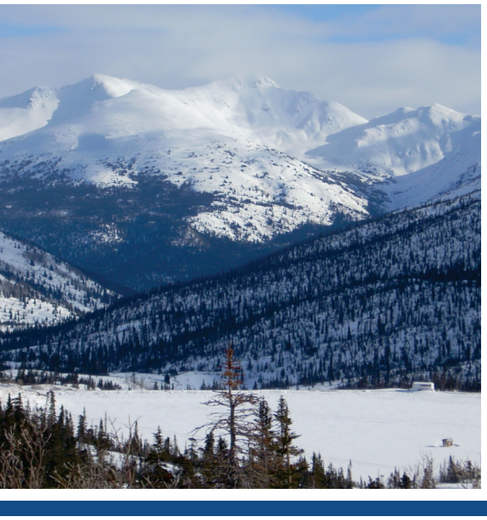
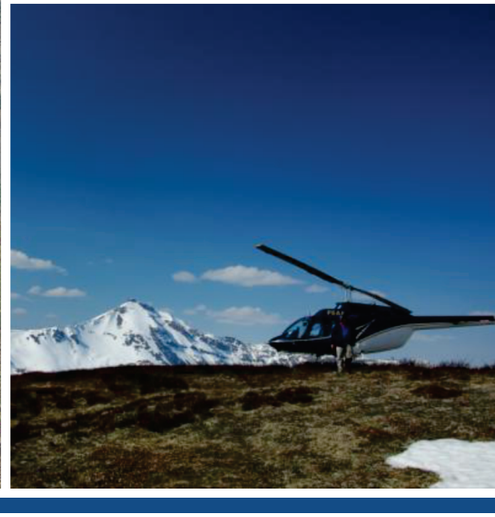
KETZA RIVER HOLDINGS

YESAA EXECUTIVE COMMITTEE PROJECT PROPOSAL
KETZA RIVER PROJECT - ROSS RIVER, YUKON



MAIN REPORT - VOLUME I

SUBMITTED TO:
YUKON ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT BOARD
SEPTEMBER 2011
FILE: W23101052.114

Ketza River Holdings

Monday, September 19, 2011

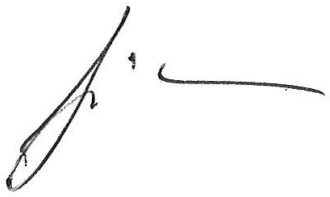
YESAB Executive Committee
Suite 200-309 Strickland Street
Whitehorse, Y1A 2J9

Attention: Stephen Mills

Ketza River Holdings Ltd. (KRH) is pleased to provide to the Executive Committee of the Yukon Environmental and Socio-economic Assessment Board 15 hard copies and 5 digital copies on CD of the Project Proposal document and supporting appendices for the Ketza River Mine.

Should you have any other inquiries or questions, please don't hesitate to contact the undersigned,

Regards,



Graham Dickson

President, KRH

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KETZA RIVER HOLDINGS

YESAA EXECUTIVE COMMITTEE PROJECT PROPOSAL
KETZA RIVER PROJECT - ROSS RIVER, YUKON

MAIN REPORT – VOLUME 1

SUBMITTED TO: YUKON ENVIRONMENTAL AND SOCIO-ECONOMIC ASSESSMENT BOARD
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Ketza River Holdings

Ketza River Holdings

EXECUTIVE SUMMARY

Ketza River Holdings (KRH), a fully Canadian-owned subsidiary of Yukon-Nevada Gold Corp., proposes to develop the Ketza River Project (KRP, the Project) which is located approximately 80 km by road from Ross River, Yukon in the Watson Lake Mining District (Figure 1). The KRP is in the same location as the historic Ketza River Mine, which produced 100,000 oz of gold and 100,000 oz of silver between 1986 and 1990.

Development Description

The KRP involves the mining, milling, and production of gold doré from nine open pits and two underground operations. Approximately 49.5 million tonnes of material will be mined over a period of about 5 years at a milling rate of 1,500 tonnes per day. At the end of the mine life, reclamation activities will begin, although progressive reclamation will be conducted throughout operations as appropriate.

Mining: Material will be excavated from the open pits using conventional mining methods. Underground mining, scheduled to occur below the Peel and Lab-Hoodoo pits, will use a combination of short sublevel stoping and drift and fill methods. The steep nature of the Lab-Hoodoo ore body could result in the exclusive use of short sublevel stoping.

Processing: Mixed-sulphide and oxide ore will be processed using a conventional Carbon-in-Leach (CIL) system. Ore will be crushed and ground prior to the application of a cyanide-based solvent which will dissolve the gold into solution. CIL, pressure Zadra elution, and electrowinning will be used to remove the gold from the gold-bearing solution. The cyanide will then be destroyed using the copper catalyzed SO_2/Air removal method.

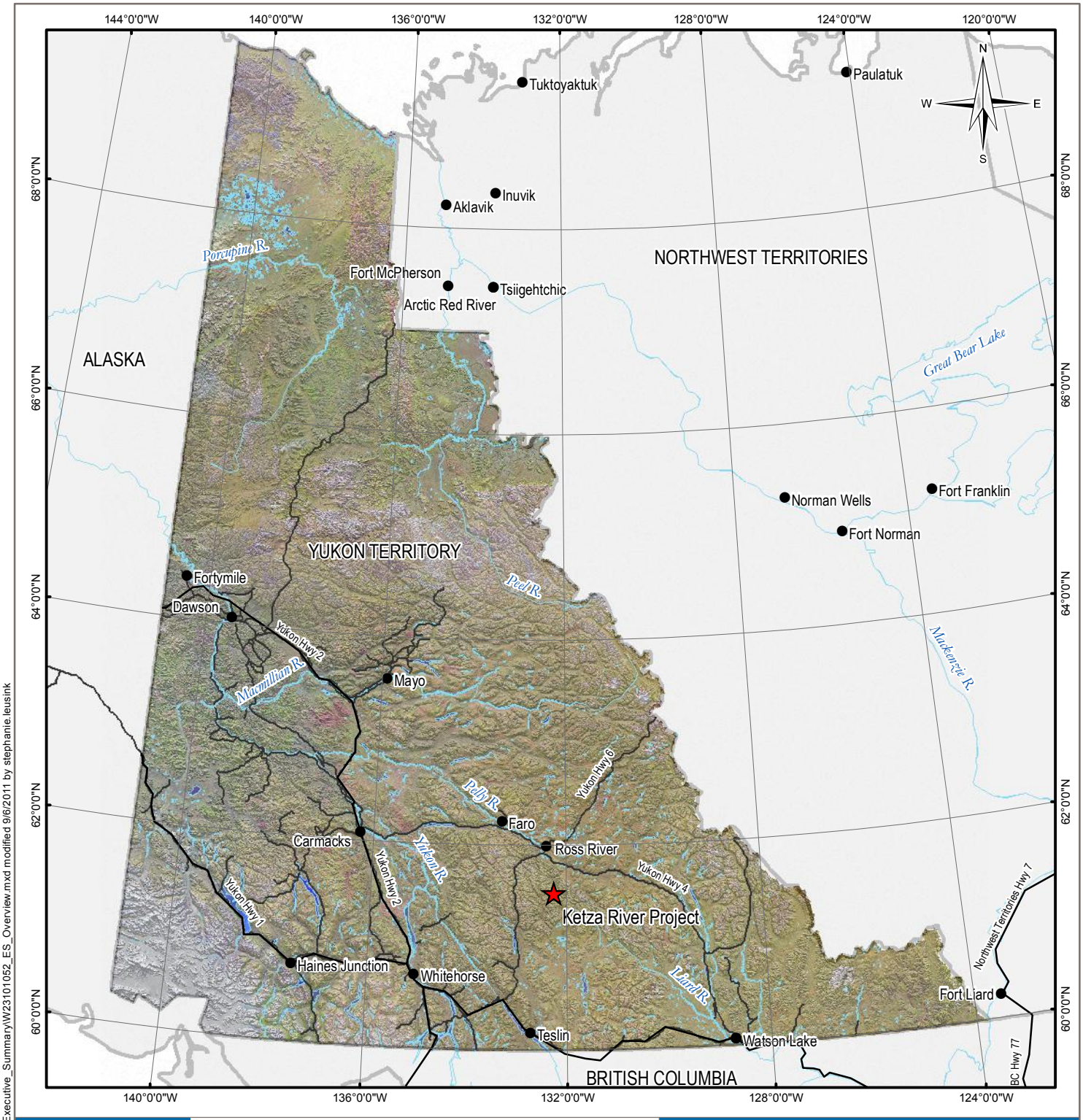
Waste Rock: Waste rock will be deposited into dumps largely composed of non-acid generating (NAG) material. Only two dumps will receive potentially-acid generating (PAG) material. PAG will be blended with sufficient quantities of NAG waste prior to final placement in order to neutralize any acid drainage that may be generated via sulphide oxidation.

Tailings Storage Facility (TSF): The KRP will produce approximately 3 million tonnes of thickened tailings during operations which will be contained in an engineered facility located in the Cache Creek catchment area. The face of the embankment and entire TSF base will be fully lined with a geosynthetic liner. The CIL process will produce a single thickened tailings stream for disposal in the TSF. The resulting tailings beaches are expected to form a relatively gentle slope of about 2% to 2.5%.

Other Waste: Other waste produced by the KRP includes domestic and food waste, solid waste from construction, waste oils and lubricants, and hazardous waste such as paint, aerosol cans, and batteries. All combustible waste will be burned on-site. Other wastes will be sorted according to type and hauled off-site to an approved disposal facility.

Water Supply: Process water for the mill will consist of water reclaimed from the TSF supernatant pond, a fresh water retention pond downstream of the TSF, and fresh water from a well that will also be used as a potable water supply (following treatment).

Camp: A 200 person camp will be constructed to house employees and staff. The camp will be upgraded from the 49 person camp currently at the Site.



LEGEND

- Site Location
- Populated Place
- Roads
- Waterbodies
- Political Boundaries

NOTES

Base data source: ESRI, Government of Yukon

STATUS

ISSUED FOR USE

KETZA RIVER PROJECT

Ketza River Project Location

PROJECTION	DATUM	CLIENT
Yukon Albers	NAD83	Ketza River Holdings

Scale: 1:6,000,000

100 50 0 100

Kilometres

FILE NO. W23101052_ES_Overview.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052	SL	KG	KG	0

OFFICE	DATE
EBA-VANC	July 29, 2011

eba A TETRA TECH COMPANY

Figure 1

Q:\Vancouver\GIS\ENVIRONMENTAL\W23\1\W23101052_Ketza\Maps\Executive_Summary\W23101052_ES_Overview.mxd modified 9/6/2011 by stephanie.leusink

Power Supply: Electricity requirements for the mine are estimated to be 3 MW during operations, 80% of which will be for the process plant. Diesel generators and a heat recovery system will be used to supply the required power, the former being located within a separate powerhouse.

Fuel Storage: Diesel fuel will be transported to Site from Whitehorse using tanker trucks. Fuel will be stored in a bermed facility consisting of four double-walled 200,000 L capacity tanks equipped with corrosion and leak detection systems.

Access and Transportation: All equipment, supplies, and personnel will be transported to Site via existing all-weather roads from Whitehorse or nearby communities. The 40 km Ketza Road that leads to the KRP branches off the Robert Campbell Highway at approximately Km 323 and provides year-round access.

Land Treatment Facility (LTF): A land treatment facility is proposed to treat contaminated soils during the life of the mine. The LTF will be located at approximately Km 4 along the Ketza Road (starting from the Robert Campbell Highway) and will have the capacity to treat up to 2,500 m^3 of soil. Treated soils will then be used in reclamation activities at the Site.

Human Resources: The KRP will operate year-round with personnel working 12 hour days on a 2 week in, 2 week out rotation. It is anticipated that approximately 200 people will be required during construction of the KRP and approximately 150 during operations.

Community Engagement

The KRP is located in the traditional territories of the Ross River Dena Council (RRDC), Liard First Nation (LFN), and Teslin Tlingit Council (TTC), and will potentially affect the communities of Faro and Ross River. The RRDC and LFN are part of the broader Kaska Dena Nation and are two of the five Kaska First Nations that form the Kaska Tribal Council. As Kaska Nations, both are also associated with the Kaska Dena Council, a society formed to advance the interests of all Kaska individuals. In 2008, KRH signed a Memorandum of Understanding with the Kaska Nation, represented by the RRDC.

Community engagement is ongoing, beginning in February 2007 until present. KRH has made regular efforts to notify, engage, and consult with potentially affected communities and First Nations regarding the Project. A total of 24 meetings, open houses, and community dinners have been held with RRDC, the community of Ross River, the community of Faro, the TTC, and the community of Teslin. Information was also conveyed through presentations, handouts, publications in local community newsletters, and community emails.

Comments, concerns, and questions resulting from community consultation, as well as differing views offered by various potentially affected communities and First Nations have been addressed by KRH in an open, honest, and transparent manner. KRH intends to continue engaging with all affected parties throughout the permitting process and the life of the Project.

Description of Existing Conditions

The KRP is located in south-central Yukon, within the Boreal Cordillera Ecozone, Pelly Mountains Ecoregion, and Saint Cyr Range Ecodistrict.

General Physiography, Terrain, Soils, and Geology

The KRP area is entirely within the late Wisconsinan McConnell glacial limit and has moderate-gradient to steep, glacially–scoured valley side slopes of bedrock and colluvium (talus). Subalpine valley floors are primarily a veneer of colluvium or weathered bedrock overlying or with hummocky ridges of lateral, terminal and basal moraines. Lower elevation valley floors are characterized by deposits of glacial outwash sands and gravels with small fluvial deposits occurring near present day stream channels.

The KRP area is underlain by Lower to Late Cambrian carbonate and clastic sedimentary rock units. Gold mineralization occurs within manto replacement deposits of Lower Cambrian Limestone and as massive sulphide deposits within cross-stratigraphic structural zones.

Dominant soils are Orthic Eutric Brunisols developed on sandy loam moraine and coarse colluvium. Turbic Cryosols are expected to occur on north-facing slopes. Mass movement processes in the area include rockfall, debris flows, and avalanches. In most areas the probability of natural hazards except avalanche is low. Avalanches are a winter hazard on some smooth, unforested slopes.

Climate, Air Quality, and Noise

Air temperatures at the KRP typically range from 20°C during the summer to -20°C during the winter. The presence of strong winter inversions often results in warmer temperatures at elevation (typically to 1,600 m) compared to those in the valleys. The Site receives an average of 715 mm of water-equivalent precipitation annually (275 mm as rainfall and 440 mm as water-equivalent snowfall). Precipitation is also likely greater at higher elevations based on observed regional rates of precipitation increase with height. The prevailing wind direction (at the camp) is from the south-southwest and wind speeds are typically light (75% of all winds recorded as less than 3 m/s).

Long-term regional data show a slightly increasing trend in both winter and summer temperatures and a near-neutral trend in precipitation. Climate models generally predict an increase in annual air temperatures between 2°C and 5°C and an increase in annual precipitation up to 10% for the region over the next half century. KRP activities will result in the emission of greenhouse gases (GHGs), most notably as carbon dioxide (CO_2). Annual GHG emissions produced from mining operations are largely attributable to diesel consumption.

Air quality at the KRP is typical for remote sites. Elevated levels of particulates may occur during the summer months due to vehicular traffic travelling along unpaved roadways or as a result of forest fire smoke migrating in the region, although the occurrence of the latter is considered rare. Noise levels at the Site are also considered typical of remote, forested, mountainous settings undergoing exploration. Noise is currently produced from vehicle use and occasional drilling.

Ecosystems and Vegetation

The ecosystems and vegetation present at the Site are characteristic of Boreal, Subalpine, and Alpine bioclimate zones, which are all present. Non-vegetated talus slopes, Spruce-Moss forest, and Fir-Moss forest are relatively common, particularly along the Ketza Road. Anthropogenic features, such as roads and previous mine workings are also evident within the proposed mine site area.

No rare plants were identified during baseline studies, however, ecosystems with a higher potential of providing suitable habitat for rare plants were characterized. Ecosystems that are particularly sensitive to disturbance were also described and included those with a higher *Sphagnum* moss cover, those with a higher lichen cover, and wetlands.

Wildlife

The abundance and distribution of wildlife in the KRP area is reflective of the Boreal-high, Subalpine, and Alpine habitats present. Wildlife studies were conducted within a Wildlife Regional Study Area (WRSA) and included the characterization of Caribou, Moose, Thinhorn Sheep, Mule Deer, Grizzly Bear, Black Bear, Grey Wolf, Wolverine, small mammals, birds, and amphibians.

Caribou from the Finlayson and Wolf Lake herds were found to use the WRSA, however, not extensively as the majority of their ranges lie outside the WRSA. Moose were also observed within the WRSA throughout the year, as suitable habitat for all seasons is present. The WRSA also contains high quality habitat for Thinhorn Sheep, which are known to use the area year round. Den emergence surveys for Grizzly Bear showed that the WRSA supports suitable denning habitat as well as high quality feeding habitat. Wolverine have also been observed within the WRSA and their use of the area is expected to occur year round. Wolf, Fox, Beaver, and other small mammals are also present in the area year round.

Surface Water Quality

The KRP is situated within the Ketza River drainage basin with several tributaries flowing into the Ketza River, which then flows into the Pelly River. Water quality monitoring has been conducted at the Site since 1988 as part of the Water Licence issued for the past producing Canamax Mine. A total of 26 water sampling stations are located throughout the KRP and have been selected to represent the range of conditions present, particularly given the past history of mining at the Site. Locations include areas that are upstream of known areas of historical development, as well as those within, and downgradient of, historically affected areas.

Results of water quality analyses indicate that eight chemicals are never or rarely found in concentrations that exceed the Canadian Council of Ministers of the Environment (CCME 2003a) Water Quality Guidelines for the Protection of Aquatic Life and 15 chemicals / physical parameters were observed to occasionally, frequently, or always exceed CCME guidelines. Higher concentrations were observed throughout the KRP, including at background stations. The current water quality conditions are characteristic of the area, including its past mining history.

Acid Rock Drainage and Metal Leaching

Preliminary characterizations of KRP waste rock, ore, and tailings for acid rock drainage (ARD) and metal leaching (ML) potential were conducted beginning in 2008. Results indicate that unaltered argillite, oxide limestone, transulphide limestone, and unaltered limestone rock types within the Manto Zone (Tarn, Penguin, Lab-Hoodoo, and Peel pits) are dominantly classified as non-acid generating (NAG). Samples collected from the Shamrock Zone (Gully, QB, and 3M pits) displayed variable acid base accounting (ABA) characteristics. Argillite oxide waste rocks are NAG, while argillite sulphides and transulphide are potentially acid generating (PAG). Unaltered argillite is classified as uncertain.

A clear distinction between sulphide bearing and oxide bearing samples was evident in ore and tailings. Both sulphide ore and sulphide tailings samples were classified as PAG, while the oxide tailings sample was NAG.

Waste rock from both the Manto and Shamrock Zones have a strong potential for metal leaching, even at near neutral or slightly alkaline pH ranges. Stockpiled ore material will likely pose an acid-leaching risk within a minimum of three years of placement in situ.

Sulphide tailings will not produce acid leachate within the first three years; however, ABA testing confirms that sulphide tailings will likely generate acid in future if exposed to air and water. Once acid generating conditions are established, the metal leaching behaviour of the sulphide tailings will be altered, likely generating higher concentrations of dissolved metals. Oxide tailings may leach high concentrations of arsenic soon after placement in situ as soluble arsenic species are flushed from the tailings during precipitation events. Over time, the concentration of dissolved arsenic can be expected to decrease.

Hydrology

The KRP is located within the South Mountain Hydrological Zone of the Yukon River Basin. Hydrologic conditions were assessed within the Cache Creek watershed (the LSA) which is composed of three creeks and sub-watersheds: Oxo Creek, Peel Creek, and Misery Creek. Most creek alignments are in their natural condition with the exception of upper Cache Creek, which is diverted around the existing Canamax TSF. The diversion reconnects with Cache Creek approximately 300-400 metres downstream.

Flows associated with Cache Creek and its tributaries tend to be seasonally distinct and linked to temperature conditions, which is characteristic of the hydrological regime for mountainous creeks in Yukon. Creeks are frozen during much of the winter (November to April) and have very low flows. Warmer temperatures in spring (May to July) result in melting snow and ice, resulting in very high flows. During summer and fall (August to October), flows typically recede gradually until winter. Flows during the summer are largely influenced by a combination of rainfall events, the melting of any remaining seasonal snowpacks, and groundwater inflows.

The hydrograph produced for the LSA demonstrated that the streams of the Cache Creek watershed exhibit a flow regime typical of mountain creeks in Yukon. The LSA hydrograph was also compared to nearby regional hydrometric stations to assess the expected variability of flows within a month. There is year to year natural variability in flows within the LSA. Monthly variability ranges from estimated lows of 31% (in June) to estimated highs of over 40% (in April, July, October, and November).

Hydrogeology

Data from 37 existing observation and water wells at the Site indicate that the local hydrogeological system consists of an unconfined shallow overburden aquifer (including seasonally thawed active zone of discontinuous permafrost) and a deep bedrock aquifer in multiply-deformed fractured Cambrian age limestone and shale. Overburden consists of sand and gravel glacial deposits and colluvium. Fine-grained sediments in the Cache Creek valley bottom may also act as semi confining layer above the bedrock aquifer there. Bedrock depths range from 0 to 20 m below grade and bedrock hydraulic conductivities range from <10-8 to 4×10^{-6} m/s.

Groundwater types range from calcium-bicarbonate or calcium-magnesium-bicarbonate type up-gradient of mineralized areas to calcium-magnesium-bicarbonate-sulphate type in the Manto Zone and down-gradient within the Cache Creek valley; and calcium-magnesium-sulphate type in the Shamrock zone. Groundwater typically has a wide range of total dissolved solids, largely neutral to alkaline pH, hardness values mostly <500 mg/L and dissolved oxygen levels mostly >5 mg/L in the shallow aquifer. Many dissolved metal concentrations in groundwater exceeded CCME (2003a) Guidelines for the Protection of Aquatic Life and some also exceeded Yukon Contaminated Site Regulation standards and Metal Mining Effluent Regulations guidelines. Groundwater quality remains similar throughout the year.

Groundwater flowing within the Manto Zone discharges directly to Cache Creek, while groundwater flowing within the Shamrock Zone in part discharges to Peel Creek before it flows into Cache Creek or directly discharges to Cache Creek further downstream. General groundwater flow patterns mimic surface topography and the regional groundwater flow divide is assumed to coincide with surface water divides above the Cache Creek and Peel Creek valleys. Horizontal hydraulic groundwater flow gradients in the bedrock aquifer range from about 0.08 (near the proposed Lab-Hoodoo Pit) to about 0.4 (near the QB Pit). Inferred mean flow velocity of groundwater in the bedrock aquifer ranges from about a few tens of metres to several hundred metres per year.

Aquatic Ecosystems and Fisheries Resources

Several watercourses were assessed for the KRP, which are tributaries of Cache Creek and eventually the Ketza River. Slimy Sculpin (*Cottus cognatus*), and Arctic Grayling (*Thymallus arcticus*) were found most often in the KRP area and also occur within the Ketza River. Fish use within the Ketza River system near the Cache Creek confluence appears to be limited and is of low productivity. Cache Creek itself was also assumed to be even less likely to support fish due to steeper gradients and limited fish cover. Little spawning, rearing, over-wintering, and holding/feeding habitat was found in Cache Creek.

The abundance and distribution of benthic invertebrates in Cache Creek and the Ketza River were generally representative of moderately unproductive aquatic ecosystems. Benthic communities in the upper Ketza River and upper Cache Creek systems were generally of low abundance and diversity, but displayed a taxonomic distribution characteristic of moderately healthy environments.

Periphyton densities and productivities were relatively high in the central and upper reaches of Cache Creek. Conversely, Cache Creek immediately above the confluence with the Ketza River displayed the lowest periphyton density and productivity of all sites sampled. Additionally, despite heavy iron precipitate, Peel Creek was found to have a higher productivity than lower Cache Creek or the Ketza River.

Heritage Resources

The heritage resource assessments included surface and sub-surface investigations at sites within the KRP footprint that had the potential to contain heritage resources. Many areas in the KRP footprint have existing ground disturbance related to previous mining and exploration activities and were considered to have little or no heritage resource potential.

No heritage resources were identified within the KRP footprint area assessed. A paleontological site was identified outside of the KRP footprint approximately two kilometres north of the Ketza Road. The heritage overview assessment concluded that the KRP was situated in a sub-boreal environment and people did not historically occupy this type of environment for long periods of time. As such, anthropological heritage resources do not tend to occur.

Environmental and Socio-economic Effects Assessment

Valued Environmental and Socio-economic Components (VESECs) were identified through community consultation, baseline studies analysis, reviews of literature, and professional experience. The potential effects of the KRP have been systematically assessed for each identified VESEC.

Methods

The effects assessment has involved identification of mitigations related to potential effects associated with each VESEC. Remaining or residual effects are identified as those that would be expected following the application of all identified mitigations; often, with mitigations applied, no residual effects remain. However, where they are identified, residual effects are then evaluated in terms of the nature of the effect, its geographic range, the timing, magnitude and reversibility of the effect, and the likelihood that it would occur, to determine a consequence rating. The consequence rating is assigned using professional judgment to determine a significance for each residual effect, as well as a level of confidence in that determination. Where there was no residual effect following mitigations, the effect was not considered further.

Natural Landscape, Soil Stability and Terrain Hazards

Three VESECs were identified to be associated with the Project: the natural landscape; the stability of soils and effects on water quality; and human safety. The potential effects on these VESECs are related to stripping of soils, altering the landscape, and degrading permafrost.

Stripping soils and altering the landscape, for example during new access road construction, could destabilize slopes should unstable cut slopes be created, or if fill is placed on unstable slopes, permafrost is exposed, or natural runoff is redirected and concentrated. These potential effects will be mitigated with proper design, construction and maintenance, establishing appropriate slope gradients, and properly compacting materials. Erosion of exposed soils may occur; however, the coarse-grained texture of most native parent soils and mitigation practices will mitigate this effect. Procedures will be put in place to identify, monitor and manage terrain hazards, particularly where there is a potential impact to natural terrain during development, to address human safety.

Two residual effects were identified: stripped soils and permafrost degradation. The consequence of stripped soils was assessed as low, and the consequence of permafrost degradation was moderate. The significance of both residual effects was determined to be low, with moderate confidence.

Climate, Air Quality and Noise Levels

Climate, air quality, noise levels were identified as VESECs. The potential effects of these VESECs are: global climate change due to GHG emissions; impacts to human and biological health due to dust and other emissions; and impacts to human health and wildlife behaviour due to increased noise levels during the mine life.

KRP activities will emit GHGs, in particular carbon dioxide (CO_2). Potential annual GHG emissions produced from mining operations, due mostly to diesel consumption, is estimated to be 13% of all GHGs produced in the Yukon in 2009, but is insignificant (less than 0.001%) compared to the 2009 national inventory.

Dust and other emissions contain particulate matter (PM) that can be harmful to health, especially where the PM has small particle sizes. Sources of particulates during the mine life include blasting, clearing, quarrying, crushing and hauling.

Noise will be generated for the life of the KRP, where Project-related activities occur, most notably blast areas, and along the Ketza Road and Robert Campbell Highway. Maximum noise levels are expected to occur during the construction phase during blasting events. Noise levels will be lowest during the decommissioning phase when drills and blasting are absent.

Following application of mitigations, three residual effects were determined: GHG emissions; exposure to particulate matter / dust emission; and noise. The consequence of GHG emissions was assessed to be moderate, and the consequences of exposure to particulate matter / dust emission and noise were low. The significance of the three residual effects was determined to be low, with medium to high confidence.

Ecosystems and Vegetation

Ecosystems and plant species in general were identified as VESECs, as well as ecosystems that may be particularly sensitive to disturbance (i.e., wetlands and ecosystems with high *Sphagnum* moss or lichen component) and those with higher potential to support rare plant habitat. Anticipated effects of the KRP on ecosystems and vegetation include the removal and/or burial of plant species due to infrastructure development, changes to soil conditions, an increase in air emissions largely in the form of fugitive dust, and the potential to introduce non-native and invasive plant species into previously undisturbed areas. With reclamation, the majority of the anticipated effects will be reversible over the long-term.

Following the application of mitigations, three residual effects were determined: removal or burial of Ecosystem Units and plant species (including sensitive ecosystems and those that potentially provide high to very high rare plant habitat) by pits and waste rock storage areas; removal or burial of Ecosystem Units and plant species (including sensitive ecosystems and those that potentially provide high to very high rare plant habitat) by other infrastructure; and dust deposition and potential introduction of invasive plant species. The consequences of removal or burial of Ecosystem Units and plant species for pits, waste rock storage areas and by other infrastructure were assessed to be moderate. The consequence of dust deposition and potential introduction of invasive plant species was low. The significance of the three residual effects was determined to be low, with a high level of confidence.

Wildlife

VESECs identified for the wildlife effects assessment are: Woodland Caribou; Moose; Thinhorn Sheep; Grizzly Bear; Wolverine; Raptor Nesting (Cliff Habitat); and Upland Breeding Birds. Project activities most likely to contribute to an effect on the wildlife VESECs include vegetation removal / alteration, blasting, helicopter disturbance, dust accumulation, and other physical or behavioural disturbances.

With the implementation of mitigation measures, disturbance and habitat-related effects from KRP development-related activities are not expected to affect the VESECs within the WRSA. No residual effects are anticipated to occur. The overall significance of the Project on the wildlife VESECs is predicted to be low, and the effect of the Project on the wildlife resources within the WRSA is anticipated to be insignificant, with a high level of confidence.

Surface Water Quality

Surface water quality was identified as a VESEC, as high water quality increases ecological productivity and socio-economic benefits. Anticipated effects of the KRP on surface water quality are: leaching chemicals and other materials into surface water (e.g., petroleum or chemical / tailings / processing spills, metal leaching, acid rock drainage, hazardous materials), causing changes in metal or chemical concentrations or changes in pH; sediment and dust introduction to surface water (e.g., erosion, ash outfall from incineration).

Following the application of mitigations, four residual effects were determined: after decommissioning, exposed rock in the underground workings could be a source of ARD and/or ML; exposed rock in open pits could be a source of ARD or ML; accumulated sediments and metals in the water retention pond could be flushed downstream during a flooding or pumping event; and accumulated processing chemicals, sediments and/or metals could be flushed downstream from the TSF through pumping during decommissioning. The residual effects of ARD or ML will not occur in a short time period. Monitoring groundwater and surface water will indicate if these residual effects are occurring. Additional mitigations may include groundwater treatment, surface water treatment, and re-engineering the underground and/or open pit workings. The consequences of the two ARD and ML residual effects were assessed to be low. The consequences of the two flushing residual effects were very low. The significance of the four residual effects was determined to be low, with moderate confidence.

Hydrology

Flow quantity and timing were identified as VESECs, as Project activities could change baseline flow conditions which may potentially affect fisheries and water quality VESECs in the Cache Creek and Ketza River systems. Anticipated effects on flow quantity and timing include reduction in downstream flows because of water withdrawals from Peel Creek during construction; changes to downstream flow timing related to constructing and operating ditches and diversions; reduction in flow quantity in Cache Creek while filling the TSF and water retention pond; reduction in system flows by using water in processing or for dust control from the water retention pond; reduction in flows by collecting surface runoff in the TSF; flow changes from decommissioning the water retention pond and TSF; and erosion from discharge and flow changes.

Following the application of mitigation measures, five residual effects remained, including reduced flows during construction and maintenance of roads; reduced flows downstream during the initial filling of the TSF; reduced flows downstream during the initial filling of the water retention pond; reduced flows downstream from surface runoff from Site dumps and pits diverted to the TSF; and increased flows downstream from decommissioning the water retention pond. The consequences of all residual effects were assessed to be low, and the significance was determined to be low, with moderate confidence.

Hydrogeology

Groundwater quality and quantity were identified as VESECs. Anticipated effects on groundwater quality and quantity occur where there is a spatial and temporal overlap of mine infrastructure or activities resulting in a potential change to groundwater quality or quantity; specifically, where surface water exfiltrates from or drains through surface or subsurface mine facilities, groundwater is extracted from or added to the subsurface, or chemicals are released to the ground surface or subsurface (i.e., open pits, underground workings, TSF, waste rock dumps, run-of-mine (ROM) stockpile and potential spill locations).

Dewatering mine workings could lead to adverse effects on groundwater quality due to contact with pit and drift walls or explosive residues, and in turn potentially affect water quality in Cache Creek. Dewatering may also change groundwater elevations and flow regime in the area of dewatering, potentially altering base flows to Cache Creek and groundwater discharge to Tarn Lake. Flow through abandoned pits and underground workings could potentially degrade groundwater quality and in turn potentially affect water quality in Cache Creek.

At the TSF, seepage underflow could potentially alter groundwater quality down-gradient and in turn potentially affect water quality in Cache Creek. At the waste rock dumps, acid drainage or metal leaching from waste rock could infiltrate to groundwater, affecting groundwater quality and the quality of down-gradient receiving waters. At the ROM stockpile, acid drainage or metal leaching from ore could infiltrate to groundwater and alter groundwater quality, or there could be direct deposition of stockpile dust into Cache Creek affecting its water quality. 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.

Following the application of mitigations, two residual effects were identified: dewatering effects on the local groundwater flow regime, Cache Creek base flow and Tarn Lake; and negative effects on groundwater quality downgradient of abandoned mine workings. The consequences of both residual effects were assessed to be low. The significance of the residual effects was determined to be low, with moderate confidence.

Aquatic Ecosystems and Fisheries Resources

There are six VESECs for aquatic ecosystems and fisheries resources: water quality; water quantity; benthic invertebrates and periphyton; fish habitat – riparian; fish habitat – stream substrate; and fish presence and abundance. The Project activities that are most likely to affect these VESECs include: vegetation clearing for mine development; blasting and grading works; water diversion; water storage; water use; and waste handling. The anticipated effects on these VESECs are reductions in water quality and quantity, negative impacts to benthic invertebrate, periphyton and fish populations, and reduction in riparian habitats.

Following the application of mitigations, four residual effects were identified: changes to riparian vegetation because of changes to topography; changes to reach five of Cache Creek and fish passage; changes to water quality due to mobilization of fines from waste rock; and changes to stream sediments. The consequences of changes to riparian vegetation, water quality and sediments were assessed as low. The consequence of changes to reach five of Cache Creek was moderate. The significance of the four residual effects was determined to be low, with high confidence.

Heritage Resources

Historic sites and archaeological or paleontological remains are VESECs for heritage resources. No heritage resources were identified in the heritage resources assessment. Should a heritage resource be discovered, mitigations have been identified, and KRH will comply with all applicable legislation and guidelines and implement mitigation measures to protect the resource. The KRP is not expected to result in residual effects related to heritage resources.

Aesthetics

Aesthetics and visual quality, including viewscapes, recreational activities and wilderness viewing, were identified as a VESEC for the KRP. Anticipated effects on aesthetics and visual quality were assessed using viewshed and line-of-sight analyses. Effects were only anticipated to occur from Tarn Lake, which is located within the Project area. All other assessed viewsheds did not result in any portion of KRP infrastructure being visible. There are no residual effects anticipated to aesthetics and visual quality as a result of the KRP.

Accidents and Malfunctions

Accidents and malfunctions can be associated with any human activities or natural events that are carried out or occur during the construction, operation, and closure and decommissioning phases of the KRP. Only those accidents and malfunctions that have some probability of occurring during the various stages of the Project were assessed and included the failure of hazardous materials transportation, storage, and handling systems, the failure of major mine infrastructure, and vehicle and industrial accidents. In many cases, Project design, preventative measures, and mitigation measures were able to reduce the risk of a potential event occurring to an acceptable level. Additionally, the development of an Emergency Response Plan for the KRP will include all reasonably foreseeable potential accidents and malfunctions and the response procedures for each.

Effects of the Environment on the Project

The KRP may be affected by various environmental occurrences, including rockfalls, landslides, snow avalanches, earthquakes, and permafrost. Following the application of mitigations, no residual effects related to rockfalls, landslides, snow avalanches, earthquakes, and permafrost are anticipated on the KRP.

Socio-economic Effects Assessment

A number of communities, governments, organizations, and other groups have an interest in the KRP because it may have an effect, positive or negative, on a part of the social and economic system that they, or those they represent, value. Because of the Project's location in Kaska traditional territory not far south of

Ross River, the RRDC and the wider community of Ross River have a particularly strong interest. The LFN and the TTC also have identified interests in the KRP as does the community of Faro and various departments of the Yukon Government. The traditional land stewards of the area and the Ross River trappers are smaller entities who have long-standing ties and interests in the region.

Socio-economic based VESECs are defined as those parts of the socio-economic fabric that are valued because of their importance to the community. Some VESECs are specific to a particular community or interest, but many overlap among communities and interests. The VESECs identified for the KRP have been grouped into five clusters:

- Economy and Sustainable Livelihood
- Human Health and Well-being
- Community Vitality
- Infrastructure and Services
- Culture, History and Heritage.

Each of the broad VESECs have a number of more concrete sub-components that have been identified by different interests.

The socio-economic based VESECs were assessed for potential effects, both positive and negative, on the economy and society. Following the application of mitigations, the residual socio-economic effects were determined to be insignificant or positive for the KRP. The KRP will have significant positive effects on a number of the VESECs, particularly through a number of proposed enhancement measures.

Summary of Effects

Mitigation measures have been identified for the KRP to address concerns related to VESECs (Table 1). Residual effects, those effects that are unavoidable or remain after mitigation, were further examined and determined to be of low significance overall.

Cumulative Effects

Local and regional residual effects resulting from the Project were also assessed for their potential to combine with the effects from other current and reasonably foreseeable projects and activities within the traditional territory of the RRDC and the LFN. Communities, roads, other existing and likely developments, and hunting are examples of land uses that may combine with effects from the KRP in a cumulative manner.

For the following VESECs, the potential for cumulative effects to occur as a result of the KRP is considered negligible: natural landscapes; soil stability; terrain hazards; air quality; noise; ecosystems and vegetation; wildlife; water quality; hydrology; hydrogeology; aquatic ecosystems and fisheries; heritage resources; and aesthetics. The geographic extent of identified potential residual effects associated with the KRP does not overlap with the geographic extent of other identified projects and activities in the area.

Climate (i.e., GHG emissions) was the only VESEC that may have a cumulative effect following the implementation of mitigation measures. The cumulative effect of GHG emissions on the traditional territory was determined to be low.

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
Natural Landscape, Soil Stability and Terrain Hazards		
Section 8.1.3 – Natural Landscape	1	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
	2	Selection of borrow sites will consider aesthetics, i.e., visual effects of development
	3	Where possible, borrow sites will be developed in areas where visual effects will be minimized
	4	Minimizing the effect to the natural landscape will be considered when designing and clearing for mine infrastructure development
	5	Where there is a potential for soil erosion, exposed soils will be revegetated with native species to enhance soil stability
	6	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
	7	Erosion will be mitigated by seeding, armouring or other techniques recommended by a qualified professional
	8	Slope stability studies will be completed to aid road design and construction
	9	If unstable slopes are identified, they will be avoided or suitable construction methods will be used to increase stability in these sections
	10	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
Section 8.1.3 – Soil Stability	11	Road cutslopes will be finished at stable slope gradients. The actual finished slope gradient of cutslopes will depend on the characteristics of surficial material
	12	Final cutslope gradient will be determined by an experienced professional following assessment of site specific soil texture
	13	Fillslopes will generally be prepared by removing vegetation and organic soils prior to placement of fill material
	14	If fillslopes are constructed in terrain with naturally steep slopes, (e.g., greater than approximately 30%), a qualified professional will determine the appropriate design, including road construction using full bench and end haul methods, or using an engineered fill or other designed structure
	15	Terrain at potential fillslopes will be assessed during predesign 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
	16	Culverts or bridges, as appropriate, will be placed at all natural watercourses. The diameters of culverts will be sized according to anticipated flow conditions, using appropriate methods of analysis
	17	Appropriate structures to pass potential debris flows will be designed where required

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	18	Recommendations for culvert-spacing in areas with infrequent natural watercourses will be developed during assessment for final detailed design
	19	Micro-watersheds will be defined to avoid the over-concentration of natural drainage runoff to culverts
	20	Inlets and outlets of culverts will be armoured, where required, to protect against erosion and disperse the flow energy on to natural slopes and streams
	21	Sumps will be installed as required at culvert entrances to help trap sediment
	22	Road maintenance will include monitoring and clearing of culverts, if required, to maintain culvert functionality during periods of peak volume runoff
	23	If sections of permafrost are identified during the geotechnical evaluation for detailed road design, specifications will be developed for these areas to minimize potential degradation of permafrost
	24	In order to mitigate the effects on permafrost in areas of road widening, these areas will be constructed to minimum widths acceptable for safe vehicle use in the mining operations, where possible
	25	KRH will employ slope stabilization in areas of sloughing
	26	Best management approaches will be used to reduce the potential to introduce sediment to streams during construction
	27	Sediment fences will be placed in ditches and other appropriate locations if intercepted runoff contains unacceptable levels of suspended sediment, as defined by the anticipated Water Licence required for this Project
	28	If necessary, construction will be suspended during periods of high precipitation to reduce the potential to introduce unacceptable levels of suspended sediment to streams
	29	Where fine-textured soils on cleared slopes are identified as having erosion potential from precipitation and run-off, revegetation of the slopes, or another appropriate cover method, will be implemented as a mitigative technique as required through prescriptive measures provided by a qualified professional
	30	Upon completion of road construction, KRH 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 the road surface, cut slopes and fill slopes
	31	The integrity and function of ditches and culverts and the integrity and stability of bridge abutments will checked regularly
	32	KRH will conduct monitoring to identify potential erosion processes that could result in unacceptable levels of suspended sediment in streams
	33	If monitoring of potential erosion in streams indicates that action is required, then practical measures will be implemented such as adding sediment fences in key locations and the temporary diversion of runoff away from streams
Section 8.1.3 – Human Safety	34	KRH will conduct on-going monitoring of slopes as a component of other on-going field monitoring (e.g., road monitoring).

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	35	The magnitude and probability of occurrence of rockfalls will be evaluated during predesign geotechnical evaluation, and an appropriate mitigation strategy will be implemented, as required
	36	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, and undertake appropriate mitigative actions, as required
	37	KRH will continue to control avalanche conditions proactively, whenever a hazard is observed or anticipated
	38	Development activity in areas of high avalanche hazard will be monitored, and if required, limited during periods of high avalanche probability
	39	A snow avalanche safety program is already in place at the KRP site, and it will continue to be operated. Appropriate safety equipment will be available on site during construction, operations, and decommissioning
Climate		
Section 8.2.4	40	KRH will consider connecting to the regional electrical power grid, to potentially reduce its diesel consumption at Site, and subsequently, its GHG emissions
	41	KRH will investigate and consider the feasibility of using commercially-available alternate energy sources
	42	Generators, vehicles and other machinery used on-site will be operated in an efficient manner
	43	KRH will conduct regular maintenance of all equipment
Air Quality		
Section 8.3.5	44	Particulate monitoring will be carried out at appropriate locations, where and as needed
	45	Employees will wear appropriate Personal Protective Equipment (PPE) in higher dust areas, to reduce the potential for particulate matter inhalation
	46	KRH will apply dust suppressants (such as water or calcium chloride), as required in areas of high activity under dry conditions, to minimize airborne dust
Noise Levels		
Section 8.4.5	47	Camp walls will be insulated, which will help minimize noise levels
	48	The camp layout / design positions on-site accommodation facilities away from more active mining areas, which will help minimize noise levels
	49	Noise related to blasing activities will be controlled and minimized to the extent possible, for example through the use of constructed berms, dampening mats, or other methods.
Ecosystems and Vegetation		
Section 8.5.4	50	KRH will minimize the site footprint and maximize the use of previously disturbed areas
	51	KRH will stabilize exposed soils early to limit soil loss through erosion

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	52	Where possible, KRH will avoid Ecosystem Units that are sensitive or have higher rare plant habitat potential
	53	KRH will restrict on-site activities (e.g., ATV use) to the Project footprint/disturbed areas
	54	KRH will conduct reclamation trials to determine effective treatment options
	55	KRH will reclaim disturbed areas to ecosystems that are viable and self-sustaining
	56	KRH will limit the extent of exposed soil and re-vegetate/cover exposed areas as soon as possible
	57	KRH will implement a program to verify equipment transported to and used on site is clean. KRH will conduct periodic monitoring of disturbed sites, particularly roadsides, for the presence of invasive species
	58	KRH will develop and implement a strategy for invasive species removal if present
	59	KRH will minimize ponding and pooling of water on disturbed surfaces
	60	KRH will apply appropriate dust suppressant as required, and in accordance with Yukon Environmental Programs Branch guidelines for the use of dust suppressants (YG Environment 2002)
	61	KRH will take reasonable measures to reduce vehicle traffic volumes
	62	KRH will post and monitor appropriate vehicle traffic speed limits
Wildlife		
Woodland Caribou – Section 8.6.3.4	63	A no hunting policy for all KRH employees and contractors will be implemented
	64	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas (i.e., mineral licks)
	65	A wildlife right-of-way policy will be implemented for all mine-related traffic
	66	Dust suppressants will be applied, where and as required
	67	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	68	Following mine closure, all infrastructure will be removed from the site and the footprint will be reclaimed
	69	The harassment of wildlife, including Woodland Caribou, will be prohibited, as defined under the *Wildlife Act* (Yukon)
	70	All helicopter traffic will avoid Woodland Caribou and other large mammals
	71	Caribou observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	72	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Woodland Caribou
	73	KRH will minimize the development footprint and maximize use of previously disturbed areas
	74	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	75	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	76	Storage and disposal of all hazardous waste will be carried out in an approved manner
Moose – Section 8.6.4.4	77	A no hunting policy for all KRH employees and contractors will be implemented
	78	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas such as along the section of the access road that parallels the Ketza River
	79	A wildlife right-of-way policy will be implemented for all mine-related traffic
	80	Dust suppressants will be applied, where and as required
	81	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	82	Following mine closure, all infrastructure will be removed from the site and the footprint will be reclaimed
	83	The harassment of wildlife, including Moose, will be prohibited, as defined under the *Wildlife Act* (Yukon)
	84	All helicopter traffic will avoid Moose and other large mammals
	85	Moose observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	86	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Moose
	87	KRH will minimize the development footprint and maximize use of previously disturbed areas
	88	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	89	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	90	Storage and disposal of all hazardous waste will be carried outin an approved manner
Thinhorn Sheep – Section 8.6.5.4	91	A no hunting policy for all KRH employees and contractors will be implemented
	92	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas such as along the section of the access road that parallels the Ketza River
	93	A wildlife right-of-way policy will be implemented for all mine-related traffic
	94	Dust suppressants will be applied, where and as required
	95	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	96	Following mine closure, all infrastructure will be removed from the site and the footprint will be reclaimed
	97	The harassment of wildlife, including Thinhorn Sheep, will be prohibited, as defined under the *Wildlife Act* (Yukon)
	98	All helicopter traffic will avoid sheep and other large mammals

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	99	Thinhorn Sheep observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	100	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Thinhorn Sheep
	101	KRH will minimize the development footprint and maximize use of previously disturbed areas
	102	KRH will salvage organic or mineral topsoils for future re-application during reclamation
	103	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	104	Storage and disposal of all hazardous waste will be carried out in an approved manner
Grizzly Bear – Section 8.6.6.4	105	A no hunting policy for all KRH employees and contractors will be implemented
	106	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas, such as along the section of the Ketza Road that parallels the Ketza River
	107	A wildlife right-of-way policy will be implemented for all mine-related traffic
	108	As is the current practice at the Site, to minimize potential attraction / habituation of bears to the KRP, all work sites will be kept clean and free of garbage. All food waste, garbage, and non-hazardous waste will be burned in an on-site incinerator, and non-combustible waste will be disposed in an approved manner
	109	All hazardous waste will be stored and disposed in an approved manner
	110	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	111	Following mine closure, all of the infrastructure will be removed from site and the footprint will be reclaimed
	112	The harassment of wildlife, including Grizzly Bears, will be prohibited, as defined under the Wildlife Act (Yukon)
	113	All helicopter traffic will avoid Grizzly Bears and other large mammals
	114	Grizzly Bear observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	115	A wildlife monitoring program will be implemented during the construction, operation, and closure / reclamation phases which will assess and address any other effects on Grizzly Bears
	116	KRH will minimize the development footprint and maximize use of previously disturbed areas
	117	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	118	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	119	Storage and disposal of all hazardous waste will be carried out in an approved manner

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
Wolverine – Section 8.6.7.4	120	As is the current practice at the site, to minimize potential attraction/habituation of Wolverines to the KRP, all work sites will be kept clean and free of garbage. All food waste, garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed in an approved manner
	121	A no hunting policy for all KRH employees and contractors will be implemented
	122	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas, such as along the section of the Ketza Road that parallels the Ketza River
	123	A wildlife right-of-way policy will be implemented for all mine-related traffic
	124	All hazardous waste will be stored and disposed in an approved manner
	125	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures, including the appropriate protocol for addressing nuisance Wolverines
	126	Following mine closure, all of the infrastructure will be removed from site and the footprint will be reclaimed
	127	The harassment of wildlife, including Wolverines, will be prohibited, as defined under the *Wildlife Act* (Yukon)
	128	All helicopter traffic will avoid Wolverines and large mammals
	129	Wolverine observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	130	A wildlife monitoring program will be implemented during the construction, operation, and closure / reclamation phases which will assess and address any other effects on Wolverines
	131	KRH will minimize the development footprint and maximize use of previously disturbed areas
	132	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	133	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	134	Storage and disposal of all hazardous waste will be carried out in an approved manner
Raptor Nesting (Cliff Habitat) – Section 8.6.8.4	135	A nest survey will be conducted at the Site at the start of the breeding season each year, to locate any active raptor nests. If active raptor nests are found near work sites, appropriate measures will be taken to avoid disturbance of these nests during the breeding season (May 1 to August 1)
	136	Helicopter traffic will avoid raptors and active raptor nests
	137	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	138	Raptors observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	139	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases to assess and address any other possible effects on raptors
	140	KRH will minimize development footprint and maximize use of previously disturbed areas

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	141	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	142	KRH will re-contour, scarify, and reseed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	143	Storage and disposal of all hazardous waste will be carried out in an approved manner
Upland Breeding Birds (Passerines) – Section 8.6.9.4	144	To reduce the effects of localized direct habitat loss, the Project footprint will be minimized as much as possible (including use of existing cleared lands). During the final abandonment phase, infrastructure pads, roads and development sites will be re-contoured and scarified as required to ensure surface stability, and to encourage re-establishment of native vegetation
	145	If upland breeding bird nests are encountered in close proximity to active work sites, appropriate measures will be taken, as possible, to minimize clearing activities that would disturb actively-used nests during the breeding season
	146	Dust suppressants will be applied, where and as required
	147	A no hunting policy for all KRH employees and contractors while working on-site will be enforced
	148	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	149	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases to assess and address any other possible effects on Upland Breeding Birds
Surface Water Quality		
Section 8.7.5	150	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust, in accordance with Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002)
	151	A minimum 30 m riparian buffer will be maintained along streams, wherever possible
	152	KRH will limit vegetation removal, wherever possible. KRH will re-establish vegetation in cleared areas, where the Project plan allows.
	153	KRH will stabilize exposed erodible materials
	154	KRH will follow and maintain natural drainage patterns wherever possible
	155	KRH will use geochemical characterization to minimize PAG volumes and to understand long term ARD/ML behavior
	156	KRH will monitor drainage water quality to determine if ARD or ML is occurring
	157	Hazardous materials will not be stored within 30 m of any watercourse
	158	KRH will maintain and monitor equipment to ensure it is in good condition and leak free
	159	All motorized vehicles will be equipped with a spill response kit
	160	KRH staff will be familiar with the Emergency Response Plan which will be applied as soon as a spill or leak has been detected

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	161	KRH will place fuel storage tanks in secondary containment
	162	Dust will be suppressed on the stockpiled ore when necessary through measures which could include wetting down with water, tarp coverings or constructing a shed structure over the stockpile to retain dust on the pad
	163	KRH will visually inspect and record conditions of the waste rock dumps during mine operations, to look for signs of oxidation of sulphide minerals
	164	All waste rock stockpiles will be constructed with a low-permeability basal layer (pad) with drainage collection to an outlet pipe or structure
	165	KRH will segregate waste rock into NAG and PAG for storage in waste rock piles (PAG rock will be encapsulated so piles are net-NAG).
	166	KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of pads or liners
	167	Surface runoff from affected Site areas, including pits, waste rock dumps, and stockpiles will be directed to the TSF or treated to site specific water quality criteria as identified in the approved Water License for the KRP.
	168	A passive water treatment system may be included near waste rock dumps and/or open pit outfalls
	169	KRH will use geochemical characterization to minimize PAG volumes and to understand long term ARD/ML behavior
	170	Where possible, waste rock dumps will be placed on existing ground surface (above the existing groundwater table)
	171	Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific water quality criteria as identified in the KRP's approved Water License.
	172	KRH will follow best practices for explosives handling and blasting
	173	All waste rock stockpiles will be constructed with a low-permeability basal layer with drainage collection to an outlet pipe or structure
	174	KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of liners
	175	KRH will adhere to the Waste Management Permit for incinerating
	176	All food wastes and garbage will be incinerated regularly
	177	KRH will implement preventative design measures for TSF (e.g., full liner, drains, sump, recirculating system back to TSF); on closure, low-permeability cover and full reclamation of TSF; monitoring groundwater and surface water quality downstream of the TSF
	178	Groundwater and surface water around the TSF will be monitored during operations and after closure. The groundwater monitoring wells will be retained for use as long term monitoring devices
	179	Dewatering water will be diverted to the TSF during operation
	180	KRH will design the dewatering system to minimize dewatering volumes
	181	Surface runoff water that meets water quality discharge criteria will be released to the surface water drainage system. Drainage that does not meet those criteria will be conveyed and discharged to the TSF

