Business Sector	Not significant to positive effect
Community Vitality	
Community Population	Faro – Positive effect Ross River – Not significant
Social Cohesion and Quality of Life	Not significant to positive effect
Health and Socio-cultural Well-being	
Best Possible Health	Not significant
Reducing Alcohol and Drug Abuse	Not significant
Public health and safety	Not significant
Workplace health and safety	Not significant
Cultural Continuity	Not significant

6.6 STATEMENT OF SIGNIFICANCE

Under YESAA, proponents are required to conduct an analysis of significance as part of their environmental and socio-economic assessment documentation.

For the Mactung project, the methods used for analysing and determining the significance of effects for the valued environmental and socio-economic components are described in Sections 6.1.1 and 6.1.2, respectively.

With respect to environmental effects, the significance ranking was determined as either "low", "moderate", or "high". With the application of mitigation measures, the assessment of each of the valued environmental components has found the significance of effects to be "low" for all environmental components, except for the following:

- The project may have moderate effects on the aesthetic value of the natural landscape after mitigation and until final decommissioning. Some visual effects will remain from clearing, stripping and excavating the road corridor, mine footprint, borrow pit and quarry sites. These effects will decrease with time.
- Clearing of alpine riparian and wetland ecosystems may result in some moderate effects in terms of loss of habitat.

No environmental effects with "high" significance were found as a result of applying mitigation measures.

With respect to socio-economic effects, the significance ranking is described as "positive effect", "not significant", or "significant adverse effect". With the application of mitigation measures, the assessment of each of the valued socio-economic components has found the significance of effects to be "not significant" for all categories, except for the following:

- A positive effect was determined for the categories "Employment" and "Employability".
- A combination of "not significant to positive effect" was determined for "Community Population", "Social Cohesion and Quality of Life", and "Economic Growth/Healthy Business Sector".

No "significant adverse socio-economic effects" were found.

With the overall low significance of the environmental effects, and the combination of "not significant to positive effect" significance determination for socio-economic effects, the overall significance of the effects of the Mactung project is considered to be low.

7.0 CUMULATIVE EFFECTS ASSESSMENT

In order to assist the Executive Committee with its assessment of matters related to Section 42(1)(d), NATC has reviewed the activities that exist in the area of the proposed project as well as any projects for which there is a known proposal.

The project area is remote and at high elevation. There is limited activity occurring in the region; with no agriculture or timber harvesting, or oil or gas exploration currently underway.

The Macmillan Pass area has been subject to considerable mineral exploration since the 1960s, but there are no operating mines in the region. The closest mineral properties to Mactung are the Jason and Tom lead-zinc deposits located about 13 km southeast of Macmillan Pass. NATC understands that deposits are owned by Hudson Bay Mining and Smelting Co. Limited, and that they are not currently being subject to mineral exploration or mine development. However, a Designated Office proposal has been submitted for the installation of an adit plug and associated workings at the Tom property (YOR Project 2008-0242). The nearest active mineral exploration properties to Mactung are the Selwyn project at Howard's Pass (along the NWT border approximately 80 km southeast of Mactung) and the Andrew Property (located approximately 90 km southwest of Mactung).

Traditional subsistence hunting has been identified to occur in the project area and its effects to wildlife and wildlife habitat are considered within Section 6 of this proposal: Environmental and Socio-economic Effects Assessment. Recreational hunting has also been considered and has been found to be limited.

The project area is used by trappers. The North Canol Road is mostly covered by a group trapline registered to the Ross River Dena Council. Trapline #112, registered under Gregory Keating and Neilson Sisson, is partly within the Mactung project area. Statistics from the Yukon Department of Environment over the past 10 years show that the region around the project area has experienced trapping activity with total fur harvest varying from

105 to 1,612 pelts annually. The Mactung project area falls within Yukon outfitting concession #9, owned by Koser Outfitters Ltd. Potential effects to trappers and outfitters have been integrated into Section 6.

A summary of residual effects that are predicted to occur after proposed mitigation has been provided in Section 6. NATC is not aware of any industrial or other activity in the area that would result in residual effects that could be assessed with any residual effects from the Mactung proposal.

8.0 ACKNOWLEDGEMENT AND CERTIFICATION

The information submitted in this Project Proposal is required for the purpose of conducting a screening under the *Yukon Environmental and Socio-economic Assessment Act.* I acknowledge that, pursuant to section 119 of the *Act*, a copy of this Project Proposal will be placed on a public register and be available to any member of the public to review.

I understand that misrepresenting or omitting information required for the evaluation may cause delays in the screening or render the recommendation invalid.

I certify that the information provided is true and correct to the best of my knowledge and belief.

S. Wade Stogran
VP, Environmental and Corporate Affairs
North American Tungsten Corporation Ltd.

Nov 28/08
Date

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APPENDICES