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	182	Water discharged from the TSF, Water Retention Pond, and waste rock piles will meet site specific water quality criteria as identified in the anticipated Water License for the KRP prior to discharge to the receiving environment
	183	Worksites will be kept clean and free of garbage
	184	Non-combustible waste will be handled appropriately and either transferred to an off-site approved landfill or managed within an approved on-site landfill contained on an impermeable foundation and covered
	185	Leaks or spills will be contained and treated according to the Emergency Response Plan
	186	KRH will store hazardous materials as instructed by the manufacturer
	187	KRH will direct surface runoff away from/off the TSF at closure
	188	Selective discharge of tailings around the TSF will be conducted during the final years of operations to establish a final tailings beach that will facilitate surface water storage and reclamation
Hydrology		
Section 8.8.4	189	Downstream effects will be mitigated by controlling the rate and location of water withdrawal. If the water retention pond is not built prior to the construction and upgrading of haul roads, water will likely be sourced from Peel Creek
	190	The rate of water withdrawal, in total for all mine-related water uses, will be limited to 10% of Peel Creek flows to mitigate downstream withdrawal effects
	191	Ditches will follow local topography and drainage patterns
	192	Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream
	193	Temporary ditches will follow local topography and drainage patterns. Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream
	194	The TSF will be filled during periods of high flow. Depending on the filling schedule, a maximum of 10% of the total natural Cache Creek flows at the Peel Creek confluence will be used.
	195	The TSF and water retention pond will not be filled concurrently
	196	A diversion structure will be built to maintain base flows from Peel Creek downstream and limit the filling rate during construction of the water retention pond
	197	Ditch inspections and maintenance will be conducted on a regular basis to ensure ditches are working properly
	198	Downstream effects will be mitigated by controlling and monitoring the rate and timing of water withdrawal from the water retention pond
	199	Discharges will be regulated to mimic natural pre-development flow conditions and prevent downstream channel erosion
	200	A streambed will be constructed through the water retention pond footprint to mimic and re-establish natural Peel Creek conditions
	201	Discharges will be regulated to prevent unwanted downstream channel erosion and mimic natural pre-development flow conditions

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
Hydrogeology		
Section 8.9.5	202	KRH will design the dewatering system to minimize contact of groundwater with PAG or ML rock types in open pits, underground mines, and explosive residues
	203	KRH will follow best practices for explosives handling and blasting
	204	Dewatering water will be diverted to the TSF during operation
	205	KRH will design the dewatering system to minimize dewatering volumes
	206	KRH will monitor groundwater quality downgradient of flooded mine workings after closure, and extract and treat or remediate groundwater if required to meet applicable water quality criteria
	207	KRH will implement preventative design measures for the TSF (e.g., full liner, drains, sump, recirculating system back to TSF); on closure, a low-permeability cover and full reclamation of TSF.
	208	KRH will segregate waste rock into NAG and PAG for storage in waste rock piles (PAG rock will be encapsulated so piles are net-NAG). A liner and drainage collection system may be constructed under the waste rock piles, as required
	209	KRH will divert water that does not meet applicable water quality criteria to the TSF
	210	On closure, KRH will contour, cover and revegetate waste rock sites
	211	KRH will install an engineered ROM pad with runoff and leachate collected and conveyed to TSF
	212	KRH will implement dust suppression measures on the active ROM stockpile
	213	Water collected by the drains and sump that does not meet applicable water quality criteria will be pumped back into the TSF
	214	Selective discharge of tailings into the TSF will be conducted during the final years of operations to establish a final tailings beach that will facilitate surface water storage and reclamation
	215	During closure, KRH will construct an engineered cover, including runoff control, and progressively re-vegetate the remaining embankment faces and exposed tailings surfaces using overburden stockpiled from stripping activities
	216	KRH will construct a permanent outlet channel to enable discharge of clean surface water from the covered TSF to the reclaimed fresh water reservoir and downstream reaches of Cache Creek
	217	KRH will dismantle and remove the tailings and reclaim delivery systems, including the barge, all pipelines, structures, berms and equipment not required beyond mine closure
	218	KRH will dismantle and remove other related TSF infrastructure, including drainage diversion channels, tailings distribution and deposition systems, the fresh water pump station, and pipelines
	219	KRH will remove the seepage collection system when water quality objectives have been reached
	220	KRH will remove and re-grade all access roads, ponds, ditches, and borrow areas not required beyond mine closure
	221	KRH will stabilize exposed erodible materials

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	222	Groundwater and surface water around the TSF will be monitored throughout the life of the Project. The groundwater monitoring wells will be retained for use as long term monitoring devices
	223	Post-closure requirements will include an annual inspection of the TSF and an evaluation of impoundment water quality, sump flow rates and instrumentation records to confirm design assumptions for closure
	224	All dump sites will be constructed with a low-permeability basal layer with drainage collection to an outlet pipe or structure
	225	KRH will visually inspect and record conditions at the waste rock dumps during mine operations, to look for signs of oxidation of sulphide minerals
	226	KRH will monitor drainage water quality in accordance with with water quality criteria indicated in the anticipated Water License for the Project, to determine if ARD or ML is occurring
	227	Drainage water that meets water quality discharge criteria will be released to the surface water drainage system. Drainage that does not meet those criteria will be conveyed and discharged to the TSF
	228	On closure, the waste rock dumps will be contoured, covered with a low-permeability layer and revegetated
	229	The ROM pad will be designed and constructed (using concrete or compacted NAG rock) to collect and convey runoff and leachate to the TSF. The ROM pad will be constructed and commissioned under a high level of quality control, to ensure it functions as designed, before any ore is placed on the pad
	230	Dust will be suppressed on the stockpiled ore when and as necessary
	231	On closure, the pad structure will be decommissioned and removed if necessary along with rest of the mine infrastructure
Aquatic Ecosystems and Fisheries Resources		
Section 8.10.5	232	Water used to service the camp will usually come from an on-site well (rather than from a surface water source)
	233	KRH will recycle process water from the TSF so that water will not have to be diverted continuously from Cache Creek
	234	Additional water will be obtained from the water retention pond
	235	The diversion channel will divert the flow from Cache Creek around the TSF and Water Retention Pond. Excess clean water in the water retention pond will be released via a spillway
	236	Appropriate erosion and sediment control measures will help reduce sediment deposition into surface waters
	237	A minimum 30 m riparian buffer will be maintained along streams wherever possible
	238	KRH will limit vegetation removal wherever possible. KRH will re-establish vegetation in cleared areas where the project plan allows. Areas will be planted with native species whenever possible
	239	Zones that are not to be disturbed will be delineated clearly so that equipment operators are familiar these boundaries

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	240	Erosion and sediment control measures will be implemented in areas where vegetation has been removed and erosion may be a concern
	241	Stream water quality will be monitored during all phases of the Project
	242	Material movement and grading will be limited wherever possible
	243	Vegetation will be retained wherever possible and KRH will implement erosion and sediment control measures as and where necessary
	244	All clearing and site works will be completed with reference to, where appropriate, the DFO Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993), the Guidebook of Mitigation Measures for Placer Mining in the Yukon (YPS 2008) and the Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide (YCOM 2010). Diversion works or channel restoration works that may be required, will be undertaken with reference to the Guidebook of Mitigation Measures for Placer Mining in the Yukon
	245	Tailings and waste rock will be handled appropriately
	246	Areas will be retained with the intent of reinstating original flow patterns
	247	Sediment that accumulates in the water retention dam will be tested to determine if removal of the sediments is needed during reclamation and breaching of the water retention dam
	248	Procedures will be developed for handling explosives near surface water bodies. KRH will follow, where appropriate, DFO's Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998)
	249	The use of explosives will be limited wherever possible. Explosives will not be stored within 30 m of waterbodies.
	250	Appropriate erosion and sediment control measures will be implemented in proximity to surface water bodies where explosives may be used. Where possible, a vegetated buffer will be retained between explosives activity and watercourses.
	251	Clean-up measures will be implemented for spilled explosive products.
	252	Equipment operators will be informed as to the importance of limiting erosion near water bodies, the importance of proper equipment maintenance, and the necessity for spill response and management
	253	On-site personnel will be familiarized with the spill plan, spill response materials and procedures
	254	No fuelling or hazardous materials storage will occur within 30 m of any watercourse
	255	Any road and associated crossings that are no longer required for operation of the mine will be reclaimed
	256	Instream works and their footprint will be limited and avoided whenever possible
	257	Instream works will be completed before May or after early July to avoid the time period when grayling are likely to spawn and to allow time for the eggs to develop
	258	DFO operational statements for road crossings will be followed, as appropriate, and natural drainage patterns will be maintained wherever possible
	259	KRH will armour outfalls, as and where required, to prevent erosion and sedimentation

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	260	KRH will limit the amount of diverted surface water that enters the tailings storage facility, so that flows are sustained
	261	In addition to the main diversion channel redirecting partial flows from Cache Creek and Oxo Creek, there will also be a second open drainage ditch to collect surface runoff from the northwest and northeast of the TSF
	262	KRH will encourage efficient use of water on-site. Water conservation measures will be implemented wherever feasible
	263	An approved sewage treatment system will be employed
	264	A state of the art system for recovering clean water during sewage treatment is being investigated, however in the eventuality it is not determined to be feasible or if it is periodically inoperable, then treated sewage effluent will be comingled into the TSF along with process water
	265	Water collected in seepage or catchment ditches and contaminated groundwater will be collected and treated
	266	Water quality and quantity and stream sediment metals will be monitored throughout the life of the Project
	267	Diversion ditches will be put in place upslope of the waste rock dumps, and catchment ditches will be put in place downslope of the waste rock dumps, to prevent water from the waste rock dumps from entering the receiving environment
	268	If any natural watercourse that contains fish is used as a water source, the water withdrawal apparatus will contain a fish screen of an appropriate size to exclude fish. Reference the Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO 1995) for guidance on installing fish screens
	269	Riparian vegetation will be retained wherever possible to protect watercourses
	270	Tailings and waste rock will be handled appropriately
	271	Stream water quality will be monitored during all phases of the Project
	272	Consolidation of the tailings will occur during deposition and after operations are complete until excess pore pressures have dissipated. This will increase the density of the deposit and will allow for an impermeable cover to be placed over the tailings after mine closure to limit the ability of water to seep into the tailings
	273	KRH will operate a land treatement facility to contain and treat non-hazardous wastes
	274	Garbage will be incinerated on site, as appropriate
	275	Waste oil will be collected, managed and disposed of in an appropriate manner
Heritage Resources		
Section 8.11.4	276	KRH will comply with all applicable regulations pertaining to the protection of heritage resources.
	277	KRH will comply with the *Yukon Mineral Exploration Best Management Practices for Heritage Resources* (YG TC 2010a) and the *Guidelines Respecting the Discovery of Human Remains and First Nation Burial Sites in the Yukon* (YG THB 1999)

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	278	KRH will provide education to its employees on the protection of heritage resources. KRH employees will be provided general heritage resource identification tools as described in the *Handbook for the Identification of Heritage Sites and Features* (YG TC 2005)
	279	KRH employees will be informed as to the importance of leaving artifacts in place
	280	Should an employee discover a heritage resource at the KRP, they will be required to report the finding to a manager
	281	KRH employees will be advised to not disturb heritage sites whether on or off the KRP footprint
	282	If a potential heritage resource is discovered, KRH will adhere to actions as presented in the Traditional Knowledge Protocol
	283	If a heritage resource appears to be a human burial site, management personnel will first report the finding to the Royal Canadian Mounted Police
	284	Should a paleontological resource be found, KRH will adhere to actions as presented in the Traditional Knowledge Protocol
	285	KRH will continue to protect potential heritage resources until instructed otherwise by the authority to which the resources were reported
	286	KRH will mitigate effects to newly discovered heritage resources with employee education, avoidance, a buffer zone, and reporting
Socio-economics		
Section 9.4.1	287	KRH plans a standard 2-week in, 2-week out rotation for all employees. The two week period of time off will likely provide sufficient time for First Nation employees to pursue traditional economic activities
	288	KRH policies will include no firearms or other weapons allowed, and no hunting by employees while on rotation. No hunting by anyone allowed on the site and access through the site will be controlled for safety reasons
	289	KRH, through its MOU with the Ross River Dena, will use existing mechanisms to compensate the Ross River trappers for loss of access due to the company's activities
	290	Construction, operation, decommissioning, and monitoring phases total approximately 13 years. KRH will continue to explore its property for further reserves and attempt to extend the operating life of the mine
	291	Ketza River Holdings 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 Teslin
	292	KRH will offer a variety of standard programs for its employees. For employees recruited locally, KRH is planning to offer hands-on training in mine and mill operations in its Jerritt Canyon mine in Nevada. KRH will have a policy of initially posting all employment positions internally, and, with a particular focus on First Nation candidates, help create individual training and succession plans
	293	KRH will continue to actively recruit First Nation and female employees and continue to work with local contractors and suppliers through the construction, operation and closure of the Project

Table 1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	294	As part of ongoing discussions with the Ross River Dena Council, the Liard First Nation, and the Teslin Tlingit Council, KRH is exploring ways of maximizing First Nation participation in the Project's business opportunities
Section 9.4.2	295	To help employees and their families maintain good health, Ketza River Holdings will be offering a dental and extended health plan to all employees at the Ketza River Mine
	296	The camp will be dry through all phases of the Project, no alcohol or nonprescription drugs will be permitted. KRH will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter
	297	KRH, while making workplace safety the first priority, will take a graduated disciplinary approach to employees suffering from drug or alcohol abuse issues and work with the employee if he or she wishes to enter a treatment program
	298	To increase the safety of its employees, contractors and the general public using the Ketza River road, KRH will install a radio communication system on the road to allow truck drivers to communicate their presence and location on the road to all users
	299	KRH will transport cyanide needed for mill processes to site only in solid briquette form. KRH will have a trained emergency response team, along with an assortment of relevant equipment available to respond to accidents and spills
	300	KRH 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
	301	KRH will follow all applicable safety laws and regulations in every aspect of its operations. KRH will provide every employee with the training required to safely do their work. KRH will have a fully qualified EMT on site with all required medical supplies and equipment and have an on-call medevacs service available at all times
Section 9.4.3	302	KRH 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
	303	KRH will look for opportunities to provide support for selected community events
Section 9.4.4	304	KRH has been maintaining Ketza Road using contractors from Ross River. Although KRH would like the Yukon Government to assume maintenance, KRH is prepared to continue to use local contractors for maintenance

Ketza River Holdings

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

ACRONYMS AND ABBREVIATIONS lvi

1.0 INTRODUCTION 1

1.1 The Organization and Layout of the Project Proposal 1
1.2 Proponent Information 1
1.2.1 Corporate Policies 3
1.3 Project Background 4
1.3.1 Chronology of Mining Operations at Ketza River Mine 4
1.3.2 Communications 5
1.3.3 Existing On-Site Facilities 8
1.3.4 Existing Authorizations and Approvals 8
1.3.5 Care and Maintenance Program 9
1.4 Project Purpose 9
1.5 Required Authorizations and Regulatory Approvals 10
1.5.1 YESAA Requirements 10
1.5.2 Applicable Legislation and Anticipated Required Permits and Licenses 11

2.0 FIRST NATIONS / COMMUNITY CONSULTATION 14

2.1 Introduction 14
2.2 Identification of Parties to be Consulted 14
2.3 Form of Consultation 17
2.3.1 Public Meetings with Presentations 28
2.3.2 Open Houses 31
2.3.3 Meetings with Community Leadership 34
2.3.4 Meetings with Elders 34
2.4 Information Provided During Consultation 35
2.4.1 PowerPoint Presentations 35
2.4.2 Detailed Maps, Figures and Display Materials 36
2.4.3 Information Handouts 36
2.4.4 Use of Community Publications 38
2.5 Opportunity to Present Views 38
2.6 Summary of Views Presented 38
2.6.1 Similarity of Views 40
2.6.1.1 Mine Scope 41
2.6.1.2 Mine Scope Socio-economic 42
2.6.1.3 Economic 42
2.6.1.4 Social 42
2.6.1.5 Environment 42
2.6.2 Differences of Views 43
2.7 Consideration of Views Presented 43

3.0 PROJECT LOCATION 44
3.1 Geographical Location 44
3.2 Land Tenure 44
3.2.1 Quartz Mineral Claims 44
3.2.2 Outfitting Concession 45
3.2.3 Trapping Concessions 45
3.2.4 Interim Protected Lands 45
3.2.5 Parks and Protected Areas 45
3.2.6 Yukon Land Use Planning Region 45
3.3 Traditional Territory 49
3.4 Consistency with Other Plans 49
3.4.1 The Snow That Eats the Snow (A Mining Strategy for Ross River, Yukon Territory) 49
3.4.2 Faro Forward: Integrated Community Sustainability Plan 50
3.4.3 Teslin Tlingit Council Mining Policy 50
3.4.4 Integrated Community Sustainability Plan: Ross River 50
3.4.5 Integrated Wildlife Management Plan: Ross River Traditional Territory 50

4.0 DESCRIPTION OF EXISTING ENVIRONMENTAL CONDITIONS 52
4.1 Scope of the Project / Study Area 52
4.2 General Physiography 54
4.3 Terrain, Soils and Geology 54
4.3.1 Terrain Production Area Footprint Study Area 56
4.3.1.1 Quaternary History 56
4.3.1.2 Surficial Geology and Terrain 57
4.3.1.3 Permafrost 57
4.3.1.4 Bedrock Geology 58
4.3.1.5 Soils 60
4.3.1.6 Terrain Hazards 61
4.3.1.7 Avalanche Hazard 61
4.3.2 Ketza Road Terrain and Geology 62
4.4 Climate 62
4.4.1 Meteorological Stations 62
4.4.2 Wind 63
4.4.3 Air Temperature 64
4.4.4 Relative Humidity 64
4.4.5 Incident Solar Radiation 70
4.4.6 Precipitation 70
4.4.7 Evaporation 73
4.4.8 Climate Trends 74
4.5 Air Quality 74
4.6 Noise Levels 80
4.7 Ecosystems and Vegetation 80
4.7.1 Regional Ecology 80

4.7.2 Local Ecology 82
4.7.2.1 Bioclimate Zones 82
4.7.2.2 Ecosystem Units 84
4.7.2.3 Sensitive Ecosystems 94
4.7.2.4 Rare Plant Potential 96
4.7.2.5 Invasive Plants 100
4.8 Wildlife 101
4.8.1 Species with Conservation Status 104
4.8.2 Mammals 104
4.8.2.1 Woodland Caribou, Northern Mountain Population (*Rangifer tarandus caribou*) 106
4.8.2.2 Moose (*Alces alces*) 110
4.8.2.3 Thinhorn Sheep (*Ovis dalli*) 117
4.8.2.4 Mule Deer (*Odocoileus hemionus*) 124
4.8.2.5 Grizzly Bear (*Ursus arctos*) 124
4.8.2.6 Black Bear (*Ursus americanus*) 126
4.8.2.7 Grey Wolf (*Canis lupus*) 128
4.8.2.8 Wolverine (*Gulo gulo*) 128
4.8.2.9 Small Mammals 131
4.8.3 Birds 132
4.8.3.1 Waterfowl and Water Birds 136
4.8.3.2 Raptors 137
4.8.3.3 Upland Birds 142
4.8.3.4 Passerines 142
4.8.4 Amphibians 145
4.9 Surface Water Quality 146
4.9.1 Introduction 146
4.9.1.1 Adit Portal Water 150
4.9.1.2 Ketza Road 150
4.9.2 Surface Water Quality Monitoring Sample Collection Method 150
4.9.3 Surface Water Quality Monitoring Results 151
4.9.3.1 Comparison to CCME Water Quality Guidelines for the Protection of Aquatic Life 152
4.9.3.2 Comparison between Areas 156
4.9.3.3 Seasonal and Temporal Trends in Surface Water Quality 163
4.9.3.4 Canamax Tailings Storage Facility Discharge 163
4.9.4 Summary of Surface Water Quality Existing Conditions 164
4.10 Hydrology 164
4.10.1 Hydrological Setting 164
4.10.2 Streamflow and Runoff 165
4.11 Hydrogeology 170
4.11.1 Hydrogeological Data for the Site 171
4.11.2 Hydrogeochemistry 174
4.11.2.1 Major Ion Chemistry and Hydrochemical Facies 179

4.11.2.2 Comparison of Project Area Hydrogeochemistry with Guidelines and Standards 180
4.11.2.3 Seasonal Variability of Groundwater Chemistry 183
4.11.2.4 Conceptual Baseline Hydrogeological Model 184
4.11.2.5 Overburden Aquifer 184
4.11.2.6 Bedrock Aquifers 187
4.11.2.7 Groundwater – Surface Water Interaction 188
4.11.2.8 Groundwater Flow Regime Summary 189
4.12 Aquatic Ecosystems and Fisheries Resources 189
4.12.1 Regional Setting 190
4.12.2 Baseline Study Program 190
4.12.3 Fish and Fish Habitat 192
4.12.3.1 Historical Studies and Existing Information 192
4.12.3.2 Assessment Methods 197
4.12.3.3 Ketza River Results 204
4.12.3.4 Cache Creek Results 207
4.12.3.5 Oxo Creek Results 214
4.12.3.6 Subsidiary Creek Results 216
4.12.3.7 Peel Creek Results 217
4.12.3.8 Unnamed Tributary to Cache Creek (KR16) 219
4.12.3.9 Discussion 219
4.12.4 Aquatic Ecosystem – Benthic Macroinvertebrate and Periphyton 220
4.12.4.1 Historical Studies 220
4.12.4.2 Assessment Methods 222
4.12.4.3 Results 222
4.12.4.4 Cache Creek Results 223
4.12.4.5 Oxo Creek Results 224
4.12.4.6 Peel Creek Results 224
4.12.4.7 Discussion 225
4.12.5 Aquatic Ecosystem – Stream Sediment Metals and Particle Size 227
4.12.5.1 Historical Studies 227
4.12.5.2 Assessment Methods 228
4.12.5.3 Results 229
4.12.5.4 Cache Creek Results 229
4.12.5.5 Oxo Creek Results 232
4.12.5.6 Peel Creek Results 232
4.12.5.7 Discussion 232
4.13 Heritage Resources 236
4.13.1 Human History Summary 237
4.13.1.1 Kaska Dena 237
4.13.1.2 Teslin Tlingit 237

4.13.2 Heritage Resources Assessments 238
4.13.2.1 Methods 238
4.13.2.2 Findings 239

5.0 DESCRIPTION OF EXISTING SOCIO-ECONOMIC CONDITIONS 247

5.1 Project Area, Land and Resource Use 247
5.2 Yukon 248
5.2.1 Yukon: Demographics 249
5.2.2 Yukon: Labour Force and Employment 249
5.2.3 Yukon: Earnings and Incomes 250
5.2.4 Yukon: Education Levels 250
5.2.5 Yukon: GDP and Inflation 250
5.2.6 Yukon: Industrial Structure 251
5.3 Ross River 252
5.3.1 Ross River: History 252
5.3.2 Ross River: Demographics and Community Economy 253
5.3.3 Ross River: Social Infrastructure and Social Issues 254
5.4 Faro 254
5.4.1 Faro: History 255
5.4.2 Faro: Demographics and Community Economy 256
5.4.3 Faro: Social Infrastructure and Social Issues 257
5.5 Watson Lake and Liard First Nation 257
5.6 Teslin and Teslin Tlingit Council 258

6.0 PROJECT DESCRIPTION 259

6.1 Project Identification 259
6.1.1 Principal Project 259
6.2 Accessory Activities 259
6.3 Alternatives and Chosen Approach 262
6.3.1 Access Alternatives 262
6.3.2 Tailings Containment Alternatives 262
6.3.3 Power Alternatives 263
6.3.4 Processing Alternatives 263
6.3.5 Mining Trade-offs 264
6.3.6 Underground Mining Method Alternatives 264
6.3.7 Water Source Alternatives 267
6.3.8 Alternative Infrastructure and Facilities 267
6.3.9 Closure Alternatives 268
6.3.9.1 Tailings Storage Facility 268
6.3.9.2 Open Pits 268
6.4 Geological Setting 268
6.4.1 Proposed Mine Site Area 268
6.4.2 Results of Waste Rock Geochemical Characterization Program 269
6.4.3 Results of Tailings and Ore Geochemical Characterization Program 274

6.4.4 Mitigation Measures....278
6.5 Technologies....278
6.5.1 Mining....279
6.5.2 Processing and Refining....280
6.5.2.1 Primary Crushing....280
6.5.2.2 Semi-Autogenous Grinding Mill....280
6.5.2.3 Secondary Grinding....280
6.5.2.4 Cyanide Leaching....280
6.5.2.5 Carbon-in-Leach Processing....280
6.5.2.6 Carbon Elution....280
6.5.2.7 Electrowinning....281
6.5.2.8 Cyanide Destruction....281
6.5.3 Water Balance....281
6.5.4 Tailings Storage and Treatment....285
6.5.5 Water Distribution and Treatment....285
6.5.6 Other....286
6.6 Project Scheduling and Phases....286
6.6.1 Project Schedule....286
6.6.2 Construction Phase....287
6.6.2.1 Road Infrastructure....287
6.6.2.2 Site Buildings....290
6.6.2.3 Staging Area....295
6.6.2.4 Borrow Sites....295
6.6.2.5 Open Pit Mining Pre-Production....295
6.6.2.6 Underground Mining Pre-Production....296
6.6.2.7 Tailings Storage Facility....296
6.6.2.8 Water Storage....300
6.6.2.9 Water Diversion Structures....300
6.6.2.10 Water Usage....304
6.6.2.11 Waste Generation and Handling....304
6.6.2.12 Land Treatment Facility....305
6.6.2.13 Bulk Fuel Storage....306
6.6.2.14 Power Generation Requirements....306
6.6.2.15 Fuel, Hazardous Materials and Explosives Management....306
6.6.2.16 Access and Transportation....307
6.6.2.17 Work Force Requirements....307
6.6.2.18 Quality Assurance / Quality Control....308
6.6.2.19 Commissioning....308
6.6.3 Operations Phase....308
6.6.3.1 Open Pit Mining....308
6.6.3.2 Underground Mining....314
6.6.3.3 Processing....314
6.6.3.4 Water Usage....316

6.6.3.5 Pumping Water to Site 316
6.6.3.6 Water Storage 316
6.6.3.7 Water Diversion Structures 317
6.6.3.8 Potable and Waste Water Treatment 317
6.6.3.9 Tailings Disposal 317
6.6.3.10 Camp Operations 318
6.6.3.11 Warehouse 318
6.6.3.12 Fuel, Hazardous Material, and Explosives Management 318
6.6.3.13 Access and Transportation 319
6.6.3.14 Work Force Requirements 319
6.6.3.15 Power Generation and Requirements 320
6.6.3.16 Quality Assurance / Quality Control 320
6.6.4 Closure and Reclamation Phase 321

7.0 ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS ASSESSMENT METHODS 322
7.1 Environmental Assessment Methods 322
7.1.1 Identifying Valued Environmental and Socio-economic Components 322
7.1.2 Identifying Temporal and Spatial Boundaries 322
7.1.3 Summarizing Baseline Information 322
7.1.4 Effects Characterization and Mitigation 323
7.1.5 Evaluating Consequence 326
7.1.6 Determining Significance 328
7.2 Socio-economic Assessment Methods 328
7.2.1 Determine Scope of the Project 329
7.2.2 Determine Scope of the Assessment 330
7.2.3 Compile Socio-economic Baseline 330
7.2.4 Socio-economic Effects Assessment with Mitigation and Enhancement Measures 331
7.2.5 Significance Analysis and Cumulative Effects 331

8.0 ENVIRONMENTAL EFFECTS ASSESSMENT 332
8.1 Natural Landscape, Soil Stability, and Terrain Hazards 332
8.1.1 Identification of Valued Environmental and Socio-economic Components 332
8.1.2 Effects Characterization 332
8.1.3 Mitigation Measures 334
8.1.4 Residual Effects, Consequence, and Significance Determination 337
8.2 Climate 339
8.2.1 Identification of Valued Environmental and Socio-economic Components 339
8.2.2 Summary of Baseline Information 339
8.2.3 Effects Characterization 339
8.2.4 Mitigation Measures 340
8.2.5 Residual Effects, Consequence, and Significance Determination 341
8.3 Air Quality 341
8.3.1 Identification of Valued Environmental and Socio-economic Components 341
8.3.2 Summary of Baseline Information 341

8.3.3 Identification of Temporal and Spatial Boundaries 342
8.3.4 Effects Characterization 342
8.3.5 Mitigation Measures 343
8.3.6 Residual Effects, Consequence, and Significance Determination 344
8.4 Noise Levels 345
8.4.1 Identification of Valued Environmental and Socio-economic Components 345
8.4.2 Summary of Baseline Information 345
8.4.3 Identification of Temporal and Spatial Boundaries 345
8.4.4 Effects Characterization 345
8.4.5 Mitigation Measures 346
8.4.6 Residual Effects, Consequence, and Significance Determination 346
8.5 Ecosystems and Vegetation 347
8.5.1 Identification of Valued Environmental and Socio-economic Components 347
8.5.2 Summary of Baseline Information 347
8.5.3 Effects Characterization 347
8.5.3.1 Removal and/or Burial of Ecosystems and Vegetation 348
8.5.3.2 Sensitive Ecosystems 350
8.5.3.3 Rare Plant Potential 350
8.5.3.4 Potential Introduction of Invasive Plant Species 352
8.5.3.5 Changes to Soil Conditions 353
8.5.3.6 Effects of Dust Deposition 353
8.5.4 Mitigation Measures 355
8.5.4.1 Invasive Plant Species 355
8.5.4.2 Changes to Soil Conditions 355
8.5.4.3 Dust Deposition 355
8.5.5 Residual Effects, Consequence, and Significance Determination 356
8.6 Wildlife 358
8.6.1 Identification of Valued Environmental and Socio-economic Components 358
8.6.2 Potential Wildlife Effects and Mitigation Measures 360
8.6.3 Woodland Caribou 360
8.6.3.1 Summary of Baseline Information 360
8.6.3.2 Identification of Temporal and Spatial Boundaries 362
8.6.3.3 Effects Characterization 362
8.6.3.4 Mitigation Measures 363
8.6.3.5 Residual Effects and Consequence Determination 363
8.6.3.6 Significance Determination 364
8.6.4 Moose 364
8.6.4.1 Summary of Baseline Information 364
8.6.4.2 Identification of Temporal and Spatial Boundaries 364
8.6.4.3 Effects Characterization 365
8.6.4.4 Mitigation Measures 365
8.6.4.5 Residual Effects and Consequence Determination 366
8.6.4.6 Significance Determination 366

8.6.5 Thinhorn Sheep 366
8.6.5.1 Summary of Baseline Information 366
8.6.5.2 Identification of Temporal and Spatial Boundaries 367
8.6.5.3 Effects Characterization 367
8.6.5.4 Mitigation Measures 367
8.6.5.5 Residual Effects and Consequence Determination 368
8.6.5.6 Significance Determination 368
8.6.6 Grizzly Bear 368
8.6.6.1 Summary of Baseline Information 369
8.6.6.2 Identification of Temporal and Spatial Boundaries 369
8.6.6.3 Effects Characterization 369
8.6.6.4 Mitigation Measures 370
8.6.6.5 Residual Effects and Consequence Determination 370
8.6.6.6 Significance Determination 371
8.6.7 Wolverine 371
8.6.7.1 Summary of Baseline Information 371
8.6.7.2 Identification of Temporal and Spatial Boundaries 371
8.6.7.3 Effects Characterization 372
8.6.7.4 Mitigation Measures 372
8.6.7.5 Residual Effects and Consequence Determination 373
8.6.7.6 Significance Determination 373
8.6.8 Raptor Nesting (Cliff Habitat) 373
8.6.8.1 Summary of Baseline Information 373
8.6.8.2 Identification of Temporal and Spatial Boundaries 374
8.6.8.3 Effects Characterization 374
8.6.8.4 Mitigation Measures 375
8.6.8.5 Residual Effects and Consequence Determination 375
8.6.8.6 Significance Determination 375
8.6.9 Upland Breeding Birds (Passerines) 375
8.6.9.1 Summary of Baseline Information 376
8.6.9.2 Identification of Temporal and Spatial Boundaries 376
8.6.9.3 Effects Characterization 376
8.6.9.4 Mitigation Measures 376
8.6.9.5 Residual Effects and Consequence Determination 377
8.6.9.6 Significance Determination 377
8.7 Surface Water Quality 377
8.7.1 Identification of Valued Environmental and Socio-economic Component 377
8.7.2 Summary of Baseline Information 378
8.7.3 Summary of Baseline Acid Rock Drainage and Metal Leaching Information 379
8.7.3.1 Waste Rock 379
8.7.3.2 Tailings and Ore 380
8.7.4 Effects Characterization 380
8.7.5 Mitigation Measures 381

8.7.6 Consequence and Significance Determination....383
8.8 Hydrology....409
8.8.1 Identification of Valued Environmental and Socio-economic Components....409
8.8.2 Identification of Temporal and Spatial Boundaries....409
8.8.3 Summary of Baseline Information....409
8.8.4 Effects Characterization and Mitigation....409
8.8.4.1 Construction Phase....410
8.8.4.2 Operations Phase....416
8.8.4.3 Decommissioning and Closure Phase....419
8.8.5 Summary of Mitigation Measures....421
8.8.6 Significance Determination....423
8.9 Hydrogeology....423
8.9.1 Identification of Valued Environmental and Socio-economic Components....423
8.9.2 Summary of Baseline Information....423
8.9.3 Identification of Temporal and Spatial Boundaries....424
8.9.4 Effects Characterization....425
8.9.4.1 Groundwater Inflow to Open Pits and Underground Mines....425
8.9.4.2 Groundwater Flow through Open Pits and Underground Mines Post-Closure....431
8.9.4.3 Tailings Storage Facility....432
8.9.4.4 Chemical Spills and Releases....434
8.9.4.5 Waste Rock Dumps....434
8.9.4.6 ROM Stockpiles....435
8.9.5 Mitigation Measures....435
8.9.5.1 Mine Workings during Operations....437
8.9.5.2 Mine Workings Post-closure....437
8.9.5.3 Tailings Storage Facility....437
8.9.5.4 Waste Rock Dump Sites....439
8.9.5.5 ROM Stockpile....439
8.9.6 Residual Effects, Consequence, and Significance Determination....439
8.9.6.1 Dewatering Effects on Groundwater Quantities....440
8.9.6.2 Post-Closure Groundwater Seepage through Open Pits and Underground Mines 441
8.10 Aquatic Ecosystems and Fisheries Resources....443
8.10.1 Identification of Valued Environmental and Socio-economic Components....443
8.10.2 Identification of Temporal and Spatial Boundaries....443
8.10.3 Summary of Baseline Information....443
8.10.3.1 Fish and Fish Habitat....443
8.10.3.2 Aquatic Resources....445
8.10.4 Effects Characterization....449
8.10.5 Mitigation Measures....451
8.10.6 Residual Effects, Consequence and Significance Determination....452
8.11 Heritage Resources....458
8.11.1 Identification of Temporal and Spatial Boundaries....459
8.11.2 Summary of Baseline Information....459

8.11.3 Effects Characterization....460
8.11.4 Mitigation Measures....460
8.11.5 Consequence and Significance Determination....461
8.12 Aesthetics....462
8.12.1 Approach....462
8.12.2 Viewshed Analysis....462
8.12.3 Line-of-Sight Analysis....466
8.13 Effects of the Environment on the Project....466
8.13.1 Rockfalls, Landslides, and Snow Avalanches....466
8.13.2 Earthquakes....466
8.13.3 Permafrost....466
8.13.4 Flooding....467
8.13.5 Fire....467

9.0 SOCIO-ECONOMIC EFFECTS ASSESSMENT....468

9.1 Scope of Project....468
9.1.1 Project Components and Activities....469
9.1.2 Summary and Rationale: Socio-economic Scope....470
9.2 Scope of Assessment....470
9.2.1 Identified Interests....470
9.2.1.1 Government of Canada....472
9.2.1.2 Yukon Government....472
9.2.1.3 First Nations....474
9.2.1.4 Municipalities....474
9.2.1.5 Communities....474
9.2.1.6 Groups, Businesses and Organizations....475
9.2.2 Identification of Valued Environmental and Socio-economic Components....475
9.2.3 Preliminary Determination of Potential Effects....477
9.2.4 Summary and Rationale: Scope of Socio-economic Assessment....479
9.2.4.1 Canada....479
9.2.4.2 Yukon....479
9.2.4.3 Ross River and the Ross River Dena Council....479
9.2.4.4 Faro and the Town of Faro....479
9.2.4.5 Liard First Nation....479
9.2.4.6 Teslin Tlingit Council....479
9.2.4.7 Groups, Businesses and Organizations....480
9.2.4.8 Temporal Scope of Assessment....480
9.3 Summary of Socio-economic Baseline Information....480
9.3.1 Data Sources....481
9.3.2 Baseline Indicators: Linkages and Rationale....481
9.3.3 Baseline: Economy and Sustainable Livelihood....484
9.3.3.1 Traditional Economic Activities – Hunting, Fishing, Trapping, Food Gathering....484
9.3.3.2 Economic Growth....485

9.3.3.3 Diverse and Stable Economy – Discouraging Boom and Bust 487
9.3.3.4 Employment 491
9.3.3.5 Employability – Education, Training and Experience 493
9.3.3.6 Broad Participation in Economic Development 495
9.3.3.7 Business Opportunities 497
9.3.3.8 Government Revenues 498
9.3.4 Baseline: Human Health and Well-Being 499
9.3.4.1 Individual Health 499
9.3.4.2 Family Stress 500
9.3.4.3 Reducing Alcohol and Drug Abuse 500
9.3.4.4 Gathering Traditional Medicine 503
9.3.4.5 Public Health and Safety – Increased Traffic, Hazardous Material Transport 503
9.3.4.6 Workplace Health and Safety 503
9.3.5 Baseline: Community Vitality 503
9.3.5.1 Population – Number of Children 503
9.3.5.2 Healthy Local Business Sector — Reducing the Cost of Living 506
9.3.5.3 Reducing Crime 507
9.3.5.4 Reducing Discrimination and Racism 508
9.3.5.5 Political Structure, Leadership and Capacity 509
9.3.5.6 Community Events and Volunteerism 509
9.3.5.7 Recreational Facilities and Opportunities 510
9.3.6 Baseline: Infrastructure and Services 511
9.3.6.1 Housing and Land Availability 511
9.3.6.2 Transportation Infrastructure — Roads and Airports 512
9.3.6.3 Municipal Services — Water, Sewer, Solid Waste 512
9.3.6.4 Healthcare Services 513
9.3.6.5 Police Services 513
9.3.6.6 Child Care 513
9.3.7 Baseline: Culture, History and Heritage 513
9.3.7.1 Language Preservation and Restoration 513
9.3.7.2 Traditional Knowledge and Practice Preservation and Restoration 513
9.3.7.3 Heritage and Historic Sites 514
9.4 Socio-economic Effects Assessment 514
9.4.1 Project Effects: Economy and Sustainable Livelihood 514
9.4.1.1 Traditional Economic Activities – Hunting, Fishing, Trapping, Food Gathering 514
9.4.1.2 Economic Growth 515
9.4.1.3 Diverse and Stable Economy – Discouraging Boom and Bust 517
9.4.1.4 Employment 517
9.4.1.5 Employability – Education, Training and Experience 520
9.4.1.6 Broad Participation in Economic Development 520
9.4.1.7 Business Opportunities 521
9.4.1.8 Government Revenues 522

9.4.2 Project Effects: Human Health and Well-Being 523
9.4.2.1 Individual Health 523
9.4.2.2 Family Stress 524
9.4.2.3 Reducing Alcohol and Drug Abuse 525
9.4.2.4 Gathering Traditional Medicine 525
9.4.2.5 Public Health and Safety – Increased Traffic, Hazardous Material Transport 525
9.4.2.6 Workplace Health and Safety 526
9.4.3 Project Effects: Community Vitality 527
9.4.3.1 Population – Number of Children 527
9.4.3.2 Healthy Local Business Sector – Reducing the Cost of Living 528
9.4.3.3 Reducing Crime 528
9.4.3.4 Reducing Discrimination and Racism 528
9.4.3.5 Political Structure, Leadership and Capacity 528
9.4.3.6 Community Events and Volunteerism 529
9.4.3.7 Recreational Facilities and Opportunities 529
9.4.4 Project Effects: Infrastructure and Services 529
9.4.4.1 Housing and Land Availability 529
9.4.4.2 Transportation Infrastructure – Roads and Airports 529
9.4.4.3 Municipal Services – Water, Sewer, Solid Waste 530
9.4.4.4 Healthcare Services 530
9.4.4.5 Police Services 530
9.4.4.6 Child Care 530
9.4.5 Project Effects: Culture, History and Heritage 531
9.4.5.1 Language Preservation and Restoration 531
9.4.5.2 Traditional Knowledge and Practice Preservation and Restoration 531
9.5 Significance Determination 531

10.0 ACCIDENTS AND MALFUNCTIONS 546

10.1 Emergency Response Plan Overview 547
10.2 Hazardous Materials Storage, Transportation, and Handling 548
10.2.1 Storage-related Spills 548
10.2.1.1 Fuel and Other Petroleum Products 548
10.2.1.2 Cyanide 548
10.2.1.3 Other Materials 549
10.2.2 Transportation-related Spills 549
10.2.2.1 Fuel and Other Petroleum Products 549
10.2.2.2 Cyanide 550
10.2.2.3 Other Materials 550
10.2.2.4 Contractors 550
10.3 Mine Site Infrastructure 551
10.3.1 Pit Wall Failure 551
10.3.2 Waste Rock Dump Failure 552
10.3.3 Tailings Storage Facility Failure 552

10.3.3.1 Design Strategies to Minimize Risk 552
10.3.3.2 Possible Failure Modes 557
10.4 Vehicle and Industrial Accidents Resulting in Injury 559
10.5 Summary of Mitigation Measures 560
10.5.1 Project Construction Phase 560
10.5.2 Project Operations Phase 560

11.0 SUMMARY OF EFFECTS 562
11.1 Summary of Effects and Mitigations 562
11.2 Summary of Residual Effects 562
11.3 Statement of Significance 562

12.0 CUMULATIVE EFFECTS ASSESSMENT 586
12.1 Regulatory Context 586
12.2 Ketza River Project Cumulative Effects Assessment 586
12.2.1 Regional Valued Environmental and Socio-economic Components 587
12.2.2 Cumulative Effects VESEC Baseline Information 589
12.2.3 Spatial Boundaries 589
12.2.4 Temporal Boundaries 589
12.2.5 Regional Developments 589
12.2.5.1 Previous and Existing Developments 589
12.2.5.2 Reasonably Foreseeable Projects 592
12.2.6 Potential Cumulative Effects and Proposed Mitigation Measures 593
12.2.6.1 Natural Landscape, Soil Stability, and Terrain Hazards 594
12.2.6.2 Climate 594
12.2.6.3 Air Quality 595
12.2.6.4 Noise 595
12.2.6.5 Ecosystems and Vegetation 595
12.2.6.6 Wildlife 596
12.2.6.7 Surface Water Quality 596
12.2.6.8 Hydrology 597
12.2.6.9 Hydrogeology 598
12.2.6.10 Aquatic Ecosystems and Fisheries 598
12.2.6.11 Heritage Resources 599
12.2.6.12 Aesthetics 599
12.2.6.13 Socio-economics 599
12.2.7 Significance of Potential Cumulative Effects 602

REFERENCES 603

Ketza River Holdings

TABLES

Table 1 Summary of Proposed Mitigation Measures xiv
Table 1.3-1 Ketza River Mine Working Group Meetings Pertaining to the Ketza River Project 7
Table 1.3-2 Existing Authorizations or Approvals Issued to Ketza River Holdings 8
Table 1.5-1 Applicable Legislation, Regulations, and Anticipated Approvals for the Ketza River Project 11
Table 2.2-1 Summary of Parties Notified of the Ketza River Project 16
Table 2.3-1 Summary of Consultation Methods and Locations 17
Table 2.3-2 Record of Contact with Ross River Dena Council and Ross River Community 17
Table 2.3-3 Record of Contact with Faro Mayor and Council and Faro Community 20
Table 2.3-4 Record of Contact with Liard First Nation 23
Table 2.3-5 Record of Contact with Teslin Tlingit Council and Teslin Community 26
Table 2.6-1 Summary of Common Views Presented in Potentially Affected Communities and First Nations 40
Table 3.2-1 Summary of Active Claims and Leases 44
Table 4.4-1 Summary of Ketza River Project Meteorological Observations (2006 – 2010) 69
Table 4.4-2 Comparison of Monthly Air Temperatures – Ketza River Project and Ross River (Jan 2006 – Aug 2008) 69
Table 4.4-3 Monthly and Annual Rainfall (mm) 72
Table 4.4-4 Monthly and Annual Snowfall (mm) 72
Table 4.4-5 Regional Annual Precipitation Increase with Elevation (mm) 73
Table 4.4-6 Estimates of Monthly Lake Evaporation (mm) 73
Table 4.7-1 Distribution of Bioclimate Zones within the Ketza River Project Local Study Area 84
Table 4.7-2 Distribution of Ecosystem Units and Land Cover Classes within the Ketza River Project Local Study Area 93
Table 4.7-3 Distribution of Sensitive Ecosystems within the Ketza River Project Local Study Area 95
Table 4.7-4 Potential Rare Plants within the Ketza River Project Local Study Area 96
Table 4.7-5 Distribution of Rare Plant Habitat Potential within the Ketza River Project Local Study Area 98
Table 4.7-6 Invasive Species Present along Major Yukon Roadways 100
Table 4.8-1 Wildlife Surveys Conducted at the Ketza River Mine; Wildlife Baseline Program (2007 – 2011) 103
Table 4.8-2 Mammals that Occur, or have the Potential to Occur, in the Wildlife Regional Study Area 104
Table 4.8-3 Conservation Status – Woodland Caribou 106
Table 4.8-4 Population Estimates for the Wolf Lake Caribou Herd 107
Table 4.8-5 Population Estimates for the Finlayson Caribou Herd 107
Table 4.8-6 Caribou Observations, Ketza Wildlife Baseline Program (2007 – 2011) 108
Table 4.8-7 Conservation Status – Moose 110

Table 4.8-8 Summary of Moose Population Estimates near the Wildlife Regional Study Area 112
Table 4.8-9 Incidental Moose Observations, Ketza Wildlife Baseline Program (2007 – 2010) 113
Table 4.8-10 Conservation Status – Thinhorn Sheep 117
Table 4.8-11 Summary of Spring Sheep Observations 120
Table 4.8-12 Summary of Summer Sheep Observations 120
Table 4.8-13 Conservation Status – Mule Deer 124
Table 4.8-14 Conservation Status – Grizzly Bear 124
Table 4.8-15 Conservation Status – Black Bear 126
Table 4.8-16 Conservation Status – Grey Wolf 128
Table 4.8-17 Grey Wolf Observations, Ketza Wildlife Baseline Program (2007 – 2011) 128
Table 4.8-18 Conservation Status – Wolverine 128
Table 4.8-19 Wolverine Observations, Ketza Wildlife Baseline Program (2007 – 2011) 129
Table 4.8-20 Summary of Small Mammal Harvest Data, Ross River Area (1980 – 2006) 131
Table 4.8-21 Birds that Occur, or Have the Potential to Occur, in the Wildlife Regional Study Area 132
Table 4.8-22 Waterfowl and Water Birds of Conservation Concern 136
Table 4.8-23 Raptors of Conservation Concern 137
Table 4.8-24 Passerines of Conservation Concern 142
Table 4.8-25 Conservation Status – Wood Frog 145
Table 4.9-1 Summary of Surface Water Quality Stations and Sampling Events 149
Table 4.9-2 Surface Water Quality Sample Collection Requirements 151
Table 4.9-3 Percentage of Samples that Exceeded CCME Guidelines for Parameters Measured at Background Stations 153
Table 4.9-4 Percentage of Samples that Exceeded CCME Guidelines for Parameters Measured at On Site: Non Tailings Storage Facility Stations 154
Table 4.9-5 Percentage of Samples that Exceeded CCME Guidelines for Parameters Measured at On Site: Tailings Storage Facility Area Stations 155
Table 4.9-6 Percentage of Samples that Exceeded CCME Guidelines for Parameters Measured at Receiving Environment Stations 156
Table 4.9-7 Comparison of Average Total Arsenic Concentrations During Canamax Tailings Storage Facility Discharge and Non-Discharge Periods 163
Table 4.10-1 Summary of Available Flow Monitoring Data for Cache Creek Watershed 165
Table 4.10-2 Baseline Average Monthly Flows (m^3/d) for Cache Creek and Ketza River 168
Table 4.10-3 Regional Hydrometric Data Near the Ketza River Project Local Study Area 169
Table 4.10-4 Natural Variability of Local Flows (+/- Percentage of Monthly Variability) 169
Table 4.11-1 Groundwater Well Summary 177
Table 4.11-2 Hydraulic Test Results 178

Table 4.11-3 Ongoing Quarterly Groundwater Monitoring 185
Table 4.12-1 Summary of Fisheries / Aquatics Baseline Study Components 190
Table 4.12-2 Summary of Fish Capture Studies for Cache Creek and Ketza River (1981 – 1992) 195
Table 4.12-3 Summary of Historic Stream Habitat Assessments for Cache Creek and Ketza River 196
Table 4.12-4 BC Forest Practices Code Stream Riparian Classes 200
Table 4.12-5 Summary of Study Sites and Sampling Effort for 2010 Field Program 200
Table 4.12-6 Spring 2010 Electrofishing Effort, Catch Results and Fish Observations for Ketza River 204
Table 4.12-7 Ketza River Fish Sampling (July and September 2007) 205
Table 4.12-8 Summary of Spring 2010 Electrofishing Effort, Catch Results and Fish Observations for Cache Creek 207
Table 4.12-9 Aquatic Sampling in Lower Cache Creek During July and September 2007 207
Table 4.12-10 Summary of Sampling at Reach 0, Cache Creek 208
Table 4.12-11 Summary of Sampling at Reach 1, Cache Creek 208
Table 4.12-12 Summary of Sampling at Reach 2, Cache Creek 209
Table 4.12-13 Summary of Sampling at Reach 3, Cache Creek 209
Table 4.12-14 Summary of Sampling at Reach 4, Cache Creek 210
Table 4.12-15 Summary of Sampling at Reach 5, Cache Creek 210
Table 4.12-16 Summary of Sampling at Reach 6, Cache Creek 211
Table 4.12-17 Cache Creek Channel Type by Reach 214
Table 4.12-18 Summary of Fish Sampling for Oxo Creek 215
Table 4.12-19 Channel Type by Reach for Oxo Creek 216
Table 4.12-20 Summary of Fish Sampling for Subsidiary Creek 216
Table 4.12-21 Channel Type by Reach for Subsidiary Creek 217
Table 4.12-22 Summary of Fish Sampling for Peel Creek 217
Table 4.12-23 Channel Type by Reach for Peel Creek 218
Table 4.12-24 Stream Sediment Metals (2007) 230
Table 4.12-25 Physical Sediment Analysis Results 231
Table 4.12-26 Coefficient of Variation Values from Grain Size Analysis Results 235
Table 4.13-1 Results of Heritage Resources Assessments 242
Table 5.2-1 Yukon Industries as a Percentage of GDP (2009) 250
Table 6.4-1 Summary of Samples from the Geochemical Characterization Program 270
Table 6.4-2 ARD Classification for Ketza Material Types 270
Table 6.4-3 Average Concentration and Standard Deviation of Leachable Metals per Waste Rock Type 272
Table 6.4-4 Humidity Cell Sample Description 273
Table 6.4-5 Summary of Samples Submitted for Humidity Cell Testing 274

Table 6.4-6 Acid Base Accounting Analyses of Tailings and Ore Composite Samples 275
Table 6.4-7 Metal Leaching Analyses of Tailings and Ore Composite Samples 276
Table 6.5-1 Updated Hydrological Baseline Data for Tailings Pond Catchment 283
Table 6.6-1 Potential Wastes Generated during Construction Phase 305
Table 6.6-2 Estimated Fuel Consumption 306
Table 6.6-3 Estimated Pre-production Mining Work Force for Construction Phase 307
Table 6.6-4 Operations Employment Estimates 320
Table 7.1-1 Ketza River Project Valued Environmental and Socio-economic Components 324
Table 7.1-2 Residual Effects Assessment and Consequence Criteria 326
Table 7.1-3 Consequence Evaluation Criteria 327
Table 7.1-4 Sample Residual Effects Assessment Table 328
Table 8.1-1 Typical Cutslope Ratios 335
Table 8.1-2 Natural Landscape, Soil Stability and Terrain Hazards – Key Environmental Effects and Mitigation 337
Table 8.1-3 Natural Landscape, Soil Stability and Terrain Residual Effects Assessment 338
Table 8.2-1 Trends in GHG Emissions – Yukon and Canada 340
Table 8.2-2 Climate Residual Effects Assessment 341
Table 8.3-1 Air Quality Residual Effects Assessment 344
Table 8.4-1 Noise Residual Effects Assessment 346
Table 8.5-1 Valued Environmental and Socio-economic Components Related to Ecosystems and Vegetation Considered in the Assessment of Project Effects 347
Table 8.5-2 Distribution of Ketza River Project Infrastructure Footprint Components 348
Table 8.5-3 Ecosystem Unit Distribution within the Infrastructure Footprint and Mine Site Local Study Area 349
Table 8.5-4 Sensitive Ecosystem Unit Distribution within the Infrastructure Footprint and Mine Site Local Study Area 350
Table 8.5-5 Rare Plant Habitat Potential Distribution within the Infrastructure Footprint and Mine Site Local Study Area 351
Table 8.5-6 Summary of Ecosystem and Vegetation-Related Mitigation for the Ketza River Project 356
Table 8.5-7 Ecosystem and Vegetation Residual Effects Assessment 357
Table 8.6-1 Valued Environmental and Socio-economic Components Evaluated for Ketza River Project's Wildlife Effects Assessment 359
Table 8.6-2 Summary of Potential Residual Wildlife Effects and Proposed Mitigation Measures 361
Table 8.7-1 Construction Phase Effects Assessment for Surface Water Quality 384
Table 8.7-2 Maintenance and Operations Phase Effects Assessment for Surface Water Quality 390
Table 8.7-3 Reclamation and Closure Phase Effects Assessment for Surface Water Quality 399
Table 8.7-4 Surface Water Quality Residual Effects Assessment 408
Table 8.8-1 Hydrology Residual Effects Assessment 412

Table 8.8-2 Effect on the Watershed Flows for Filling the Tailings Storage Facility During an Average Year....414
Table 8.8-3 Effect on the Watershed Flows for Filling the Water Retention Pond During an Average Year....416
Table 8.8-4 Summary of Potential Effects, Mitigation Measures and Residual Effects for Hydrology....422
Table 8.9-1 Estimated Groundwater Inflow to Open Pits....428
Table 8.9-2 Estimated Inflow Rates to Underground Mines....429
Table 8.9-3 Annual Breakdown of Inflow Rates to Open Pits and Underground Workings....429
Table 8.9-4 Estimated Post-closure Groundwater Flow through Open Pits and Underground Mines....432
Table 8.9-5 Summary of Potential Effects, Mitigation Measures and Anticipated Success for Hydrogeology....435
Table 8.9-6 Hydrogeology Residual Effects Assessment....442
Table 8.10-1 Temporal and Spatial Boundaries for Valued Environmental and Socio-economic Components....443
Table 8.10-2 Project Components and Associated Activities Related to Aquatic Ecosystems and Fisheries Resources....451
Table 8.10-3 Potential Effects and Proposed Mitigation for Project Activities During Construction, Operations and Decommissioning....453
Table 8.10-4 Aquatic Ecosystems and Fisheries Resources Residual Effects Assessment....457
Table 9.1-1 Project Scope Components and Activities....469
Table 9.2-1 Identified Interests....471
Table 9.2-2 Socio-economic Based Valued Environmental and Socio-economic Components Associated with the Project....476
Table 9.2-3 Preliminary Determination of Potential Socio-economic Effects....477
Table 9.3-1 Baseline Indicators: Linkages to Valued Environmental and Socio-economic Components and Interests....481
Table 9.3-2 Employment by Industry, Faro and Ross River (2006)....489
Table 9.3-3 Number of Trainees by Sponsor for Affected Communities, Yukon Mine Training Association. (2009 – 2010)....494
Table 9.3-4 Town of Faro Property Tax Revenues (2007 – 2010)....498
Table 9.3-5 Net GST Collected, Faro and Ross River (1997 – 2006)....498
Table 9.3-6 Federal and Territorial Income Tax Collected, Faro and Ross River (1999 – 2008)....499
Table 9.3-7 Selected Health Indicators, Yukon (2007 – 2010)....499
Table 9.3-8 Litres of Alcohol Sold and Spending on Alcohol, Canada and Yukon (2010)....501
Table 9.3-9 Litres of Alcohol Sold and Spending on Alcohol, Faro (2010)....502
Table 9.3-10 Traffic Counts, Selected Locations, Robert Campbell Highway....503
Table 9.3-11 School Enrolment, Faro and Ross River (2004 – 2010)....505
Table 9.3-12 Number of Businesses and Employees (2008 – 2010)....506
Table 9.3-13 Number of Faro Business Licenses (2005 – 2009)....506
Table 9.3-14 Faro Spatial Price Index (2005 – 2009)....507

Table 9.3-15 Dwellings and Occupied Dwellings, Faro and Ross River (2006) 511
Table 9.3-16 Average Dwelling Value, Faro and Ross River (2006) 511
Table 9.3-17 Yukon Government Airports/Aerodromes 512
Table 9.3-18 Aboriginal Languages in the Yukon (2006) 513
Table 9.4-1 Annual Increase in Community Incomes, Operations Phase 516
Table 9.4-2 Operations Employment 518
Table 9.4-3 Estimated Employment Distribution by Community, Operations Phase 519
Table 9.4-4 Yukon Mineral Royalties and Lease Payments 522
Table 9.4-5 Estimated Total Income Tax, Yukon Employees, by Project Phase 523
Table 9.5-1 Socio-Economic Significance Determination Definitions 532
Table 9.5-2 Significance Analysis, Socio-Economic Effects 533
Table 10.3-1 Suggested Design Flood and Earthquake Level 552
Table 10.3-2 Design Peak Ground Acceleration for the Ketza River Project 553
Table 10.3-3 Design Earthquake Magnitudes for the Ketza River Project 554
Table 10.3-4 Possible Failure Scenarios of the Ketza Tailing Storage Facility 558
Table 11.1-1 Summary of Proposed Mitigation Measures 563
Table 11.2-1 Summary of Residual Effects Assessments within the Local or Regional Study Area 579
Table 11.3-1 Summary of Consequence and Significance Evaluation for Residual Effects 585
Table 12.2-1 VESECs Identified in Effects Assessments (Sections 8 and 9) 587

FIGURES

Figure 1 Ketza River Project Location ii
Figure 1.2-1 Ketza River Project Location 2
Figure 1.3-1 Ketza River Project Setting 6
Figure 2.2-1 Communities near the Ketza River Project 15
Figure 3.1-1 Regional Site Plan 46
Figure 3.2-1 Mineral Claims 47
Figure 3.2-2 First Nations Interim Protected Lands in the Ketza River Project 48
Figure 4.1-1 Study Areas 53
Figure 4.3-1 Terrain and Surficial Geology 55
Figure 4.3-2 Bedrock Geology 59
Figure 4.3-3 Schematic Stratigraphic Column for the Ketza River Project Area 60
Figure 4.4-1 Regional Meteorological Stations 65
Figure 4.4-2 Ketza Meteorological Station Period of Record Wind Rose 66

Figure 4.4-3 Local Hourly Air Temperature 67
Figure 4.4-4 Local Hourly Relative Humidity 68
Figure 4.4-5 Local Incident Solar Radiation 71
Figure 4.4-6 Regional Winter Temperature Trend 75
Figure 4.4-7 Regional Winter Temperature 76
Figure 4.4-8 Regional Summer Temperature Trend 77
Figure 4.4-9 Regional Spring Temperature Trend 78
Figure 4.4-10 Regional Precipitation Trend 79
Figure 4.7-1 Regional Ecology 81
Figure 4.7-2 Study Area Boundaries for the Ketza River Project 83
Figure 4.7-3 Ecosystem Distribution within the Study Areas 85
Figure 4.7-4 Rare Plant Survey Locations in the Local Study Area 99
Figure 4.8-1 Wildlife Study Area 102
Figure 4.8-2 Caribou Distribution, Post Calving 109
Figure 4.8-3 Late Winter Moose Survey 114
Figure 4.8-4 Early Winter Moose Geospatial Survey 115
Figure 4.8-5 Incidental Moose Observations 116
Figure 4.8-6 Thinhorn Sheep Wildlife Key Areas 119
Figure 4.8-7 Spring Thinhorn Sheep Distribution 121
Figure 4.8-8 Summer Thinhorn Sheep Distribution 122
Figure 4.8-9 Winter Thinhorn Sheep Sheep Distribution 123
Figure 4.8-10 Grizzly Bear Observations and Den Locations 127
Figure 4.8-11 Wolverine Observations 130
Figure 4.8-12 Raptor Observations 139
Figure 4.9-1 Surface Water Quality Sampling Stations and Project Footprint 147
Figure 4.9-2 Surface Water Quality Regional Study Area 148
Figure 4.9-3 Average Concentrations of Aluminum from Surface Water Samples 157
Figure 4.9-4 Average Concentrations of Arsenic from Surface Water Samples 157
Figure 4.9-5 Average Concentrations of Cadmium from Surface Water Samples 158
Figure 4.9-6 Average Concentrations of Copper from Surface Water Samples 158
Figure 4.9-7 Average Concentrations of Zinc from Surface Water Samples 159
Figure 4.9-8 Average Concentrations of Ammonia from Surface Water Samples 159
Figure 4.9-9 Average Concentrations of Ammonia (as N) from Surface Water Samples 160
Figure 4.9-10 Average Concentrations of Iron from Surface Water Samples 160
Figure 4.9-11 Average Concentrations of Selenium from Surface Water Samples 161

Figure 4.9-12 Average Concentrations of Silver from Surface Water Samples 161
Figure 4.9-13 Average Concentrations of Cyanide total from Surface Water Samples 162
Figure 4.9-14 Average Concentrations of Total Suspended Solids from Surface Water Samples 162
Figure 4.10-1 Hydrology Monitoring Stations 166
Figure 4.10-2 Average Monthly Flow Hydrograph per Unit Area for the Ketza River Project Local Study Area 167
Figure 4.10-3 Local Study Area Hydrograph Comparison to Regional Hydrograph 170
Figure 4.11-1 Site Plan Showing Monitoring Well Locations 172
Figure 4.11-2 Plan Map Showing Open Pits, Waste Dumps and Peel Fault 173
Figure 4.11-3 Borehole Log HYD-08-01 175
Figure 4.11-4 Groundwater Contours 176
Figure 4.11-5 Piper Plot 181
Figure 4.11-6 Hydrogeological Cross Sections 186
Figure 4.12-1 Fish and Aquatic Resources Study Area 191
Figure 4.12-2 Receiving Environment 2007 Fish Sampling Locations 199
Figure 4.12-3 Receiving Environment 2010 Fish Sampling Locations 202
Figure 4.12-4 Receiving Environment Aquatic Sample Locations 203
Figure 4.13-1 Heritage Assessment Sites within the Project Footprint 240
Figure 4.13-2 Heritage Assessment Sites outside the Project Footprint 244
Figure 6.2-1 Proposed Project Layout 261
Figure 6.3-1 Schematic of Sublevel Stoping Mining Method 265
Figure 6.3-2 Schematic of Drift and Fill Mining Method 266
Figure 6.5-1 Regional Water Catchments Division Plan Map 282
Figure 6.5-2 Average Monthly Water Balance 284
Figure 6.6-1 Preliminary Project Schedule 288
Figure 6.6-2 Existing and Future Road Development 289
Figure 6.6-3 Typical Haul Road Cross Section 291
Figure 6.6-4 Typical Process Plant Layout 294
Figure 6.6-5 Tailings Storage Facility Plan 297
Figure 6.6-6 Tailings Storage Facility Section A-A', B-B' 298
Figure 6.6-7 Tailings Embankment Cross Section A-A' 301
Figure 6.6-8 Tailings Storage Facility Staged Dyked Site Plan 302
Figure 6.6-9 Water Retention Dam Cross-Section B-B' 303
Figure 6.6-10 Plan Map Showing Open Pits, Waste Dumps and Peel Fault 309
Figure 6.6-11 Lab-Hoodoo Pit Plan and Cross Section 310
Figure 6.6-12 Penguin Pit Plan and Cross Section 311

Ketza River Holdings

Figure 6.6-13 Proposed Open Pit Mining Schedule 312
Figure 6.6-14 Typical Carbon-In-Leach Process Flowsheet 315
Figure 7.1-1 Study Areas 325
Figure 8.9-1 Relative Groundwater Elevation in the Open Pit 426
Figure 8.12-1 Viewshed Analysis 463
Figure 8.12-2 Line of Sight Analysis 464
Figure 8.12-3 3D Representative of Line of Sight Analysis from Tarn Lake 465
Figure 9.3-1 Average Annual Big Game Non-Native Harvest in Game Management Zones: 10.01, 10.02, 10.03, 10.04 and 10.05 (2001 – 2010) 485
Figure 9.3-2 Yukon Real GDP and GDP per Person (2000 – 2009) 486
Figure 9.3-3 Faro and Ross River Total Declared Income (1998 – 2008) 487
Figure 9.3-4 Yukon Real GDP (1981 – 2009) 488
Figure 9.3-5 Annual Percentage Changes in Population, Faro (1974 – 2010) 490
Figure 9.3-6 Annual Percentage Changes in Population, Ross River and Yukon (1974 – 2010) 491
Figure 9.3-7 Labour Force Participation, Employment and Unemployment Rates, Affected Communities (2006) 492
Figure 9.3-8 Highest Level of Education Attained, Affected Communities (2006) 493
Figure 9.3-9 Broad Occupational Breakdown, Affected communities (2006) 494
Figure 9.3-10 Male and Female Labour Force Participation Rates, Affected communities and Yukon (2006) 495
Figure 9.3-11 Male and Female Employment Rates, Affected communities and Yukon (2006) 496
Figure 9.3-12 Labour Force Participation Rates and Employment Rates, Aboriginal and Entire Working Age Population, Yukon (2006) 496
Figure 9.3-13 Percentage of Divorced and Separated People 15+ years of age, Affected Communities and Yukon (2006) 500
Figure 9.3-14 Average Annual Number of Drug and Traffic Related Criminal Incidents, Faro and Ross River (1995 – 2003) 501
Figure 9.3-15 Percentage of Yukoners 12+ years reporting having 5 or more Drinks on one Occasion, at Least once a Month 502
Figure 9.3-16 Population of Faro, Ross River and Yukon (1991 – 2010) 504
Figure 9.3-17 Young People Aged 0-24 Years by Age Group, Faro and Ross River (2006 – 2010) 505
Figure 9.3-18 All Reported Criminal Code Violations per 100 Inhabitants. Faro, Ross River and Yukon (2003 – 2009) 508
Figure 12.2-1 Cumulative Effects Assessment Area 590

Ketza River Holdings

PHOTOGRAPHS

Photo 2.3-1 Public Meeting with Presentation, Faro (2007) 30
Photo 2.3-2 Public Meeting with Presentation, Ross River (2007) 30
Photo 2.3-3 Community Dinner, Ross River (2007) 31
Photo 2.3-4 Community Open House, Teslin (2011) 32
Photo 2.3-5 Community Open House, Faro (2010) 32
Photo 2.3-6 Community Open House, Ross River (2010) 33
Photo 2.3-7 Community Open House, Ross River (2011) 33
Photo 2.3-8 Ross River Elders Meeting (July 2011) 34
Photo 2.4-1 Posters at Ross River Open House 2007) 37
Photo 2.4-2 More Posters at Ross River Open House (2007) 37
Photo 4.1-1 Signing the Ross River Dena Council Traditional Knowledge Protocol (July 2011) 54
Photo 4.3-1 View looking Northward of Mostly Alpine Terrain within the Terrain Production Area Footprint 56
Photo 4.7-1 Spruce-Moss Ecosystem Unit – located in the eastern portion of the access road corridor 86
Photo 4.7-2 Heather-Lichen Ecosystem Unit 89
Photo 4.7-3 Willow-Forb complex in the Subalpine southeast of the existing camp 90
Photo 4.7-4 View looking northward at existing roads and general disturbance present within the mine site local study area 94
Photo 4.13-1 Site 1: Western zone of the Ketza River Project along the main valley access road in the valley showing the knoll that was sub-surface tested 241
Photo 4.13-2 Site 1: Western zone of the Ketza River Project footprint along the main valley access road in the valley showing the knoll that was sub-surface tested. The direction photograph is facing south 241
Photo 4.13-3 Site 14: Modern storage cache located south of the airfield along the Ketza Road 245
Photo 4.13-4 Site 14: Modern can midden located south of the airfield along the Ketza Road 245
Photo 4.13-5 Site 5: Northwest corner of the Project; north hillslope. Previous road construction can be seen on the right side of the photo 246
Photo 4.13-6 Remains related to past mining activity at the Ketza River Project 246
Photo 8.6-1 Sweetclover obstructing signage along the Alaska Highway 352

APPENDICES

Volume 2: Appendices A to I

Appendix A **KRH Environmental Policy**

- A1 KRH Environmental Policy for the Ketza River Mine

Appendix B **Existing Authorizations**

- B1 Quartz Mining Land Use Approval
- B2 Ketza Claims Table
- B3 Waste Certificate
- B4 Storage Tank System Permit

Appendix C **Community Consultation**

- C1 Information Provided to Ross River Dena Council and Ross River Community
- C2 Information Provided to Faro Mayor and council and Faro Community
- C3 Information Provided to Liard First Nation
- C4 Information Provided to Teslin Tlingit Council and Teslin Community
- C5 Consideration of Questions and Comments Raised by Ross River Dena Council and Ross River Community
- C6 Consideration of Questions and Comments Raised by Faro's Mayor and Council and Faro Community
- C7 Consideration of Questions and Comments Raised by Teslin Tlingit Council and Teslin Community

Appendix D **Geology and Terrain Baseline Report**

- D1 Bedrock Geology, Surficial Geology and Terrain, Terrain Hazards: 2007 Environmental Baseline Studies

Appendix E **Vegetation Baseline Reports**

- E1 2007 Environmental Baseline Studies Program: Ecosystem Land Classification and Vegetation Baseline Studies
- E2 2008 Environmental Baseline Studies Program: Rare Plant Species and Community Survey

Appendix F **Wildlife Baseline Reports**

- F1 2007-2008 Environmental Baseline Studies: Wildlife Program
- F2 2008 Environmental Baseline Studies: Wildlife Program
- F3 2010-2011 Environmental Baseline Studies: Wildlife Program
- F4 Grizzly Bear Cumulative Effects Assessment Models, Keta River Project

Appendix G **Surface Water Quality Sampling Results**

- G1 Surface Water Quality Testing Results: Summary Tables

Ketza River Holdings

Appendix H **Detailed Hydrogeological Assessment**

H1 Detailed Hydrogeological Assessment, Ketza River Mine, Yukon

Appendix I **Fisheries Baseline Reports**

I1 2007 Environmental Baseline Studies: Aquatic Resources Program

I2 2007 Fisheries Study of Cache Creek Watershed

I3 2010 Environmental Baseline Assessment: Fisheries Study

Volume 3: Appendices J to M1

Appendix J **Heritage Assessments**

J1 2007 Ketza Mine Heritage Assessment Report

J2 2008 Ketza Mine Heritage Assessment Final Report

Appendix K **Acid Rock Drainage**

K1 Summary of Waste Rock Characterization for the Ketza River Mine Project, Yukon

K2 Tailings and Ore Humidity Cell Test Status Update for the Ketza River Mine Project, Yukon

Appendix L **Mine Development and Closure**

L1 Ketza Project Schedule

L2 Operating Personnel Requirements

L3 Conceptual Closure and Reclamation Plan

Appendix M **Pit Stability Assessment**

M1 Manto Geotechnical Open Pit Pre-feasibility Assessment

Volume 4: Appendices M2 to N3

Appendix M **Pit Stability Assessment**

M2 Shamrock Geotechnical Open Pit Pre-feasibility Assessment

Appendix N **Emergency, Spill and Safety Plans**

N1 Ketza Emergency Response Plan

N2 Ketza River Project Safety Manual

N3 Ketza Spill Contingency Plan

ACRONYMS AND ABBREVIATIONS

Acronym	Full Text
AANDC	Aboriginal Affairs and Northern Development
ABA	Acid Base Accounting
ALG	Aquatic Life Guidelines
ANFO	Ammonium Nitrate Fuel Oil
ARD	Acid Rock Drainage
asl	Above Sea Level
ATV	All-Terrain Vehicle
BCWQ	BC Water Quality Guidelines
bgs	Below Ground Surface
BSLT	Silty Black Limestone
BXLT	Blue Fine Grained Crystalline Limestone
CCME	The Canadian Council of Ministers of the Environment
CEA	Cumulative Effects Assessment
CH_4	Methane
CIL	Carbon in Leach
CN	Cyanide
CO_2	Carbon Dioxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSR	Contaminated Sites Regulations
CV	Coefficient of Variation
dBA	Decibels
DDH	Diamond Drill Hole
DFO	Department of Fisheries and Oceans
DHA	Detailed Hydrogeological Assessment
EARP	Environmental Assessment and Review Process
EBA	EBA, A Tetra Tech Company
EDI	Environmental Dynamics Inc.
ELC	Ecological and Landscape Classification
ELR	Ecological Logistics and Research
EMO	Emergency Measures Organization
EMR	Yukon Government Department of Energy Mines and Resources

Acronym	Full Text
EOSD	Earth Observation for Sustainable Development
ERP	Emergency Response Plan
FAL	Freshwater Aquatic Life
FSLT	Archeocyathid Fossils
GDP	Gross Domestic Product
g/t	Grams per Tonne
GHG	Greenhouse Gas
HADD	Harmful Alteration, Disruption or Destruction (of Fish Habitat)
HC	Health Canada
HCT	Humidity Cell Test
HDPE	High-Density Polyethylene
HRSDC	Human Resources and Skills Development
HSC	Health and Social Services
ICSP	Integrated Community Sustainability Plans
KRH	Ketza River Holdings Ltd.
KRP, The Project	Ketza River Project
kt	Kilotonne (10^3)
LECO	LECO Corporation (corporate brand name)
LSA	Local Study Area
LFN	Liard First Nation
m ags	Metres Above Ground Surface
m bgs	Metres Below Ground Surface
m asl	Metres Above Sea Level
m^3/s	Cubic Metres per Second
m^3/day	Cubic Metres per Day
ML	Metal Leaching
MMER	Metal Mining Effluent Regulations
MOU	Memorandum of Understanding
MPA	Maximum Potential Acidity
MSC	Meteorological Service of Canada
MSDS	Material Safety Data Sheet
MSLT	Fine-Grained Light Grey Limestone

Acronym	Full Text
Mt	Megatonne or million tonnes (10^6)
$MtCO_2e$	Megatonnes of Carbon Dioxide Equivalent
N_2O	Nitrous Oxide
NAPS	National Air Quality Surveillance Network
NAQO	National Air Quality Objectives
NP	Neutralizing Potential
NPR	Neutralizing Potential Ratio
oz	Ounces
P.E., P.Eng.	Professional Engineer
PDF	Portable Document Format
PGA	Peak Ground Acceleration
PEL	Probable Effect Level
PM_{10}	Particles 10 Micrometres or Less in Size
$PM_{2.5}$	Particles 2.5 Micrometres or Less in Size
PMF	Probable Maximum Flood
RH	Relative Humidity
RQD	Rock Quality Designation
RRDC	Ross River Dena Council
RSA	Regional Study Area
Sa	Spectrum Acceleration
Salix	Salix Heritage Consulting
SARA	Federal Species at Risk Act
SCP	Spill Contingency Plan
SEPA	Socio-economic Partnership Agreement
Site	Ketza River Mine, near Ross River, Yukon
SLC	Soil Landscapes of Canada
t	Tonne
TC	Transport Canada
tCO_2e	Tonnes of CO_2 equivalency
TDS	Total Dissolved Solids
tpd	Tonnes per Day
TPAF	Terrain Production Area Footprint

Acronym	Full Text
TSF	Tailings Storage Facility
TSP	Total suspended particulates
TSS	Total Suspended Solids
TTC	Teslin Tlingit Council
UFA	Umbrella Final Agreement
VESEC	Valued Environmental and Socio-economic Component
Previous Water Licence	Water Licence QZ04-063 issued to Ketza River Holdings
W/m^2	Watts per Square Metre
WBN	Thin And Wispy Silt Banded Limestone
WMO	World Meteorological Organization
WKA	Wildlife Key Area
WRP	Water Retention Pond
WRSA	Wildlife Regional Study Area
YESAA	*Yukon Environmental and Socio-economic Assessment Act*
YESAB	Yukon Environmental and Socio-economic Assessment Board
YG	Government of Yukon
YG TC	YG, Department of Tourism and Culture
YG THB	YG, Department of Tourism, Heritage Branch
YGC	YGC Resources Inc.
YMTA	Yukon Mine Training Association
YNG	Yukon-Nevada Gold Corporation
YWCHSB	Yukon Workers' Compensation Health and Safety Board

1.0 INTRODUCTION

1.1 The Organization and Layout of the Project Proposal

Ketza River Holdings, (KRH) is pleased to submit the Ketza River Mine Project Proposal (Project Proposal) for assessment and consideration under the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*).

The Project Proposal follows a report format that is consistent with the order of topics set out in the Yukon Environmental Assessment Board's *Proponents Guide to Information Requirements for Executive Committee Project Proposal Submissions* (YESAB 2005). A list of acronyms and abbreviations used throughout the document is located after the Table of Contents.

The Project Proposal's tables, figures and photographs are incorporated within the body of the text and are listed in the Table of Contents. Main sections of the Project Proposal have dedicated Appendices which are referenced in each Section (e.g., KRH Environmental Policy – Appendix A). Where appropriate, Appendices are subdivided into sub-appendices (e.g., A1, A2, A3 etc.). Appendices are contained at the back of the Project Proposal and in digital form on a compact disc.

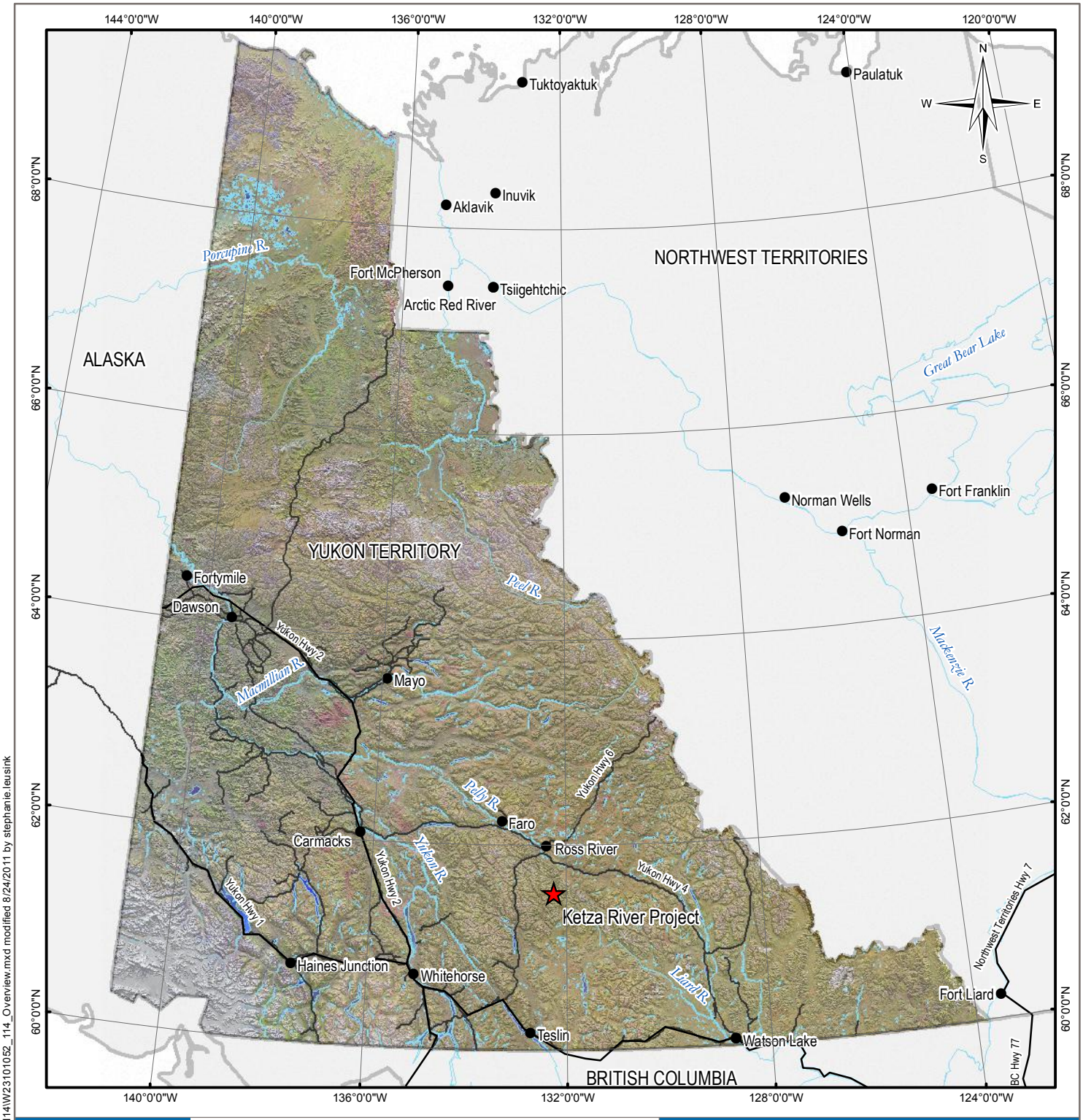
1.2 Proponent Information

KRH is the Proponent for the proposed Ketza River Project (the Project; KRP; Figure 1.2-1). The Ketza River Mine is owned and undergoing exploration by KRH, which in turn is wholly owned by Yukon-Nevada Gold Corp. (YNG). YNG is a North American gold company in the business of discovering and developing gold deposits (YNG 2011). YNG holds a portfolio of gold, silver, zinc and copper properties in the Yukon Territory and British Columbia, Canada and in Nevada, United States (YNG 2011). YGC Resources Ltd. merged with Queenstake Resources Ltd. to become Yukon-Nevada Gold Corp. on June 20, 2007, thus acquiring Jerritt Canyon, a gold producing property in northeastern Nevada. Jerritt Canyon has been in production since 1982.

The Proponent representative is Mr. Graham Dickson (B.Sc. A.R.C.S.), President of KRH. Mr. Dickson has worked in the North American mining industry for 31 years, during which time he has acted as general manager of a turnkey construction company servicing gold milling facilities in remote locations, including: the Snip Mill (Cominco Ltd.); Golden Patricia Mill (Bond Gold); and Seabee Mill (Claude Resources). Prior to joining YNG, Mr. Dickson also served in various capacities with BYG Natural Resources Ltd., which had an operating gold mine in the Yukon Territory. Recently, as General Manager of Argent Mining, Mr. Dickson oversaw the construction of surface facilities for Bema Gold's Julietta mine in far east Russia, which were completed ahead of schedule and under budget.

Mr. Dickson can be contacted at:

Ketza River Holdings
900-688 West Hastings St.
Vancouver, BC V6B 1P1
1.604.688.9427



LEGEND

- Site Location
- Populated Place
- Roads
- Waterbodies
- Political Boundaries

NOTES
Base data source: ESRI, Government of Yukon

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Ketza River Project Location

PROJECTION	DATUM	CLIENT
Yukon Albers	NAD83	Ketza River Holdings

Scale: 1:6,000,000
100 50 0 100
Kilometres

FILE NO. W23101052_114_Overview.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	KG	KG	0

OFFICE	DATE
EBA-VANC	July 13, 2011

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Figure 1.2-1

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Primary Contact

EBA, a Tetra Tech Company (EBA) was retained by KRH to prepare the Project Proposal including the effects assessment and proposed mitigations. EBA is also the primary contact for the KRP through the *YESAA* process.

For the purposes of this Assessment please use the following contacts:

Main Contact:

Kristina Gardner, RPF, MSF
YESAA Project Manager
Whitehorse Environment Group
EBA, A Tetra Tech Company
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Alternate Contact:

Tania Perzoff, M.Sc., RPBio.
Ketza Project Manager
Vancouver Mining Group
EBA , A Tetra Tech Company
Direct Line: 604.685.0017 x226
Email: tperzoff@eba.ca

Ms. Kristina Gardner is the primary contact for the KRP for the purposes of the *YESAA* assessment. Ms. Gardner is the Community and Regulatory Affairs Specialist in EBA's Whitehorse office. Ms. Gardner has 16 years of experience in natural resource management and development assessment for industrial clients, including four years in this capacity in the Yukon. Her professional experience includes managing development projects through assessment and permitting, community consultation, and environmental and socio-economic effects assessment.

Ms. Tania Perzoff is the alternate contact for the Project. Ms. Perzoff is a Senior Biologist with EBA in the Vancouver-based mining practice. She has 17 years of experience with environmental impact assessment, regulatory and permitting support, vegetation baseline study design and implementation, and project management. She has worked on numerous mining projects in British Columbia, the Arctic, Yukon, Saskatchewan, as well as internationally.

As Primary Contacts, Ms. Gardner and Ms. Perzoff will manage any inquiries or requests for additional information about the KRP, and liaise with regulators, affected communities, and the Proponent as required to manage the KRP through the *YESAA* process.

1.2.1 Corporate Policies

KRH recognizes responsible environmental stewardship as an integral part of its business practices and has recognized environmental management as a corporate priority. KRH has integrated environmental factors into the decision-making process throughout the company. Sufficient resources have and will be devoted to environmental protection and remediation to minimize environmental risks and to protect the environment and public welfare during the Company's activities. KRH's *Environmental Policy for the Ketza River Mine* (Appendix A1)operates in accordance with International Standards Organization (ISO) 14001, and outlines the overarching environmental commitments of the company (Appendix A1). These commitments are designed to provide KRH with the ability to establish environmental procedures, which can be implemented, communicated, maintained and evaluated. The Environmental Policy and resulting procedures will be communicated to employees and contractors working at the KRP.

An Environmental Protection Policy, a document that is directed at mine staff concerning personal conduct on Site with respect to the Project and the environment, will be developed prior to construction, and will include the Emergency Response Plan (ERP).

1.3 Project Background

1.3.1 Chronology of Mining Operations at Ketza River Mine

In 1947, lead-silver veins were discovered in the Ketza River area by prospectors of the Hudson Bay Mining and Smelting Company Limited. Gold mineralization on the property was first discovered in 1954 by Conwest Exploration Company Limited (Conwest). Between 1955 and 1960, Conwest explored several mineralized occurrences with trenching and drilling.

Interest in the property was renewed in 1983, when Pacific Trans Ocean Resources Ltd. (Pacific Trans Ocean) optioned the property from Conwest and carried out limited geochemical and geological surveys before entering into a joint venture with Canamax Resources Inc. (Canamax) in 1984.

Between 1984 and 1990, Canamax conducted mapping, trenching, geophysical surveys, soil sampling, drilling, underground development and production. In 1987, Canamax completed a feasibility study which was reviewed by Wright Engineers Ltd. (Canamax and Pacific Trans-Ocean 1987). A decision was made to construct a mill and commercial production started in 1988. Canamax purchased Pacific Trans-Ocean's interest in the KRP in January 1989.

From 1988 to 1990 commercial production used conventional carbon-in-pulp (CIP) cyanidation techniques to produce gold from mined ore. Commercial production included commercial opportunities for the community of Ross River and the Kaska Nation. While commercial production was in operation a Memorandum of Understanding (MOU) was in place with the Kaska Nation, comprised of the Ross River Dena Council (RRDC) and the Liard First Nation (LFN).

From July 1988 to November 1990, commercial production from the Ketza River mill was approximately 2,778 kg (93,312 oz from production drilling and 4,680 oz from preproduction milling) of gold from 337,343 tonnes (t) milled at an average mill head grade of 10.68 grams per tonne (g/t) during production and 7.78 g/t during preproduction of gold. Average mill throughput over the life of the mine was 364 tonnes per day (tpd) with an average gold recovery of 88.31% (Canamax 1991).

Process tailings from the Canamax operation are contained in a surface impoundment behind two earth-fill water retaining dams (Figure 1.3-1). During the period of mine operations, water was recycled from the tailings impoundment for use in ore processing. Excess water from the tailings impoundment was treated for removal of cyanide and heavy metals prior to release to the environment (Gartner Lee et al. 2001).

In 1992 Wheaton River Minerals Ltd. (Wheaton) acquired the property from Canamax. In 1994 Wheaton transferred it to YGC Resources Inc. (YGC) in exchange for a controlling interest. Wheaton later divested in YGC.

From 1993 to 1995 Helmo Gold Mines had an option on claims located outside the main resource area and conducted exploration drilling. From 1994 to 1997 YGC conducted drilling, mapping and sampling programs at the KRP. From 2005 to 2008 YNG conducted drilling and exploration campaigns.

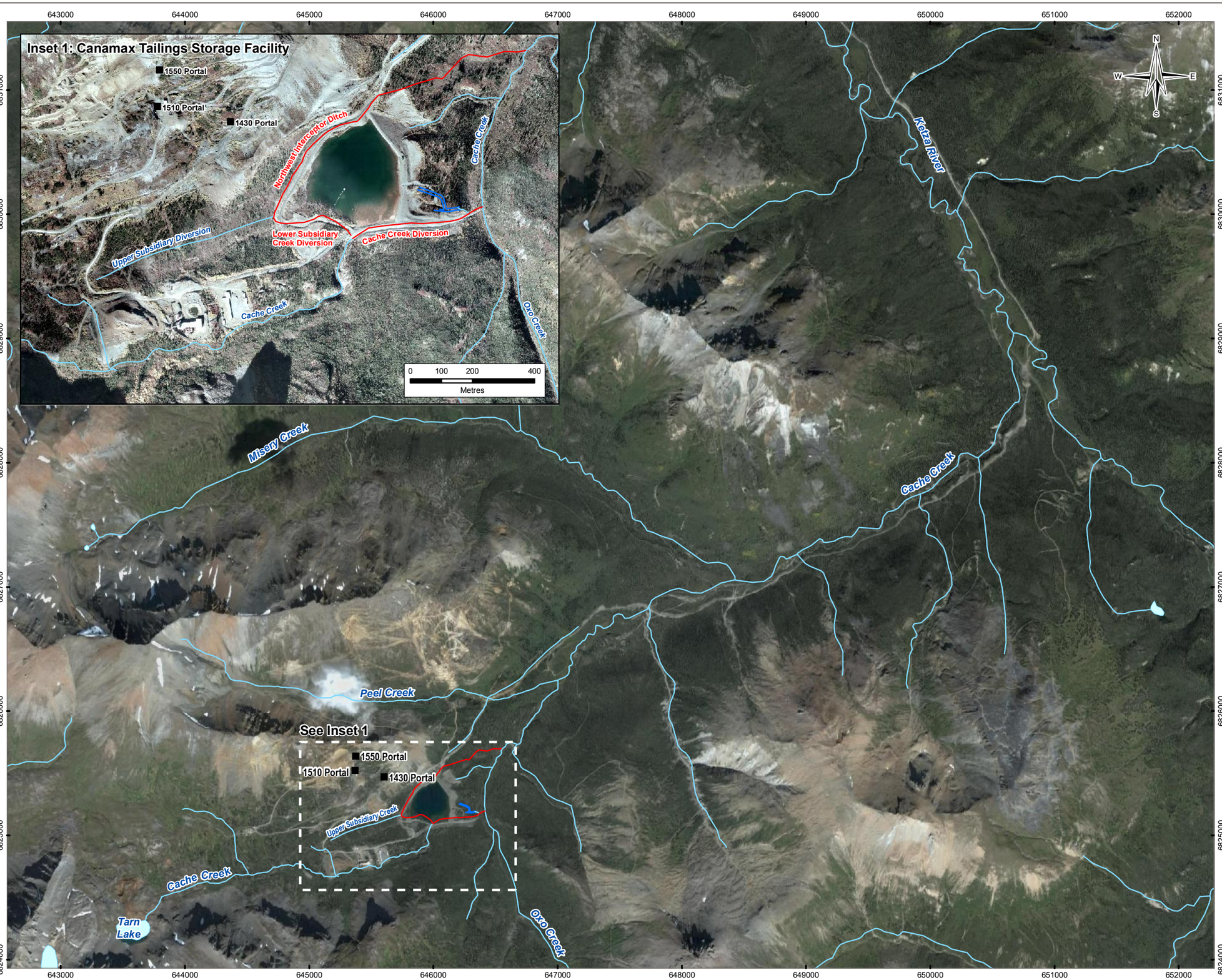
In 2006 and 2007 YGC conducted cleanup at the Site. Reclamation efforts to date have included removing chemicals and waste petroleum from the Site, disposing of 600 barrels of miscellaneous substances, and removing over 100 truck loads of garbage, including scrap metal. Various areas have also been resloped and seeded, several buildings have been removed, and a new incinerator was installed to replace the existing landfill. In 2007 YGC received the Robert E. Leckie Award for Outstanding Environmental Reclamation Practices. The Robert E. Leckie Award honours a mining inspector from Mayo, and is presented to recipients for exceptional reclamation and restoration efforts (YG EMR 2010).

In 2007 YGC merged with Queenstake Resources Ltd and formed YNG, acquiring the Jerritt Canyon property in Nevada. From mid-2009 to December 2010 drilling exploration campaigns have been ongoing by YNG. Exploration is planned to continue in 2011 and through mine permitting and development.

1.3.2 Communications

KRH has been communicating regularly with potentially 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. KRH and their representatives have been working with all parties to acquire and present information required for the successful permitting of the KRP into the Project Proposal.

To further facilitate regular communication amongst the various parties involved and interested with the KRP, a working group (the Ketza River Mine Working Group) was established which meets approximately every six weeks. The meetings provide an opportunity to collaboratively exchange information between regulators, affected First Nations, and the proponent regarding the KRP in order to facilitate regulatory processes through the life of the mine. The Ketza River Mine Working Group is supported by technical sub-working groups which meet on an as-needed basis to discuss the technical details of the various KRP components. The Ketza River Mine Working Group membership changes in relation to the active KRP components being considered or addressed. Ketza River Mine Working Group meetings which focused on the KRP are summarized in Table 1.3-1.



LEGEND

- Portal
- Emergency Spillway
- Diversion
- Drainage
- Waterbody

NOTES
Base data source: NTS 1:50,000
Imagery from Google Earth Pro.

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Ketza River Project Setting

PROJECTION UTM Zone 8			**DATUM** NAD27		
Scale: 1:30,000 400 200 0 400 Metres					
FILE NO. W23101052_114_SiteWaterMgmt.mxd					
PROJECT NO. W23101052.114	**DWN** SL	**CKD** KG	**APVD** TP	**REV** 0	
OFFICE EBA-VANC	**DATE** July 26, 2011				

CLIENT Ketza River Holdings

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Figure 1.3-1

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Parties included in the working group are:

- YESAB
- EBA
- KRH
- YG
- Canadian Northern Economic Development Agency (CanNor)
- Natural Resources Canada (NRC)
- Transport Canada (TC)
- Health Canada (HC)
- TTC
- RRDC, invited but have not yet attended
- LFN, invited but have not yet attended
- Environment Canada (EC)
- Fisheries and Oceans Canada (DFO).

Table 1.3-1: Ketza River Mine Working Group Meetings Pertaining to the Ketza River Project

Date	Parties Present	Pertinent Component of Meeting
November 24, 2010	KRH, EBA, YG	Development of Working Group objectives and structure, update of progress to date in preparation for Project Proposal to YESAB Executive Committee
January 11, 2011	KRH, EBA, YG	Formalization of Working Group objectives and structure, update of consultation to date in preparation for Project Proposal to YESAB Executive Committee
February 24, 2011	KRH, EBA, YG, TTC, CanNor, YESAB, EC	Presentation provided to give an overview of the KRP, planning and objectives
April 21, 2011	KRH, EBA, YG, YESAB, TTC	Update on timing of submission of Project Proposal to YESAB Executive Committee
April 21, 2011	KRH, EBA, CanNor, EC, NRC, TC	Presentation provided to give an overview of the KRP, planning and objectives
June 16, 2011	KRH, EBA, YG, TTC, CanNor, EC	Update on timing of submission of Proposal Proposal to YESAB Executive Committee
June 16, 2011	KRH, EBA, CanNor, EC, NRC, DFO, HC, CanNor	Presentation provided to give an overview of the KRP, planning and objectives

1.3.3 Existing On-Site Facilities

KRH currently maintains a number of facilities on the Site (the footprint of the existing and proposed mine workings) as part of its care and maintenance and mineral exploration activities. These facilities include:

- A camp and ancillary buildings for support of up to 49 people
- A propane-fired solid waste incinerator
- A potable water supply, including a well, water treatment facility and storage tanks
- A sewage treatment facility comprised of two siphon tanks and a septic field
- A tailings storage facility (TSF) from Canamax commercial operation
- A mill building and ancillary facilities
- A 160 KW diesel-operated generator set for electric power supply (two back-up units at 210 kW and 60 kW)
- A tank farm with diesel and gasoline tanks
- Access roads, including the Ketza Road from the Campbell Highway to the Site
- Other ancillary facilities.

1.3.4 Existing Authorizations and Approvals

KRH currently holds Mining Land Use Approval LQ00156 for the Ketza River Mine (Appendix B1). KRH is currently in the process of applying for a Type A Water Licence to continue care and maintenance of the Canamax TSF, and has applied for a Type B Water Licence to conduct care and maintenance of the existing Ketza Road to the Site. The KRP is comprised of both Quartz Leases and Quartz Claims (Appendix B2. These are discussed in Section 3.2.1.

YG Department of Environment, Environmental Programs Branch has advised that the Ketza River Property is not a Designated Contaminated Site pursuant to the Contaminated Sites Regulation (*Environment Act*); however, the Branch does have information regarding some contamination on the property (File 4202-20-124). Table 1.3-2 shows the existing authorizations or approvals that have been issued for KRH. Copies of existing authorizations are contained in Appendix B.

Table 1.3-2: Existing Authorizations or Approvals Issued to Ketza River Holdings

Authorization / Approval	Number
Quartz Mining License	LQ001565
Quartz Lease	105F09-001
Waste Management Permit	81-013
Storage Tank System Permit	02011-41

1.3.5 Care and Maintenance Program

Since 2004, KRH has conducted a care and maintenance program at the Site. This program has included an environmental monitoring program with a number of monitoring stations at the Site to measure water quality and water quantity. This monitoring is further described in Section 4.10.

KRH has obtained required authorizations required for the care and maintenance program at the Site, for instance, approvals such as waste management and storage tanks permits (Table 1.3-2).

KRH has also completed an environmental cleanup and reclamation program of the wastes and un-used products that remained on the Site from the Canamax commercial operation. This included:

- Removal of approximately 800 empty or full barrels containing acid, waste oil, sodium hydroxide, and unknown caustic substances
- Removal of approximately 70 truck loads of general waste, including un-used mill buildings and scrap metal. Barrels and other materials were removed and disposed of in accordance with applicable regulations
- A former barrel storage area near the Canamax TSF and a solid waste dump were decommissioned, reclaimed and revegetated
- Exploration sites in the area, where there are no future plans for additional mining, have been reclaimed and revegetated as well.

In 2007, KRH was granted the Robert E. Leckie Award for Outstanding Environmental Reclamation Practices for its cleanup and reclamation program at Ketza River Mine. The Robert E. Leckie Award is presented to worthy recipients for exceptional reclamation and restoration efforts, in honour of Robert E. Leckie, an innovative mining inspector in Mayo who passed away in 1999 (YG EMR 2010).

1.4 Project Purpose

The purpose of the Project is to design, construct, operate, decommission and abandon a gold and silver extraction mine in south-central Yukon to address current market demands for gold and silver.

KRH's objectives for the KRP are to:

- Design, construct and operate a cost-effective and environmentally responsible mine project
- Extract gold-bearing ore from nine open-pit mines and two potential underground mines, expanding on previous mining areas where applicable, operating for five years, commencing in fall 2014
- Process the ore on site using a Carbon in Leach (CIL) system, and pour gold doré bars for transport to Whitehorse
- Provide employment opportunities to local communities
- Minimize and mitigate potential environmental effects from inception through the life of the mine
- Decommission and reclaim the mine site using best practices.

Mining operations will be conducted in an environmentally responsible manner and in accordance with best practices. The operation will enhance the social and economic well-being in the area, where possible. The socio-economic benefits from the Canamax operation at the Ketza River Mine are known to local residents. The re-opening and operation of the mine will allow for the continuation of socio-economic benefits to local residents and all Yukoners.

Gold and silver prices are currently high and are expected to remain high for a number of years. Exploration on the property has identified potential areas of additional mining, which would expand the KRP mine life at the Site. These potential new areas are not part of this KRP scope and may require separate *YESAA* assessment if added to the KRP at a later date.

There are significant advantages to developing a mine at this Site, particularly as it presents the opportunity to incorporate pre-existing disturbance and infrastructure into the new mine design. Wildlife and human users of the area are accustomed to the presence of the mine, and have accommodated it in their activities and patterns. Developing a previously disturbed area reduces additional habitat fragmentation and linear habitat disturbance. Furthermore, major infrastructure components are in place, including:

- Access and ancillary roads and bridges
- Electric power distributed around the site
- Camp and ancillary buildings
- Sewage treatment plant
- Waste management disposal equipment and practices
- Mill building.

These components are planned to be used or upgraded for the KRP, alleviating the development of new access roads, electrical systems and other infrastructure and services.

1.5 Required Authorizations and Regulatory Approvals

1.5.1 YESAA Requirements

The KRP requires assessment under *YESAA* Section 47 by YESAB as it:

- Is located in the Yukon
- Involves project and accessory activities listed in the *Assessable Activities, Exceptions and Executive Committee Project Regulations*, including:
  - Schedule 3, Part 3 (b; Construction, decommissioning or abandonment of a gold mine with an ore production capacity of 300 tpd or more)
- Requires or may require the following permits or licenses:
  - Quartz Mining License
  - Type A Water Licence
  - Federal Fisheries Authorization.

Details of the required permits and licenses are detailed in Section1.5.2.

1.5.2 Applicable Legislation and Anticipated Required Permits and Licenses

Quartz Mining Licence

The Quartz Mining License, issued under the *Quartz Mining Act*, is anticipated to be required by the KRP, and may be issued in two phases as follows:

- Phase 1 – authorization to proceed with construction activities which do not require licensing through the *Waters Act* (Yukon)
- Phase 2 – authorization to finalize construction activities and proceed with the mining program (in concert with *Waters Act* (Yukon) licensing).

Type A Water Licence

Water licensing is conducted by the Yukon Water Board under the *Waters Act* (Yukon). It is anticipated that the KRP will require a Type A Water Licence for its operation activities.

Federal Fisheries Authorization

An authorization under the Federal Fisheries Act is required if possible Project-related effects on fish or fish habitat are identified. It is anticipated that the KRP will potentially require a Fisheries Authorization for its construction and operation activities.

Applicable legislation, regulations and anticipated approvals for the Project are identified in Table 1.5-1.

Table 1.5-1: Applicable Legislation, Regulations, and Anticipated Approvals for the Ketza River Project

Legislation or Applicable Organization	Regulations	Anticipated Approvals
Federal		
Canada Wildlife Act		
Canadian Environmental Protection Act		
Explosives Act	Blasting Regulations	Blasting Permit
		Factory Licence
		Explosives Magazine Permit
	Ammonium Nitrate and Fuel Oil (ANFO) Order	Non-mechanical ANFO Certificate
		Blasting Explosives Purchase and Possession Permit
		Permit to Transport Explosives
Fisheries Act	Metal Mine Effluent Regulations	Metal Mining Effluent Authorization
		Authorization for Works or Undertakings Affecting Fish Habitats
		Fisheries Authorization
Migratory Birds Convention Act		

Table 1.5-1: Applicable Legislation, Regulations, and Anticipated Approvals for the Ketza River Project

Legislation or Applicable Organization	Regulations	Anticipated Approvals
Navigable Waters Protection Act		Navigable Waters authorization
Species at Risk Act		
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
		Plumbing Permit
Dangerous Goods Transportation Act	Dangerous Goods Transportation Regulation	
Electrical Protection Act		Electrical Permit
Environment Act	Storage Tank Regulations	Storage Tank Permit
	Air Emissions Regulations	Air Emissions Permit
	Solid Waste Regulations	Solid Waste Permit
	Special Waste Regulations	Special Waste Permit
	Contaminated Sites Regulations	Relocation Permit
		Land Treatment Facility (LTF) Permit
	Spills Regulations	
Gas Burning Devices Act		
Highways Act	Highways Regulations	Overdimensional Weight Permit
	Bulk Commodity Haul Regulations	Access Permit
Historic Resources Act	Archaeological Sites Regulation	Archaeological Sites Permit
Lands Act	Lands Regulation	
Occupational Health and Safety Act	Occupational Health and Safety Regulations	Sewage Disposal System Permit
Public Health and Safety Act	Eating and Drinking Places Regulation	Permit to Operate a Food Premises
	Sewage Disposal Systems Regulation	Permit to Install a Sewage Disposal System
	Drinking Water Regulation	
Quartz Mining Act	Quartz Regulation	Quartz Mining License
Territorial Lands (Yukon) Act	Territorial Lands Regulation	Land Use Permit
	Land Use Regulation	Land Lease
	Territorial Quarrying Regulation	Quarry Permit
Waters Act	Waters Regulation	Water Licence
Wildlife Act	Wildlife Regulations	
Yukon Environmental and Socio-economic Effects Act	Assessable Activities, Exceptions and Executive Committee Projects Regulations	Decision Document

Table 1.5-1: Applicable Legislation, Regulations, and Anticipated Approvals for the Ketza River Project

Legislation or Applicable Organization	Regulations	Anticipated 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 Systems Containing Petroleum and Allied Petroleum Products	
	Canada-wide Standards for Petroleum Hydrocarbons in Soil	
Canadian Dam Association	Canadian Dam Association Dam Safety Guidelines	
Canadian Electrical Code		
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 *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 KRH notified, engaged with, and consulted potentially affected communities and First Nations regarding the KRP. It also describes how any views or information provided to KRH about the KRP 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 KRP, the route to be taken by Project-related traffic and the foreseeable environmental, economic and social effects of the Project, KRH identified the following communities as being potentially affected (also shown on Figure 2.2-1):

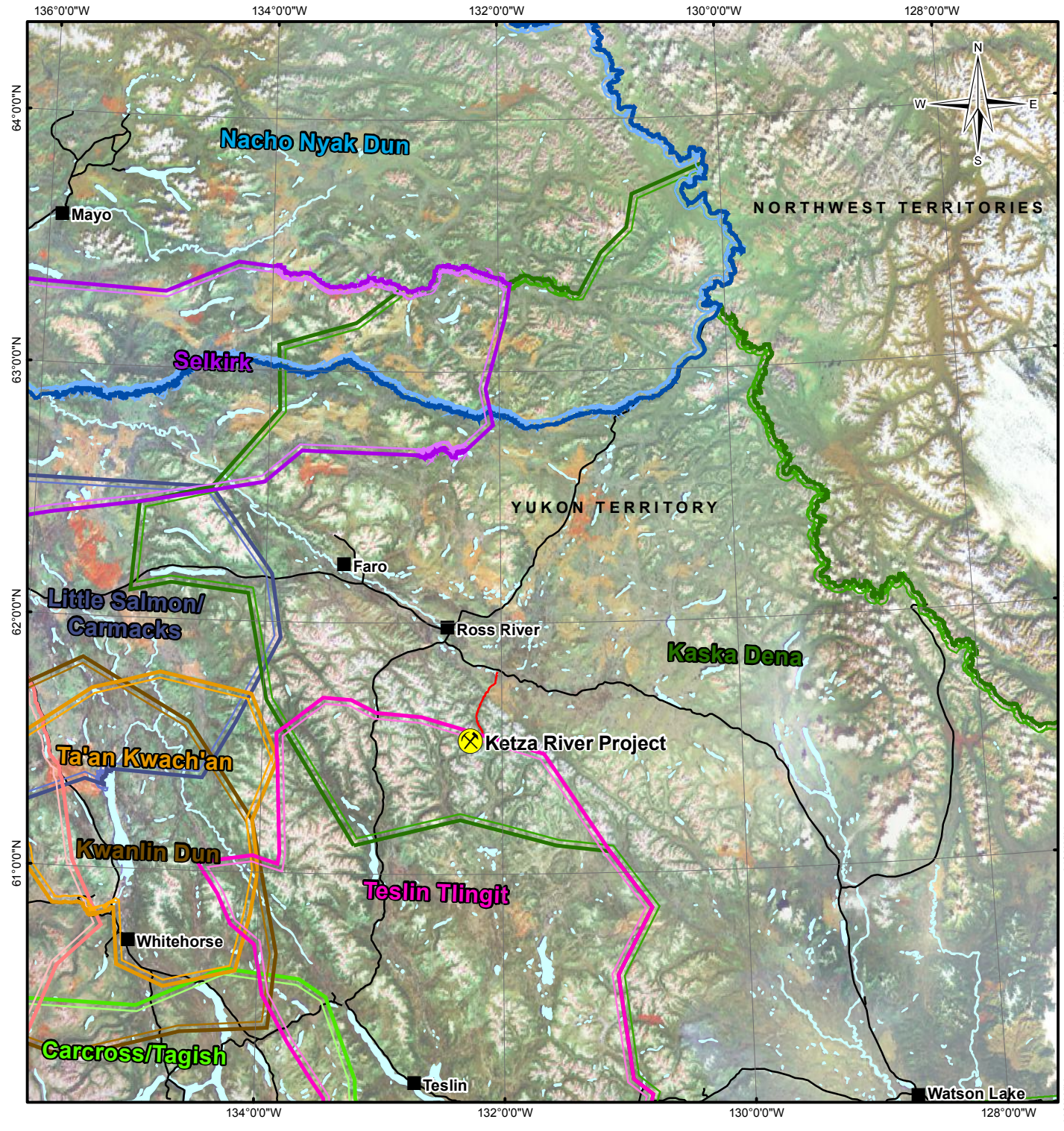
- The community of Ross River
- The Municipality of the Town of Faro (Faro).

KRH identified that the KRP is located within the traditional territories of the following three First Nations, and needed to consult with each First Nation regarding the KRP:

- Ross River Dena Council (RRDC)
- Liard First Nation (LFN)
- Teslin Tlingit Council (TTC).

Table 2.2-1 provides a summary of those communities and First Nations who were contacted and given notice of the KRP. The information provided to communities and First Nations, including copies of letters, flyers, emails, presentations and KRP information handouts, are appended to this proposal (Appendix C). The appended information is grouped by community as follows:

- Appendix C1: Information Provided to Ross River Dena Council and Ross River Community
- Appendix C2: Information Provided to Faro Mayor and Council and Faro Community
- Appendix C3: Information Provided to Liard First Nation
- Appendix C4: Information Provided to Teslin Tlingit Council and Teslin Community.



LEGEND

First Nation Traditional Territories

- Carcross/Tagish
- Champagne & Aishihik
- Kaska Dena (Ross River Dena Council; Liard First Nation)
- Kwanlin Dun
- Little Salmon/Carmacks
- Nacho Nyak Dun
- Selkirk
- Ta'an Kwach'an
- Teslin Tlingit

- Town or Community
- Ketza River Project
- Major Road
- Ketza Road

NOTES
Base data source: Yukon Geomatics

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Communities Near the Ketza River Project

PROJECTION	DATUM	CLIENT
Albers	NAD83	Ketza River Holdings

Scale: 1:2,500,000
50 25 0 50
Kilometres

FILE NO. W23101052_103_FirstNations.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.103	SL	TP	KG	0

OFFICE	DATE
EBA-VANC	July 26, 2011

eba A TETRA TECH COMPANY

Figure 2.2-1

Q:\Vancouver\GIS\ENVIRONMENTAL\W23\W23101052_KetzaMaps\103\W23101052_103_FirstNations.mxd modified 8/24/2011 by stephanie.leusink

Table 2.2-1: Summary of Parties Notified of the Ketza River Project

Contact Information	Method of Contact
Chief Jack Caesar and Mary Maje, *YESAA* Coordinator RRDC General Delivery Ross River, YT YOB 1SO	Letters, emails, telephone calls, meetings. See Table 2.3-2 and Appendix C1 for further details.
Community of Ross River	Posters at RRDC office and Dena Store, and flyers sent to each household advertising public meetings/open houses (approximately 90 occupied houses and businesses). Meetings and open houses. See Table 2.3-2 and Appendix C1 for further details.
Mayor and Council Municipality of the Town of Faro P.O. Box 580 Faro, YT Y0B 1K0	Letters, emails, telephone calls, meetings. See Table 2.3-3 and Appendix C2 for further details.
The Municipality of the Town of Faro (Faro)	Posters at Municipal Administration Building and Discovery Store, and flyers sent to each household advertising public meetings/open houses (approximately 275 occupied houses and businesses). Postings in monthly newsletter. Meetings and open houses. See Table 2.3-3 and Appendix C2 for further details.
Chief Liard McMillan LFN Box 328 Watson Lake, YT Y0A 1C0	Letters, emails, telephone calls, meetings. See Table 2.3-4 and Appendix C3 for further details.
Chief Executive Officer Peter Johnston, and Environmental Officers: Connie Jules and Karl Blattman TTC Box 133 Teslin, YT Y0B 1B0	Letters, emails, telephone calls, meetings. See Table 2.3-5 and Appendix C4 for further details
Community of Teslin	Posters at TTC office and Nisutlin Trading Post, and flyers sent to each household advertising public meetings/open houses (approximately 161 occupied houses and businesses). Meetings and open houses. See Table 2.3-5 and Appendix C4 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 Methods and Locations

Method	RRDC and Ross River Community	Faro Mayor and Council and Faro Community	LFN	TTC and Teslin Community
Public Meeting(s)	✓	✓	-	✓
Information Open House	✓	✓	✓	✓
Information Handouts	✓	✓	✓	✓
Community Publications and Emails	-	✓	-	✓
Meetings with Chief/Executive Director/Mayor and Council	✓	✓	✓	✓

Dates, methods, format and content of contact with First Nations and communities are provided in Tables 2.3-2 (RRDC and Ross River Community), 2.3-3 (Faro Mayor and Council and Faro Community), 2.3-4 (LFN), and 2.3-5 (TTC and Teslin Community) along with the time provided for recipients to consider the information. Where N/A is used in the tables, it indicates that time provided for the recipients to consider the information received was either not provided or not applicable. The location of supporting documentation is also provided in Tables 2.3-2 to 2.3-5.

Table 2.3-2: Record of Contact with Ross River Dena Council and Ross River Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
28-Jan-07	Mailed flyers to residences and businesses. Emailed posters to RRDC	Flyers and poster advertised community meeting scheduled for February 12, 2007.	15 days	Appendix C1: flyers and posters
30-Jan-07	Meeting	Meeting held between KRH and Kaska Nation representatives, including members from RRDC, LFN, and Kaska Tribal Council, regarding general issues surrounding the Project Proposal, the MOU and its implementation.	N/A	N/A
12-Feb-07	Community open house14 attendees. 2:00-5:00 pm	KRP presentation and discussion. Provided an informal opportunity for people to call in, review and collect information, and ask questions.	N/A	Appendix C1: presentation; Appendix C5: comments and questions

Table 2.3-2: Record of Contact with Ross River Dena Council and Ross River Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
12-Feb-07	Community dinner (provided by KRH). 80 attendees (60 adults, 20 children). 5:30-8:30pm	Community dinner, followed by presentations on the proposed mine, the YESAA process, and the socio-economic considerations.	N/A	Appendix C1: presentation; Appendix C5: comments and questions
13-Feb-07	Meeting with Chief and Council. 9:30am – 12:00pm	Meeting to provide a KRP overview and general discussion.	N/A	Appendix C5:: comments and questions
28-Feb-07	Letter from KRH to RRDC	Letter thanking RRDC for the opportunity to hold meetings in Ross River on February 12 and 13, 2007.	N/A	Appendix C1: letter
6-Mar-07	Letter from KRH to RRDC	Letter requesting a workshop with Ross River residents on March 28, 2007.	14 days	Appendix C1: letter
18-Mar-07	Mailed flyers to residences and businesses. Emailed posters to RRDC	Flyers and poster advertised community meeting for March 28, 2007.	N/A	Appendix C2: flyers and posters
28-Mar-07	Meeting with Elders. 9 attendees. 2:00-4:30pm	Meeting to discuss the experiences with previous mines in the area and the Project Proposal. Poster boards were displayed.	No end date specified	Appendix C1: presentation and poster boards; Appendix C5: comments and questions
28-Mar-07	Community meeting. 20 attendees. 5.30pm – 9.00pm	Meeting to discuss the experiences with previous mines in the area and the Project Proposal.	No end date specified	Appendix C1: information handout; Appendix C5: comments and questions
4-Apr-07	Letter from KRH to RRDC	Letter thanking RRDC for the opportunity to hold meetings with elders in Ross River on March 28, 2007.	N/A	Appendix C1: letter
10-May-07	Letter from KRH to RRDC	Letter requesting follow-up meetings in summer or fall 2007.	N/A	Appendix C1: letter
22-Oct-07	Letter from KRH to RRDC	Letter outlining status of the KRP and delaying future consultation.	No end date specified	Appendix C1: letter

Table 2.3-2: Record of Contact with Ross River Dena Council and Ross River Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
12-14 Aug-08	Booth at Kaska General Assembly, Watson Lake	Booth materials and information handouts regarding the Project Proposal available.	N/A	Appendix C1: information handout
18-Oct-10	Letter from KRH to Chief Jack Caesar	Letter requesting a meeting during the week of November 29, 2010 to discuss the KRP.	November 12, 2010 to respond with availability and interest to meet	Appendix C1: letter
16-Nov-10	Flyers sent to residences and businesses. (Posters sent to Sharon Ladue, RRDC and the Dena Store for distribution.	Flyers and posters advertised community meeting and community dinner scheduled for November 30, 2010.	14 days	Appendix C1: flyers and posters
30-Nov-10	Meeting with Chief Jack Caesar and Council	KRP presentation and discussion.	N/A	Appendix C1: presentation Appendix C5: comments and questions
30-Nov-10	Community meeting and dinner. 25 attendees. 3:30-8:30 pm	Community meeting included two KRP presentations, posters,, community dinner, and discussion. Printed copies of the presentation were available.	N/A	Appendix C1: presentation Appendix C5: comments and questions
23-Feb-11	Emailed technical memo to Mary Maje, RRDC	Technical Memo responding to questions raised at the November 2010 meeting regarding the use of cyanide at KRP.	N/A	Appendix C1: technical memo
12-May-11	Letter from KRH to Chief Jack Caesar, copied by email	Request for meeting during June 13-17, 2011 regarding the KRP.	May 27, 2011 to respond with interest and availability to meet	Appendix C1: letter
16-May-11	Emailed letter to Mary Maje, RRDC for posting at RRDC office	Letter (dated May 12, 2011) responded to questions raised by a member of the public.	N/A	Appendix C1: letter

Table 2.3-2: Record of Contact with Ross River Dena Council and Ross River Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
14-Jun-11	Flyers sent to residences and businesses. Posters posted in RRDC office and the Dena Store.	Flyers and posters advertised open house scheduled for June 23, 2011.	9 days	Appendix C1: flyers and posters
23-Jun-11	Meeting with Chief Jack Caesar and Council	KRP presentation and discussion.	N/A	Appendix C1: presentation Appendix C5: comments and questions
23-Jun-11	Community Open House. 15 attendees. 5:30-8:30 pm	Open house included two KRP presentations, posters, and discussion. Printed copies of the presentation were available.	N/A	Appendix C1: presentation Appendix C5: comments and questions
27-Jun-11	Letter from KRH to Chief Jack Caesar	Letter thanking the RRDC for the opportunity to meet regarding the KRP. Requested that additional comments or questions regarding KRP be provided by July 20, 2011.	July 20, 2011 to respond with any additional questions and comments	Appendix C1: Letter
20-Jul-11	Elders meeting. 30 attendees. 9:00-11:00 am	Meeting to provide a presentation and discuss the KRP.	N/A	Appendix C1: presentation Appendix C5: comments and questions

Table 2.3-3: Record of Contact with Faro Mayor and Council and Faro Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
28-Jan-07	Mailed flyers to residences and businesses. Emailed posters to Faro Town Council	Poster and flyers advertised community meeting scheduled for February 13, 2007.	16 days	Appendix C2: posters and flyers

Table 2.3-3: Record of Contact with Faro Mayor and Council and Faro Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
13-Feb-07	Meeting with Mayor and Council. 3:00-4:30 pm	Presentation followed by questions and comments.	Verbal timeline provided of June 2008 for YESAB submission	Appendix C2: presentation; Appendix C6: comments and questions
13-Feb-07	Community meeting. 22 attendees. 7:15-–9:00pm	Meeting included presentations on the KRP, the YESAA process, and socio-economic considerations	Verbal timeline provided of June 2008 for YESAB submission	Appendix C2: presentation; Appendix C6: comments and questions
28-Feb-07	Letter from KRH to Mayor and Council	Letter thanking Faro Town Council for opportunity to hold Feb 13, 2007 meetings and intention to conduct March 2007 workshop.	No deadline provided	Appendix C2: letter
15-Mar-07	Mailed flyers to residences and businesses. Emailed posters to Faro Town Council	Poster and flyers advertised community meeting and workshop for March 27, 2007.	12 days	Appendix C2: posters
27-Mar-07	Community meeting. 26 attendees. 6:15-–9:00 pm	Meeting to discuss the experiences with previous mines in the area and the Project Proposal. Poster boards were displayed.	N/A	Appendix C2: information handout, presentation, poster boards; Appendix C6: comments and questions
10-May-07	Letter from KRH to Mayor Michelle Vainio	Letter explaining plan to conduct additional meetings in summer or fall 2007.	Until further notice	Appendix C2: letter
22-Oct-07	Letter from KRH to Mayor Michelle Vainio	Letter explaining current status at mine and delaying future consultation.	No deadline provided	Appendix C2: letter
18-Oct-10	Letter from KRH to Mayor Heather Campbell and Council	Letter requesting a meeting during the week of November 29, 2010 regarding the KRP.	November 12, 2010 to respond with availability and interest to meet	Appendix C2: letter

Table 2.3-3: Record of Contact with Faro Mayor and Council and Faro Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
16-Nov-10	Flyers mailed to residences and businesses. Posters sent to Faro Municipal Administration Building and the Discovery Store for distribution.	Flyers and posters advertised open house/ community meeting scheduled for November 29, 2010.	13 days	Appendix C2: flyers and posters
29-Nov-10	Meeting with Mayor and Council. 4:30-6:00 pm	KRP presentation and discussion.	N/A	Appendix C2: presentation Appendix C6: comments and questions
29-Nov-10	Community open house/ meeting. 7 Attendees. 5:30-9:00 pm.	Open house/ community meeting including two KRP presentations, posters, and discussion. Printed copies of the presentation were available.	N/A	Appendix C2: presentation Appendix C6: comments and questions
30-Nov-10	Meeting with Faro Chief Administrative Officer	Meeting to discuss KRP and opportunities for Faro residents.	N/A	Table 2.6.2 comments and questions
23-Feb-11	Emailed technical memo to Mayor Heather Campbell for posting in The Frozen Mukluk (newsletter)	Technical Memo responding to questions raised at the November 2010 meeting regarding the use of cyanide at KRP.	N/A	Appendix C2: technical memo and posting from The Frozen Mukluk (March and April 2011 editions)
11-May-11	Letter from KRH to Mayor Heather Campbell, copied by email (May 12, 2011).	Request for meeting during the week of June 13, 2011 regarding the KRP.	May 27, 2011 to respond with interest and availability to meet	Appendix C2: letter
16-May-11	Emailed letter to Mayor Heather Campbell for posting in The Frozen Mukluk (newsletter)	Letter (dated May 12, 2011) responded to questions raised by a member of the public.	N/A	Appendix C2: letter

Table 2.3-3: Record of Contact with Faro Mayor and Council and Faro Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
6-Jun-11	Flyers mailed to residences and businesses. Posters sent to Faro Municipal Administration Building and the Discovery Store for distribution.	Flyers and posters advertised open house/ community meeting scheduled for June 14, 2011.	8 days	Appendix C2: flyers and posters
14-Jun-11	Meeting with Mayor and Council. 3:30-4:30 pm.	KRP presentation and discussion.	N/A	Appendix C2: presentation Appendix C6: comments and questions
14-Jun-11	Community open house/ meeting. 12 Attendees. 5:30-9:00 pm.	Community open house/ meeting, including two KRP presentations, posters, and discussion. Printed copies of the presentation were available.	N/A	Appendix C2: presentation Appendix C6: comments and questions
27-Jun-11	Letter from KRH to Mayor Heather Campbell, copied by email (June 29, 2011)	Letter thanking the Mayor for the opportunity to meet with the Mayor, Council and community regarding the KRP. Requested that additional comments or questions regarding KRP be provided by July 20, 2011.	July 20, 2011 to respond with any additional questions and comments	Appendix C2: letter

Table 2.3-4: Record of Contact with Liard First Nation

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
30-Jan-07	Meeting	Meeting held between KRH and Kaska Nation representatives, including members from RRDC, LFN, and Kaska Tribal Council, regarding general issues surrounding the Project Proposal, the MOU and its implementation. LFN informed KRH that information updates via email would be sufficient, and that full consultation meetings would not be required.	N/A	N/A

Table 2.3-4: Record of Contact with Liard First Nation

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
28-Feb-07	Letter from KRH to RRDC, LFN cc'd	Letter thanking RRDC for the opportunity to hold meetings in Ross River on February 12 and 13, 2007.	N/A	Appendix C3: letter
4-Apr-07	Letter from KRH to RRDC, LFN cc'd	Letter thanking RRDC for the opportunity to hold meetings with elders in Ross River on March 28, 2007.	N/A	Appendix C3: letter
10-May-07	Letter from KRH to RRDC, LFN cc'd	Letter requesting follow-up meetings in summer or fall 2007.	N/A	Appendix C3: letter
22-Oct-07	Letter from KRH to RRDC, LFN cc'd	Letter outlining status of the KRP and delaying future consultation.	No end date specified	Appendix C3: letter
12-14-Aug-08	Booth at Kaska General Assembly, Watson Lake	Booth materials and information handouts regarding the Project Proposal available.	N/A	Appendix C3: information handout
18-Oct-10	Letter from KRH to Chief Liard McMillan	Letter requesting a meeting during the week of November 29, 2010 to discuss the KRP.	November 12, 2010 to respond with availability and interest to meet	Appendix C3: letter
15-Nov-10	Email from KRH to LFN	Email inviting the LFN to meet with KRH to discuss the KRP on November 26 or December 6, 7, or 8, 2010.	November 26, or December 8, 2010 to respond with availability and interest to meet	Not attached
18-Feb-11	Email from Trevor Harding, LFN Development Corp. to KRH	Email requesting to negotiate a SEPA and Engagement Agreement.	N/A	Not attached
2-Mar-11	Emailed technical memo to Chief Liard McMillan	Technical Memo responding to questions raised at the November 2010 meetings in Teslin, Faro and Ross River regarding the use of cyanide at KRP.	N/A	Appendix C3: technical memo

Table 2.3-4: Record of Contact with Liard First Nation

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
3-Mar-11	Email from Drew Mildon (legal counsel for LFN) to KRH	Forwarded an email from Chief Liard McMillan re: proposed Ketza Mine Water Licensing.	N/A	Not attached
11-May-11	Letter from KRH to Chief Liard McMillan with follow-up email (dated May 12, 2011)	Letter requesting meeting during the week of June 13, 2011 regarding the KRP.	May 27, 2011 to respond with interest and availability to meet	Appendix C3: letter
17-May-11	Emailed technical memo to Chief Liard McMillan, for posting at LFN office.	Technical Memo responding to questions raised at the November 2010 meeting regarding the use of cyanide at KRP.	N/A	Appendix C3: technical memo
30-May-11	Email from Trevor Harding (on behalf of Chief McMillan) to KRH	Email attachment contained a copy of a proposed Engagement Agreement.	N/A	Not attached
31-May-11	Email from KRH to Trevor Harding (LFN)	Email stating that KRH has responded to the agreement and requested the results of the RRDC and LFN meeting.	N/A	Not attached
1-Jun-11	Email from Trevor Harding (LFN) to KRH	Email following up regarding the proposed Engagement Agreement and response regarding the RRDC and LFN meeting.	N/A	Not attached
6-Jun-11	Email from KRH (via EBA) to Trevor Harding (LFN)	Email requesting a meeting in June 2011.	N/A	Not attached
6-Jun-11	Email from Trevor Harding (LFN) to KRH (via EBA)	Email requesting a response regarding the Engagement Agreement prior to scheduling a meeting with the LFN.	N/A	Not attached
6-Jun-11	Email from Tom Cove to KRH (via EBA)	Email clarifying that LFN requires an engagement agreement before it will participate in consultation and request to move meeting until after June 2011.	N/A	Not attached
5-Jul-11	Letter from KRH to Chief Liard McMillan with follow-up email	Letter thanking the LFN for the opportunity to meet regarding the KRP. Requested that additional comments or questions regarding KRP be provided by July 20, 2011.	July 20, 2011 to respond with any additional questions and comments	Appendix C3: letter

Table 2.3-5: Record of Contact with Teslin Tlingit Council and Teslin Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
15-Mar-08	Mailed flyers to residences and businesses; Posters distributed to TTC office for posting.	Flyers and posters advertised a community meeting and dinner scheduled for April 1, 2008.	17 days	Appendix C4: flyer and poster
1-Apr-08	Meeting with Chief Executive Officer and Council	KRP presentation and discussion. TTC provided KRH with the Draft TTC Mining Policy for consideration.	N/A	Appendix C4: presentation and information handout; Appendix C7: comments and questions
1-Apr-08	Community meeting and dinner. 5:00-8:00 pm	KRP presentation and discussion.	N/A	Appendix C4: presentation and information handouts; Appendix C7: comments and questions
23-Apr-08	Letter to Chief Eric Morris from KRH	Letter thanking the TTC for the opportunity to meet regarding the KRP and to discuss the process for ongoing consultation.	N/A	Appendix C4: letter
12-Jun-08	Email to Karl Blattman, TTC	Email providing the information requested in the Draft TTC Mining Policy.	N/A	Appendix C4: email
31-Jul-08	Meeting with Chief Executive Officer and Council	KRP presentation and discussion.	N/A	Appendix C4: presentation, information handouts, and poster boards; Appendix C7: comments and questions
18-Oct-10	Letter from KRH to Peter Johnston, CEO of TTC	Request for meeting during the week of November 29, 2010 regarding the KRP.	November 12, 2010 to respond with availability and interest to meet	Appendix C4: letter

Table 2.3-5: Record of Contact with Teslin Tlingit Council and Teslin Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
26-Nov-10	Meeting with TTC Lands and Resources Department	KRP presentation and discussion.	N/A	Appendix C4: presentation Appendix C7: comments and questions
3-Jan-11	Flyers sent to residences and businesses. Posters sent to Connie Jules (TTC), the post office, the Nisutlin Trading Post, and the Yukon Motel for distribution.	Flyers and posters advertised the open house and community dinner scheduled for January 12, 2011.	9 days	Appendix C4: flyers and posters
12-Jan-11	Meeting with Chief Executive Officer and Council	KRP presentation and discussion	N/A	Appendix C4: presentation Appendix C7: comments and questions
12-Jan-11	Meeting with Connie Jules, TTC Environmental Officer	Meeting to discuss the TTC Traditional Knowledge Protocol and the TTC Mining Policy.	N/A	Appendix C7: comments and questions
12-Jan-11	Community open house and dinner. 64 Attendees. 4:00-7:30 pm	Open house, including two KRP presentations, posters, community dinner, and discussion. Printed copies of the presentation were available.	N/A	Appendix C4: presentation Appendix C7: comments and questions
2-Mar-11	Emailed technical memo to Connie Jules, TTC	Technical Memo responding to questions raised at the November 2010 meeting regarding the use of cyanide at KRP.	N/A	Appendix C4: technical memo
11-May-11	Letter from KRH to Peter Johnston (TTC), copied by email (dated May 12, 2011)	Request for meeting during the week of June 13, 2011 regarding the KRP.	May 27, 2011 to respond with interest and availability to meet	Appendix C4: letter
12-May-11	Emailed letter to Connie Jules, Environmental Officer, TTC (email dated May 16, 2011)	Letter responded to questions raised by a member of the public.	N/A	Appendix C4: letter

Table 2.3-5: Record of Contact with Teslin Tlingit Council and Teslin Community

Date	Method of Contact	Format/ Content of Contact	Time Provided to Consider the Information Received	Location of Documentation/ Comments
14-Jun-11	Flyers and posters sent to Connie Jules for posting in the TTC office, Teslin Motel and Store, and to be emailed out to TTC residents.	Flyers and posters advertised community meeting and lunch scheduled for June 24, 2011.	9 days	Appendix C4: flyers and posters
24-Jun-11	Community meeting and lunch. 10 attendees. 11:30 am - 1:30 pm	Community meeting, including two KRP presentations, posters, and discussion. Printed copies of the presentation were available.	N/A	Appendix C4: presentation Appendix C7: comments and questions
24-Jun-11	Meeting with Chief Executive Officer and Council	KRP presentation and discussion.	N/A	Appendix C4: presentation Appendix C7: comments and questions
27-Jun-11	Letter from KRH to Peter Johnston (CEO TTC)	Letter thanking the TTC for the opportunity to meet regarding the KRP. Requested that additional comments or questions regarding KRP be provided by July 20, 2011.	July 20, 2011 to respond with any additional questions and comments	Appendix C4: letter

2.3.1 Public Meetings with Presentations

Public meetings with presentations were advertised to communities to allow people to come together at a community venue (Photos 2.3-1 to 2.3-3) to:

- Learn about the KRP
- Ask questions about the KRP
- Provide views or suggestions.

The purpose of the public community meetings was to:

- Inform members of the respective communities about the KRP
- Provide information on the consultation process required under *YESAA*
- Seek ideas from the communities on how best to organize the consultation process
- Receive specific questions and comments on the KRP.

A community dinner and/or light refreshments were available during the public meetings. Presentations were given by KRH representatives Graham Dickson and Todd Johnson.

Mr. Dickson's qualifications are summarized in Section 1.2 of this Project Proposal. Mr. Johnson has over 16 years of experience in the precious and base metal resource industry, as well as four years of geotechnical engineering experience ranging from grass-roots exploration to mine predevelopment. Mr. Johnson is a Qualified Person as defined by the Canadian National Instrument 43-101 guidelines, a recognized expert in the assessment of base and precious metal mines, and has worked throughout the western United States, northern Mexico, and Canada. In addition to his geological and exploration experience, Mr. Johnson is a Professional Engineer (P.E.) in the state of Nevada and has worked on several commercial and industrial developments, mine developments, residential developments, utility lines, and roadways with several engineering companies including AMEC.

Presentations were given prior to and following dinner as a way of reaching the majority of interested members of the public who were available to see them. Views and questions were also invited from attendees and were documented for full consideration. The public meetings also provided an opportunity for KRH to obtain information about the communities' Valued Environmental and Socio-economic Components (VESECs, as described in Section 7.1.1). KRH asked those present at the 2008 meetings about their experiences with previous mines in the area. By asking people what they liked and disliked about former mines in the area, attendees provided KRH with an 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 KRH, including *The Snow that Eats the Snow (A Mining Strategy for Ross River, Yukon Territory)* (RRDCEDP and RRMC 2004); *Faro Forward: Integrated Community Sustainability Plan* (Town of Faro 2007); *Teslin Tlingit Council Mining Policy* (Teslin Tlingit Council 2008); and *RRDC Integrated Community Sustainability Plan* (RRDC 2006).

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, either during the meeting or via email to KRH or their representatives.



Photo 2.3-1: Public Meeting with Presentation, Faro (2007)



Photo 2.3-2: Public Meeting with Presentation, Ross River (2007)



Photo 2.3-3: Community Dinner, Ross River (2007)

2.3.2 Open Houses

Open houses (Photos 2.3-4 – 2.3-7) were organized as a less formal and more flexible alternative to public meetings, and frequently occurred prior to the public meeting. Anyone interested in the KRP could visit the venue of the open house during advertised times and obtain the same level of information as at the public meeting. Open houses generally took place between 4 pm and 9 pm to allow people the opportunity to attend who may not be available during the public meeting.

The open house format provided individuals with the opportunity to speak with a representative from KRH 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, either during the meeting or via email to KRH or their representatives.

Maps, photographs, figures and information handouts were also available at the open houses. Refreshments were provided at all the open houses and presentations about the KRP were offered at pre-set times.



Photo 2.3-4: Community Open House, Teslin (2011)



Photo 2.3-5: Community Open House, Faro (2010)



Photo 2.3-6: Community Open House, Ross River (2010)



Photo 2.3-7: Community Open House, Ross River (2011)

2.3.3 Meetings with Community Leadership

Meetings with Chief and Council of the RRDC, the Executive Council of the TTC, Chief and Council of the LFN and meetings with Mayor and Council in Faro, were organized to:

- Provide information about the KRP
- Provide feedback to community leadership on any related public meetings and open houses
- Respond to views and questions about the KRP
- Where relevant, discuss matters relating to the KRP 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 KRH.

2.3.4 Meetings with Elders

Meetings were organized separately for the RRDC elders so the elders would feel more comfortable discussing the Project amongst their peers (Photo 2.3-8). An interpreter was available during all meetings with elders.



Photo 2.3-8: Ross River Elders Meeting (July 2011)

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 C1: Information Provided to Ross River Dena Council and Ross River Community
- Appendix C2: Information Provided to Faro Mayor and Council and Faro Community
- Appendix C3: Information Provided to Liard First Nation
- Appendix C4: Information Provided to Teslin Tlingit Council and Teslin Community.

A summary of the information used as part of the consultation process is provided in Sections 2.4.1 to 2.4.3.

2.4.1 PowerPoint Presentations

The presentations were used to introduce people to KRH and to the Project. In general, the presentations covered the following topics:

- The mine Site location, ownership and existing infrastructure
- The history of the KRP to date
- Minerals to be mined at the Site
- The KRP, e.g., locations of pits, infrastructure, tailings storage facility, etc.
- The workforce and contract opportunities
- The value of the environment and how it will be protected
- Environmental monitoring at the Site
- Traditional use and the Ketza River valley
- Employment and training during construction and operation
- Other social values such as celebration days for the sacred sites near the KRP
- The consultation process
- Disclosure of major shareholders and company directors
- Contact information for any questions, concerns or comments.

The presentation information was updated over time by KRH as decisions about the Project were made by KRH. Copies of the presentations are provided in the relevant Appendices (C1 to C4) for each community or First Nation.

2.4.2 Detailed Maps, Figures and Display Materials

In addition to presentations about the KRP, information was provided at open houses and community meetings in the form of detailed maps, figures and display materials (Photos 2.41 – 2.4-2). Copies of all maps, figures and materials are included in the Appendix C. The following topics were addressed in the display materials, maps and figures:

- The Site location, ownership and existing infrastructure
- The KRP, e.g., locations of pits, infrastructure, TSF, etc.
- The value of the environment and how it will be protected
- Environmental monitoring at the Site
- Employment and training during construction and operation
- The consultation process
- Contact information for any questions, concerns or comments.

2.4.3 Information Handouts

In addition to presentations about the mine proposal, information was also provided at the meetings in the form of information handouts, covering the following topics:

- The mine site location, ownership and existing infrastructure
- The history of the KRP to date
- Minerals to be mined at the Site
- The KRP, e.g., locations of pits, infrastructure, TSF, etc.
- The workforce and contract opportunities
- The value of the environment and how it will be protected
- Environmental monitoring at the Site
- Traditional use and the Ketza River Valley
- Employment and training during construction and operation
- Other social values such as celebration days for the sacred sites near the KRP
- The consultation process
- Disclosure of major shareholders and company directors
- Contact information for any questions, concerns or comments
- Detailed responses to questions about cyanide and cyanide management.

Information handouts were also left in the communities to be available for others not present at the meetings.

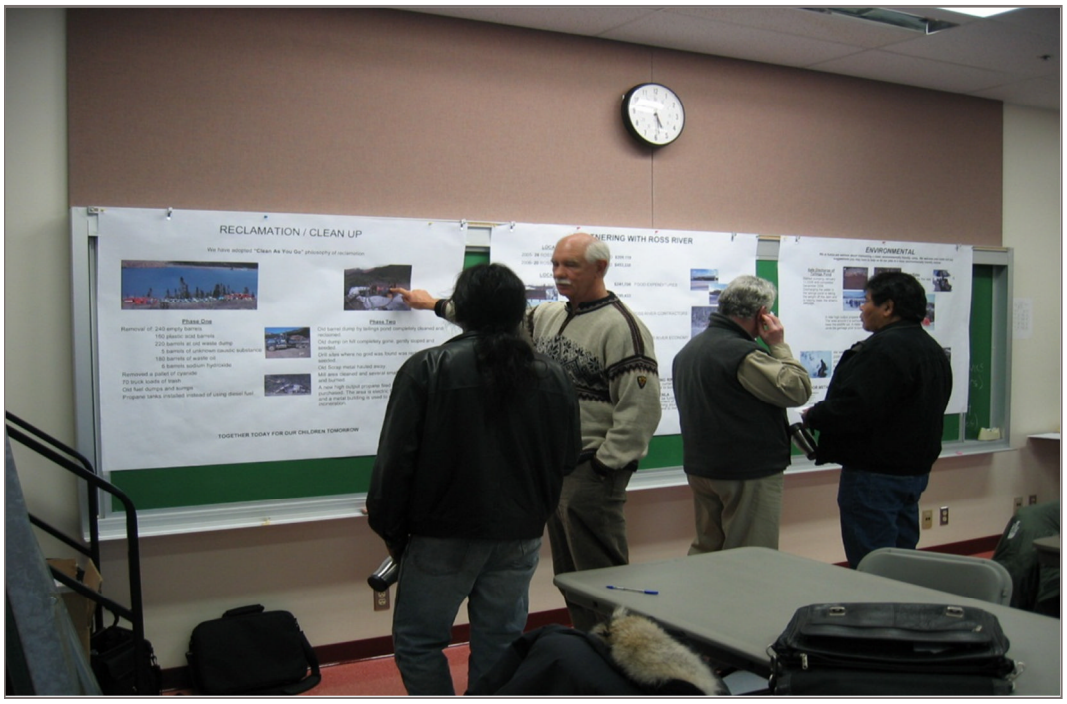


Photo 2.4-1: Posters at Ross River Open House (2007)



Photo 2.4-2: More Posters at Ross River Open House (2007)

2.4.4 Use of Community Publications

Copies of information handouts were provided to the community of Faro and included in the Frozen Mukluk newsletter. The handouts were provided to the RRDC, TTC and LFN for posting in their offices and use in any internal publications that they may have, such as email mailouts by TTC. Notices of meetings were provided in the Frozen Mukluk and in internal TTC and RRDC publications as well.

2.5 Opportunity to Present Views

Since the initial meetings and correspondence in 2007 with the affected communities and First Nations, KRH representatives have indicated that they were interested in receiving any views, questions or concerns about any aspect of the KRP. Affected communities and First Nations were encouraged to contact KRH representatives by phone, letter, fax, email or in person. Contact information was provided to individuals in the form of business cards, pre-printed fax sheets, email addresses, and in information handouts.

During the meetings, responses to views, questions and comments were provided by KRH's representatives. The views, questions and comments were documented, and fully and fairly considered in the development of the KRP (see Section 2.6). Views, questions and concerns received outside of the meetings (e.g., via email or phone) were treated in the same manner as those raised in meetings, with the response presented in writing to all affected communities and First Nations by email, through community publications, and during the following meetings.

Notice of meetings was sent out in advance of their occurrence in order to provide each affected community and First Nation the opportunity to plan to attend. During meetings the timeline to Project Proposal submission was provided, and the opportunity to present views, questions and concerns was repeated. Where applicable, specific deadlines were set for affected communities and First Nations to respond to a meeting request, or to present views, questions and concerns about the KRP. The deadlines are presented in Tables 2.3-2 to 2.3-5.

2.6 Summary of Views Presented

The views, questions and concerns received from individuals about the KRP were placed into 6 broad categories, and grouped into sub-categories, as follows:

1. Mine Scope

- General mine scope
- Underground mining
- Water Management
- Resource
- Limestone
- Camp
- Power
- Safety
- Exploration

- Drilling
- Mine productivity
- Processing
- TSF
- Canamax TSF
- Mine chemical use
- Roads
- Transportation
- Funding
- Regulatory
- Mine ownership and management

2. Mine scope socio-economic

- Employment
- Training
- Housing

3. Economic

- Business opportunities

4. Social

- Social concerns
- Community development / benefits
- Culture, traditional knowledge, history and heritage

5. Environment

- Fish and wildlife
- Environmental monitoring
- Water monitoring
- Environmental cleanup / reclamation
- Acid
- Security
- Canamax tailings storage facility reclamation

6. Consultation

- SEPA

The views, questions and comments received during the consultation process were recorded in tables to allow the views to be compared across the affected communities and First Nations. Table 2.6-1 provides a summary of common questions, views and concerns presented in potentially affected communities and First Nations. Detailed tables summarizing the questions, views and concerns per community are located in Appendices C5 to C7.

It should be noted that specific views, questions and comments pertaining to Traditional Knowledge are confidential according to the *Traditional Knowledge Protocol* between KRH and RRDC, and have been removed from the tables.

KRH has identified the main views and comments presented by individuals from affected communities and First Nations, and has assessed these for similarities and differences between groups. These similarities and differences have been summarized in the sections below.

2.6.1 Similarity of Views

Table 2.6-1 presents a summary of the most common questions, views and comments received by all affected communities or First Nations by category. Most common questions were defined as questions asked more than four times during consultation. The summary columns in Table 2.6-1 present the number of times a question or comment was raised in the meetings in each community. Full and fair consideration of each view, comment and question is provided in Appendices C5 to C7.

Common views, questions and concerns presented in a variety of different forms are summarized in the following subsections.

Table 2.6-1: Summary of Common Views Presented in Potentially Affected Communities and First Nations

Theme	Question / Comment	Ross River Summary (# times commented)	Faro Summary (# times commented)	Teslin Summary (# times commented)
Mine Scope				
	How long will the mine be operational?	2	2	0
	How will you power the mine?	1	4	1
	Will there be liners for the tailings? How long will they last?	3	1	0
	What happens to the cyanide? Can the cyanide be re-used? How do you destroy hydrocyanic acid?	2	3	1
	Who will maintain the Ketza Road?	3	1	0
	Will you put in a gate at the junction at the highway. There should be only RRDC access.	3	1	0
Mine Scope Socio-economic				
	Will you be using your own miners or contract miners?	2	1	1
	How many workers will be at the mine?	1	3	1
	Will there be training programs for workers?	3	1	0

Table 2.6-1: Summary of Common Views Presented in Potentially Affected Communities and First Nations

Theme	Question / Comment	Ross River Summary (# times commented)	Faro Summary (# times commented)	Teslin Summary (# times commented)
Social				
	Is the Project really in TTC traditional territory?	2	2	1
	RRDC are not signatories to the Umbrella Final Agreement. Therefore, Bill C-2 doesn't apply to Ross River. Therefore, YESAB cannot determine who has an interest. RRDC elders testimony on location of the traditional territory boundary must be accepted.	4	0	0
Environment				
	How long will it take the reclaim the Site? Will you use progressive reclamation?	2	2	0
Consultation				
	The RRDC needs resources to attend meetings and to develop meaningful input, especially on technical issues. We need time to consider information and funds to hire expertise to review components (e.g., mine design and hydrology).	5	0	0

2.6.1.1 Mine Scope

The following comments and questions about the mine scope were raised more than four times at the community meetings:

- Will exploration be continuing during mine operations, and will the life of the mine be expanded from the KRP scope?
- How will the mine be powered, and will alternative power sources be used?
- Will the Ketza Road be maintained and gated? If gated, where will the gate be located?
- Where will the camp be located and why not in other locations?
- How will the ore be processed, what materials will be used, and what materials will be in the tailings?
- How will the doré bars be transported and will ore be transported?
- Will the TSF be lined, sufficient and safe?
- If, when and how will the Canamax TSF be decommissioned?
- Concerns about cyanide. A separate document detailing answers to frequently asked questions about cyanide was produced and distributed by email, community publication, and at meetings in response to cyanide questions.
- How does the regulatory process work and what current permits are in place?
- Mine ownership, funding, and joint ventures with Chinese companies.

2.6.1.2 Mine Scope Socio-economic

The following comments and questions about the mine socio-economic scope were raised more than four times at the community meetings:

- How many workers will be at the mine, and how many will be local?
- How will they be trained, in what areas, and where?
- How they will be housed while at the Site and where might they be encouraged to live?
- Liaison between KRH and affected communities and First Nations.

2.6.1.3 Economic

The following comments and questions about the mine economics were raised more than four times at the community meetings:

- What will be the contract opportunities?
- Using existing companies and local contractors.

2.6.1.4 Social

The following comments and questions about social conditions were raised more than four times at the community meetings:

- How employees will be transported to the Site?
- Concerns about alcohol and drug abuse.
- Concerns about two week shifts, effects on families and individuals.

2.6.1.5 Environment

The following comments and questions about the environment were raised more than four times at the community meetings:

- Concerns about hunting and limiting access to the Site.
- Compensation for trappers, and comments about traplines.
- Concerns about wildlife harassment by staff.
- Will there be environmental monitors, who will they be, how long will they be at the Site, and could the affected First Nations have their own independent environmental monitors?
- How will environmental monitoring data and reports be provided?
- How will water be used, treated and monitored?
- Will there be fences and other deterrents to keep wildlife away from the TSF and camp?
- How will waste rock and acid generation be handled?
- Will limestone at the Site be used / good enough, and how?

- If limestone could be used in Faro reclamation.
- How will fish habitats be protected?
- How and when reclamation will be done, including details of acid management.

Consultation

The following comments and questions about consultation were raised more than four times at the community meetings:

- Discussions around requirements for MOU, SEPAs and Traditional Knowledge agreements
- Requests for Site visits and monitoring
- Request for resources for consultation meetings and to attend the Ketza River Mine Working Group.

2.6.2 Differences of Views

There have been differences of views expressed among affected communities and First Nations on the subjects of traditional territory, housing and economic benefits, as follows:

- TTC traditional territory, as accepted by YESAB, covers a portion of the KRP area, including the mine Site itself. RRDC maintains that TTC's traditional territory does not extend so far north and that the TTC has no rights in the area.
- Faro has approximately 250 empty houses, and would like KRH to encourage mine employees to settle in Faro. Faro also has the necessary municipal infrastructure and services to support a significant increase in population. RRDC has also expressed an interest in having mine employees encouraged to live in Ross River, however Ross River does not have available housing, land, or the municipal infrastructure and services needed to support a significant increase in population.
- TTC has expressed an interest in having a MOU with KRH and a SEPA so that the First Nation receive economic benefits from the KRP. RRDC has stated that TTC should not receive benefits from the KRP, as they do not believe that TTC's traditional territory overlaps the KRP, as described above.

2.7 Consideration of Views Presented

The views, questions and comments received during the consultation process have allowed KRH to identify the main issues presented by affected communities and First Nations, and to give full and fair consideration of each question, comment or view presented. Appendices C5 to C7 show how each question, comment or view has been considered. Many of the views, questions and concerns raised required clarification or further detail about the KRP. Where a view, question or concern suggested a change to the KRP, it has been considered in the appropriate section of the KRP.

Two examples of community comments or views being incorporated into the KRP are:

- Hunting will not be allowed at the KRP
- Access through the KRP will be limited.

3.0 PROJECT LOCATION

3.1 Geographical Location

The KRP is located in the Pelly Mountains near the headwaters of Cache Creek, a tributary of the Ketza River, in south-central Yukon (Figure 1.2-1). The property is approximately 40 km south of Ross River and approximately 500 km northeast of Whitehorse. The topography of the Project site ranges in elevation from 1,300 m asl to 2,100 m asl. The KRP is located in the Watson Lake Mining District of Yukon Territory, and is centered at 61º 32' N and 132º 13' W on NTS map sheet 105 F/9 (Figure 3.1-1).

3.2 Land Tenure

3.2.1 Quartz Mineral Claims

Hardrock mineral tenure in Yukon consists of quartz claims and quartz leases. Both claims and leases typically measure 457 m X 457 m (1,500 ft x 1,500 ft), although fractions may exist. Quartz claims give the claimant the right to explore for one year. Renewal of a quartz claim requires that $100 of work be spent per claim / year, based on the Schedule of Representation Work outlined in the *Quartz Mining Act*. Where work is not performed, the claimant may make a payment in lieu of work. As long as the commitment is satisfied, the quartz claim remains in good standing.

Quartz leases are the most secure form of mineral title in Yukon. Once a vein or lode is confirmed within the limits of the claim, the claimant may apply to lease the subsurface of the claim(s). Typically, companies contemplating production would take their claims to lease, which provides secure title and relieves them from their annual work requirement. Quartz leases are issued for 21 years and can be renewed for an additional 21-year term, provided that during the original term of the lease, all conditions of the lease and provisions of the legislation have been met. The cost to convert quartz claims to quartz leases is $50 per claim and the cost to renew quartz leases for an additional 21-year period is $200 per claim (YG 2008). The surface rights are owned by the Crown and leased to the Company under the Government of Yukon lease. The KRP consists of 593 quartz claims and fractions of claims, and 60 quartz leases, which cover approximately 788 ha (Figure 3.2-1).

All claims, fraction of claims and leases are 100% owned by KRH. A summary of the claims associated with the KRP is provided in Table 3.2-1. Additional details of each of the claims, fraction of claims, and leases are presented in Appendix B2.

Table 3.2-1: Summary of Active Claims and Leases

Claim Name	Number of Claims	Number of Leases
AMBROSE	2	0
ANN No.	1	1
FRED No.	3	2
FURY No.	8	8
KON	542	37

Table 3.2-1: Summary of Active Claims and Leases

Claim Name	Number of Claims	Number of Leases
MARIA	1	0
MOON	2	0
OXO	18	0
PEEL No.	6	6
PEG No.	2	2
PENGUIN No.	3	3
PIONEER No.	1	1
STAR	4	0
Total	**593**	**60**

3.2.2 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. The KRP falls within Yukon outfitting concession #15, owned by Yukon Stone Outfitters Ltd. Yukon Stone has hunts in the general area of the KRP (though no closer than approximately 10 km) and occasionally uses the Ketza Road to bring horses in and out of the area.

3.2.3 Trapping Concessions

The Yukon contains 360 registered trapping concessions and 13 group trapping concessions. These concessions are formed through legal boundaries which provide the holder with exclusive rights to trap furbearing animals. The KRP is located within the southern portion of the Ross River Group Trapline (trapping concession # 405) that is managed by the RRDC. Trapping activity in the region varies.

3.2.4 Interim Protected Lands

Interim protected lands are areas protected from development in anticipation of their use in land claim negotiation. At the Site, upstream of Peel Creek, on Cache Creek, is interim protected area RRDC S-116B. North of the Site, along the Ketza Road, is interim protected area RRDC R-13B (Figure 3.2-2). At the junction of the Ketza Road and the Robert Campbell Highway is interim protected area RRDC R-55B. Additional interim protected areas are located along the Robert Campbell Highway, outside of the KRP.

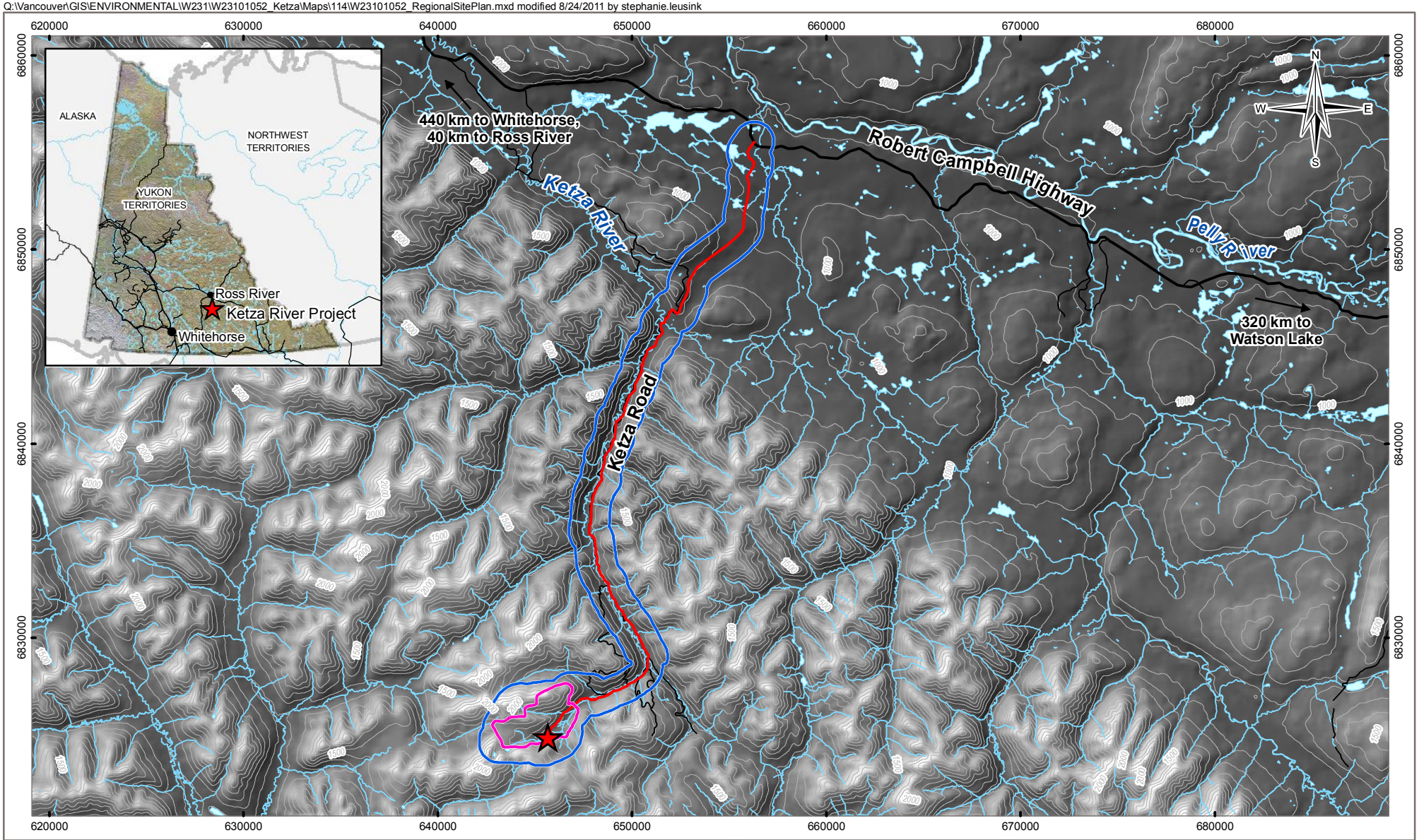
3.2.5 Parks and Protected Areas

There are no parks or protected areas located within or near the KRP.

3.2.6 Yukon Land Use Planning Region

The KRP is located in the Kaska planning region. This region is currently defined as proposed by the Yukon Land Use Planning Council (Yukon Land Use Planning Council 2011).

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LEGEND

- Camp
- Project Footprint
- Ketza River Project
- Ketza Road
- Existing Road
- Existing Limited Use Road
- Contour (100 m)
- Watercourse
- Waterbody

NOTES
Base data source: 1:50,000 NTS

STATUS
ISSUED FOR USE

Scale: 1:275,000
5 2.5 0 5
Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD27

FILE NO.
W23101052_RegionalSitePlan.mxd

CLIENT
Ketza River Holdings

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KETZA RIVER PROJECT

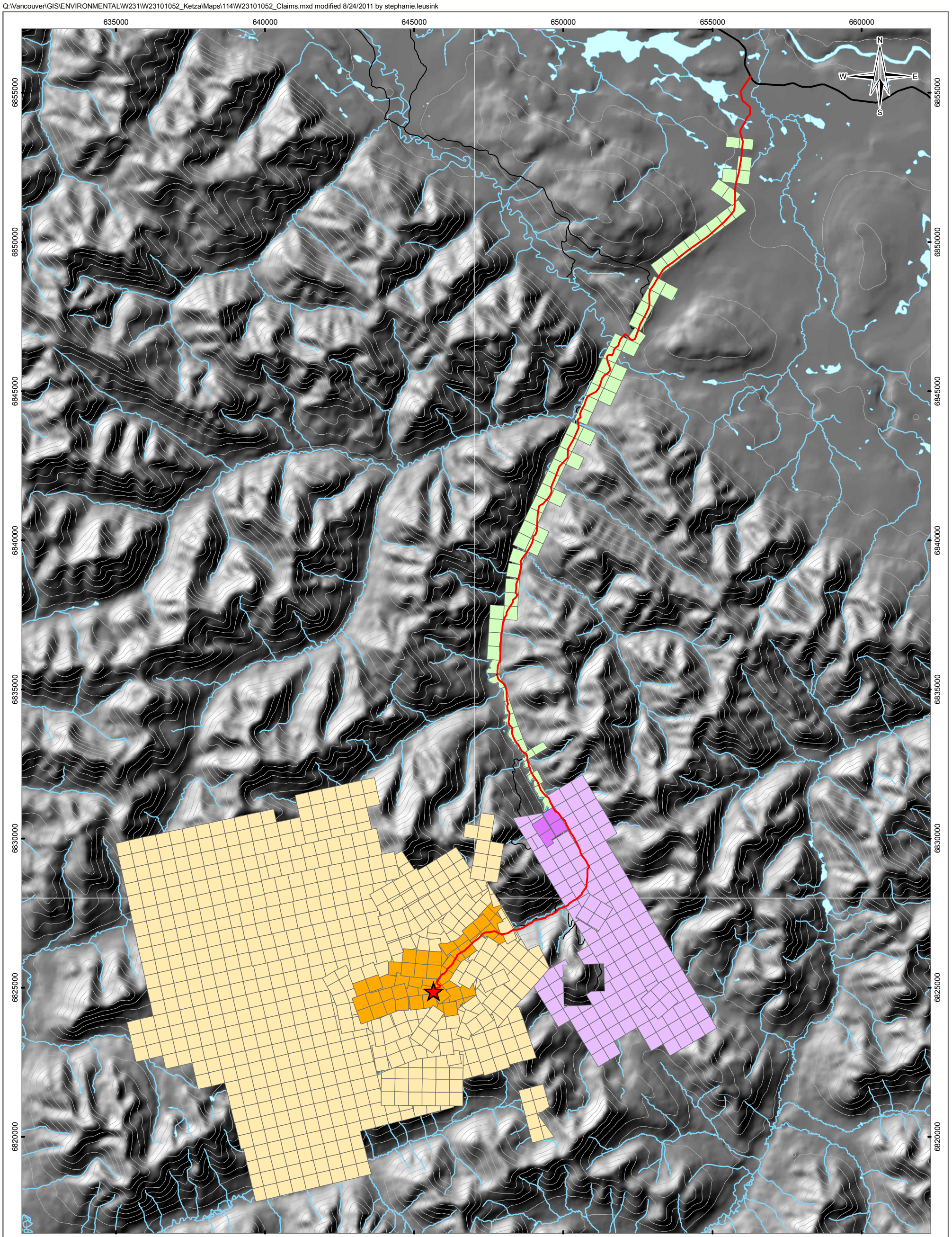
Regional Site Plan

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 3.1-1

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LEGEND

- Camp
- Silver Valley Claim (143)
- Silver Valley Lease (6)
- Access Road Claims (69)
- Ketza River Claim (679)
- Ketza River Lease (60)
- Ketza Road
- Robert Campbell Highway
- Minor Road
- Contour (100 m)
- Watercourse
- Waterbody

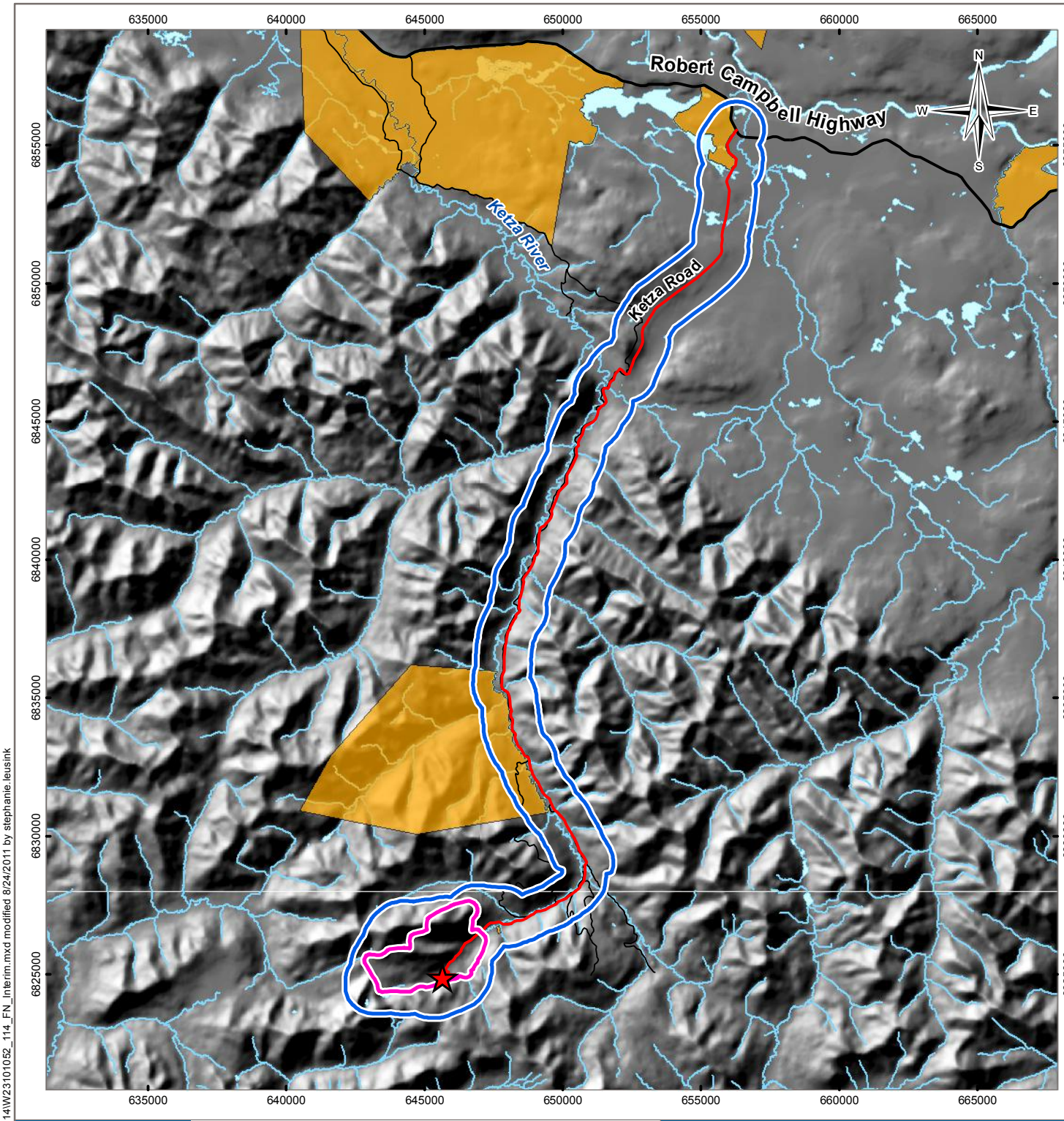
NOTES
Base data source: NTS 1:50,000

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Mineral Claims

PROJECTION UTM Zone 8		**DATUM** NAD27			**CLIENT** Ketza River Holdings
Scale: 1:120,000 (2 1 0 2 Kilometres)					eba A TETRA TECH COMPANY
FILE NO. W23101052_Claims.mxd					
PROJECT NO. W23101052.114	**DWN** SL	**CKD** TP	**APVD** TP	**REV** 0	**Figure 3.2-1**
OFFICE EBA-VANC	**DATE** July 26, 2011				



LEGEND

- Camp
- Interim Protected Lands
- Project Footprint
- Ketza River Project
- Ketza Road
- Robert Campbell Highway
- Minor Road
- Watercourse
- Waterbody

NOTES
Base data source: Yukon Geomatics

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

First Nations Interim Protected Lands in the Ketza River Project

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:200,000
4 2 0 4
Kilometres

FILE NO. W23101052_114_FN_Interim.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.107	SL	KG	KG	0

OFFICE	DATE
EBA-VANC	July 26, 2011

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Figure 3.2-2

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3.3 Traditional Territory

The KRP is located in the traditional territories of the RRDC, LFN and TTC. The RRDC and LFN are part of the broader Kaska Dena Nation and are two of the five Kaska First Nations that make up the Kaska Tribal Council. As Kaska Nations, both are also associated with the Kaska Dena Council, a society formed to advance the interests of all Kaska individuals. Community consultation has been conducted with RRDC, LFN and TTC since 2007. Consultations have been in the form of letters, open houses, meetings, information sheets, and workshops.

A Memorandum of Understanding (MOU) was signed in 2005 with the RRDC (signed on behalf of the Kaska Nation), but expired in 2008. Negotiations are underway with the RRDC and LFN for a second MOU. Land Claims Agreements have yet to be signed with the Kaska First Nation.

The TTC signed the *Teslin Tlingit Council Final Agreement* and *Teslin Tlingit Council Self-Government Agreement* in 1993, and is a self-governing First Nation, incorporating traditional Tlingit Clan culture into contemporary organization and management. Negotiations are underway with the TTC for a MOU with KRH.

3.4 Consistency with Other Plans

Plans have been developed by potentially affected communities and First Nations regarding community sustainability and development, mining, and wildlife management. These plans are:

- *The Snow that Eats the Snow (A Mining Strategy for Ross River, Yukon Territory)* (RRDCEDP and RRMC 2004)
- *Faro Forward: Integrated Community Sustainability Plan* (Faro 2007)
- *Teslin Tlingit Council Mining Policy* (TTC 2008)
- *Integrated Community Sustainability Plan: Ross River* (RRDC 2006)
- *Integrated Wildlife Management Plan: Ross River Traditional Territory*.

These plans have been considered in the development of the KRP, and are discussed in more detail below.

3.4.1 The Snow That Eats the Snow (A Mining Strategy for Ross River, Yukon Territory)

KRH understands, through the document titled *The Snow that Eats the Snow (A Mining Strategy for Ross River, Yukon Territory)(*RRDCEMP and RRMC (2004)), that the RRDC would like to fully participate and benefit socially, economically, and culturally from an environmentally sound KRP and its related activities. KRH believes that the Project cannot be successful without this level of involvement from the Ross River community.

KRH will continue to work with the RRDC to achieve this through ongoing community consultation and negotiation of a MOU and Socio-economic Partnership Agreement (SEPA), which will define how RRDC can participate and benefit from training, employment, and other opportunities that may arise.

3.4.2 Faro Forward: Integrated Community Sustainability Plan

KRH has read and considered the document *Faro Forward: Integrated Community Sustainability Plan* for the town of Faro. KRH understands that Faro would like to become an attractive, sustainable, economically viable, and united community.

KRH will support Faro in community development through employment, economic growth, and housing, as outlined in Section 9.0 of this Project Proposal.

3.4.3 Teslin Tlingit Council Mining Policy

The *Teslin Tlingit Council Mining Policy* (2008) outlines how the TTC will exercise its authority as required by its Constitution, its Self-Government Agreement, and the Final Agreement. Moreover, TTC has enacted laws to ensure that mining activities and developments in the TTC traditional territory promote the following TTC objectives:

- Protect and accommodate TTC's aboriginal and constitutional rights, title and interests
- Satisfy TTC principles for environmental, economic, social, and cultural sustainability
- Provide social and economic benefits directly and indirectly to TTC and related businesses.

KRH has operated within the *Teslin Tlingit Council Mining Policy* by respecting the TTC's objectives, providing the information required of proponents under the Policy, and committing to dialogue about a MOU or SEPA with TTC.

3.4.4 Integrated Community Sustainability Plan: Ross River

In relation to the *Integrated Community Sustainability Plan: Ross River*, KRH understands that Ross River has established long term sustainability goals that include both environmental and socio-economic aspects.

KRH would like to help Ross River meet their goals though the KRP. In terms of the goal to "minimize damage to the environment" KRH shares that goal. Suggested mitigation measures are summarized in Table 11.1-1 of this Project Proposal.

In terms of Ross River's goal of socio-economic opportunities, a MOU was signed in 2005 with the RRDC (signed on behalf of the Kaska Nation), which expired in 2008. Negotiations are underway with the RRDC and LFN for a second MOU and a SEPA with RRDC. The MOU and SEPA will define how Ross River can participate and benefit from training, employment, and other opportunities that may result from the KRP.

KRH believes the Project, in conjunction with a MOU, and SEPA can help preserve and enhance the Kaska culture, while also helping to build the regional economy.

3.4.5 Integrated Wildlife Management Plan: Ross River Traditional Territory

KRH understands, through the review of the *Integrated Wildlife Management Plan: Ross River Traditional Territory*, that the goals of protecting wildlife, providing some harvest opportunities to the public, guaranteeing sustainable harvests for the RRDC, and permitting safe levels of development to proceed are crucial for Ross River.

It is KRH's goal to help the integrated wildlife management process succeed. KRH will adhere to the *Integrated Wildlife Management Plan: Ross River Traditional Territory* through the implementation of the mitigation measures presented in Table 11.1-1 of this Project Proposal.

The KRP will also help the integrated management team complete some of the recommended actions in the Action Plan identified in the *Integrated Wildlife Management Plan: Ross River Traditional Territory* (including, but not limited to Grizzly Bear observations and building the network of wildlife observers).

4.0 DESCRIPTION OF EXISTING ENVIRONMENTAL CONDITIONS

This Section describes existing environmental conditions for the components listed below, based on existing information available at the time the Project Proposal was assembled, as well as data collected specifically for the KRP.

Environmental Components

- Scope of the Project / Study Area
- General Physiography
- Terrain, Soils and Geology
- Climate
- Air Quality
- Noise Levels
- Ecosystems and Vegetation
- Wildlife
- Surface Water Quality
- Hydrology
- Hydrogeology
- Aquatic Ecosystems and Fisheries Resources
- Heritage Resources

4.1 Scope of the Project / Study Area

The existing conditions component of this Project Proposal has been been broken into subsections by discipline. Each environmental and socio-economic component has defined a Local Study Area (LSA) and Regional Study Area (RSA) in their sections for the consideration of existing conditions and assessment of KRP effects. Most LSAs focus on the Site, or Project while most RSAs are composed of the watershed area of Cache Creek and the Ketza River around the LSA (Figure 4.1-1).

YESAA requires that proponents give equal consideration to scientific knowledge and traditional knowledge, where available, throughout their project proposal.

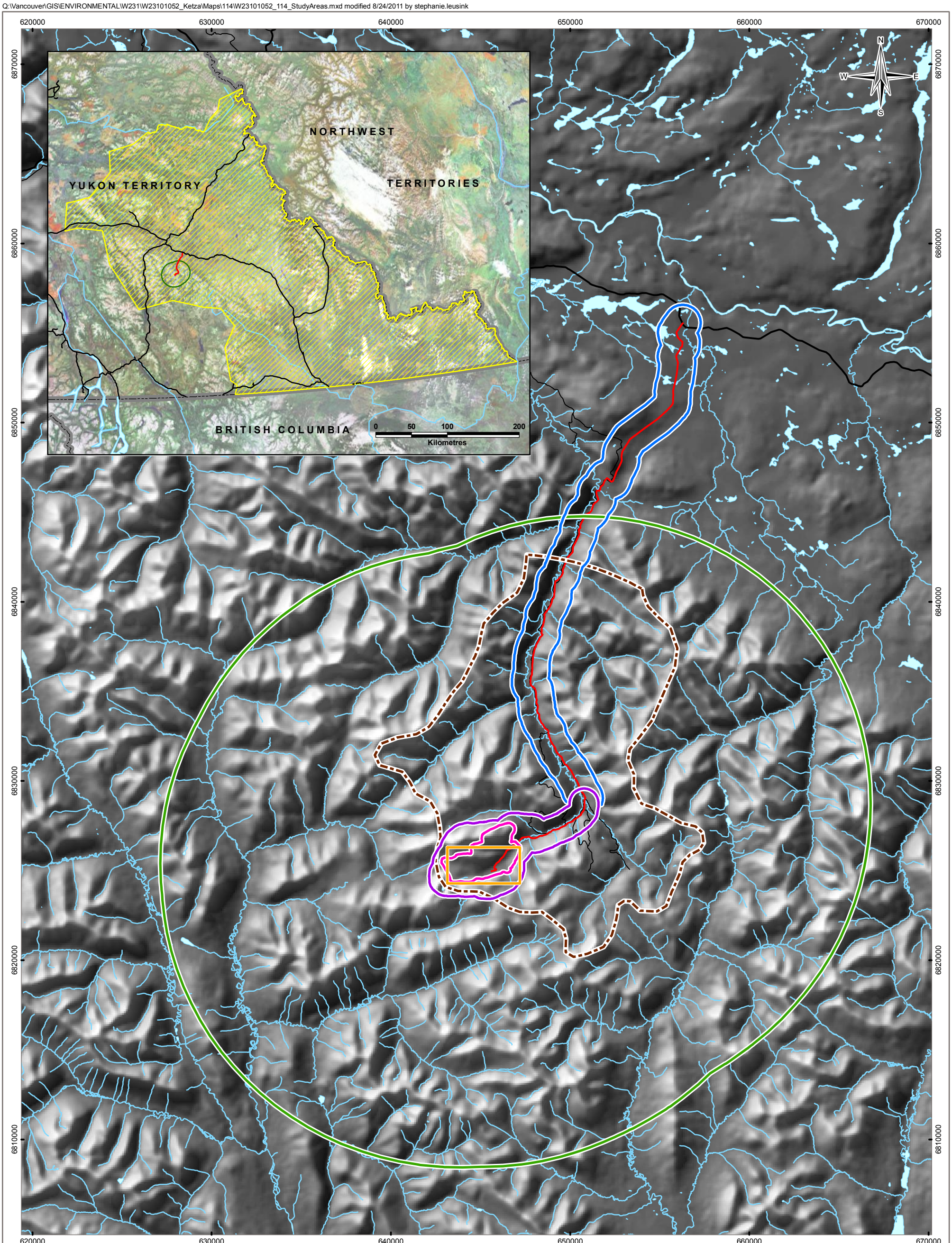
YESAB's *Discussion Document on the Incorporation of Traditional Knowledge into Assessments* quotes the traditional knowledge definition as provided in *YESAA:*

> "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 (YESAB 2005) states:

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

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LEGEND

- Cumulative Effects Study Area
- 2007 Terrain Study Area
- Project Footprint
- Local Study Area
- Ketza Road Study Area
- Surface Water Quality Regional Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway
- Minor Road
- Watercourse
- Waterbody

NOTES
Base data source: NTS 1:50,000

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Study Areas

PROJECTION UTM Zone 8			**DATUM** NAD27		**CLIENT** Ketza River Holdings
Scale: 1:200,000 4 2 0 4 Kilometres					eba A TETRA TECH COMPANY
FILE NO. W23101052_114_StudyAreas.mxd					
PROJECT NO. W23101052.114	**DWN** SL	**CKD** TP	**APVD** TP	**REV** 0	**Figure 4.1-1**
OFFICE EBA-VANC	**DATE** July 26, 2011				

Traditional knowledge is an important source of cultural information. KRH is continuing to work with the RRDC to collect traditional knowledge about the area and to integrate that knowledge into Project plans. KRH has signed a *Traditional Knowledge Protocol* with the RRDC that ensures traditional knowledge is kept confidential.



Photo 4.1-1: Signing the Ross River Dena Council Traditional Knowledge Protocol (July 2011)

4.2 General Physiography

The KRP is located within the Saint Cyr Range Ecodistrict, of the Pelly Mountain Ecoregion in the Boreal Cordillera Ecozone. The Boreal Cordillera is the midsection of the Cordilleran system, which lies between the Taiga Cordillera to the north along the Yukon border and the Pacific Maritime Ecozone to the west. The Saint Cyr Range is the highest in the Pelly Mountain Ecoregion, with elevations generally higher than 1,500 m asl and a maximum height of 2,404 m asl (Smith et al. 2004). The peaks of these mountains are believed to have existed above ice caps of the last glaciation (Jackson and Mackay 1991).

4.3 Terrain, Soils and Geology

A review and assessment of terrain, surficial geology, terrain hazards and soils for the KRP was undertaken in 2008 (EBA 2008a). The resulting baseline report titled *Bedrock Geology, Surficial Geology and Terrain, Terrain Hazards: 2007 Environmental Baseline Studies* is included in Appendix D1.

Existing terrain conditions of the general area surrounding the Project were determined through review of historic relevant reports, interpretation of aerial photographs, and limited terrain field checking. Initial terrain mapping was completed using stereo air photograph (1:20,000 scale) interpretation, which was followed by terrain field checking by EBA personnel on August 3, 2007. The preliminary terrain interpretation was revised based on the results of the field checking and a terrain map of the study area was produced (Figure 4.3-1). The following section summarizes the results of the terrain mapping and terrain hazard study, and provides a summary of the geological conditions.



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LEGEND

- Landslide
- Portal
- Project Footprint
- 2007 Study Area
- Surface Geology
- Contours (10 m)
- Watercourse
- Waterbody

surficial material → surface expression

aCv / Rks - A"Rb"

texture | underlying material | geomorphological processes

NOTES

1. Base data source: Juno, Contours and Aerial Photography provided by Aero Geometrics, Ltd.
2. Terrain mapping is reconnaissance level and materials, terrain and processes are interpreted from air photograph interpretation with no field checking.
3. Results are preliminary, cannot be verified without field checking and are not intended for use in development planning.

SURFACE MATERIAL AND SURFACE EXPRESSION

Ab	terrain altered by development - blanket
Av/Rks	terrain altered by development - veneer overlying rock - moderately steep to steep gradient slope
Ah	terrain altered by development - hummocky
Aht	terrain altered by development - mixed hummocky and terraced
Avb	terrain altered by development - mixed veneer and blanket
Ak	terrain altered by development - moderately steep slope
At(6)Cj(4)	terrain altered by development - terraced (60%) and colluvium - gentle slope (40%)
Cb	colluvium - blanket
Cf	colluvium - fan
aCv/Rks	blocky colluvium veneer overlying rock - moderately steep to steep slope
Ck(6)Rs(4)	colluvium - moderately steep (60%) and rock - steep (40%)
Cv	colluvium - veneer
Cvb/Mb	colluvium - mixed veneer and blanket overlying morainal blanket
Cv/R	colluvium - veneer overlying rock
Cv/Rt	colluvium - veneer overlying rock - terraced
Cv/Raj	colluvium - veneer overlying rock - moderate to gentle gradient slopes
Cv/Rak	colluvium - veneer overlying rock - moderate to moderately steep gradient slopes
Cv/Rks	colluvium - veneer overlying rock - moderately steep to steep gradient slopes
Fp	fluvial plain
Fp/Mb	fluvial plain overlying morainal blanket
Fp/Mt	fluvial plain overlying till - terraced
Fv	fluvial veneer
Fv/Mp	fluvial veneer overlying morainal plain
Mb	morainal blanket
Mh	moraine - hummocky
Mhr	moraine - hummocky and ridged
Mk	moraine - moderately steep gradient slope
Mbh	morainal blanket - hummocky
Mt	moraine - terraced
Mbt	moraine - mixed terraced and blanket
Mka	moraine - moderately steep to moderate gradient slope
Mmhr	moraine - rolling, hummocky and ridged
MvCv	both colluvium and moraine within polygon

*blanket (1-3 m thick); veneer (< 1 m thick)

GEOMORPHOLOGICAL PROCESSES

- A	avalanche deposition zone
- A"	active avalanche hazard initiation zone
- Rb	rockfall deposition zone
- Rb"	active rockfall initiation zone
- Rd	debris flow deposition zone
- V	gullying
- Z	rock glacier

SLOPE GRADIENT

1 (p) - plain (<5%)
2 (j) - gentle (5-26%)
3 (a) - moderate (27-49%)
4 (k) - moderately steep (50-70%)
5 (s) - steep (>70%)

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Terrain and Surficial Geology

PROJECTION UTM Zone 8	**DATUM** NAD83			**CLIENT** Ketza River Holdings
Scale: 1:20,000 (400 200 0 400 Metres)				
FILE NO. W23101052_106_Terrain.mxd				eba A TETRA TECH COMPANY
PROJECT NO. W23101052.106	**DWN** SL	**CKD** JD	**APVD** JD	**REV** 0
OFFICE EBA-VANC	**DATE** July 26, 2011			**Figure 4.3-1**

4.3.1 Terrain Production Area Footprint Study Area

A 765 ha area, identified as the Terrain Production Area Footprint (TPAF), includes the valley of Cache Creek and parts of the Oxo Creek and Peel Creek valleys, located within mapsheet NTS 105F (Figure 4.3-1).

The TPAF encompasses the U-shaped Cache Creek Valley, which has steep, glacially-scoured valley hillslopes and an irregular valley floor. The valley floor is characterized by hummocky ridges of lateral and terminal moraines. Elevation ranges from about 1,400 m to 2,000 m asl.

4.3.1.1 Quaternary History

The TPAF lies entirely within the late Wisconsinan McConnell glacial limit. According to YG (2010), there is little evidence of prior glacial or interglacial deposits in this area. Based on radiocarbon chronology, the Late Wisconsinan McConnell Glaciation of Yukon is estimated to have occurred from 23,900 years before present to 10,700 years before present (Bond 2004; Anderson et al. 2002).

According to Bond and Kennedy (2005), four distinct phases of the McConnell glaciation were recognized in the Pelly Mountains; however, landforms from the earlier ice-flow phases such as glacial maximum are not well represented. Based on the orientation and morphology of high-elevation landforms such as crag-and-tail features, it is suggested that ice was moving northwest and reached a minimum elevation of 1,676 m asl. At elevations below 1,500 asl, morainal landforms and associated lateral meltwater channels are present, as are deposits from local alpine glacial activity (Photo 4.3-1).



Photo 4.3-1: View looking Northward of Mostly Alpine Terrain within the Terrain Production Area Footprint

Ice flow in the Pelly Mountains was associated with the Selwyn and Cassiar lobes of the Cordilleran ice sheet (Bond and Kennedy 2005). The Cassiar ice lobe flowed northward, over most of the Pelly Mountains. The southward-flowing drainages in the Pelly Mountains experienced up-valley ice flow during glacial maximum and early deglaciation (YG 2010). Cordilleran ice within the Pelly Mountains was greater than 600 m thick.

4.3.1.2 Surficial Geology and Terrain

The TPAF encompasses the Cache Creek valley, which dips moderately eastwards at slopes ranging from about 7% to 16%. The adjacent valley walls are steeper with slopes ranging from 30% to 80%. The creek flows eastwards and drains into the Ketza River (Gartner Lee Limited 2002). In numerous places, Cache Creek has incised into thick glacial till deposits to form steep stream escarpments. Downstream of the Canamax TSF, a prominent moraine, forming a portion of the north Cache Creek valley hillslope at the terminus of a hanging valley, is breached by Peel Creek (Figure 4.3-1).

Upper slopes and mountain ridges are predominantly colluvium (talus) or rock outcrop. These areas are dominated by weathered, frost-shattered and colluviated bedrock. Glacial activity has over-steepened the valley walls. Fans, cones and abundant talus slopes have formed at the base of these over-steepened slopes. The valley bottom is primarily a veneer of colluvium or weathered bedrock with discontinuous pockets of till veneer overlying limestone bedrock. Near the valley sideslopes, colluvium has accumulated from rockfall, avalanching and other mass movement processes. Discontinuous areas of relatively permeable glaciofluvial outwash and alluvium may be encountered on the valley floor. Glacial outwash sands and gravels or terminal moraine form a portion of the tailings impoundment and are found in the Cache Creek valley downstream of the mine site. The mill and camp site is located on a wide, valley-centre ridge of moraine.

Geotechnical evaluation near the Canamax TSF characterized surficial material textures and depth to bedrock (5 m to 15 m). A thick (up to 8.5 m) blanket of colluvium reported at the northern abutment of the tailings dam consists of silty sand and angular gravel with some cobbles and occasional boulders. Outwash deposits south of the Canamax TSF are a 5 m to 8 m thick layer of sand and gravel with some silt, cobbles and boulders to silty sand and gravel with some cobbles and occasional boulders. Alluvial or glaciofluvial materials reported at depths of 4.6 m to 8.4 m west of the Canamax TSF are silty sand to silty sand and gravel with occasional layers of clean sand and gravel and occasional cobbles. Boreholes adjacent to Cache Creek report compact sandy (25-35%) gravel (48-62%) with some silt (10-15%) at depths of up to 7.3 m (Golder Associates 1986).

4.3.1.3 Permafrost

Permafrost in the region is considered discontinuous with regular occurrence likely above 1,500 m asl and underneath most valley bottoms (Brown 1978). The mine site is located above 1,500 m asl and zones of permafrost are known to be present in the mine area. Permafrost was observed on the north slope of the Cache Creek Diversion (Gartner Lee Limited 2002).

The incidence of permafrost in the alpine zone is high, but at lower elevations it is variable. Direct permafrost information at the study area is limited; however, valley floors in this part of the Pelly Mountains Ecoregion are typically underlain by frozen ground (Smith et al. 2004). At nearby Finlayson

Lake the base of permafrost is over 20 m below the ground surface (Burgess et al. 1982; Stanley 1986). Permafrost is common on north-facing slopes and under bog complexes, particularly at higher elevations. In this area, permafrost-free areas are thought to be limited to some south-facing slopes and river courses (Jackson 1984).

Data on local permafrost conditions, ice content and thaw susceptibility for the TPAF is not documented. Coarse-textured colluvium on valley slopes is typically well-drained and ice content is expected to be low. Valley toe slopes and floors could have pockets of fine-textured soils with high ice content.

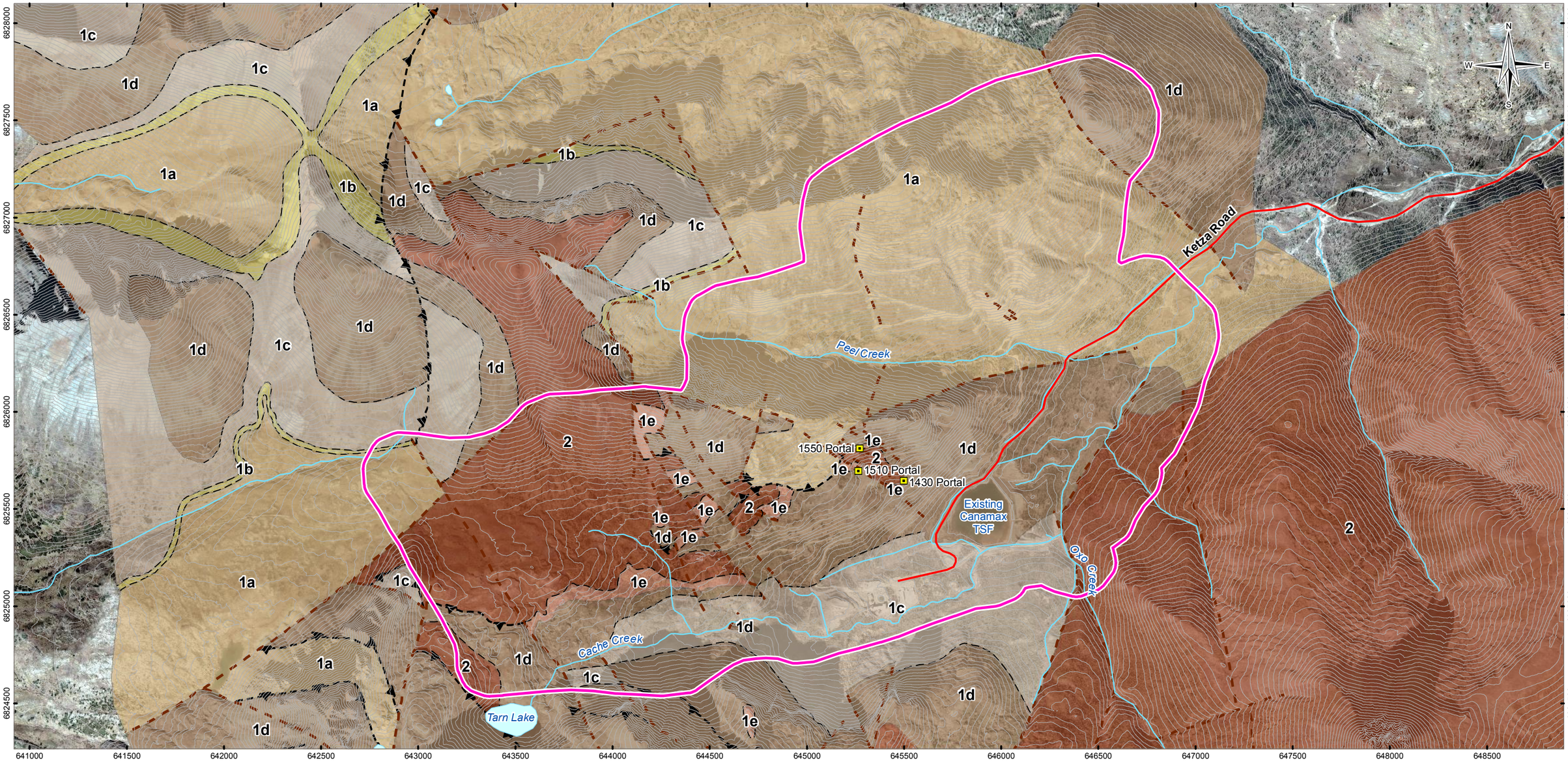
Some evidence of permafrost instability is reported at developed sites in the region. Diversion ditches show evidence of sloughing failures and the Cache Creek Diversion north slope has permafrost and is actively creeping. Permafrost was observed on the south diversion bank where retrogressive thaw slumping was attributed to permafrost degradation (Gartner Lee Limited 2002).

4.3.1.4 Bedrock Geology

The TPAF is underlain by a conformable sequence of Lower Cambrian carbonate and clastic sedimentary rock units that are unconformably overlain by black shale of Late Cambrian age (Fonseca 1998; Figure 4.3-2). Gold mineralization at the Site occurs within manto replacement deposits along permissive horizons within Lower Cambrian Limestone in the Cache Creek Valley. The important manto deposits occur on the southern flank of the Ketza Uplift, a domed feature likely underlain by mid-Cretaceous intrusive rocks. Gold-bearing massive sulphide deposits of pyrrhotite, pyrite and arsenopyrite have been oxidized and the gold values enriched within structural zones or panels where normal faulting cross cuts the stratigraphy.

A Lower Cambrian limestone sequence from 120 m to 180 m thick (Unit 1d on Figure 4.3-3) is host to all replacement type manto mineralization on the claims. An internal stratigraphy separated on the basis of textures has been recognized within Unit 1d. The limestone is grey, clean and uniformly bedded, with distinctive Archeocyathid fossils (FSLT) occurring near the top of the unit. Distinct beds of massive fine-grained light grey limestone (MSLT), blue fine grained crystalline limestone (BXLT), thin and wispy silt banded limestone (WBN), and silty black limestone (BSLT) are recognizable in drill core and outcrop. The unit is locally dolomitized, with recrystallization and orange weathering in the vicinity of mineralization. The lower contact is gradational and arbitrarily defined where the well bedded limestone becomes the major component. The limestone is resistant and forms prominent cliffs and ridges throughout the region. The carbonate component of these rocks is acid-neutralizing (Figure 4.3-3).

The stratigraphic sequence is disrupted by thrust faults and related folds, cut by multiple sets of steeply dipping normal faults. Faulting near the deposits is complex and probably controlled by the location of the mineralization, providing conduits for oxidizing fluids. Intense folding has resulted in overturned stratigraphy on fold limbs.



LEGEND

- Portal
- Project Footprint
- Ketza Road
- Contours (10 m)
- Watercourse
- Waterbody

Fault Type

- Contact
- Fault
- Thrust Fault

Geology

- 1a - argillite
- 1b - limestone
- 1c - calcareous argillite
- 1d - Lower Cambrian limestone complex host unit; includes FSLT, MSLT, BSLT, BXLT and WBN
- 1e - mudstone
- 2 - shale

NOTES
Base data source: Juno and Contours provided by Aero Geometrics, Ltd.

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Bedrock Geology

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD83	Ketza River Holdings

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

FILE NO.
W23101052_106_Geology.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.106	SL	KWW	JD	0

OFFICE	DATE
EBA-VANC	July 26, 2011

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Figure 4.3-2

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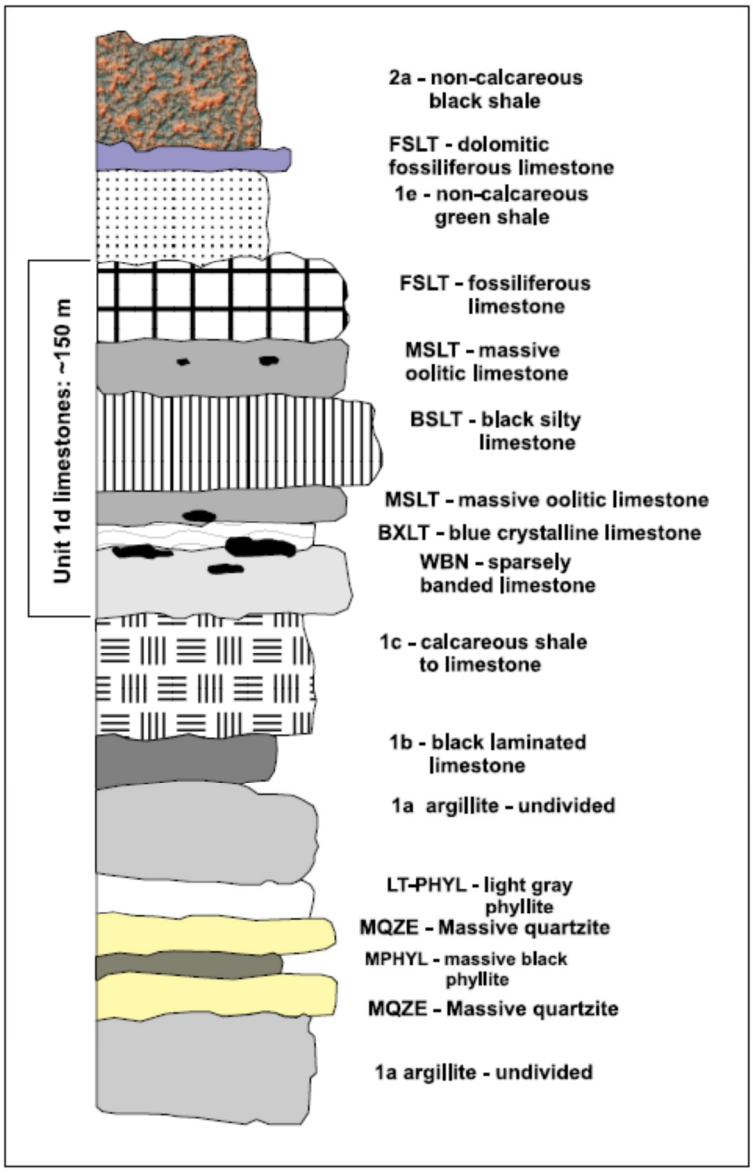


Figure 4.3-3: Schematic Stratigraphic Column for the Ketza River Project Area
Source: Fonseca 1998

4.3.1.5 Soils

The general area is dominated by sedimentary and metamorphic rocks. Orthic Eutric Brunisols develop on sandy loam moraine or on coarse colluvium derived from these sources, particularly at lower elevations. With most of the TPAF located above treeline and influenced by permafrost, Turbic Cryosols are expected to dominate, particularly on north-facing slopes (Smith et al. 2004).

4.3.1.6 Terrain Hazards

Mass movement processes in the LSA include rockfall, debris flows, and avalanches. Colluvium on lower valley slopes and at the edge of the valley floor has accumulated from each of these processes. Rockfall appears to be limited to ongoing erosion from steep, upper valley slopes. There is potential for debris flow activity in gullied stream channels on the steep valley sideslopes. A channeled colluvial fan located on the south side of Cache Creek, across from the mill, is probably subject to periodic debris flow activity. There does not appear to be evidence of recent large debris flow scours and the probability of direct impact to the mill site is likely low.

Earlier reports suggest a possible rockslide just west of the mill. There is potential for debris slides from the flanks of the valley and from small tributary creeks into the main Cache Creek valley upstream of the tailings impoundment. However, the gradient of the creek valley is likely too flat for the transport of material in the form of debris flows. Flooding and consequent transport of fine sediment could occur, but not debris flows in this sector of the creek (SRK 1990).

In general, the probability of natural hazards except avalanche is low; however some evidence of instability is reported at developed sites. Diversion ditches show evidence of sloughing failures and the Cache Creek Diversion north slope has permafrost and is actively creeping. Retrogressive thaw slumping on the south diversion bank, also containing permafrost, was observed and the possibility of ongoing slope movement in response to thawing ground is high. The potential for slumping of waste rock dumps was identified. Circular tension cracks observed 15 m back from the edge of the Ridge Pit waste dump were taken to be evidence of an old failure (Gartner Lee Limited 2002).

4.3.1.7 Avalanche Hazard

Avalanches are a winter hazard on the smooth, unforested slopes in the region. There are historical records of snow avalanches in the mountains surrounding the mine site, occasionally affecting mine infrastructure. The Peel Creek drainage is severely affected by large avalanches and the north-facing slopes of Peel Creek should not be used in the winter due to avalanche hazard. Avalanches could develop on many of the steep slopes and gullies.

Avalanche hazards have been assessed in previous reports (Mackenzie 2005; Chris Stethem and Associates 1987) and are identified on the terrain map (Figure 4.3-1). Specific avalanche areas identified in the Cache Creek drainage include:

- Below 1510 Portal potential for minor avalanches due to pockets of snow accumulation
- Break Zone open pit area could affect the Canamax and new TSF
- Above the Canamax TSF which could be damaged by a large avalanche
- The slopes and paths that reach towards the camp area.

The low-angle, treed, run-out zone in the polygon immediately south of the mill area (Figure 4.3-1) appears to contain the avalanches and the camp and mill sites appear to be well-located with respect to avalanche hazards. “Any future expansion onto the south side of Cache Creek should be undertaken only with site-specific study, as this area is affected by several large avalanche sites. Explosive control is recommended for areas of high snow accumulation to prevent large avalanche events” (Mackenzie 2005; Chris Stethem and Associates 1987). Avalanche conditions should be continually monitored and records kept for ongoing assessment of frequency, location and volume.

4.3.2 Ketza Road Terrain and Geology

The KRP is accessed along a 42 km gravel road off the Robert Campbell Highway at approximately Km 323 along the Ketza Road. This road was originally developed to supply the Canamax Mine between 1988 and 1990. The initial 10 km of the Ketza Road is underlain by Quaternary glacial deposits with numerous good sources of granular material for road construction and maintenance. The remainder of the road is located in the Ketza River valley where borrow sources typically source recent fluvial (river) deposits or colluvium. Bedrock geology in the Ketza River valley is Lower Mesozoic and Palaeozoic Era (195 to 600 million years) sediments of the Tintina Trench with a major fault trend approximately perpendicular to the valley.

The aggregate required for maintenance and improvements to the Ketza Road is planned to be sourced from permitted sand and gravel borrow pits along the road. Rip-rap is planned to be sourced from permitted KRH limestone quarries.

Orthic Eutric Brunisols are likely to be the predominant soils at lower elevations along the Ketza Road underlain by fluvial deposits, till and coarse colluvium of sedimentary and metamorphic rocks.

Permafrost is expected to occur underneath the Ketza River valley bottom in areas away from the influence of river ground water, particularly under bog complexes. Coarse-textured colluvium on valley slopes and granular fluvial deposits are typically well-drained and ice content is expected to be low. Valley toe slopes and floors could have pockets of fine-textured soils with high ice content.

In most areas along the Ketza Road the probability of natural hazards except avalanches is low. A reconnaissance level review using high altitude photographic imagery indicated no prominent active, rapid-movement landslides in the vicinity of the Ketza Road. Rockfall on some upper valley side slopes forms colluvium (talus) on middle to lower valley slopes. There is likely a potential for debris flow activity in gullied stream channels on the steep valley side slopes, but there is no known history of the road being impacted by such processes so it is assumed that the probability of debris flow impact to the Ketza Road is low. Evidence of apparent avalanche tracks on high level air photographs indicated that the Ketza Road could be influenced in the winter by avalanche where the alignment is located close to the base of the valley side slopes.

4.4 Climate

The KRP is located in a mountainous region of the Pelly-Cassiar climatic zone of the Yukon Territory, characterized by relatively cool summers, less-severe winter temperatures due to temperature inversions and relatively high precipitation as the Pelly and Cassiar Mountains act as secondary orographic barriers for air masses which originate from the Pacific Ocean (Wahl et. al 1987).

4.4.1 Meteorological Stations

Meteorological analysis was conducted using data recorded by an on-site meteorological station and at four regional stations operated by the Meteorological Service of Canada (MSC). Regional meteorological data supplements data recorded on-site, helps fill data gaps where necessary, validates the on-site data and provides a much longer period of record to identify regional climate trends. The locations of the meteorological stations are shown in Figure 4.4-1.

Hourly meteorological observations from the Site include wind speed and direction, air temperature, humidity, barometric pressure, incident solar radiation, and cumulative rainfall. The current station is installed on the roof of a trailer and has a period of record commencing February 27, 2006. Data presented here include the period up to November 17, 2010 for a period of record of 4.5 years. Portions of the hourly observations are missing (the periods between July 28, 2008 and May 23, 2009 and between July 28 and August 14, 2010) or are sporadic.

Prior to the current installation, an MSC-operated Ketza River Mine Meteorological Station (Climate ID# 2100FPP), located at 61.52° N, 132.27° W (WGS-84) at an elevation of 1380 m asl, recorded twice-daily air temperatures and total daily rainfall and snowfall accumulation from 1986 until 1995. The data record is sporadic with missing or incomplete data, however complete records exist for 65 of 117 months and are included in calculations of monthly means for air temperature and precipitation at Site.

Ross River Airport and YG Meteorological Stations (Climate IDs# 2100940 and # 2100941), located approximately 50 km north of the Site at 61.98° N, 132.45° W and at 698 m asl, provide twice daily air temperatures and total daily rainfall and snowfall accumulations for the period 1967 to 2006. A significant amount of daily data is missing and therefore does not meet World Meteorological Organization (WMO) guidelines for completeness to include in describing monthly means (daily synoptic data missing for more than 3 consecutive days or for more than a total of 5 days in a month).

Faro Airport Meteorological Station, located approximately 100 km northwest of the KRP at 62.21° N, 133.38° W (WGS-84) and at 717 m asl, provides twice daily air temperatures and total daily rainfall and snowfall accumulations for the period 1967 to 2010. The record at Faro is much more complete, with 464 of 529 complete months (data are missing for the entire period March 1968 to October 1971, inclusive).

Anvil Meteorological Station is located approximately 120 km northwest of the KRP and 20 km northwest of Faro Airport at 62.37° N, 133.38° W at 1158 m asl. It provides twice daily air temperatures and total daily rainfall and snowfall accumulations for the period 1967 to 1991. The monthly record at Anvil contains 199 complete months of 281 total.

4.4.2 Wind

Wind data presented here describe hourly observations at approximately three metres above the ground at the location of the station (on the trailer roof) and therefore wind speeds will generally be lower compared to regional observations acquired at the WMO standard of 10 m. Wind observations from site are summarized by month in Table 4.4-1.

Figure 4.4-2 shows the wind rose for the Site and illustrates the predominance of winds originating from the south-southwest (40% of all wind observations originated from the S, SSW and, SW). The small frequency of occurrence of winds from the north and northwest (less than 2% of the overall record) may indicate poor exposure of the station's wind anemometer. Average wind speeds are typically light with over 75% of winds being recorded as 3 m/s or less. Calm conditions (less than 1 m/s) have occurred 31% of the time.

The mean annual wind speed at 3 m is 1.9 m/s (6.8 km/hr). Winds are stronger on average during the summer months (Table 4.4-1). Wind gust speeds are also typically higher during the summer, although the highest wind gusts have been recorded during the winter and early spring. The highest recorded gust speed was 24.1 m/s (86.8 km/hr).

4.4.3 Air Temperature

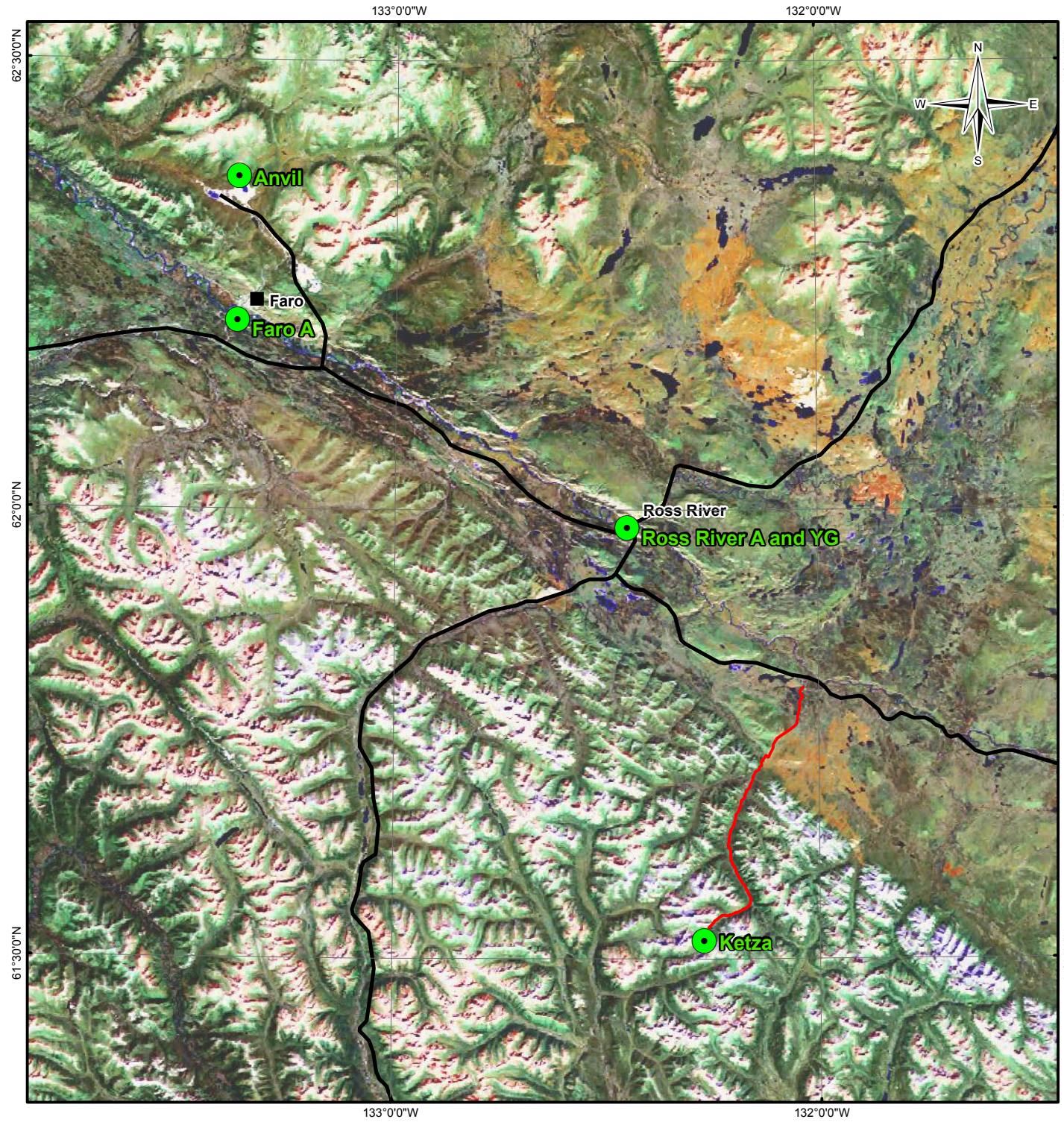
The summer period at the Site, between late-May and early-September, is characterized by temperatures typically in the range of 5°C to 20°C, which exhibit a moderate diurnal cycle. Daytime temperatures do not typically exceed 20°C. Overnight summer temperatures below 0°C are rare. The winter period, between October and March, is characterized by temperatures in the range of 0°C to -20°C. With less daylight, the diurnal cycle is less prominent; however winter temperatures tend to follow 5- to 10-day warming and cooling cycles, which results in much more week-to-week variation (Figure 4.4-3).

Air temperature observations are summarized by month in Table 4.4-1. Based on the period of record, July is the warmest month on average (11.3°C) while the coldest is January (-13.1°C). The mean annual air temperature at 1380 m asl is -1.8°C. The maximum air temperature recorded by the station was 27.6°C. The minimum air temperature recorded was -36.8°C.

A comparison of air temperature data recorded at the Site and at MSC regional station Ross River YG over a coincidental period (January 2006 to August 2008) is shown in Table 4.4-2. Average monthly temperatures at site are 3°C cooler during the summer months and 6 to 7°C warmer during the winter months than those observed at a lower elevation at Ross River (698 m asl). During the winter, inversions are prevalent in the Yukon which results in temperatures increasing with height to approximately 1,600 m asl (Pinard et al. 2009). Strong inversion lapse rates during the winter are typically in in the range of +8 to +12°C/km which would account for the observed difference. Normal (summer) lapse rates are typically in the range of -6 to -8°C/km.

4.4.4 Relative Humidity

Relative humidity (RH) at Site is much higher on average during the winter months than during the spring and summer (Table 4.4-1). RH is much more variable during the summer, typically ranging from 30% to 80% (Figure 4.4-4). Annually, mean RH is 65%.



LEGEND

- Meteorological Station
- Town or Community
- Ketza Road
- Major Road

NOTES
Base data source: Yukon Geomatics and ESRI Data

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Regional Meteorological Stations

PROJECTION	DATUM	CLIENT
Albers	NAD83	Ketza River Holdings

Scale: 1:700,000
10 5 0 10
Kilometres

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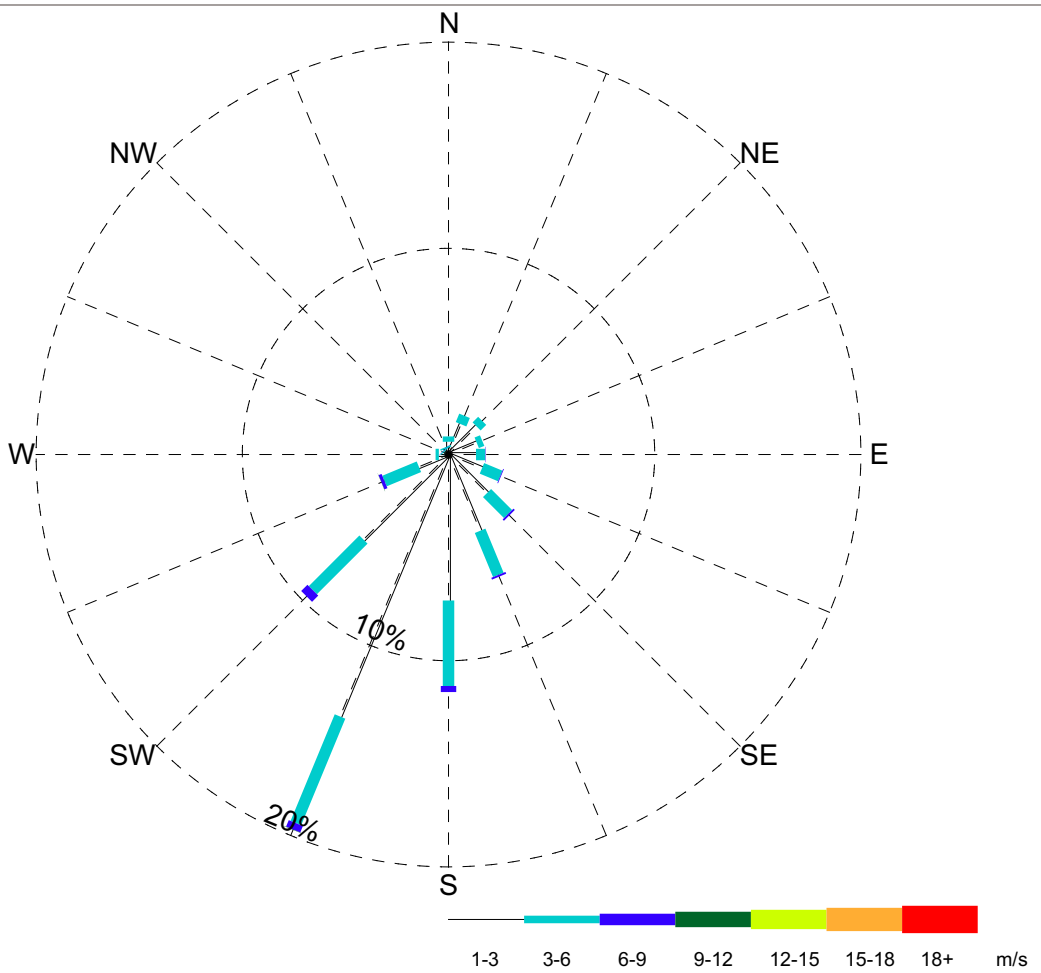
PROJECT NO.	DWN	CKD	APVD	REV
W23101052.101	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

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Figure 4.4-1

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Station Name: Ketza River Project

WGS 84 Location:

N61° 52' 12.0" W132° 16' 12.0"

Elevation above SL: 1380 m

Tower height: 3 m (approx)

Record length: *1724 days

Start Date: Feb. 27, 2006

End Date: Nov. 17, 2010

Wind Speed & Direction Frequency Distribution Table

	Percent Occurrence (%)								
Direction	**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	-	1.48	0.28	-	-	-	-	-	1.76
NE	-	1.93	0.38	-	-	-	-	-	2.31
NNE	-	1.59	0.44	-	-	-	-	-	2.04
N	-	0.62	0.26	-	-	-	-	-	0.88
NNW	-	0.31	0.08	-	-	-	-	-	0.39
NW	-	0.24	0.05	0.01	-	-	-	-	0.30
WNW	-	0.19	0.01	-	-	-	-	-	0.20
W	-	0.47	0.16	-	-	-	-	-	0.63
WSW	-	1.55	1.81	0.16	0.01	-	-	-	3.53
SW	-	5.83	3.47	0.43	-	-	-	-	9.74
SSW	-	13.75	5.60	0.34	0.02	-	-	-	19.71
S	-	7.08	4.15	0.30	-	-	-	-	11.53
SSE	-	4.00	2.31	0.09	-	-	-	-	6.41
SE	-	2.64	1.44	0.09	-	-	-	-	4.17
ESE	-	1.75	0.96	0.04	-	-	-	-	2.75
E	-	1.33	0.45	0.02	-	-	-	-	1.80
Calm	31.84	-	-	-	-	-	-	-	31.84
Total (%)	31.84	44.78	21.85	1.49	0.04	-	-	-	100.00

NOTES

Source: Ketza River Meteorological Station
*Data is missing for periods of: November 2006 to April 2007 and July 2008 to May 2009.

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STATUS
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CLIENT
Ketza River Holdings

KETZA RIVER PROJECT

Ketza Meteorological Station Period of Record Wind Rose

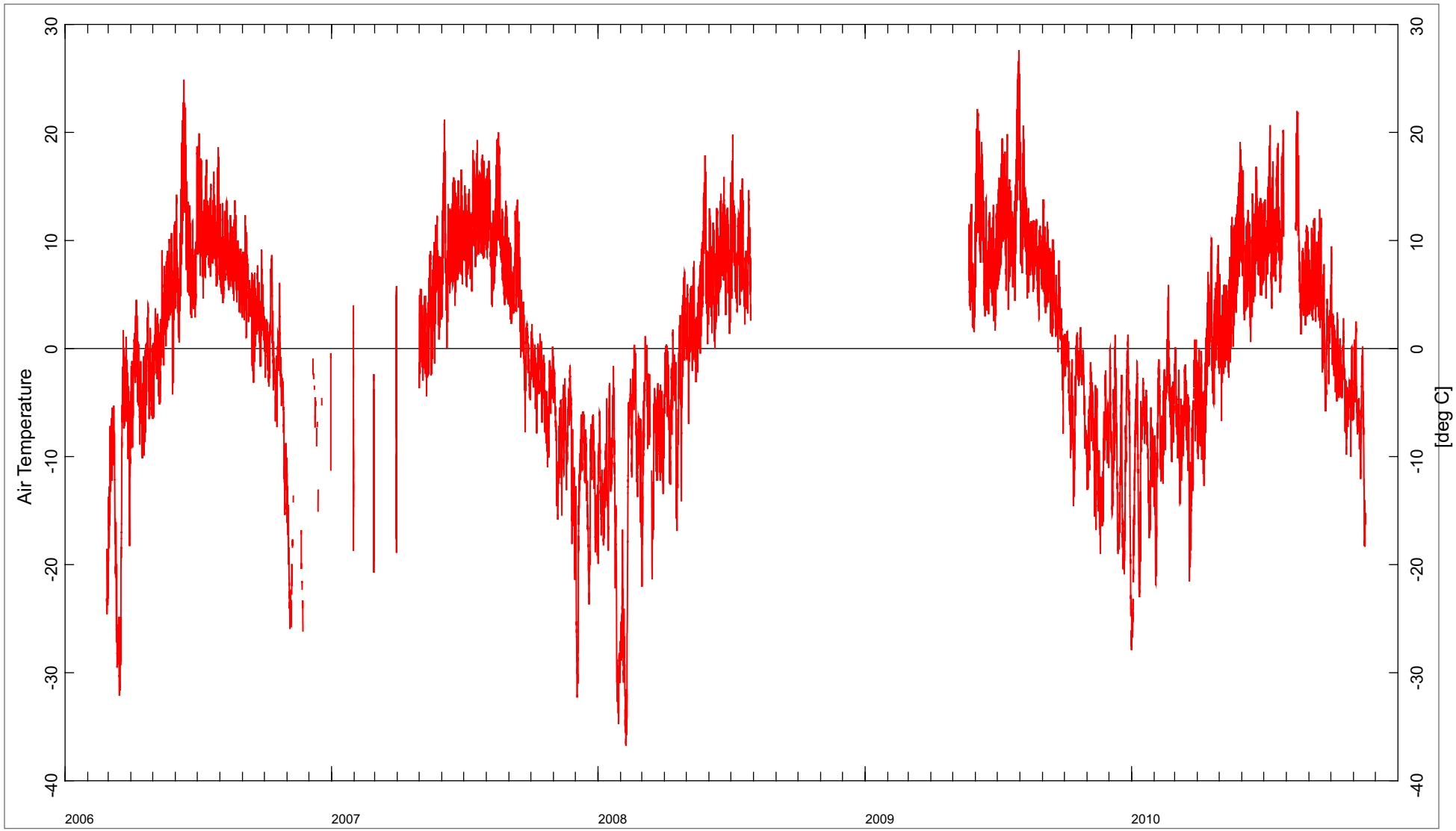
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PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

OFFICE	DATE
EBA-VANC	August 26, 2011

Figure 4.4-2

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NOTES

Source: Ketza River Meteorological Station

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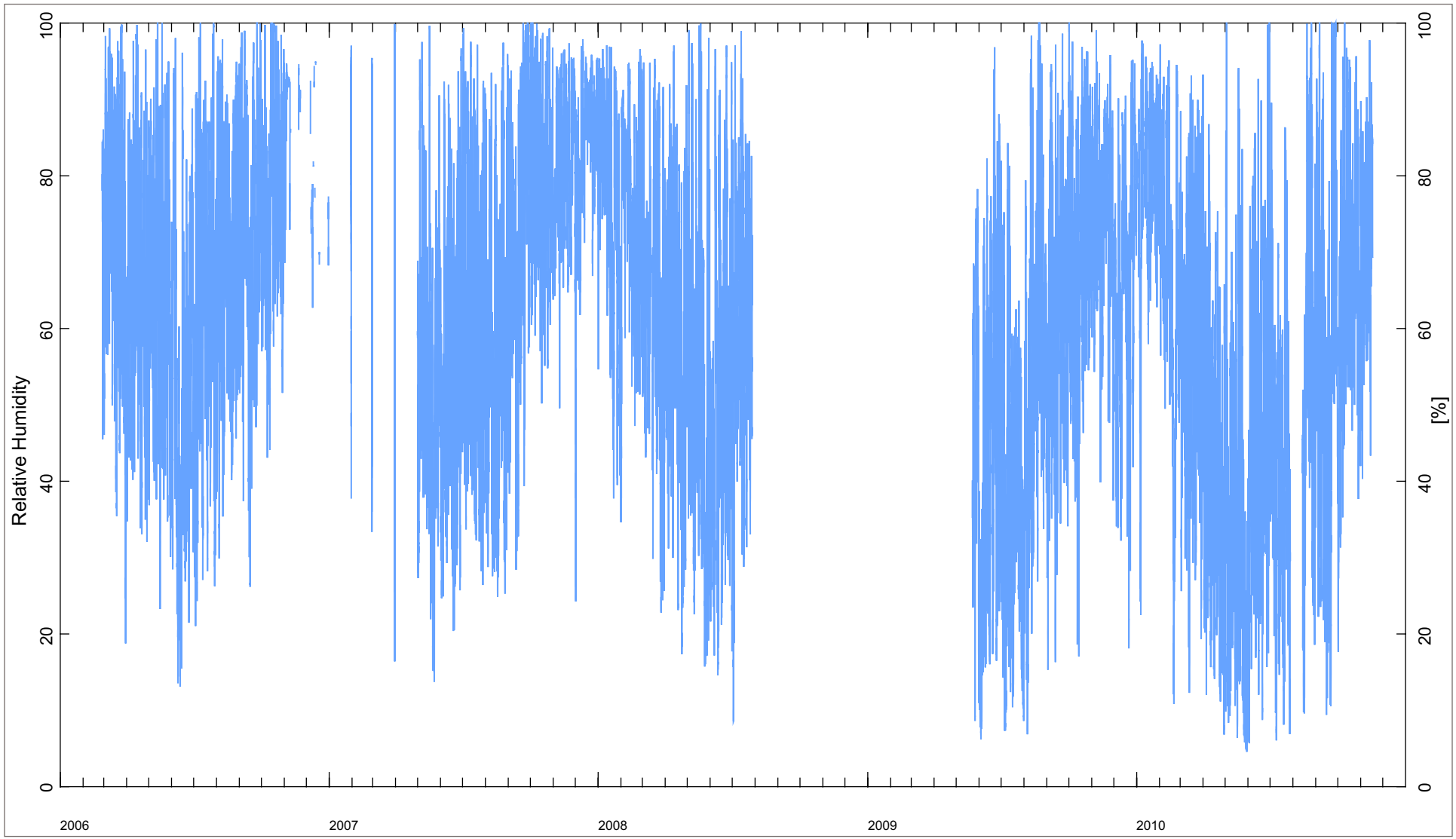
Local Hourly Air Temperature

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

OFFICE	DATE
EBA-VANC	August 30, 2011

Figure 4.4-3

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NOTES

Source: Ketza River Meteorological Station

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STATUS
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KETZA RIVER PROJECT

Local Hourly Relative Humidity

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

OFFICE	DATE
EBA-VANC	August 30, 2011

Figure 4.4-4

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Table 4.4-1: Summary of Ketza River Project Meteorological Observations (2006 – 2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Wind Speed													
Mean Wind Speed (m/s)	1.1	1.5	2.1	2.4	2.2	2.2	2.3	1.9	1.8	1.7	2.0	1.4	1.9
Mean Wind Gust (m/s)	3.6	4.2	5.1	5.6	5.1	5.4	5.6	5.1	5.0	4.6	5.2	4.2	4.9
Extreme Wind Gust (m/s)	24.1	17.0	20.6	20.8	19.6	17.6	16.8	17.1	17.9	17.2	20.6	20.9	24.1
Air Temperature													
Extreme Maximum (°C)	-0.5	5.9	1.7	10.3	19.1	24.9	27.6	22.0	13.8	9.5	2.5	1.3	27.6
Mean Daily Maximum (°C)	-10.1	-8.2	-6.5	0.6	7.2	12.8	14.7	12.1	6.7	-0.9	-6.4	-9.5	1.1
Daily Mean (°C)	-13.1	-10.8	-9.5	-2.5	4.0	9.3	11.3	9.2	4.1	-2.8	-9.1	-12.0	-1.8
Mean Daily Minimum (°C)	-15.3	-13.4	-12.5	-5.8	0.6	5.7	7.9	6.4	1.7	-4.8	-11.0	-14.5	-4.6
Extreme Daily Minimum (°C)	-34.8	-36.8	-32.1	-18.9	-7.0	0.0	2.2	1.3	-7.9	-15.4	-26.1	-32.3	-36.8
Precipitation													
Average Daily Total Rainfall (mm)	0	0	1	5	23	50	57	63	68	7	1	0	274
Incident Solar Radiation													
Average Instantaneous (W/m^2)	7	25	95	158	209	189	162	115	70	33	12	4	90
Average Daily Maximum (W/m^2)	43	125	340	509	597	581	517	404	267	153	63	23	597
Other Meteorological Parameters													
Mean Relative Humidity (%)	78	72	66	57	51	50	53	61	66	73	77	75	65
†Mean Barometric Pressure (hPa)	1001	1003	1001	1003	1009	1008	1010	1010	1007	1003	1000	1006	1005

† Adjusted to sea-level equivalent for elev. 1380

Table 4.4-2: Comparison of Monthly Air Temperatures – Ketza River Project and Ross River (Jan 2006 – Aug 2008)

Ketza River Mine	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Daily Maximum (°C)	-12.6	-12.0	-7.5	-0.3	6.4	12.8	13.8	12.1	6.1	-0.7	-7.6	-11.5	-0.1
Daily Mean (°C)	-15.1	-14.2	-10.5	-3.1	3.3	9.2	10.6	9.1	3.7	-2.6	-10.7	-13.4	-2.8
Mean Daily Minimum (°C)	-18.2	-17.1	-13.7	-6.3	0.1	5.5	7.6	6.5	1.5	-4.7	-12.2	-16.1	-5.6
Ross River YTG													
Mean Daily Maximum (°C)	-14.7	-9.9	-2.2	5.9	13.3	19.6	20.6	19.7	11.2	1.6	-10.1	-11.4	3.6
Daily Mean (°C)	-22.2	-18.4	-12.4	-1.4	5.9	11.8	13.6	12.3	5.1	-2.8	-16.6	-20.7	-3.8
Mean Daily Minimum (°C)	-29.4	-28.2	-23.1	-9.2	-1.3	4.2	6.8	5.1	-1.9	-8.0	-21.7	-30.2	-11.4

4.4.5 Incident Solar Radiation

As would be expected at high latitudes, a strong seasonal pattern to incident solar radiation is evident, peaking around the summer solstice and reaching a minimum around the winter solstice (Figure 4.4-5). Around mid- to late-June, daily maximum incident solar radiation under clear skies is in the range of 700 to 800 watts per square metre (W/m^2).

The average amount of solar radiation received annually at the Site is 90 W/m^2 (Table 4.4-1). Based on the period of record, the highest monthly-averaged insolation received occurs in May, indicating more cloudless sky than in June when the theoretical maximum will occur.

4.4.6 Precipitation

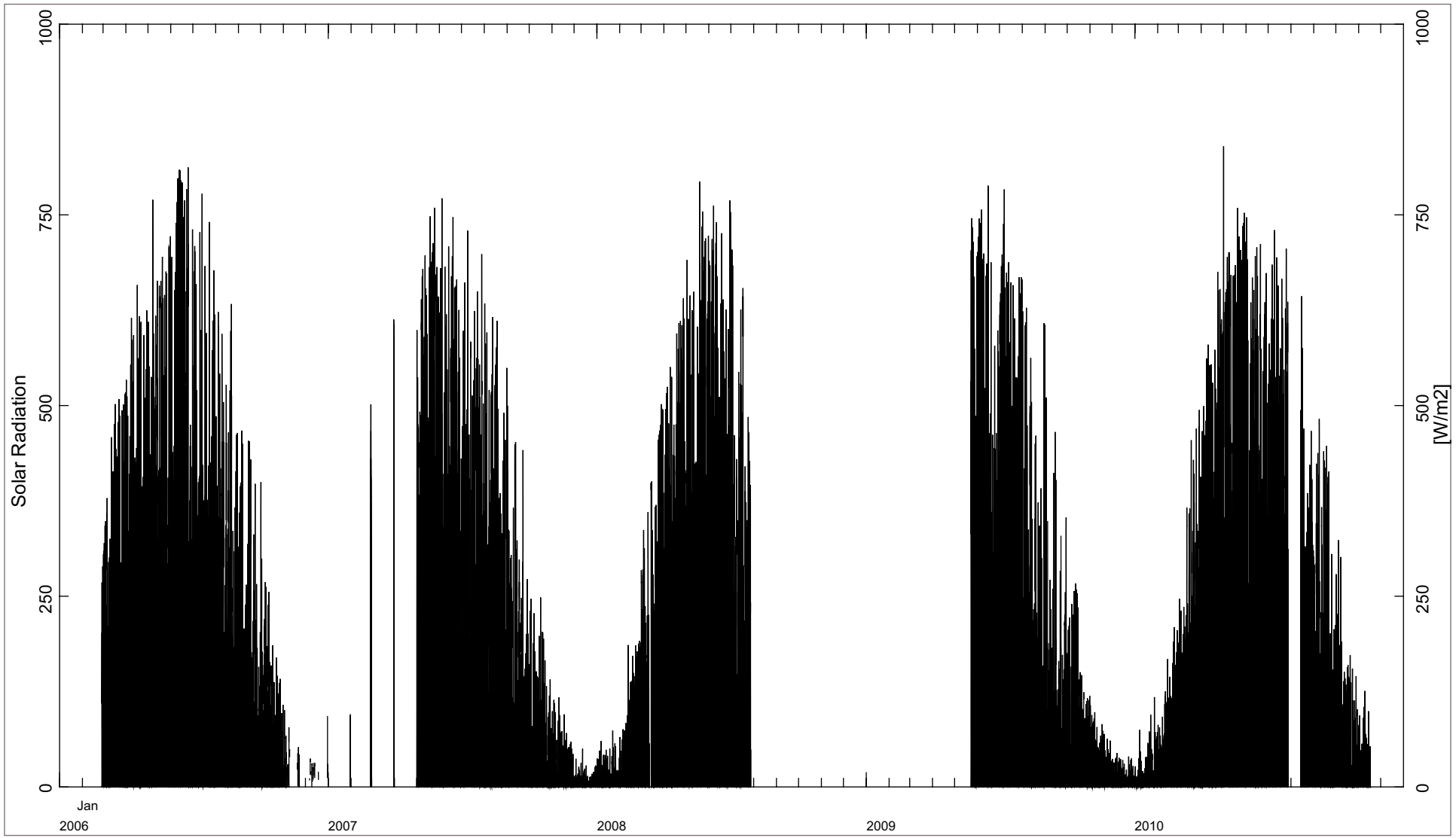
Total annual rainfall is determined for the KRP as a sum of average monthly rainfall totals, where such data exist, between 1986 and 1995 and between 2006 and 2010 (Table 4.4-3). Months in which a partial record exists are prorated over an entire month based on the percentage of available data.

Based on available data, 274 mm of rainfall is expected to occur at site annually. Annual rainfall estimates using only data between 1986-1995 and 2006-2010 are nearly identical, suggesting that rainfall has remained consistent on average over the past 25 years.

Monthly snowfall data were recorded by the Ketza River Mine Meteorological Station over the period 1986 to 1995 but has not been recorded at Site since the current station was installed in 2006. Based on a sum of average monthly totals where such data exist, annual snowfall at the KRP is estimated at 440 cm (Table 4.4-4). Assuming mean annual snowfall, like rainfall, has varied little, applying a 1:10 snow water-equivalency standard (which EC assumes where snow density data are not available), mean annual precipitation for the KRP (1380 m asl) is 714 mm, consisting of 275 mm rainfall and 440 mm water-equivalent snowfall.

Regionally, mean annual precipitation at Faro Airport (717 m asl) is 327 mm (215 mm rainfall; 112 cm snowfall), based on 1971-2000 EC climate normals. Mean annual precipitation at Ross River (698 m asl) is 243 mm (159 mm rainfall; 84 cm snowfall) based on a sum of average monthly totals where such data exist between 1964 and 2008. Regional variability with respect to precipitation is significant especially in mountainous terrain, but increasing precipitation with elevation will be expected.

The mean annual precipitation estimate of 714 mm is based on data recorded at the meteorological station elevation of 1,380 m asl; however significant portions of the KRP drainage basins are at elevations up to 2,100 m asl. An estimate of precipitation increase with elevation is provided using precipitation data recorded over a concurrent period (1967 – 1991) at Faro and Anvil. These stations are separated by 440 m in elevation, but only 20 km in the horizontal so regional variability is minimal. Ignoring any effects of orographic orientation, mean annual precipitation in the region is estimated to increase at a rate of 18 mm/100 m (Table 4.4-5). Applied to the Site, annual precipitation at higher elevations is on the order of 840 mm. If the rate of increase based on mean annual precipitation at Ross River and Ketza is applied (69 mm/ 100 m) (Table 4.4-5), higher elevations could receive up to 1200 mm annually.



NOTES

Source: Ketza River Meteorological Station

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STATUS
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Ketza River Holdings

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KETZA RIVER PROJECT

Local Incident Solar Radiation

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

OFFICE	DATE
EBA-VANC	August 30, 2011

Figure 4.4-5

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Table 4.4-3: Monthly and Annual Rainfall (mm)

Month	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	2006	2007	2008	2009	2010	Average	1986-1995 Average	2006-2010 Average
January	0				0		0	1					0		0	0	0	0
February					0	0	2.1	0				0	0		0	0	1	0
March	0				0		0	0			2	0	0		0	0	0	1
April	0				0	0	0	0			0	9	6		5	2	0	5
May	0				23.8	19	6.3	22.2	20.3	7	28	15	31	28	11	18	14	23
June	28.1				90.6	46.5		67.9	35.8	45.9	20	58	46	66	58	51	52	50
July	64.4			59.4	47		4		57.6	78.4	61	68	110	12	33	54	52	57
August	100.2			23.1	68.4	108.4	60.6		76.4	103.9	63	54		89	47	72	77	63
September	42.7			50	99.5	93.8	39.5		61.2	60.8	81	61		86	43	65	64	68
October	48.6			14.2	0	0	0				18	3		3	5	10	13	7
November	0			0	0	0	0				0	0		0	4	0	0	1
December				0		0	0				0	0		0		0	0	0
TOTALS	**284.0**				**329.3**						**273**	**268**			**206**	**274**	**273**	**274**
	Prorated from partial record																	

Table 4.4-4: Monthly and Annual Snowfall (mm)

Month	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
January	77.0				58.0		41.0	73.0			57.0
February					43.0	50.6	63.0	50.0			49.9
March	94.0				33.0		38.5	27.0			36.6
April					11.0	28.0	54.5	6.5			19.9
May	34.0				5.5	5.0	21.0	2.0	31.5		7.9
June	3.9				0.0	0.0	0.0	0.0	0.0	0.0	0.3
July	0.0			0.0	0.0		0.0		0.0	0.0	0.5
August	0.0			0.0	0.0	7.0	0.0		0.0	0.0	11.7
September	35.5			7.0	21.0	3.0	59.5		30.5	0.0	36.0
October	28.5			55.9	91.0	42.5	57.0				72.8
November	50.0			88.0	77.0	193.0	45.5				81.4
December				55.5		120.0	22.5				66.0
TOTALS	**322.9**						**402.5**				**440.0**
TOTAL SEPT TO MAY					356.9		576.5	343.0			

Table 4.4-5: Regional Annual Precipitation Increase with Elevation (mm)

Station	Elevation (m)	Mean Annual Precipitation (1967 - 1991) (mm)	Rate of Increase with Elevation (mm / 100 m)
Faro	717	314	
Anvil	1158	392	18
Station	**Elevation (m)**	**Mean Annual Precipitation (mm)**	**Rate of Increase with Elevation (mm / 100 m)**
Ketza	1380	715	-
Ross River	698	243	69

4.4.7 Evaporation

Annual lake evaporation at site, as determined from *The Hydrological Atlas of Canada* (Fisheries and Environment Canada 1978) is approximately 285 mm, comparable to a previous report by SRK (1990) which estimated a yearly lake evaporation of 300 mm. Monthly estimates of lake evaporation for the KRP derived from a bulk aerodynamic calculation based on the Dalton evaporation equation for the ice free months of May through September using on-site meteorological data are summarized in Table 4.4-6.

Table 4.4-6: Estimates of Monthly Lake Evaporation (mm)

Month	Evaporation (mm)
January	0
February	0
March	0
April	0
May	82
June	92
July	64
August	32
September	14
October	0
November	0
December	0
Annual	284

4.4.8 Climate Trends

Since the meteorological record at the Site is relatively short and has several data gaps, the best description of the regional air temperature trend is provided based on long-term meteorological records from Ross River (1963-2008) and Faro (1967-2011).

A plot of mean winter temperature in Figure 4.4-6, defined here as the average temperature for December, January, and February at Ross River and Faro, illustrates a slight warming trend in the region over the past 45 years (+0.18°C/yr and +0.08°C/yr respectively). Figure 4.4-6 also indicates winter temperatures on average have varied less from the overall trend over the past 25 years compared to the 25 years previous. The presence of winter inversions may weaken the applicability of the observed regional trend to Site, however annual December, January, and February data plotted for all three locations in Figure 4.4-7 illustrate similar year-to-year variation over a concurrent period of record (1986 – 2010), suggesting regional correlation with respect to air temperature.

A plot of mean summer (June, July, August), temperatures at Ross River and Faro, in Figure 4.4-8, also illustrates slight regional warming trends (+0.05°C/yr and +0.03°C/yr respectively). Mean spring (March, April, May), temperatures at both locations are more variable year-to-year (low R^2 values) and the overall trend is less discernable, however the trendlines would suggest near-neutral change (Figure 4.4-9).

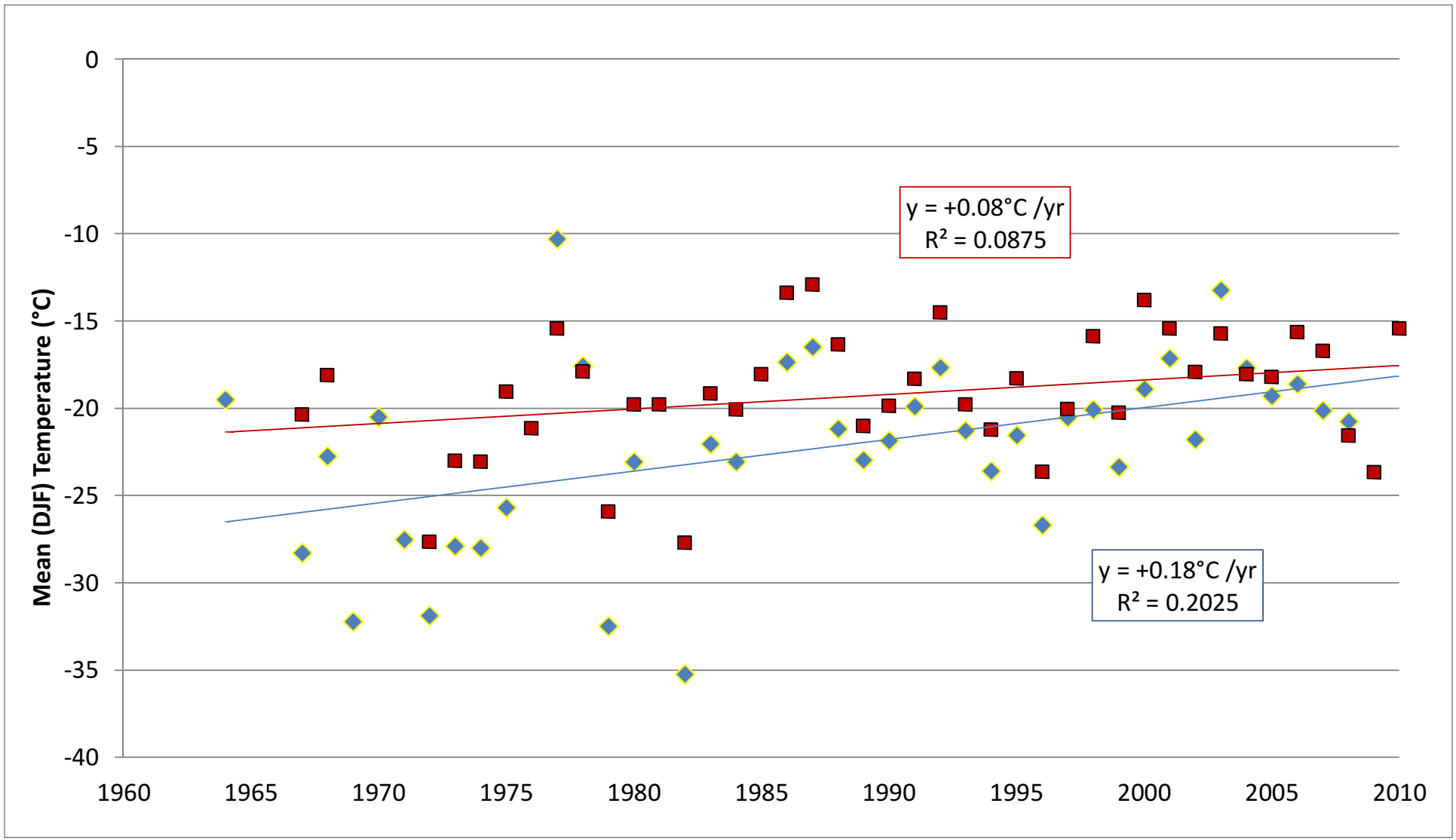
Mean annual rainfall at the Site, as determined from two sets of data (1986 – 1995 and 2006 – 2010) produced a similar estimate (274 mm). The observation suggests a near-neutral trend in precipitation at site, at least over the past 25 years. Regionally, a plot of annual precipitation recorded at Faro, Figure 4.4-10 shows a slight decreasing trend since 1967 (-1.0 mm/yr), however a low correlation of the data with the plotted trendline (R^2 = 0.0276) suggests this observation may be nebulous. Annual precipitation at Ross River, which has many instances of missing data, exhibits a slight decreasing trend but is near-neutral between 1968 and 1995 where most of the years with complete data exist .

Most climate models under a doubled CO_2 scenario predict an increase in mean annual temperature between 2°C and 5°C and an increase in annual precipitation up to 10% for the region over the next half century. Warmer temperatures are expected to increase the frequency of mild winters and warm summers and as a result, increase the frequency of intense winter storms and heavy summer rainfall events (Hengeveld 1997).

4.5 Air Quality

The KRP is located within a remote area of the Yukon, 50 km away from the nearest community of Ross River which has a population of 337. The largest anthropogenic source of emission is fugitive dust due to road traffic. Such activity, which is generally correlated with exploration activities, will temporarily elevate the levels of particles <10 µm in size (PM_{10}) in the vicinity of the road corridor, particularly during dry periods.

The largest potential natural disturbance to air quality at the KRP is particulates up to 2.5 µm in size ($PM_{2.5}$) due to migration of forest fire smoke. Such occurrences are rare and limited to the summer months and will likely pose a larger threat down-valley.



LEGEND

- MSC Faro A Station
- MSC Ross River A Station, Ross River YG Station

CLIENT

Ketza River Holdings

KETZA RIVER PROJECT

Regional Winter Temperature Trend

eba A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

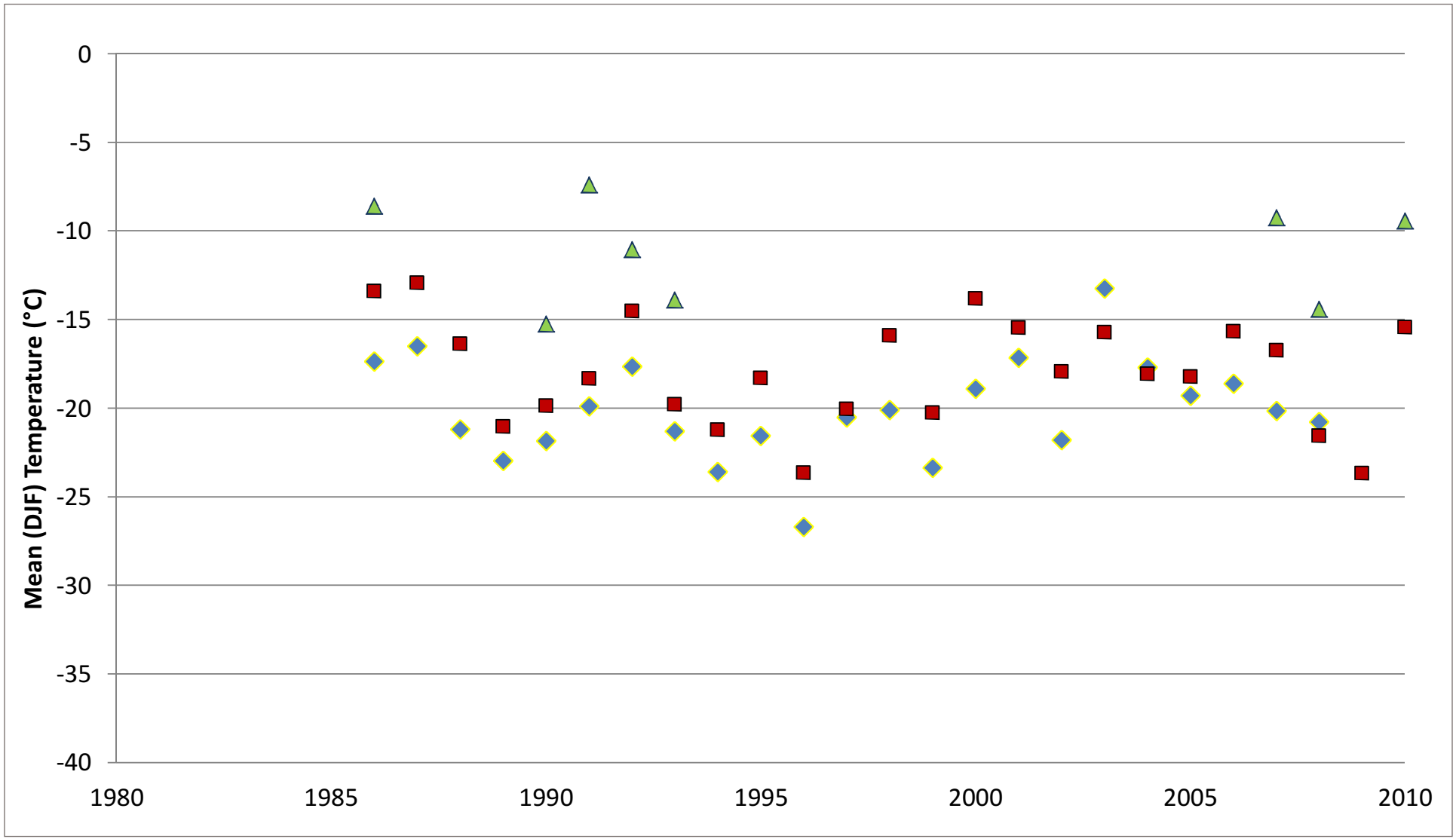
OFFICE: EBA-VANC

DATE: July 26, 2011

STATUS: ISSUED FOR USE

Figure 4.4-6

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LEGEND

- MSC Faro A Station
- MSC Ross River A Station, Ross River YG Station
- MSC Ketza River Project Station, Ketza River Property Meteorological Station

STATUS
ISSUED FOR USE

CLIENT
Ketza River Holdings

eba
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KETZA RIVER PROJECT

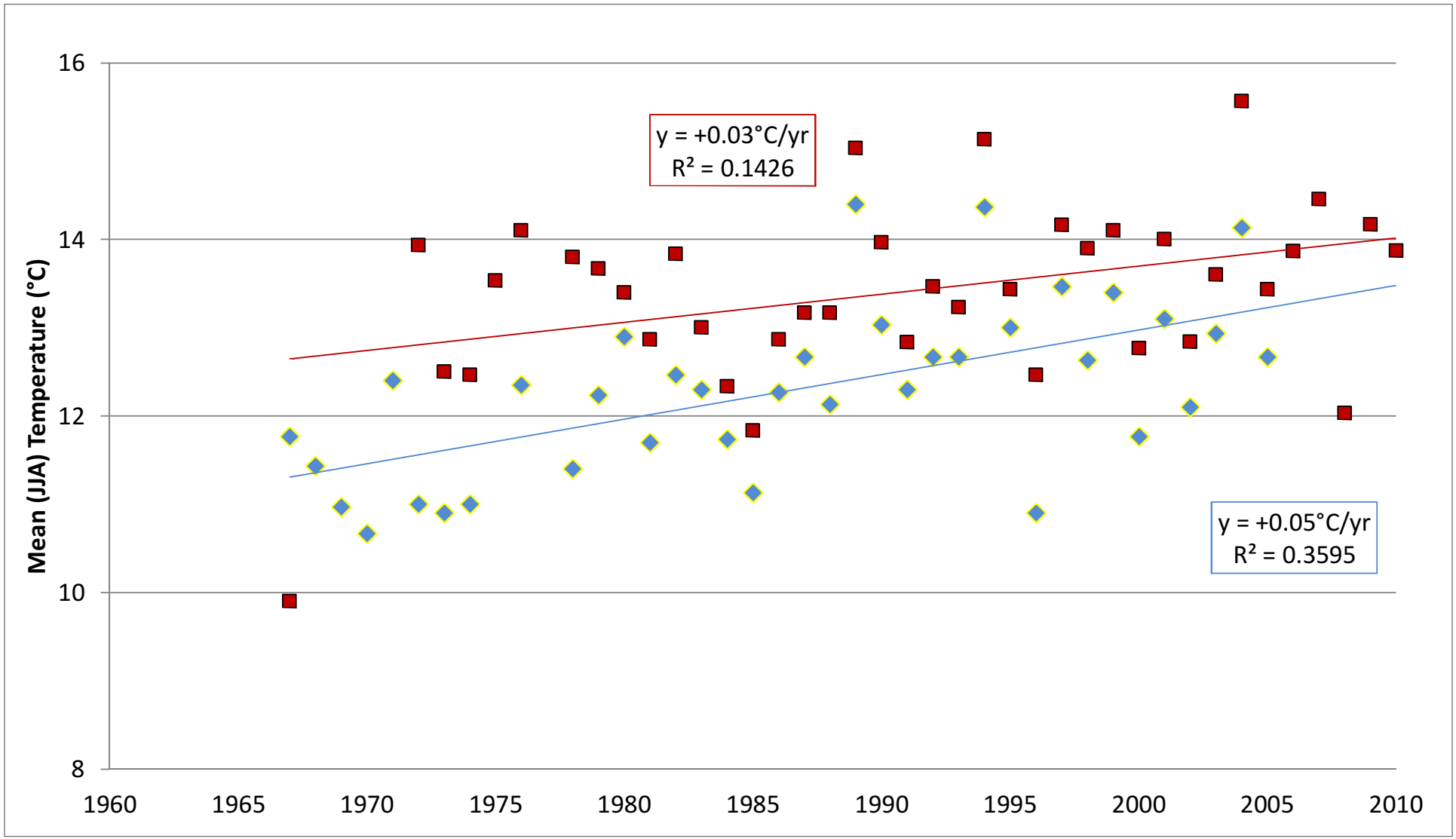
Regional Winter Temperature

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 4.4-7

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LEGEND

- MSC Faro A Station
- MSC Ross River A Station, Ross River YG Station

CLIENT

Ketza River Holdings

KETZA RIVER PROJECT

Regional Summer Temperature Trend

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

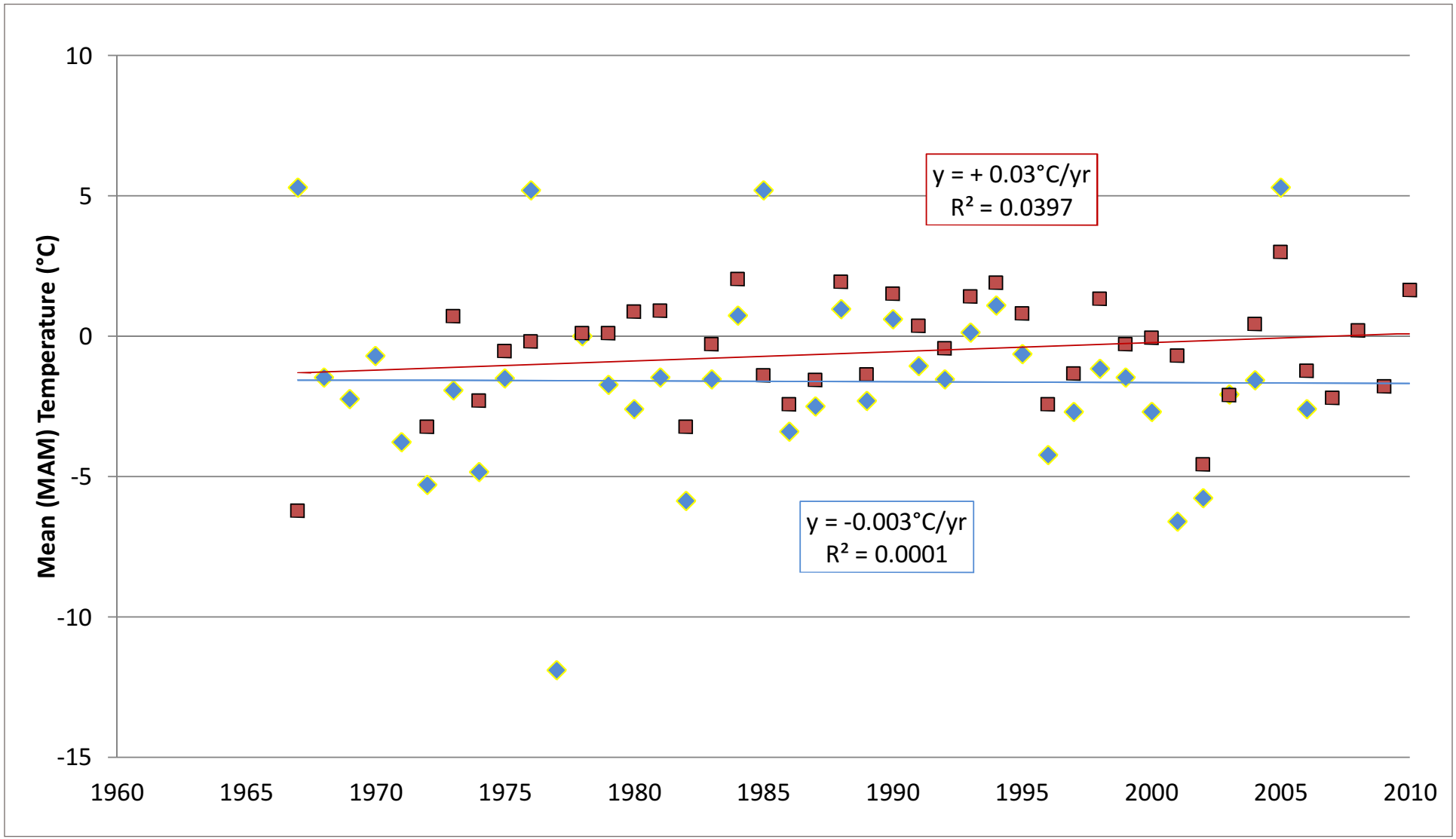
OFFICE	DATE
EBA-VANC	July 26, 2011

STATUS
ISSUED FOR USE

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Figure 4.4-8

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LEGEND

- MSC Faro A Station
- MSC Ross River A Station, Ross River YG Station

CLIENT

Ketza River Holdings

KETZA RIVER PROJECT

Regional Spring Temperature Trend

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

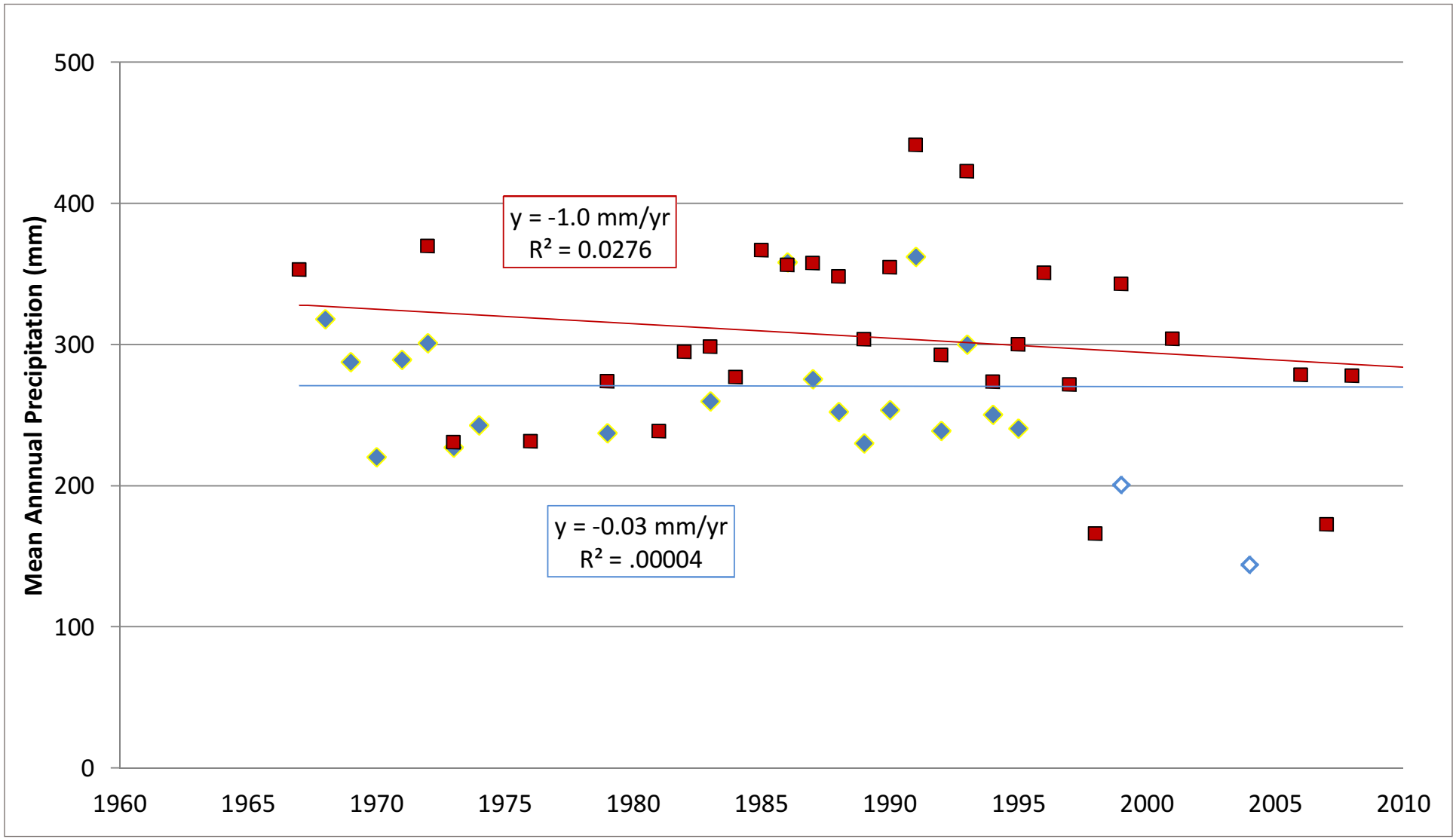
OFFICE	DATE
EBA-VANC	July 26, 2011

STATUS
ISSUED FOR USE

eba
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Figure 4.4-9

Q:\Vancouver\Graphics\ENVIRONMENTAL\W23101\W23101052_Ketza\114\W23101052_114_SpringTemp.cdr



LEGEND

- MSC Faro A Station
- MSC Ross River A Station, Ross River YG Station
- Ross River Data Omitted From Trendline

STATUS
ISSUED FOR USE

CLIENT
Ketza River Holdings

KETZA RIVER PROJECT

Regional Precipitation Trend

eba A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	TM	JAS	JAS	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 4.4-10

Q:\Vancouver\Graphics\ENVIRONMENTAL\W2311\W23101052_Ketza\114\W23101052_114_Precipitation.cdr

4.6 Noise Levels

Noise levels at the mine site are currently not monitored but are commensurate with regular exploration activities. Environmental noise is a combination of distant sounds consisting of birds, animals, wind in trees and passing aircraft (AMEC 2008). This background noise is interrupted by short duration noisy events such as passing vehicle traffic, snowmobiles, helicopters or other noises related to exploration activities and baseline studies on the Site.

Based on other studies in remote areas of British Columbia with effective noise absorbers such as trees and hills, ambient non-anthropogenic noise levels at the Site are expected to be in the range of 15 to 25 A-weighted decibels (dBA) averaged over a 24-hour period.

4.7 Ecosystems and Vegetation

Ecosystems and vegetation for the KRP are described in terms of the Yukon Ecological and Landscape Classification (ELC) Framework which has been evolving in the Territory for a number of years. ELC in general is a process that integrates climate, site, soil, and vegetation characteristics into tangible units that are repeatable across the landscape and can be used as a basis for environmental land use planning and resource management at any scale (e.g., local to territorial). In Yukon, the ELC Framework is hierarchical and draws from principles developed in other parts of Canada, but is sufficiently tailored to meet the needs and guiding principles established for Yukon (Flynn and Francis 2011).

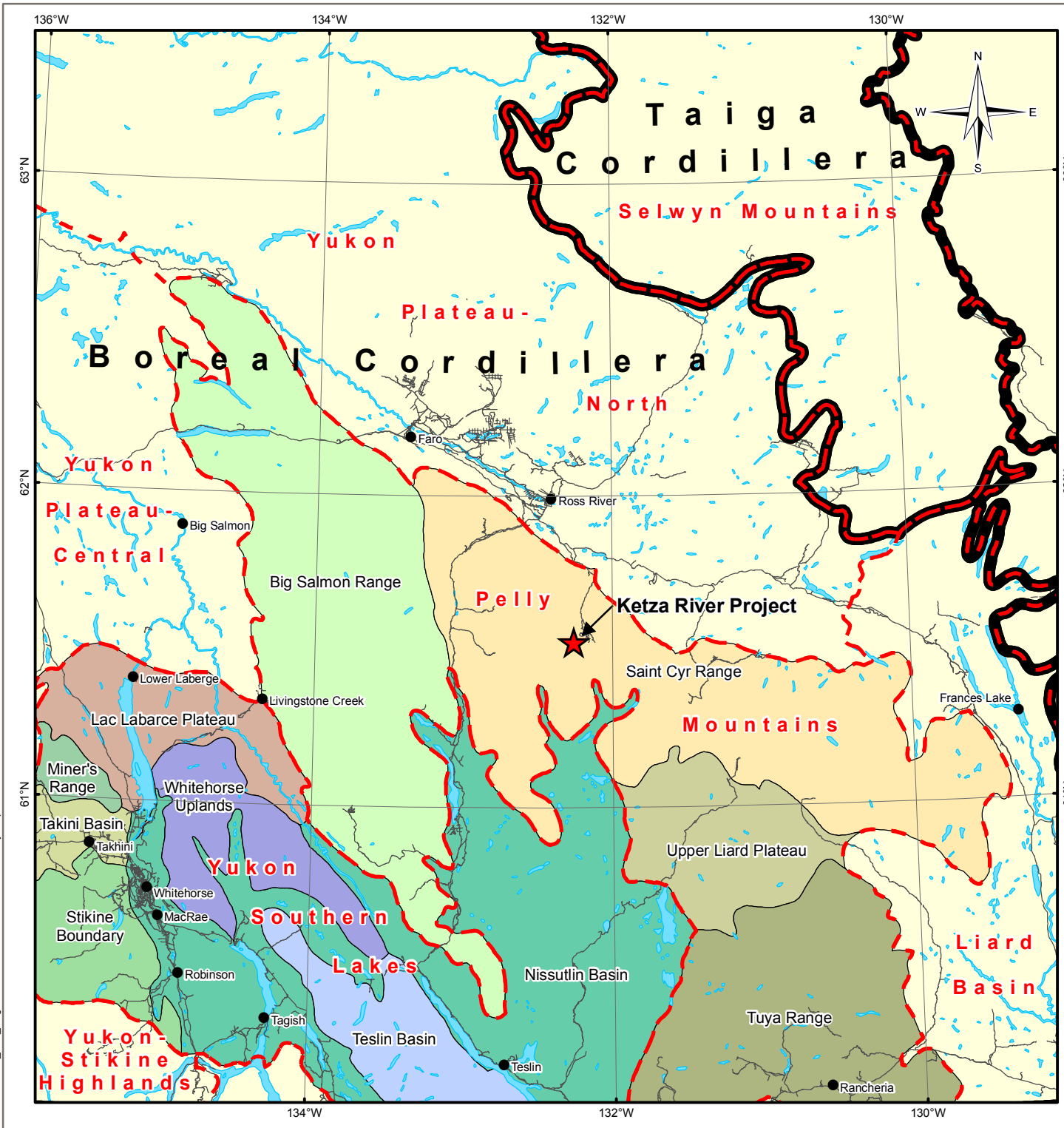
Boundaries and descriptions of the broadest ecological categories (i.e., Ecozones and Ecoregions) of the Yukon ELC Framework have been developed for Yukon overall (e.g., Smith et al. 2004). Provisional Ecodistrict boundaries have also been derived for the Yukon that are largely the result of the Soil Landscapes of Canada (SLC) mapping project that was conducted across Canada (EBA 2003).

The Yukon ELC Framework is likely to include the further stratification of landscapes into "Bioclimate Zones" as a way of capturing areas that show distinct vegetation patterns due to elevation or latitudinal gradients (Francis and Steffen 2003). To date, major Bioclimate Zones have been identified throughout Yukon.

4.7.1 Regional Ecology

The KRP is located in the south-central Yukon, approximately 80 km south of Ross River, within the Boreal Cordillera Ecozone, Pelly Mountains Ecoregion, and Saint Cyr Range Ecodistrict (Figure 4.7-1). The mountainous terrain within the Pelly Mountains Ecoregion acts as a prominent barrier to the weather systems that flow east of the St. Elias and Coast mountains, resulting in relatively heavy precipitation, cooler summers, and less severe winters (Smith et al. 2004). Elevations within the ecoregion range between 600 to 2,400 m asl and dominant portions are above the treeline, which generally occurs between 1,350 and 1,500 m asl.

Soil formation within the Pelly Mountains Ecoregion reflects a range of parent materials and lithologies and is strongly influenced by the elevation gradients present and the relatively high levels of precipitation that occur (Smith et al. 2004). As much of the ecoregion is above the treeline, soils within the alpine zone are often acidic, show signs of strong leaching, and can also support permafrost.



LEGEND

- Site Location
- Ecoregions
- Ecozones
- Roads
- Waterbodies

Ecodistricts

- Big Salmon Range
- Lac Labarce Plateau
- Miner's Range
- Nissutlin Basin
- Saint Cyr Range
- Stikine Boundary
- Takini Basin
- Teslin Basin
- Tuya Range
- Upper Liard Plateau
- Whitehorse Uplands

NOTES
Base data source: Yukon Geomatics and EBA (2003).
Ecodistricts available for Pelly Mountains and Yukon Southern Lakes Ecoregions only.

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Regional Ecology

PROJECTION	DATUM	CLIENT
Albers	NAD83	Ketza River Holdings

Scale: 1:2,000,000
25 12.5 0 25 50
Kilometres

FILE NO.				
W23101052_107_RegionalEco.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
W23101052.107	SL	TP	TP	0
OFFICE	**DATE**			
EBA-VANC	July 26, 2011			

eba A TETRA TECH COMPANY

Figure 4.7-1

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Vegetation of the Pelly Mountains Ecoregion is typically composed of shrub and dwarf shrub tundra at high elevations and coniferous forest at lower elevations (Smith et al. 2004). In the northern portion of the ecoregion, forests are commonly a mix of white spruce (*Picea glauca*), black spruce (*P. mariana*), and subalpine fir (*Abies lasiocarpa*). Areas regenerating following fire may support young stands of pine (*Pinus contorta*), but are more often colonized by shrubby communities composed of willows (*Salix spp*.) and aspen (*Populus spp*.).

Bioclimate Zones occurring within the Boreal Cordillera Ecozone and Pelly Mountains Ecoregion include Boreal, Subalpine, and Alpine (Francis and Steffen 2003). Areas within the Boreal Bioclimate Zone occupy low to middle elevations and are continuously forested. The Subalpine Bioclimate Zone occurs at moderate to high elevations and is transitional between lower elevation forested boreal slopes and valley bottoms and non-forested, dwarf-shrub dominated areas that are associated with the high elevation Alpine Bioclimate Zone.

4.7.2 Local Ecology

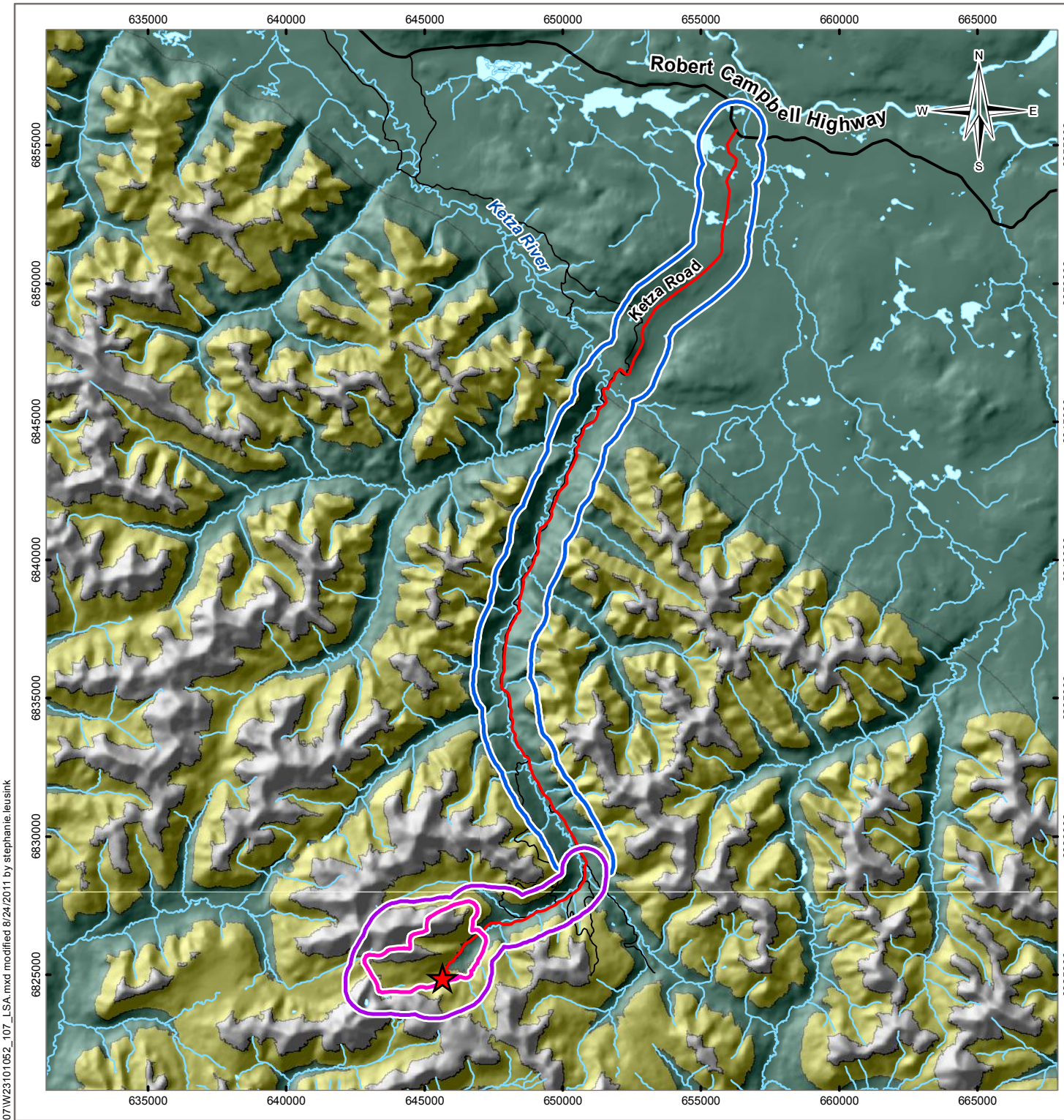
Ecosystem Units and plant species are described within a Local Study Area (LSA) that includes areas where mining activities are proposed and a two kilometre wide corridor surrounding the Ketza Road that leads from the Robert Campbell Highway to the Site (Figure 4.7-2). Ecosystem Unit and vegetation descriptions within the portion of the LSA that will support mining infrastructure are based on a combination of ELC mapping, field surveys, and information from previous studies and applications (e.g., EBA 2003, 2008b, 2008c; Francis and Steffen 2003; and Zoladeski et al. 1996). The 2007 Ecosystem Land Classification and Vegetation Baseline Study (EBA 2008b) and 2008 Rare Plant Species and Community Survey (EBA 2008c) conducted for this Project are provided in Appendices E1 and E2, respectively.

The portion of the LSA that specifically covers the Ketza Road is described using land cover classes developed as part of the Earth Observation for Sustainable Development of Forests (EOSD) initiative of the Canadian Forest Service (Wulder et al. 2004). EOSD land cover classes represent a broader scale of Ecosystem Unit compared to those identified during the ELC mapping of the Site itself.

4.7.2.1 Bioclimate Zones

The Bioclimate Zones present in the KRP LSA include Alpine, Subalpine, and Boreal Highland (Figure 4.7-2). The Alpine Bioclimate Zone occupies the highest elevations (e.g., >1,600 m asl) in the LSA and is associated with mountainous conditions. Areas may include bare rock, colluvium, or ice / snow. Dominant vegetation includes dwarf shrubs, herbs, cryptograms, and stunted, scattered trees, usually displaying a krummholz growth form.

The Subalpine Bioclimate Zone ranges from moderate to higher elevations (e.g., 1,300 – 1,700 m asl) and is typically located on sparsely forested, steep slopes above the Boreal Highland Bioclimate Zone and below the non-forested Alpine Bioclimate Zone. The area is often considered transitional, characterized by open canopy conifer forests (e.g., tree cover <20%) and tall shrub communities, with subalpine fir as the dominant tree species. The Subalpine Bioclimate Zone experiences long cold winters and short cool summers.



LEGEND

- Existing Camp
- Project Footprint
- Local Study Area
- Ketza Road Study Area

Bioclimate Zone

- Alpine
- Boreal-High
- Subalpine

- Ketza Road
- Robert Campbell Highway
- Minor Road
- Watercourse
- Waterbody

NOTES
Base data source: Yukon Geomatics

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Study Area Boundaries for the Ketza River Project

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:200,000
4 2 0 4
Kilometres

FILE NO. W23101052_107_LSA.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.107	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

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Figure 4.7-2

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The Boreal Highland Bioclimate Zone occurs in forested mountain valley and plateau Ecoregions of southern and central Yukon, and is the only Bioclimate Zone present along the Ketza Road. Elevations commonly range from 1,000 – 1,350 m asl. Forests are typically dominated by white spruce and subalpine fir. Summers in this zone are brief, cool and moist while winters are long and cold.

The distribution of Bioclimate Zones within the LSA is shown in Table 4.7-1. The Boreal Highland is predominant, largely because of its presence in both the mine site area and along the length of the Ketza Road. Within the mine site area alone, both the Boreal Highland and Alpine Bioclimate Zones cover similar extents (40 and 42% of the mine site LSA, respectively).

Table 4.7-1: Distribution of Bioclimate Zones within the Ketza River Project Local Study Area

Bioclimate Zone	Mine Site (ha)	Ketza Road (ha)	Total LSA (ha)	Proportion of LSA (%)
Alpine	1,186.6		1,186.6	13.0
Subalpine	512.3		512.3	5.6
Boreal Highland	1,142.5	6,256.0	7,398.6	81.3
Total	**2,841.4**	**6,256.0**	**9,097.5**	**100.0**

4.7.2.2 Ecosystem Units

A total of 41 Ecosystem Units were defined in the LSA, 24 from baseline studies conducted within the mine site LSA and 17 from pre-existing EOSD land cover mapping (Figure 4.7-3). The Ecosystem Units identified represent natural areas, areas resulting from previous disturbance (e.g., roads, tailings), and predominantly non-vegetated features such as waterbodies and rock outcrops. Very few Ecosystem Units occur within a single Bioclimate Zone (Table 4.7-1).

The following Ecosystem Unit and EOSD land cover class descriptions are based upon those of Zoladeski et al. (1996) and Wulder et al. (2004), respectively, supplemented based on field observations compiled during baseline studies (EBA 2008b).

Treed Units

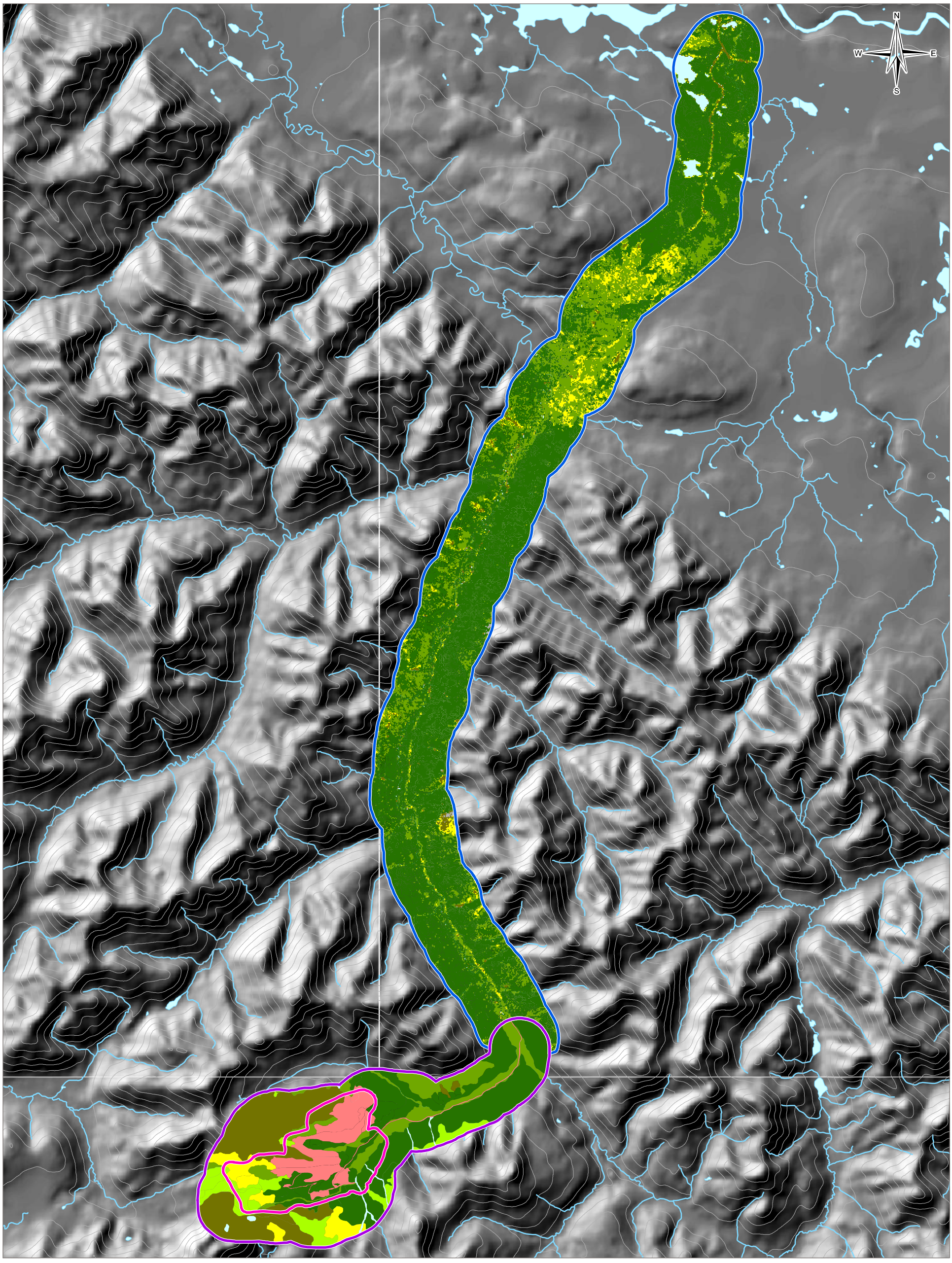
Fir-Willow

Fir-Willow ecosystems are transition units between the Subalpine and the Boreal Highland Bioclimate Zones. Dominant species include subalpine fir, often in krummholz form, and medium to tall willow species (*Salix planifolia*, *Salix alaxensis*, and *Salix glauca*). Ground cover consists mainly of step moss (*Hylocomnium splendens*) and common haircap moss (*Polytrichum commune*). On south facing slopes the canopies of this ecosystem are open, on north facing slopes the canopies are more closed. Soils are moderately drained Podzols with a relatively poor nutrient regime.

Spruce-Moss

In the lower Boreal Highland, Spruce-Moss Ecosystem Units were noted to occur between 1,100 and 1,450 m asl. The dominant vegetation includes white spruce and willow species, with a moss understory characterized by red-stemmed feathermoss (*Pleurozium schreberi*) (Photo 4.7-1). Black spruce may occur on wetter sites and subalpine fir at higher elevations. Soils are mainly moderately drained Podzols that are relatively poor.

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LEGEND

- Project Footprint
- Local Study Area
- Ketza Road Study Area
- Contour (100 m)
- Watercourse
- Waterbody

Ecosystem Units

Treed
Coniferous Open
Coniferous Sparse
Coniferous Dense
Spruce-Moss
Fir-Moss
Mixedwood Open
Fir-Willow
Broadleaf Dense
Mixedwood Sparse
Fir-Lichen
Aspen-*Virburnum*
Broadleaf Open
Black Spruce-Moss
Wetland Treed

Shrub
Shrub Low
Shrub Tall
Willow-Riparian
Willow-Shrub Birch
Shrub Birch-Lichen
Willow-Slope
Wetland Shrub

Dwarf Shrub
Heather-Lichen
Dwarf Willow-*Carex*
Crowberry-Lichen
Mountain Avens-*Carex*

Herb
Herbs
Fescue-Lichen
Willow-Forb
Carex-Moss
Wetland Herb

Sparse Vegetation
Talus
Exposed/Barren Land
Rock/Rubble
Rock Outcrop

Anthropogenic
Road
Tailings
Rural

Unclassified
Shadow

Water
Water
River
Lake

NOTES
Base data source: EBA and Canadian Forest Service (EOSD)

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Ecosystem Distribution within the Study Areas

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:100,004
2 1 0 2
Kilometres

FILE NO.
W23101052_107_ELC.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.107	SL	TP	TP	0

OFFICE	DATE
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Figure 4.7-3

Fir-Moss

Fir-Moss units are observed in the Boreal Highland at elevations ranging from 1,200 to 1,450 m asl. Dominant vegetation includes subalpine fir and a moss understory composed of step moss and common haircap moss. Fir-Moss units generally develop in concave micro-topography and/or cool aspects with sheltered, moist, but well drained soils. This community also occurs adjacent to seeps and streams.



Photo 4.7-1: Spruce-Moss Ecosystem Unit - located in the eastern portion of the access road corridor.

Fir-Lichen

Fir-Lichen sites are generally found on warm aspects and are dominated by subalpine fir that forms an open canopy. Shrub birch (*Betula nana*) and various lichen species comprise the understory. The micro-topography is generally convex and soils are exposed and well drained.

Aspen-*Virburnum*

The Aspen-*Viburnum* Ecosystem Unit is typically located on moderately-steep, well drained, south-facing slopes in the Boreal Highland Bioclimate Zone. The forest canopy is closed and dominant vegetation includes trembling aspen (*Populus tremuloides*), highbush cranberry (*Viburnum edule*), currants (*Ribes* species) and roses (*Rosa* species). Soils in these areas are sub-mesic and medium-rich.

Black Spruce-Moss

Black Spruce-Moss Ecosystem Units are generally found between 1,100 and 1,450 m asl often below the Fir-Moss Ecosystem Unit. The Ecosystem Unit is dominated by black spruce with a minor component of white spruce. Willows and step moss frequently comprise the understory. At lower elevations on gentle slopes, black spruce and white spruce may occur as co-dominants. Soils are generally poor with a mesic to hygric soil moisture.

Broadleaf (Open, Dense)

Broadleaf forest is a land cover type from the EOSD land cover mapping and is characterized as having either an open (20-60% crown closure) or dense (greater than 60% crown closure) tree canopy. Broadleaf tree species, likely represented by trembling aspen or balsam poplar (*Populus balsamifera* ssp. *baslamifera*), comprise at least 75% or more of the total basal area.

Mixedwood (Open, Sparse)

Mixedwood forest is also a land cover type from the EOSD land cover mapping and comprises a mix of both broadleaf and coniferous tree species. Forests were identified that had either an open (20-60% crown closure) or sparse (10-25% crown closure) canopy.

Coniferous (Sparse, Open, Dense)

Coniferous forest is an EOSD land cover type that represents forests that are dominated (e.g., >75% or more of the total basal area) by conifer tree species with crown closures that range from sparse (10-25% crown closure), to open (26-60% crown closure), to dense (>60% crown closure).

Wetland Treed

The Wetland Treed EOSD land cover class represents areas with a water table near, at, or above the soil surface for sufficient periods of time to promote and sustain wetland or aquatic processes. The majority of the vegetation present is coniferous, broadleaf, or mixed tree species.

Shrub Units

Willow-Shrub Birch

Willow-Shrub Birch Ecosystem Units are often found in subalpine areas on gentle, well-drained slopes. Composed of low-medium growing shrub thickets, the dominant vegetation includes a mix of willow species (*Salix planifolia*, *Salix alaxensis*, and *Salix glauca*) and shrub birch. On south facing slopes, juniper (modifier "j") species (*Juniperus* spp.) were common throughout the mine site LSA.

Shrub Birch-Lichen

Shrub Birch-Lichen Ecosystem Units generally occur in transition zones between the Subalpine and Boreal Bioclimate Zones. They are low-medium growing shrub thickets that include species such as shrub birch and lichens (particularly *Flavocetraria* and *Cladina* species). These ecosystems are found on gentle, well-drained slopes and terraces.

Willow Slope

Willow Slope Ecosystem Units are found on steep slopes such as avalanche chutes in the Subalpine Bioclimate Zone at elevations of 1,300 to 1,500 m asl. A dense canopy of medium to tall willow species (*Salix planifolia*, *Salix alaxensis*, and *Salix glauca*) forms the overstory, while the understory is composed of various herbaceous species that can include shortstalk sedge (*Carex podocarpa*) and net-veined willow (*Salix reticulata*). Soils are generally well drained and submesic.

Willow Riparian

These Ecosystem Units are found on the floodplains of streams and rivers throughout the LSA within the Subalpine and Boreal Highland Bioclimate Zone. Dominant vegetation includes a mix of willows with an understory of horsetail (*Equisetum* spp.) and sedges. Soils range from mesic to hygric with poor to rich moisture.

Shrub Low

This EOSD land cover class represents areas where woody vegetation shorter than 2 m covers a minimum of 20% of the area under consideration.

Shrub Tall

The Shrub Tall EOSD land cover class represents areas where woody vegetation taller than 2 m covers a minimum of 20% of the area under consideration.

Wetland Shrub

The Wetland Shrub EOSD land cover class represents areas with a water table near, at, or above the soil surface for sufficient periods of time to promote and sustain wetland or aquatic processes. The majority of the vegetation present is tall, low, or a mixture, of shrub species.

Dwarf Shrub Units

Heather-Lichen

Heather-Lichen units occur in the Alpine Bioclimate Zone at elevations ranging from 1,450 to 1,760 m asl. These units are dominated by species such as mountain heather (*Cassiope tetragona* and *Phyllodoce* species), crowberry (*Empetrum nigrum*), lingonberry (*Vaccinium vitis-idaea*), bilberry (*Vaccinium uliginosum*) and various lichen species (Photo 4.7-2). Plants are generally shorter than 20 cm and grow in well drained, exposed soils.



Photo 4.7-2: Heather-Lichen Ecosystem Unit

Dwarf Willow-*Carex*

Dwarf Willow-*Carex* Ecosystem Units occupy high alpine areas and are dominated by polar willow (*Salix polaris*), arctic willow (*Salix arctica*), and various sedges, and lichens. Soils are often moderately drained and submesic in nature.

Crowberry-Lichen

Crowberry-Lichen ecosystems are generally found at elevations of 1,500 – 1,700 m asl in the Alpine Bioclimate Zone. Dominant vegetation includes crowberry, lingonberry, and several lichen species. Few plants grow taller than 20 cm high. The soils of these Ecosystem Units are typically exposed and well drained.

Mountain Avens-*Carex*

Mountain Avens-*Carex* ecosystems are usually found at very high elevations (>1,700 m asl). Common plant species include entire-leaved mountain-avens (*Dryas integrifolia*), mountain heathers, moss campion (*Silene acaulis*), and purple mountain saxifrage (*Saxifraga oppositifolia*). Soils are generally exposed and well to rapidly drained.

Herbaceous Units

Fescue-Lichen

Fescue-Lichen sites are dry alpine meadows usually on convex micro-topography and warm aspects at elevations between 1,500 to 1,800 m asl. Dominant vegetation includes northern rough fescue (*Festuca altaica*) and lichen (*Cladina* species), although sedges (*Carex* spp.) and the species belonging to the genus *Poa* may also occur in high abundance on moister soils.

Willow-Forb

Willow-Forb Ecosystem Units are located in the lower Alpine and Subalpine Bioclimate Zones between the elevations of 1,500 and 1,700 m asl. They are often found in sheltered valleys and could be indicative of shallow seepage. Common plant species include shortstalk sedge and a diverse mix of forbs including tall bluebell (*Mertensia paniculata*), arrow-leaved groundsel (*Senecio triangularis*), mountain sagewort (*Artemisia arctica* also known as *A. norvegica*), and tall Jacob's ladder (*Polemonium acutiflorum*). On raised microtopography willows are the dominant cover species while depressions host a rich mix of forbs (Photo 4.7-3). These sites are often gently sloping, with moderately drained, mesic soils.



Photo 4.7-3: Willow-Forb complex in the Subalpine southeast of the existing camp

Carex-Moss

This Ecosystem Unit is dominated by water sedge (*Carex aquatilis*) with a minor component of shortstalk sedge and marsh cinquefoil (*Potentilla palustris*). *Carex*-Moss sites generally occur in depressional to flat areas in valley bottoms and have poorly drained, subhygric soils. The ground cover is mainly composed of *Sphagnum* species.

Herbs

This EOSD land cover class is characterized by areas that are dominated by herbaceous species. Herbs such as grasses, sedges, and/or forbs, must form a minimum of 20% of the ground cover or one-third of the total vegetation present in the area being considered.

Wetland Herb

The Wetland Herb EOSD land cover class represents areas with a water table near, at, or above the soil surface for sufficient periods of time to promote and sustain wetland or aquatic processes. The majority of the vegetation present is herbaceous.

Sparsely Vegetated Units

Talus

Talus areas occur above 1,500 m asl and are predominantly composed of exposed bare rock or colluvium covered with crustose lichen communities. Dwarf shrub species and graminoid species may also be present sporadically at lower elevations.

Rocky Outcrop

These areas typically occur above 1,650 m asl or as boulderfields on south facing slopes. They are mainly exposed bare rock or talus covered with crustose lichen communities. Dwarf shrub species and graminoid species may be observed at lower elevations.

Rock/Rubble

This EOSD land cover class represents areas that are composed of exposed bedrock, rubble, talus, blockfields, or rubbley mine spoils.

Exposed/Barren Land

This EOSD land cover class represents areas that are largely non-vegetated, such as gravel pits, moraines, cutbanks, exposed soils, road surfaces, and sites with obvious anthropogenic activity (e.g, buildings).

Water

River

Relatively linear watercourses that form when water flows between continuous, definable banks were characterized as rivers. Larger streams may also be included in this category.

Lake

Lakes are defined here as a naturally occurring static body of water with an average depth greater than two metres. Due to their limited occurrence in the LSA, ponds (which are frequently smaller and shallower than lakes) have also been included in this category.

Water

This EOSD land cover class identifies waterbodies such as lakes, rivers, streams, salt water, and reservoirs.

Anthropogenic Units

Road Surface

Road surfaces from past development activities are evident within the LSA and are characterized as cleared or compacted areas that serve the purpose of transporting goods and services by vehicles.

Mine Tailings

An existing TSF (Canamax TSF) is present within the LSA, remaining from previous mining activities.

Rural

Rural Ecosystem Units are areas that show evidence of human development (e.g., in the form of buildings or other infrastructure) but are scattered and intermingled with native vegetation.

Within the mine site LSA, talus slopes are the most prevalent Ecosystem Unit, covering approximately 675 ha overall (24% of the mine site LSA and 7% of the total LSA) (Table 4.7-2). Spruce-Moss and Fir-Moss Ecosystem Units are also relatively common, each covering 14% of the mine site LSA and 4% of the total LSA. Roads from previous mining activity are evident throughout the mine site LSA (Photo 4.7-4) and account for approximately 10% (286 ha) of the mine site LSA and 3% of the total LSA overall.

Conifer-dominated land cover classes and areas supporting low shrubs occur most commonly along the Ketza Road (Table 4.7-2). These four land cover classes comprise approximately 80% (4,983 ha) of the Ketza Road LSA.

Table 4.7-2: Distribution of Ecosystem Units and Land Cover Classes within the Ketza River Project Local Study Area

General Ecosystem	Ecosystem Unit/Land Cover Class	Mine Site (ha)	Ketza Road (ha)	Total LSA (ha)	Proportion of Total LSA (%)
Anthropogenic	Road	286.2		286.2	3.1
	Tailings	11.8		11.8	0.1
	Rural	8.8		8.8	0.1
Dwarf Shrub	Heather-Lichen	112.5		112.5	1.2
	Dwarf Willow-*Carex*	70.6		70.6	0.8
	Crowberry-Lichen	47.2		47.2	0.5
	Mountain Avens-*Carex*	9.5		9.5	0.1
Herbaceous	Herbs		275.3	275.3	3.0
	Fescue-Lichen	87.7		87.7	1.0
	Willow-Forb	42.0		42.0	0.5
	Carex-Moss	16.2		16.2	0.2
	Wetland Herb		4.6	4.6	0.1
Shrub	Shrub Low		985.1	985.1	10.8
	Shrub Tall		353.2	353.2	3.9
	Willow Riparian	174.4		174.4	1.9
	Willow Shrub-Birch	148.6		148.6	1.6
	Shurb Birch-Lichen	63.1		63.1	0.7
	Willow Slope	34.2		34.2	0.4
	Wetland Shrub		11.9	11.9	0.1
Sparsely Vegetated	Talus	674.6		674.6	7.4
	Exposed/Barren Land		64.6	64.6	0.7
	Rock/Rubble		26.4	26.4	0.3
	Rock Outcrop	8.6		8.6	0.1
Treed	Coniferous Open		2,294.5	2,294.5	25.2
	Coniferous Sparse		899.6	899.6	9.9
	Coniferous Dense		803.9	803.9	8.8
	Spruce-Moss	408.3		408.3	4.5
	Fir-Moss	402.1		402.1	4.4
	Mixedwood Open		215.8	215.8	2.4
	Fir-Willow	162.7		162.7	1.8
	Broadleaf Dense		158.2	158.2	1.7
	Mixedwood Sparse		70.7	70.7	0.8
	Fir-Lichen	18.6		18.6	0.2
	Aspen-*Viburnum*	16.4		16.4	0.2
	Broadleaf Open		9.0	9.0	0.1
	Black Spruce-Moss	8.8		8.8	0.1
	Wetland Treed		3.6	3.6	0.0

Table 4.7-2: Distribution of Ecosystem Units and Land Cover Classes within the Ketza River Project Local Study Area

General Ecosystem	Ecosystem Unit/Land Cover Class	Mine Site (ha)	Ketza Road (ha)	Total LSA (ha)	Proportion of Total LSA (%)
Water	Water		73.3	73.3	0.8
	River	22.4		22.4	0.2
	Lake	6.0		6.0	0.1
Unclassified[1]	Shadow		6.3	6.3	0.1
Total		**2,841.4**	**6,256.0**	**9,097.5**	**100.0**

[1]Includes areas that could not be classified due to clouds or shadow



Photo 4.7-4: View looking northward at existing roads and general disturbance present within the mine site local study area

4.7.2.3 Sensitive Ecosystems

Certain ecosystems within the KRP's LSA may be particularly sensitive to disturbance due in part to climatic, edaphic, and other ecological factors that can influence growing conditions, the length of the growing season, and the corresponding time available for recovery. Disturbances in harsher climates in particular can take years, and sometimes decades, to recover.

Sensitive ecosystems can provide unique ecological functions such as critical habitat for species at risk, act as corridors or linkages for wildlife species, or support high levels of biological diversity. Sensitive ecosystems identified within the LSA are particularly susceptible to mining-related disturbances

(e.g., removal or burial, dust deposition, drainage pattern alterations) and are described in the following paragraphs.

Ecosystems with a higher *Sphagnum* cover – these ecosystems often occupy receiving positions on the landscape and can be sensitive to changes that affect drainage patterns. *Sphagnum*-dominated bogs in particular are generally ombrotrophic peatlands that are hydrologically isolated from groundwater that is influenced by mineral soil. These ecosystems are generally acidic and nutrient poor and frequently support other sensitive species, such as lichen. In combination, these factors contribute to an overall sensitivity of the ecosystem to changes in hydrologic, pH, or nutrient status which can result from general disturbance or atmospheric changes, such as increased dustfall or air emissions. The *Carex*-Moss Ecosystem Unit represents sensitive ecosystems with a high *Sphagnum* cover in the LSA.

Ecosystems with higher lichen cover – these ecosystems tend to be highly sensitive to physical disturbance as well as atmospheric changes, such as increased nutrient input. Ecosystem Units with a high lichen cover in the LSA include Fir-Lichen, Shrub Birch-Lichen, Heather-Lichen, Crowberry-Lichen, and Fescue-Lichen.

Wetland ecosystems are often biologically diverse areas that provide distinct habitats for various plant and wildlife species. Disturbances that can affect the features that make wetlands unique, such as the local hydrology, can change the characteristics of the wetland itself, as well as the habitat of the species wetlands support. Sensitive wetland ecosystems in the LSA include Willow Riparian, Willow-Forb, *Carex*-Moss, Wetland Treed, Wetland Shrub, and Wetland Herb.

Sensitive ecosystems account for approximately 6% (582 ha) of the LSA, the majority of which occur within the proposed mine site area (Table 4.7-3). Willow Riparian and Heather-Lichen Ecosystem Units are the most extensive sensitive ecosystems present.

Table 4.7-3: Distribution of Sensitive Ecosystems within the Ketza River Project Local Study Area

Sensitivity	Ecosystem Unit/Land Cover Class	Mine Site (ha)	Ketza Road (ha)	Total LSA (ha)	Proportion of Total LSA (%)
High lichen cover	Heather-Lichen	112.5		112.5	1.2
	Fescue-Lichen	87.7		87.7	1.0
	Shrub Birch-Lichen	63.1		63.1	0.7
	Crowberry-Lichen	47.2		47.2	0.5
	Fir-Lichen	18.6		18.6	0.2
High *Sphagnum* cover, Wetland	*Carex*-Moss	16.2		16.2	0.2
Wetland	Willow Riparian	174.4		174.4	1.9
	Willow-Forb	42.0		42.0	0.5
	Wetland Shrub		11.9	11.9	0.1
	Wetland Herb		4.6	4.6	0.1
	Wetland Treed		3.6	3.6	0.04
Sensitive Ecosystem Total		561.6	20.1	581.8	6.4
Not Sensitive		2,279.8	6,235.9	8,515.7	93.6
Total		**2,841.4**	**6,256.0**	**9,097.5**	**100.0**

4.7.2.4 Rare Plant Potential

Rare plant surveys were included as part of baseline studies and involved both desktop research and field assessments. Prior to the conduct of field surveys, a preliminary plant species list was compiled from various sources including Douglas et al. (1981), NatureServe Yukon (accessed in 2007), Cody (2000) and Cody et al. (1998, 2000, 2001) in an effort to identify which species could potentially occur in the Project area. The habitat requirements of each species were then researched in more detail, which resulted in the further refinement of the species list based on the habitats that were likely present within the LSA.

A total of 27 plant species were identified as having a higher potential to occur within the LSA (Table 4.7-4). Overall, the Fir-Willow, Willow-Shrub Birch, and Willow-Forb Ecosystem Units, Herbs, Shrub Low, and Shrub Tall EOSD land cover types have the highest potential to support multiple rare plant species.

The information compiled for rare plant species was also used to assess the potential for each Ecosystem Unit and EOSD Land Cover Class to support rare plant habitat. Rare plant habitat potential was based on the number of rare plant species the ecosystems present in the LSA could support. This approach tries to accommodate the fact that rare plants often occupy habitats that are too small to map (particularly at the scales commonly used in resource management planning) and that field assessments for rare plants can only confirm their presence in an area, not their absence. Approximately 1,967 ha (22%) of the total LSA (353 ha in the proposed mine site area and 1,614 ha within the road corridor) was rated as having a very high potential to support rare plant habitat (Table 4.7-5).

Field assessments for rare plants focused on the habitat types of the 27 species identified during the desktop studies as well as uncommon landscape features and microhabitats within the LSA (e.g., early snowmelt areas, drainage channels, rock outcrops). Areas with a restricted distribution and unique microhabitats often have a higher potential of supporting rare plant habitat.

One species, *Saxifraga aizoides*, which was considered rare by Douglas et al. (1981) was observed during baseline data collection in the vicinity of the proposed TSF (Figure 4.7-4; EBA 2008c). Further communication with NatureServe Yukon (Bruce Bennett, personal communication) indicated that this species is not particularly rare, but simply poorly reported. It is currently considered secure (e.g., common, widespread, and abundant) in Yukon and as such, will not be negatively affected by development within the LSA.

Table 4.7-4: Potential Rare Plants within the Ketza River Project Local Study Area

Name	Observed	Ranking[1]	Habitat	Source[2]	Potential Ecosystem Unit[3]	Potential Land Cover Class
Aquilegia formosa	No	S2	Moist subalpine meadows and thickets	A, B	WC, FW, WB, BL, WF, CM	Herbs, Shrub Low, Shrub Tall, Wetland Herb, Wetland Shrub
Arnica latifolia var. *latifolia*	No	-	Moist alpine/subalpine meadows and thickets	A	WC, FW, WB, BL, WF, CM	Herbs, Shrub Low, Shrub Tall, Wetland Herb, Wetland Shrub
Arnica mollis	No	S2	Moist montane and subalpine meadows	A, B	WC, FW, WB, BL, WF, CM	Herbs, Shrub Low, Shrub Tall, Wetland Herb, Wetland Shrub

Table 4.7-4: Potential Rare Plants within the Ketza River Project Local Study Area

Name	Observed	Ranking[1]	Habitat	Source[2]	Potential Ecosystem Unit[3]	Potential Land Cover Class
Arnica parryi ssp. *parryi*	No	S1	Dry alpine slopes and meadows	A, B	GL, DC	Herbs, Shrub Low, Shrub Tall
Artemesia dracunculus	No	S2S3	Dry rocky slopes	A	TA, RO	Exposed/Barren Land, Rock/Rubble
Caltha leptosepala	No	S2	Moist alpine/subalpine meadows and pools	B	WC, FW, WB, BL, WF, CM, PM, RI, LA	Herbs, Shrub Low
Campanula rotundifolia	No	S2	High elevation meadows	B	GL, FW, WB, BL, WF, WS, CM	Herbs, Shrub Low, Shrub Tall
Carex albo-nigra	-	-	Dry, rocky alpine	A	TA, GL, RO	Exposed/Barren Land, Herbs, Rock/Rubble
Carex bonanzensis	No	-	Wet meadows	A	WC, FW, WB, BL, WF, CM, WR	Herbs, Shrub Low, Shrub Tall, Wetland Herb, Wetland Shrub
Carex synchnocephala	No	-	Forested slopes	A	FW, WB, SM, FM, FL, AV, PM	Broadleaf, Coniferous, Mixedwood
Carex viridula	No	S2	Wetland	B	WR, PM, RI, LA	Water, Wetland Herb, Wetland Shrub, Wetland Treed
Cassiope mertensiana	No	S1	High elevation meadows	B	HL, DC, WB, BL, WF, CM	Herbs, Shrub Low, Shrub Tall
Cryptogramma crispa	No	S1S2	Talus	B	TA, RO	Exposed/Barren Land, Rock/Rubble
Draba porsildii	No	S2	Granite cliffs	A, B	TA, RO	Exposed/Barren Land, Rock/Rubble
Draba scotteri	No	-	Alpine scree slopes	B	TA, RO	Exposed/Barren Land, Rock/Rubble
Erigeron uniflorus ssp. *eriocephalus*	No	-	Arctic-alpine tundra	A	HL, GL, WC, EL, DC	Exposed/Barren Land, Herbs, Rock/Rubble, Mixedwood Sparse
Festuca saximontana var. *purpusiana*	No	S2	Dry meadows and rocky areas	B	TA, GL, DC, RO	Exposed/Barren Land, Herbs, Rock/Rubble, Shrub Low
Listera cordata	No	-	Moist coniferous forest	A	FW, SM, FM, PM	Coniferous, Wetland Treed
Mitella nuda	No		Moist coniferous forest	A	FW, SM, FM, WR, FL, AV, PM	Coniferous, Wetland Treed

Table 4.7-4: Potential Rare Plants within the Ketza River Project Local Study Area

Name	Observed	Ranking[1]	Habitat	Source[2]	Potential Ecosystem Unit[3]	Potential Land Cover Class
Mitella pentandra	No	S2	Moist coniferous forest	A, B	FW, SM, FM, WR, FL, AV, PM	Coniferous, Wetland Treed
Polypodium sibiricum	No	S1	Rocky areas; riverbanks	B	TA, RO	Exposed/Barren Land, Rock/Rubble, Water
Ranunculus occidentalis var. *brevistylus*	No	S2	Moist subalpine meadows, sandy deciduous forest	A, B	FW, WB, BL, WF, CM	Broadleaf, Herbs, Mixedwood, Shrub Low, Shrub Tall, Wetland Herb, Wetland Shrub
Rosa woodsii	No	S2	Dry open slopes	B	FL, AV	Broadleaf Open, Coniferous Sparse, Mixedwood
Rubus arcticus ssp. *stellatus*	No	S2	Wet woods, thickets, and meadows	A	WC, FW, WB, WF, WS, SM, FM, PM	Broadleaf, Coniferous, Mixedwood, Shrub Tall, Wetland Shrub, Wetland Treed
Rubus pedatus	No	S1	Moist subalpine meadows	B	WC, FW, WB, BL, WF, CM	Herbs, Shrub Low, Shrub Tall, Wetland Herb, Wetland Shrub
Saxifraga aizoides[4]	Yes	-	Alpine steam banks	A	WR, RI	Water, Wetland Herb, Wetland Shrub, Wetland Treed
Senecio sheldonensis	No	S2	Subalpine meadows	B	WB, BL, WF, CM	Herbs, Shrub Low, Shrub Tall

[1]Territorial Conservation Status: S1 – Critically imperilled; S2 - Imperilled; S3 – Vulnerable.

[2]A – Douglas et al. (1981); B – NatureServe Yukon (information retrieved February 2007).

[3]Ecosystem Unit codes follow EBA (2008b).

[4]Considered secure in Yukon after baseline studies were completed.

Table 4.7-5: Distribution of Rare Plant Habitat Potential within the Ketza River Project Local Study Area

Rare Plant Habitat Potential	Potential Number of Rare Plant Species	Mine Site (ha)	Ketza Road (ha)	Total LSA (ha)	Proportion of Total LSA (%)
Very Low	≤2	506.8	6.3	513.1	5.6
Low	3-4	67.0	456.2	523.2	5.8
Moderate	5-7	1,835.2	4,072.3	5,907.5	64.9
High	8-10	79.2	107.6	186.8	2.1
Very High	≥11	353.2	1,613.7	1,966.9	21.6
Total		**2,841.4**	**6,256.0**	**9,097.5**	**100.0**

642000 643000 644000 645000 646000 647000 648000

6828000 6827000 6826000 6825000 6824000

N W E S

KG016 KG017 KG018 KV019 KG020 KG015 KG002 KV014 KF013 KV050 KG011 KG012 KV052 KV051 KV010 KF009 KF003 KG007 KF001 KG005 KG006 KV047 KV048 KV049 KG004 KG008 KV032 KV033 KG031

LEGEND

- Rare Plant Survey Tracks
- Rare Plant Survey Points
- *Saxifraga aizoides* identified in the field
- Dumps
- Pits
- Dam Structure
- Proposed Tailings Storage Facility
- Supernatant Water Pond
- Water Retention Pond
- Canamax Tailings Storage Facility
- Project Footprint
- Local Study Area
- Ketza Road
- Minor Road
- Watercourse
- Waterbody

NOTES
Base data source: NTS 1:50,000
Imagery provided by Aero Geometrics, Ltd.

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Rare Plant Survey Locations in the Local Study Area

PROJECTION UTM Zone 8		**DATUM** NAD27		**CLIENT** Ketza River Holdings	
Scale: 1:20,000 — 400 200 0 400 Metres					
FILE NO. W23101052_107_RarePlants.mxd				EBA A TETRA TECH COMPANY	
PROJECT NO. W23101052.107	**DWN** SL	**CKD** TP	**APVD** TP	**REV** 0	**Figure 4.7-4**
OFFICE EBA-VANC	**DATE** July 26, 2011				

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4.7.2.5 Invasive Plants

Over the past decade the ranges of non-native and invasive plants have been expanding in the Yukon, and a number of new non-native plant species have been identified. Non-native plant species are those that occur in a region but originate elsewhere (e.g., from Europe or Asia). Invasive species are typically non-natives that have established in natural ecosystems and have somehow altered the characteristics of the ecosystem, either through their abundance or their effect on other ecosystem functions (Klinkenberg 2011). Not all non-native plant species are invasive.

In the Yukon, approximately 154 non-native species have been identified, and of those, 20 are considered invasive (YG Environment 2011; YISC 2011). The presence and abundance of non-native species has been documented on disturbed sites throughout the territory, such as near bridges, culverts, rest stops, pullouts, campgrounds, gravel pits and other areas along major highways areas, particularly where recent highway construction and maintenance activities have occurred (Line et al. 2008).

In 2007, NatureServe Yukon, in partnership with YG Department of Environment, assembled an inventory of invasive species along major roadways in Yukon. A total of 28 non-native plant species were recorded, 17 of which were considered to be invasive, having the potential to negatively affect native ecosystems (Line et al. 2008). These are listed along with their invasiveness rank in Table 4.7-6.

Table 4.7-6: Invasive Species Present along Major Yukon Roadways[1]

Invasiveness Rank	Scientific Name	Common Name
1	*Agropyron pectiniforme*	Crested Wheat Grass
1	*Bromus inermis*	Smooth Brome
3	*Capsella bursa-pastoris*	Shepherd's Purse
2	*Chenopodium album*	Lamb's Quarters
1	*Crepis tectorum*	Narrow-leaf Hawk's beard
1	*Elymus repens*	Creeping Wild Rye
1	*Leucanthemum vulgare*	Ox-eye daisy
1	*Linaria vulgaris*	Yellow Toadflax
2	*Matricaria discoidea*	Pineapple weed
1	*Medicago falcata*	Yellow Alfalfa/ Lucerne
1	*Melilotus albus*	White Sweetclover
1	*Melilotus officinalis*	Yellow Sweetclover
1	*Phalaris arundinacea*	Reed Canary Grass
1	*Sonchus arvensis* ssp. *uliginosus*	Field Sow-thistle
2	*Stellaria media*	Common Chickweed
3	*Thlaspi arvense*	Field Pennycress
1	*Vicia cracca*	Tufted Vetch

[1]Source: Line et al. 2008
[2]Invasiveness Rank as per Bennett (2008):
1 – highly invasive – may displace or replace native ecosystems
2 – aggressive – widespread, persistent, but may not replace native species or change ecosystem function
3 – taxa present in the territory that are not known to be invasive here – but have been found to be invasive in other jurisdictions

Of the Yukon roadways surveyed for invasive plants, the Robert Campbell Highway and the South Canol Road are the two major roadways located nearest the Site. The following invasive species were recorded on either one or both of those roadways (Line et al. 2008):

- Smooth Brome (*Bromus inermis*)
- Narrow-leaf Hawk's beard (*Crepis tectorum*)
- Pineapple weed (*Matricaria discoidea*)
- Yellow Alfalfa/Lucerne (*Medicago falcata*).

It is possible that other invasive and non-native species may be found within and around the Site given the level of previous disturbance in the area. If present, they will likely be localized along roadsides and areas with exposed soil.

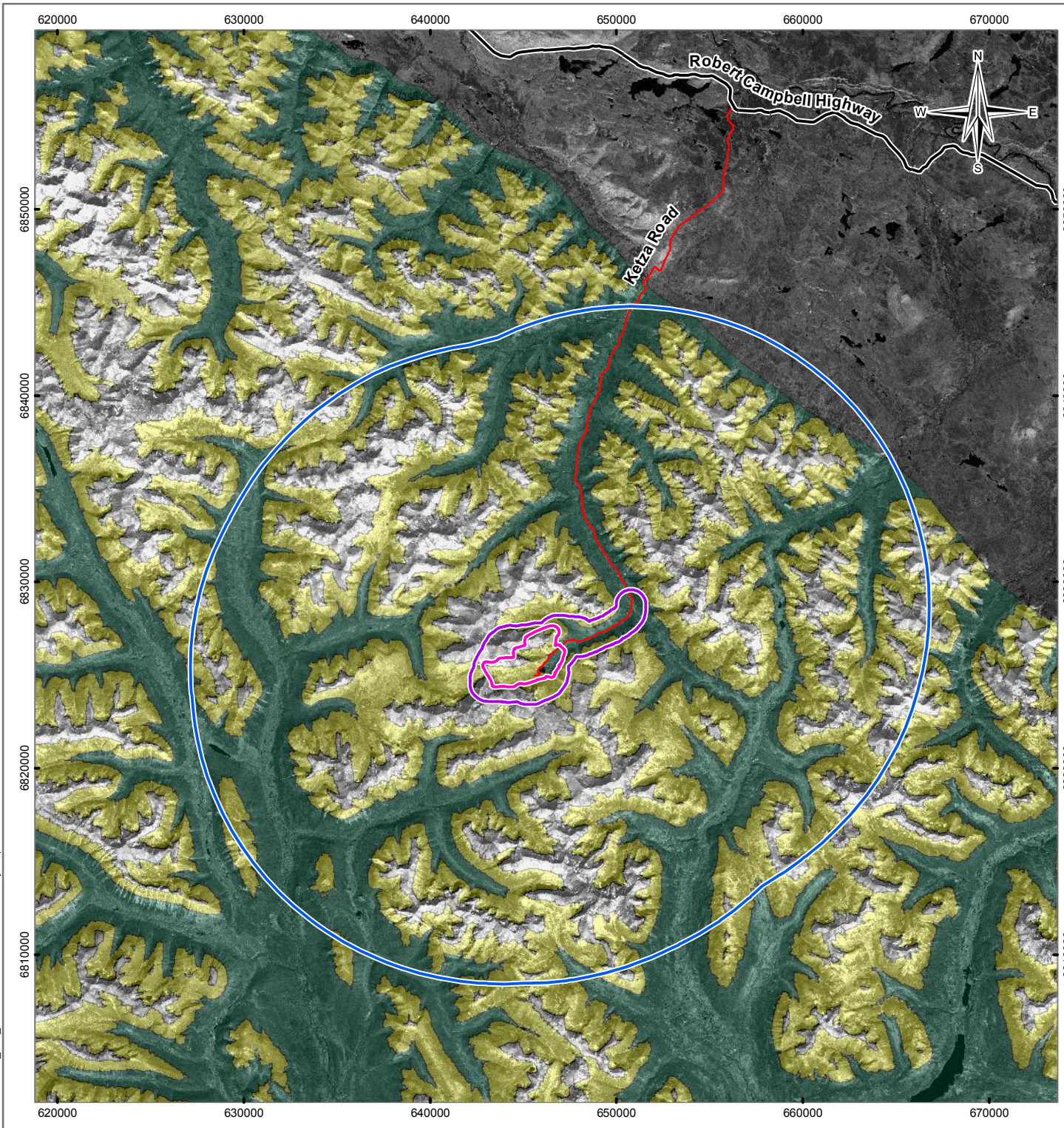
4.8 Wildlife

This section describes existing wildlife species and wildlife habitat within the Ketza River Mine Wildlife Regional Study Area (WRSA; Figure 4.8-1). The following are documented and discussed in this section: abundance and distribution of key wildlife groups (i.e., ungulates, large carnivores, small mammals, birds and amphibians) with detailed analysis on select wildlife species that have special conservation status (i.e., species protected under federal and/or territorial legislation) and/or are considered to have social or economic importance to local stakeholders.

Information presented in this section is based on research completed by YG, on behalf of the previous owners of the KRP, and work completed by EBA on behalf of KRH between 2007 and 2011. Detailed descriptions of wildlife resources within this report focus specifically on the study area where information was available.

Wildlife field surveys were conducted for KRH between 2007 and 2011 to document existing wildlife baseline conditions. Table 4.8-1 lists the surveys that were conducted as part of the wildlife baseline program for the KRP. Four reports documenting the Wildlife Baseline Program are included in Appendix F. These reports are:

- 2007-2008 Environmental Baseline Studies: Wildlife Program (EBA 2008d; Appendix F1)
- 2008 Environmental Baseline Studies: Wildlife Program (EBA 2011a; Appendix F2)
- 2010-2011 Environmental Baseline Studies: Wildlife Program. (EBA 2011b; Appendix F3)
- Grizzly Bear Cumulative Effects Assessment Models, Ketza River Project (EBA 2011c; Appendix F4).



LEGEND

Bioclimate Zone

- Alpine
- Boreal-High
- Subalpine

- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
Base data source: Yukon Geomatics

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Wildlife Study Areas

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_WSA.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	July 26, 2011

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Figure 4.8-1

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Table 4.8-1: Wildlife Surveys Conducted at the Ketza River Mine; Wildlife Baseline Program (2007 – 2011)

Survey	Survey Date	Target Species/Feature	Survey Method
Spring Mixed Aerial Reconnaissance[1]	June 24, 2007	Woodland Caribou, Raptors, Thinhorn Sheep, Grizzly Bear, and mineral licks	Total Block Count
Breeding Bird[1]	June 25 – 30, 2007	Passerines	Point Count (presence/not detected)
Mineral Lick Reconnaissance[1]	June 27, 2007	Mineral Licks	Use Assessment
Caribou Aerial Survey[1]	July 24, 2007	Woodland Caribou, Raptors	Contour Based
Sheep Survey[1]	August 8 – 11, 2007	Thinhorn Sheep	Ground Based Aerial Contour Based
Sheep Survey[1]	September 9 – 10, 2007	Thinhorn Sheep	Ground Based Visual Survey
Caribou Aerial Rut[1]	October 3, 2007	Woodland Caribou	Total Block Count
Winter Track Survey[1]	March 11 – 15, 2008	Furbearers	Ground Based Transect Survey
Winter Ungulate Aerial[1]Survey	March 27, 2008	Woodland Caribou, Thinhorn Sheep, Moose	Aerial Transect Survey
Riparian Bird Assessment[2]	July 16 – 19, 2008	Riparian Birds	Point Count
Aerial Ungulate Survey[2]	July 25, 2008	Caribou and Sheep	Contour Based
Riparian Bird Assessment[2]	Sept 8 – 9, 2008	Riparian Birds	Point Count
Post Calving / Lambing Survey[3]	July 30 – 31, 2010	Woodland Caribou Thinhorn Sheep	Total Block Count
Early Winter Moose Survey[3]	November 18 – 21, 2010	Moose	Geospatial
Grizzly Bear Den Emergence Survey[3]	April 28, 2011 May 13, 2011 May 26, 2011	Grizzly Bear	Total Block Count

[1] EBA 2007 [2] EBA 2011a [3] EBA 2011b

A WRSA of approximately 1,118 km^2 was used for the majority of wildlife surveys completed for this Project (Figure 4.8-1), unless otherwise noted. The WRSA was delineated by a 15 km radius around the mine site. An access road to the site was constructed in the 1980s and is described in further detail in Section 6.0. To assess the effects on wildlife that have smaller or more localized habitat requirements, a LSA was delineated by an 800 m buffer around the Site footprint (Figure 4.8-1).

As previously described, the KRP lies within the Saint Cyr Ecodistrict, of the Pelly Mountain Ecoregion in the Boreal Cordillera Ecozone (Smith et al. 2004). The Site lies within a subalpine / alpine valley and is surrounded by mountains. There are numerous riparian and wetland complexes within the WRSA, including Seagull Creek, McConnell River, Ketza River, and a tributary of the McNeil River. Within the LSA, high quality riparian habitat is adjacent to Cache Creek and the Ketza River. No wetland complexes exist within the LSA. EBA (2008d) estimated that the LSA contains 40% boreal highland, 18% subalpine and 42% alpine. Numerous alpine plateaus are present in the WRSA.

Wildlife Key Areas (WKAs) are areas the YG Department of Environment has identified as important habitat for specific species (YG Environment 2010a). They are discussed below for respective species.

4.8.1 Species with Conservation Status

The Federal *Species at Risk Act* (SARA) was established to help protect species at risk and their habitats in Canada. SARA is intended to prevent species extinction, and support species at risk recovery efforts (*Species at Risk Act* 2002). Species are added to SARA following detailed assessments of their populations, population trends, population threats and habitat status across Canada and the rest of their ranges (i.e., United States of America and Mexico). Through scientific reviews and considering community and aboriginal traditional knowledge, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) identifies and assesses the risk status of a species. Once COSEWIC determines the risk status of a species (i.e., extinct, extirpated, endangered, threatened, special concern, data deficient, or not at risk), SARA's Government in Council decides to either 1) accept the COSEWIC assessment and adds the species under Schedule 1 of the Act, 2); decline the COSEWIC assessment; or 3) refer back to COSEWIC for further assessment and adds the species under Schedules 2 or 3. Under the Species at Risk Act, species listed under Schedule 1 are given legal protection and a recovery planning is required. Wildlife species listed under Schedules 2 or 3 must be assessed by COSEWIC within a given time period. Once the COSEWIC assessment is complete, the species will be assessed and classified under SARA.

In addition to SARA designations, an amendment to the *Yukon Wildlife Act* has been proposed to protect species of special conservation status by relying on SARA and COSEWIC conservation designations and species assessments. This amendment proposes the territorial participation with federal jurisdictions in the recovery and management plan strategies of species occurring in the Yukon (YG Environment ND). The *Wildlife Act* (Yukon) currently lists seven species as *Specially Protected*. Four species on this list (Gyrfalcon, Peregrine Falcon, Mule Deer and Cougar) occur, or have the potential to occur, within the WRSA. The conservation status of species that occur, or have the potential to occur in the WRSA are provided below.

4.8.2 Mammals

A total of 52 species of mammals occur, or have the potential to occur in the WRSA (Table 4.8-2; Wilson and Ruff 1999). Species that have conservation status, or are considered to have significant social or economic importance are described below in further detail.

Table 4.8-2: Mammals That Occur, or Have the Potential to Occur, in the Wildlife Regional Study Area

Common Name	Scientific Name
River Otter	*Lontra canadensis yukonensis*
Striped Skunk	*Mephitis mephitis*
American Marten	*Martes americana*
Ermine	*Mustela erminea*
Least Weasel	*Mustela nivalis*
Fisher	*Martes pennanti*
American Mink	*Mustela vison*
Little Brown Myotis	*Myotis lucifugus*
Long-legged Myotis	*Myotis volans*
Pygmy Shrew	*Microsorex hoyi*
Arctic Shrew	*Sorex arcticus tundrensis*
Masked Shrew	*Sorex cinereus*

Table 4.8-2: Mammals That Occur, or Have the Potential to Occur, in the Wildlife Regional Study Area

Common Name	Scientific Name
Montane Shrew	*Sorex monticolus*
Water Shrew	*Sorex palustris*
Snowshoe Hare	*Lepus americanus*
Collared Pika	*Ochotona collaris*
Beaver*	*Castor canadensis*
Muskrat	*Ondatra zibethicus*
Meadow Jumping Mouse	*Zapus hudsonius*
Western Jumping Mouse	*Zapus princeps*
Deer Mouse	*Peromyscus maniculatus*
North American Porcupine*	*Erethizon dorsatum*
Northern Bog Lemming	*Synaptomys borealis*
Brown Lemming	*Lemmus trimucronatus*
Northern Red-backed Vole*	*Clethrionomys rutilus*
Eastern Heather Vole	*Phenacomys ungava*
Long-tailed Vole	*Microtus longicaudus*
Singing Vole	*Microtus miurus*
Taiga Vole	*Microtus xanthognathus*
Tundra Vole	*Microtus oeconomus*
Meadow Vole	*Microtus pennsylvanicus*
Northern Flying Squirrel	*Glaucomys sabrinus*
Hoary Marmot*	*Marmota caligata*
Woodchuck	*Marmota monax*
Arctic Ground Squirrel*	*Spermophilus parryii*
Least Chipmunk	*Eutamias minimus*
Red Squirrel*	*Tamiasciurus hudsonicus*
Bushy-tailed Woodrat	*Neotoma cinerea*
Canada Lynx	*Lynx canadensis*
Cougar	*Puma concolor*
Coyote	*Canis latrans*
Grey Wolf*	*Canis lupus*
Black Bear*	*Ursus americanus*
Red Fox	*Vulpes vulpes*
Grizzly Bear*	*Ursus arctos*
Wolverine*	*Gulo gulo*
Woodland Caribou*	*Rangifer tarandus caribou*
Thinhorn Sheep*	*Ovis dalli*
Moose*	*Alces alces*
Black-tail (Mule) Deer	*Odocoileus hemionus*
American Bison	*Bison bison*
Mountain Goat	*Oreamnos americanus*

* Mammal species observed in the KRP area during the Wildlife Baseline Program.

4.8.2.1 Woodland Caribou, Northern Mountain Population (*Rangifer tarandus caribou*)

Table. 4.8-3 describes the current conservation status of Woodland Caribou.

Table 4.8-3: Conservation Status – Woodland Caribou

System	Status
Species at Risk Act	Schedule 1 Species of Special Concern
COSEWIC	Species of Special Concern
Wildlife Act (Yukon)	Not Listed

Population Status

Woodland Caribou (Northern Mountain population) are listed as Special Concern (Schedule 1) under SARA (2008). Two caribou herds, the Wolf Lake and Finlayson Herds, use areas near the WRSA. The KRP area lies between their respective core ranges and, accordingly, the WRSA is not considered to be used extensively by either herd (J. Adamczewski, YG Biologist, pers. comm. 2007).

Few surveys have been conducted on the Wolf Lake and Finlayson Herds and, consequently, little information exists regarding their respective demographics.

Life History and Habitat Requirements

Two caribou ecotypes occur in the Yukon: Barren-Ground Caribou (*Rangifer tarandus groenlandicus*) and Woodland Caribou (Northern Mountain population; *Rangifer tarandus caribou*). Barren-ground Caribou occur in the northern third of the Yukon, while Woodland Caribou occur in the southern two-thirds of the Yukon. Only Woodland Caribou (mountain ecotype) occur in the KRP region.

Woodland Caribou populations in the Yukon are found in relatively discrete herds. There are 23 herds within the Territory (Caribou Management Team 1996). They typically occur at densities well below habitat carrying capacity and are held at that level by predation and human harvest (Caribou Management Team 1996). In the Yukon, 5 to 10% of adult caribou die naturally each year as a result of predators, disease / parasites, climate, and the quality of forage and habitat. The relative importance of these factors varies from herd to herd. Predation, mainly by wolves and bears, can play a significant role in caribou abundance, particularly for small herds (Caribou Management Team 1996).

Woodland Caribou do not form large aggregations or migrate large distances like Barren-Ground Caribou. Woodland Caribou move much shorter distances between seasonal ranges, which involve elevation shifts. Annual Woodland Caribou movements within the Yukon are presumed to be similar to those documented for adjacent herds such as the South Nahanni, Coal and Little Rancheria Herds. Woodland Caribou exhibit directional movements from valleys to higher elevations in the spring and typically occupy alpine/subalpine areas from June to November, grazing in alpine environments and using snow patches to reduce insect harassment (Gullickson and Mansequ 2000). Woodland Caribou migrate to calving areas, such as plateaus and upland sites, to give birth. Post-calving areas include moist alpine tundra and open meadows in the mountains (Gray and Panegyuk 1989). During the calving and post calving period, caribou are dispersed (T. Hegel, YG Biologist, pers. comm. 2011). During late fall and early winter, Woodland Caribou exhibit directional movements down to lower elevations, to forested habitats containing a high density of lichens. Lichens are an important food source for caribou year-round and during the winter they

seek out valleys with mature forests containing terrestrial lichens. Mature forests also provide thermal cover during extreme winter conditions.

Key habitats (WKAs) for Woodland Caribou include calving areas, winter range, rutting areas, migration corridors and mineral licks.

A WKA for caribou rutting is located in the southwest corner of the WRSA, which is shown in Figure 4.8-2.

Wolf Lake Herd

Distribution, demographic and range studies were conducted on the Wolf Lake Herd in 1984 and 1987. The most recent population surveys were conducted in 1998, which estimate the Wolf Lake Herd at approximately 1,400 animals (Table 4.8-4). This herd is considered healthy and slowly expanding in numbers (CPAWS 2002; Farnell and MacDonald 1989).

Table 4.8-4: Population Estimates for the Wolf Lake Caribou Herd

Year	Population Estimate
October 1981	1500
March 1987	664 ± 133
March 1991	785
October 1992	583
March 1993	1249 ± 150
1998	1400

Sources: Farnell et al. 1996 and CPAWs 2002

Finlayson Herd

The most recent population survey for the Finlayson Herd was conducted in March 2007 (Adamczewski et al. 2010). Following this survey, the Finlayson Herd was estimated at approximately 3077 caribou. Historical population estimates for this herd are summarized in Table 4.8-5.

Table 4.8-5: Population Estimates for the Finlayson Caribou Herd

Year	Population Estimate
2007	3077
1999	4130
1990	6000
1982	2000

Source: Adamczeski et al. 2010

Caribou densities in the Finlayson Lake area were considered high in the 1990s following intensive aerial wolf control. This wolf control program was carried out on an annual basis between 1983 and 1989 and it is estimated that the local wolf population was reduced by approximately 85% (Larsen and Ward 1995). The Finlayson Herd population size increased to three times what it was prior to the Wolf Control Program. Fall surveys conducted by YG Environment from 1999 to 2006 indicated that low calf numbers may indicate the herd size was declining. The 2007 survey also indicated the herd was declining (Adamczeski et al. 2010). It should be noted, however, that the herd size is still higher than what it was prior to the wolf control program.

Local Distribution and Habitat Use

Wolf Lake Herd

The range of the Wolf Lake Herd is described in Farnell et al. (1996). This area centres on Wolf Lake and encompasses the headwaters of the Liard River. Wolf Lake is located approximately 95 km south of the WRSA.

Finlayson Herd

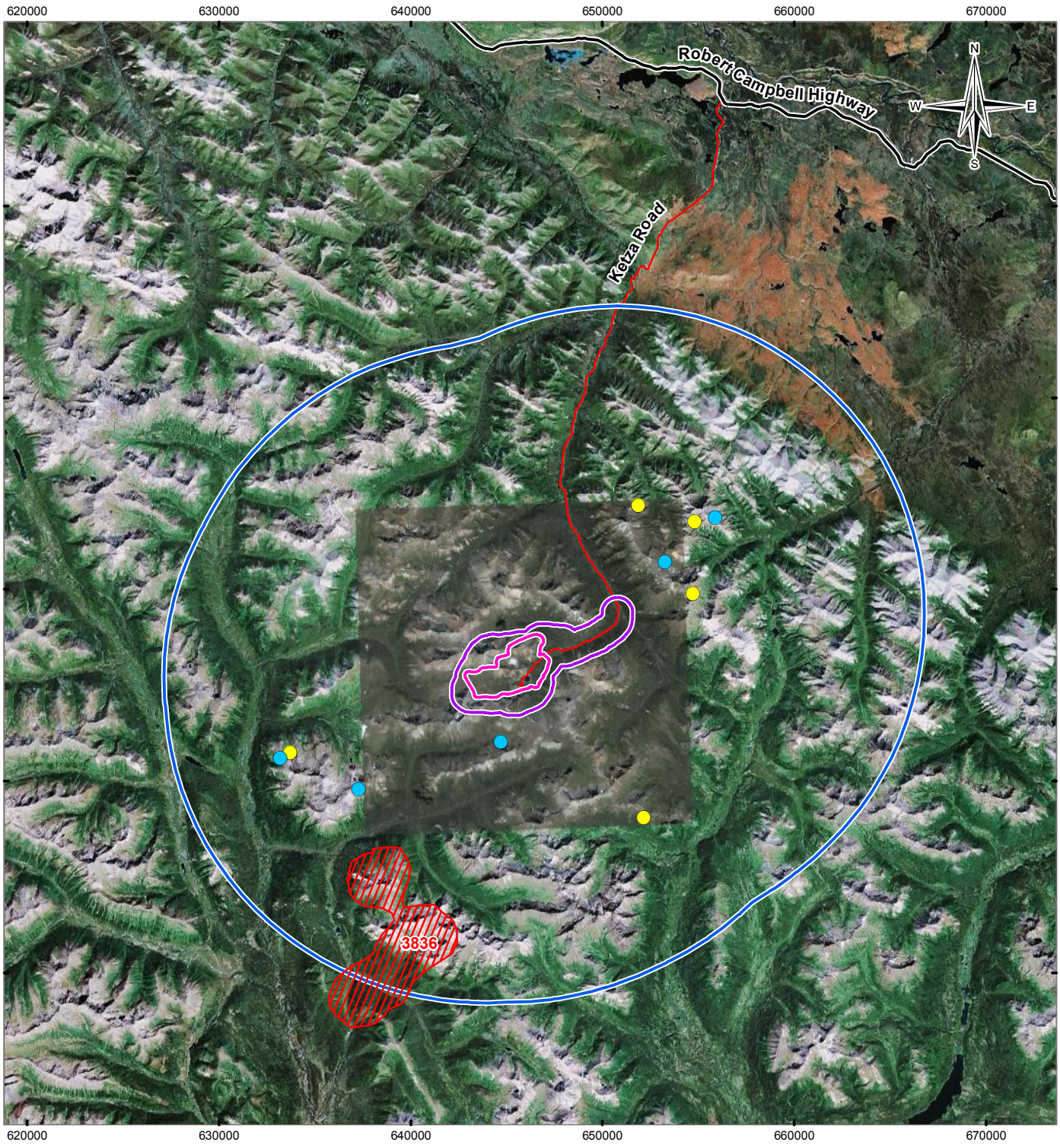
Surveys conducted between 1982 and 2004 indicate the distribution of the Finlayson Herd lies mostly outside of the WRSA. During the post-calving period, the majority of this herd occupies the area that is between approximately 20 to 100 km southeast of the KRP within the Pelly Mountains. During the rut, the majority of the herd is north of the post-calving area but still to the east and southeast of the Site. During the winter 2007 survey, the Finlayson Herd was mostly congregated near Finlayson Lake, which is located approximately 84 km to the northeast of the KRP. Caribou were also observed north of the Pelly River and in the Slate Rapids area. Surveys conducted in March of 1986, 1990, 1996, and 1999, located most caribou near Caribou Lakes on the Robert Campbell Highway and very few caribou were observed near Finlayson Lake (Adamczeski et al. 2010). It should be noted that the KRP lies outside the YG Environment survey area for the Finlayson Herd (Adamczeski et al. 2010).

KRP Wildlife Baseline Program

EBA (2008d; 2011a; 2011b) summarizes recorded temporal and spatial habitat use by caribou in relation to the KRP from data collected during the Wildlife Baseline Program. Caribou observations recorded during the Ketza Wildlife Baseline Program are summarized in Table 4.8-6 and Figure 4.8-2. The KRP WRSA overlaps with one WKA for caribou. The Ketza Road also crosses a WKA for winter caribou use outside of the WRSA (K. Egli, YG Fish and Wildlife Technician, pers. comm. 2007).

Table 4.8-6: Caribou Observations, Ketza Wildlife Baseline Program (2007 – 2011)

Survey	Date	Number of Groups	Number of Animals
Spring/Summer (Calving/Post-Calving)			
Spring Mixed Aerial Reconnaissance	July 24, 2007	8	25
Post Calving Survey	July 25, 2008	4	5
Post Calving / Lambing Survey	July 30 and 31, 2010	5	6
Fall (Rut)			
Rut Survey	October 4, 2007	0	0
Winter			
Early Winter Survey	November 18 -21, 2010	0	0
Grizzly Bear Den Emergence Survey	April 29, May 13 and May 26, 2011	0	0
	TOTAL	**17**	**36**



LEGEND

Caribou Observations[1]
- 2008
- 2010

Woodland Caribou Key Areas (Level 2)[2]
- Fall Rut - Survey Data

- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Caribou observations based on field survey results (EBA)
2. Wildlife Key Area Inventory (Government of Yukon 2009)

Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Caribou Distribution, Post Calving

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO.
W23101052_109_Caribou.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	September 13, 2011

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Figure 4.8-2

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During the six wildlife surveys conducted in the Ketza WRSA, which have targeted caribou and/or their habitat, 36 caribou have been observed in 17 groups.

Spring / Summer (Calving / Post-calving)

Very few caribou were observed during aerial surveys completed in 2007, 2008, and 2010. This may indicate that there is low to moderate habitat use within the WRSA during the calving and post-calving period. Five cows with calves were observed during the July 24, 2007 survey and one cow with calf was observed during the July 25, 2008 survey. No calves were observed during the post calving survey conducted in late July, 2010 (EBA 2008d, EBA 2011a, EBA 2011b). It should be noted that caribou are often widely dispersed throughout the alpine and subalpine, and may often use craggy areas during the calving and post calving period, making them difficult to see during these surveys (T. Hegel, YG Biologist, pers. comm. 2011). Therefore, a lack of caribou observations does not generally mean that this habitat is not used by caribou during the summer.

Fall (Rut)

One aerial survey was conducted during the 2007 rut period (October 4, 2007), which is discussed in EBA (2008d). No caribou were observed during the 2007 rut survey. An attempt was made to survey again during fall 2010, but due to poor weather the survey was cancelled (EBA 2011b). During the rut period, caribou usually congregate together which increases probability of detection. However, although one survey cannot confirm caribou use / non-use of the WRSA during rut, it does suggest limited use during this period.

Winter

Caribou typically congregate during the winter and are often found in forested areas or in the open on lakes or wetlands. Winter surveys were conducted in March 2007, November 2010 and April / May 2011. No caribou were observed during any of these surveys, suggesting that the KRP area is not used by caribou during the winter.

The Finlayson Herd has been noted to winter near Finlayson Lake and Caribou Lakes, approximately 84 km and 82 km respectively, from the KRP. The Wolf Lake Herd winters approximately 95 km to the south of the study area (Farnell et al. 1996).

Based on survey results of the Ketza Wildlife Baseline Program, caribou use of the WRSA during the winter is considered limited.

4.8.2.2 Moose (*Alces alces*)

Table 4.8-7 describes the current conservation status of moose.

Table 4.8-7: Conservation Status – Moose

System	Status
Species at Risk Act	Unlisted
COSEWIC	Not Evaluated
Wildlife Act (Yukon)	Not Listed

Population Status

Approximately 65,000 to 70,000 Moose have been estimated to occur within the Yukon Territory (YG Environment 2007a). In 1996, YG Department of Environment (2007b) calculated an average density of approximately 185 Moose per 1,000 km^2. As of January 1996, Moose densities were estimated at 150 to 249 per 1,000 km^2 for much of the south-central portion of the Yukon, including the WRSA (Moose Management Team 1996). Although Moose are not listed as a species at risk under SARA or COSEWIC (2010), they do have significant social and economic importance in the Yukon.

General Life History and Habitat Requirements

Moose require a variety of habitat types, including areas with adequate browse and cover. Important habitats for Moose are areas used for critical life functions (Moose Management Team 1996), these include:

- Winter range, such as forested river valleys that provide forage material and shelter from deep snow
- Isolated / protected calving areas
- Mineral licks.

In the southern Yukon, about two thirds of all Moose are found at treeline in the subalpine shrub zone. In locations with low snowfall, Moose will remain in the subalpine zone most of the year. Moose may also concentrate in high boreal zones along waterways with interconnecting marshes, ponds, and meandering streams, as well as within burn areas (YG Environment 2007a). Historical records indicate no major fires have occurred in the WRSA, with the exception of where the road leaves the Pelly Mountains, approximately 20 km northeast of the Site. Moose require access to shade during the summer. Gill (1978) reported that Moose in the Mackenzie Mountains seek shaded habitats, such as forested areas below timberline during the summer. Open water and mature old forested habitat are also used during summer. These features, in proximity to suitable forage, provide high-quality Moose habitat.

To avoid predators, Moose use forests and tall shrubs that provide visual cover to reduce detection. They also use shorelines and islands to reduce encounters with predators, especially during calving (Van Ballenberghe 1987); however these habitat types have not been observed in the WRSA.

Moose Management Guidelines have been developed primarily for the sustainable harvest of Moose within the Yukon, Moose viewing and land use developments. The primary mandate of the Moose Management Team is to conserve Moose populations and their habitats. Of particular relevance to the KRP, the Moose Management Guidelines (Moose Management Team 1996) indicate the identification of important Moose habitats is a priority for effectively managing populations and implementing land use guidelines that will minimize cumulative Moose impacts from land use developments (Moose Management Team 1996). This may include establishing protected areas with important Moose habitat (Moose Management Team 1996).

Local Distribution and Habitat Use

Numerous Moose population studies have been completed near the WRSA, but few actually overlap with the WRSA. The following section outlines the Moose studies completed, and results are summarized in Table 4.8-8.

In 1991, Moose surveys were completed along the North Canol Road (approximately 50 km north of the WRSA) and Frances Lake area (approximately 50 km east of the WRSA; Larsen and Ward 1995). Moose densities in 1991 were estimated at 339 and 381 Moose/1,000 km^2, respectively (the highest in all of Yukon) (Larsen and Ward 1995). A study was also completed in 2001 in the North Canol area, resulting in a density of 659 Moose/1,000 km^2. By comparing Moose densities estimated from this survey to previous estimates reported in 1987 for the same areas, Moose densities increased in both areas (1.16 and 1.18 per year, respectively) (Larsen and Ward 1995). The increase in Moose densities was attributed to a government wolf reduction program in the area (Larsen and Ward 1995).

Moose surveys were also completed at Nisutlin (approximately 50 km southwest of the WRSA) in 1994 and in the Liard West (approximately 75 km southeast of the WRSA) in 1995. These surveys yielded density estimates of 229 and 165 Moose/1,000 km^2, respectively (Moose Management Team 1996).

Table 4.8-8: Summary of Moose Population Estimates near the Wildlife Regional Study Area

Year	Area	Survey Date	Population Estimate	Moose Density (Moose/1000 km^2)	Mature Bulls: 100 Cows	Calves: 100 Cows
1991	North Canol	Oct 31 – Nov 26	988 ± 18%	339	90	52
1996	North Canol	Nov 2 - 10	818 ± 19%	277	102	28
2001	North Canol	Oct 31 – 26	659	203	76	32
1991	Frances Lake	-	1454 ± 21%	381	57	44
1996	Frances Lake	Nov 9 - 19	1323 ± 15%	338	46	30
1994	Nisutlin	-	-	229	-	-
2007	Nisutlin	Dec 20	-	-	80	18
2007	Teslin Burn	Dec 13	-	-	92	

Source: Data summarized from Larsen and Ward 1995; YG Environment 2001 unpublished data.

Habitat with adequate browse, protective cover, and mineral licks is required to support life requisites for Moose (Moose Management Team 1996). Each of these habitat characteristics have been identified in the WRSA during the Wildlife Baseline Program. These habitats support Moose throughout the year as detailed below.

EBA recorded a total of 287 Moose during the Wildlife Baseline Program conducted between June 2007 and May 2011, including targeted and incidental observations. These observations are listed by survey in Table 4.8-9. A late winter ungulate survey was conducted in March 2008 (EBA 2008d). During this survey, 16 Moose were observed (Figure 4.8-3). The majority of observations were in recently burned, conifer forests and riparian areas. No Moose were observed in subalpine areas during this survey. This survey is described in further detail in Appendix F1 (EBA 2008d).

As per YG Department of Environment's recommendations, an early winter geospatial Moose survey was conducted in the WRSA in November 2010 (EBA 2011b). A total of 209 Moose were observed during this survey, and most observations were made in subalpine valleys, primarily in draws (Figure 4.8-4). Moose were also observed in the alpine, burns and riparian areas within the boreal forest. Only two Moose were observed within the LSA, with the exception of the Ketza Road. Moose have been observed repeatedly

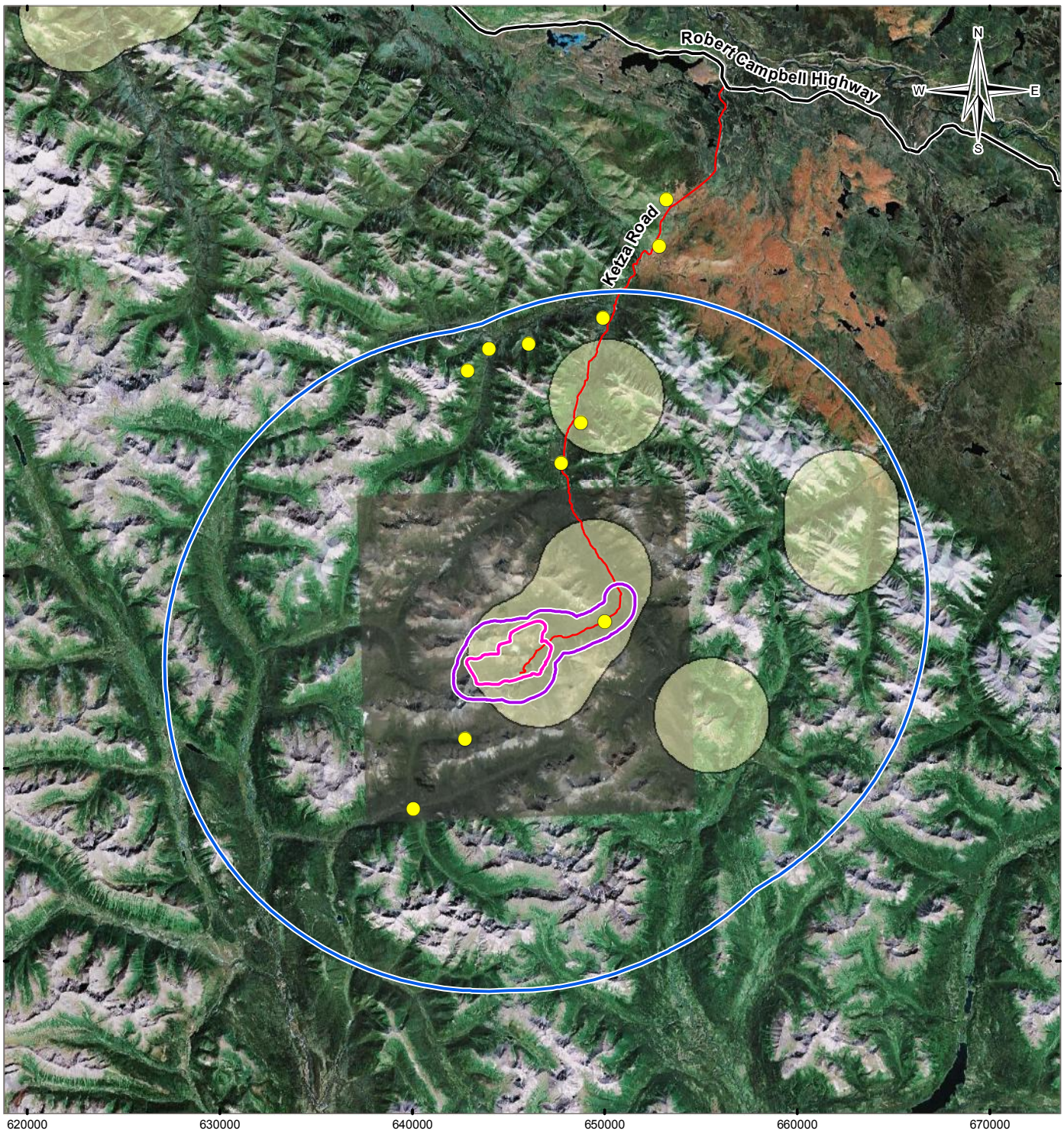
within the riparian vegetation along the Ketza River, which is adjacent to the Ketza Road. This survey is described in further detail in Appendix F3 (EBA 2011b).

In addition to the geospatial survey and late winter aerial survey, incidental Moose observations were recorded throughout the Wildlife Baseline Program. These observations are summarized in Table 4.8-9 and depicted in Figure 4.8-5.

Table 4.8-9: Incidental Moose Observations, Ketza Wildlife Baseline Program (2007 – 2010)

Survey	Date	Total No. Moose
Spring Mixed Aerial Reconnaissance	June 24, 2007	2
Caribou Aerial Survey	July 24, 2007	2
Caribou Rut Survey	October 3, 2007	32
Winter Ungulate Survey	March 27, 2008	16
Employee Wildlife Log	2007– 2008	22
Aerial Ungulate Survey	July 25, 2007	1
Geospatial Moose Survey	Nov 18 – 21, 2010	209
Grizzly Bear Den Emergence Survey	April 28, May 13 and 26, 2011	4
	Total	288

The Ketza Road travels the length of the Ketza River valley and traverses important habitat used by Moose year round. Four mineral licks, identified by YG (2005), are known to occur near the Ketza Road and an additional four mineral licks are located within the WRSA (EBA 2008d). These mineral licks are described in Appendix F1 (EBA 2008d). Winter habitat for Moose exists along the Pelly River valley and wetland complexes east of Ross River, approximately 35 km from the Site. No WKAs for Moose have been documented within the WRSA; however, Moose are assumed to commonly occur in the boreal high (large river valleys) and Subalpine Bioclimate Zones throughout the year.



LEGEND

Moose Observations[1]
- 2008

Mineral Licks[2]
- Local Knowledge

- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Winter Ungulate Aerial Survey (EBA 2008)
2. Wildlife Key Area Inventory (Government of Yukon 2009)

Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Late Winter Moose Survey

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_MooseLate.mxd

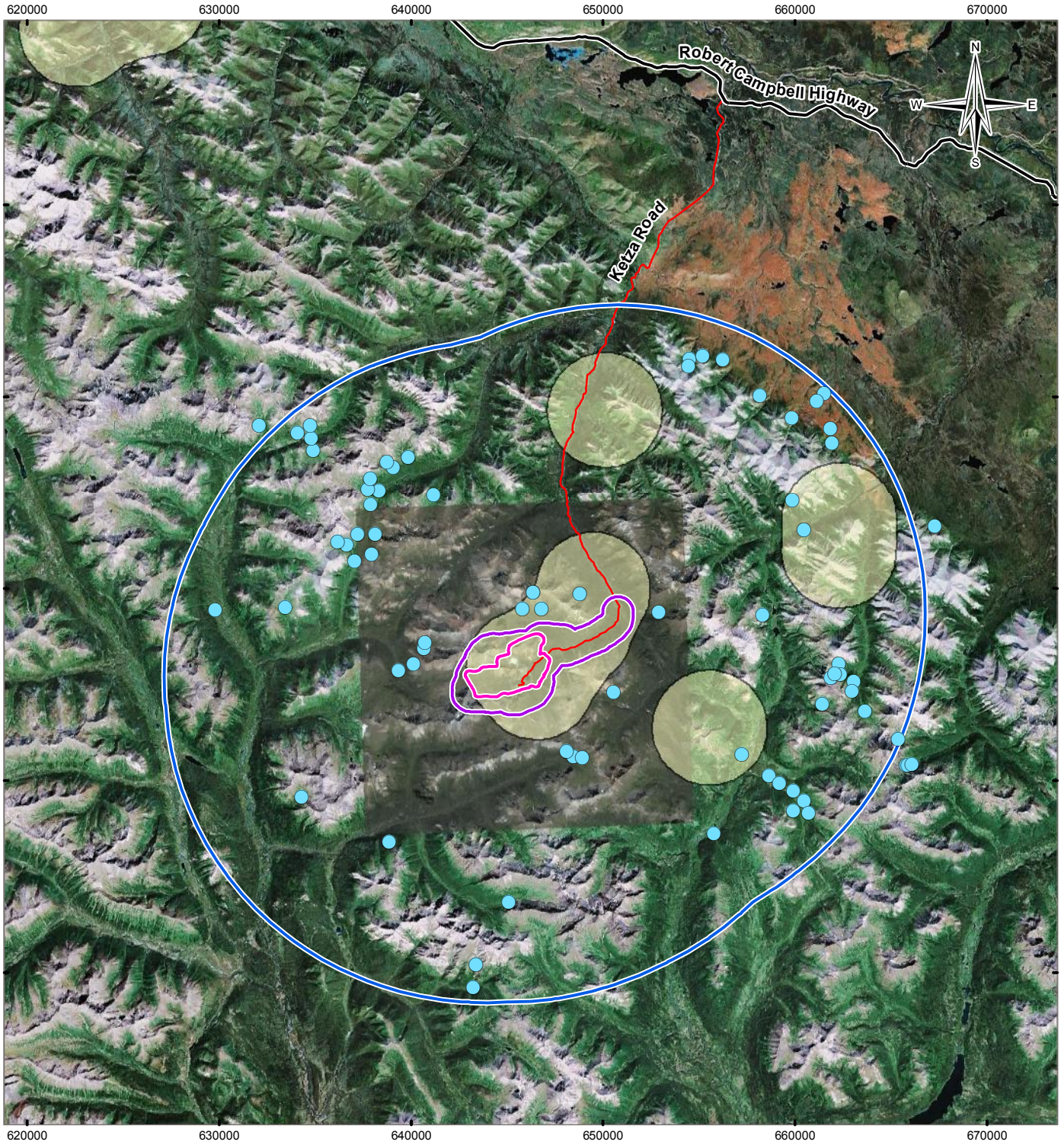
PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	September 13, 2011

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Figure 4.8-3

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LEGEND

Moose Observations[1]

- 2010

Surveyed Blocks

- High Moose Probability Stratum
- Low Moose Probability Stratum

Mineral Licks[2]

- Local Knowledge

- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Early Winter Moose Geospatial Survey (EBA 2010)
2. Wildlife Key Area Inventory (Government of Yukon 2009)
Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Early Winter Moose Geospatial Survey

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_MooseEarly.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	September 13, 2011

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Figure 4.8-4

Q:\Vancouver\GIS\ENVIRONMENTAL\W23\W23101052_KetzaMaps\109\W23101052_109_MooseEarly.mxd modified 9/13/2011 by stephanie leusink



LEGEND

Moose Observations[1]
- 2007
- 2008
- 2011

Mineral Licks[2]
- Local Knowledge

- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Moose observations based on field survey results (EBA)
2. Wildlife Key Area Inventory (Government of Yukon 2009)

Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Incidental Moose Observations

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000

4 2 0 4 8

Kilometres

FILE NO. W23101052_109_MooseIncidental.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	September 13, 2011

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Figure 4.8-5

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4.8.2.3 Thinhorn Sheep (*Ovis dalli*)

Table 4.8-10 describes the conservation status of Thinhorn Sheep.

Table 4.8-10: Conservation Status – Thinhorn Sheep

System	Status
Species at Risk Act	Unlisted
COSEWIC	Not Evaluated
Wildlife Act (Yukon)	Not Listed

Thinhorn Sheep have not been assessed by COSEWIC (2010) and are not Specially Protected under the *Wildlife Act* (Yukon) (YG Environment 2010b). They do have significant social and economic importance within the Yukon.

Population Status

Approximately 22,000 Thinhorn Sheep occur in the Yukon, of which approximately 18,000 are Dall's Sheep (*Ovis dalli dalli*), 1,500 are Stone Sheep (*Ovis dalli stonei*) and 2,500 are Fannin Sheep. Fannin Sheep are an intermediate colour phase between Dall's and Stone Sheep. Thinhorn Sheep densities vary throughout the Yukon and depend mainly on habitat quality and hunting pressure (YG Environment 2010c; Sheep Management Team 1996).

Within the Yukon, population densities are believed to be at or near historic numbers, and have been known to occur at densities ranging from less than 2 sheep per 100 km^2 to more than 30 sheep per 100 km^2 (Sheep Management Team 1996), as determined mainly by habitat quality. Thinhorn Sheep populations are considered stable within the Yukon, although annual population fluctuations (as much as ± 20%) have been documented as a result of adverse weather conditions during winter and lambing (Hoefs and Barichello 1985; Sheep Management Team 1996).

General Life History and Habitat Requirements

Both subspecies of Thinhorn Sheep, Dall's Sheep and Stone Sheep commonly occur within the WRSA (Barichello et al. 1989).

Thinhorn Sheep populations are commonly confined to specific mountain blocks, particularly areas located on the dry leeward sides of mountains (Sheep Management Team 1996). Although seasonal range migrations routinely occur, dispersal into new ranges occurs infrequently. Thinhorn Sheep residing within the study area are not isolated from other populations, but rather occur as a meta-population with others throughout much of the Yukon.

Life requisites that are critical to the survival and success of sheep populations are winter range, movement corridors, summer range, lambing habitat and mineral licks. Sheep are grazers and require abundant food supplies (predominantly grasses, sedges and forbs, as well as some woody plants during winter months) adjacent to steep terrain for security cover. Habitat characteristics of winter ranges commonly include lower elevations, wind-swept south facing slopes with no to little snow cover, and escape terrain (Bowyer and Leslie 1992; YG Environment 2007a). Treed and shrubby areas are also used

during winter months (YG Environment 2007a). Due to the long duration of snow cover in the northern mountains, sheep occupy winter ranges for a large portion of the year (Bowyer and Leslie 1992).

Summer ranges are commonly an expansion of the winter range, and include high alpine meadows. By late August and September, sheep slowly begin moving towards the winter range (YG Environment 2007a). Thinhorn Sheep have a high fidelity to movement corridors to and from seasonal ranges (Bowyer and Leslie 1992; YG Environment 2007a) and mineral licks. Movement through valley bottoms and areas with limited to no security cover from steep terrain is hurried as individuals are exposed to a higher likelihood of predation (YG Environment 2007a).

In the Yukon, sheep have been considered an important aesthetic and economic resource (i.e., trophy hunting), and in response, Sheep Management Guidelines have been developed to conserve sheep populations and their habitats. These guidelines focus primarily on sheep harvesting and managing sustainable harvests; however, the guidelines also identify key habitats that should be protected from all human disturbances (Sheep Management Team 1996).

Local Distribution and Habitat Use

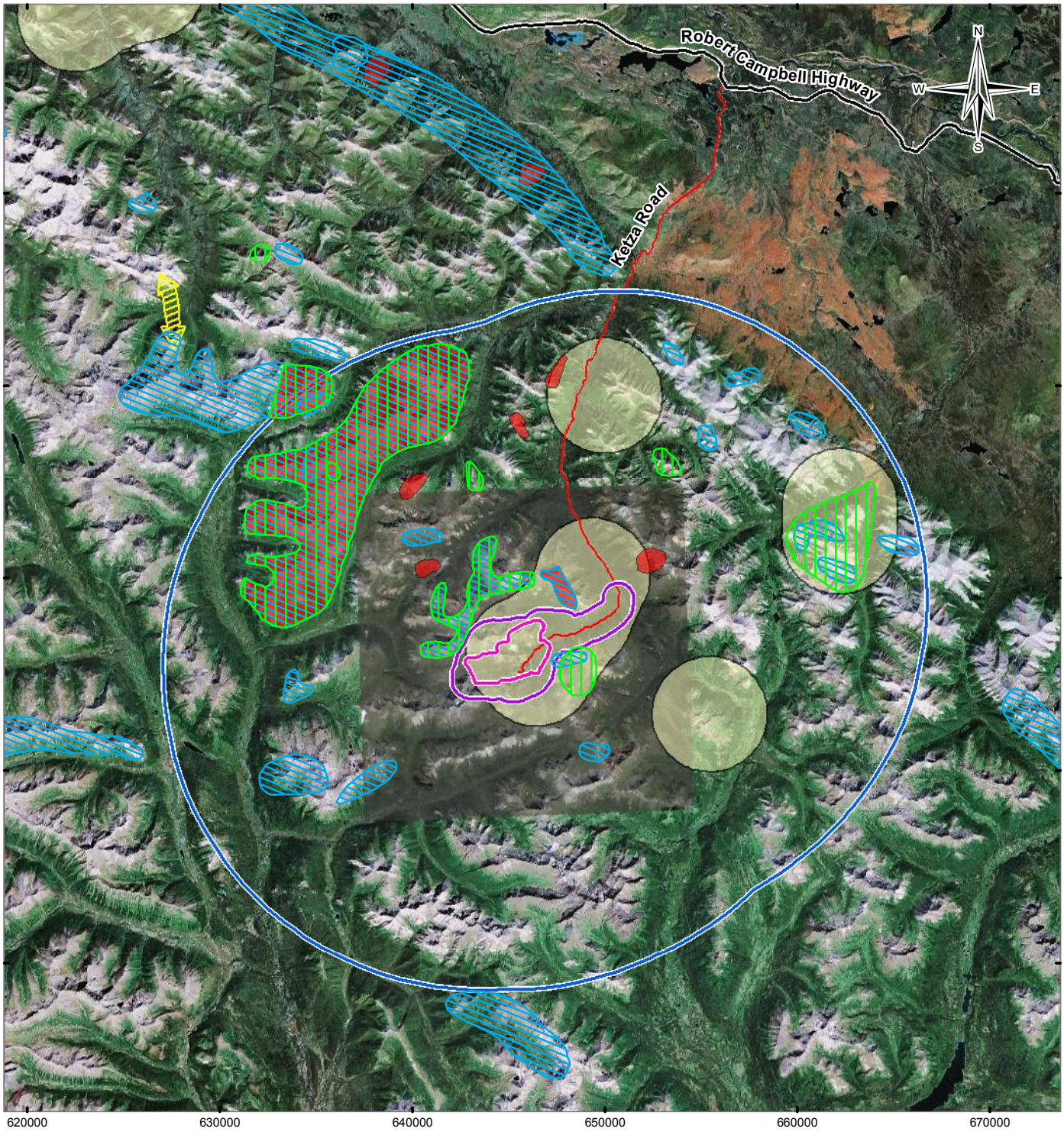
The WRSA contains high quality habitat for Thinhorn Sheep, and habitat use in this area is well documented. The WRSA contains numerous WKAs for sheep, including 15 winter range polygons, three polygons for spring lambing areas, and six early winter rutting polygons. These WKAs are shown in Figure 4.8-6.

Between 1986 and 1989, when mining was underway, several sheep surveys were completed within the WRSA and neighboring properties in response to community concerns over the mining operations and Ketza Road development that occurred in the late 1980s within known sheep ranges (Barichello et al. 1989). These surveys were conducted in March, May, June and November to provide better insight into seasonal distribution of sheep in the area. Based on these surveys, sheep were reported to use much of the WRSA throughout the year, including the alpine and subalpine areas that surround the LSA (Barichello et al. 1989). Sheep recorded in the vicinity of the mine site in 1986, 1988, and 1989 totaled 90, 104, and 73, respectively (Barichello et al. 1989).

As discussed by Barichello et al. (1989) the Ketza Road bisects known sheep ranges; however, after completing population surveys in the area from 1986 to 1989, Barichello et al. (1989) concluded that sheep were not experiencing apparent negative effects from the operation of the Canamax mine and use of the road.

Cadsand (2007) also conducted a sheep survey in the Ketza River area in July, 2007 in response to public concerns that Thinhorn Sheep population in the area were declining. A total of 163 sheep were observed during this survey, observations included 98 unclassified nursery sheep, 36 lambs, and 29 rams. This survey concluded that sheep show high fidelity to specific areas within this region.

The Ketza Road lies predominantly along the Ketza River valley. The spatial distribution of habitat and known areas of sheep presence indicate the Ketza River valley is used by sheep to access mineral licks and/or as a corridor between seasonal ranges. EBA (2008d) identified a migration corridor that crosses the Ketza Road between the winter range and lambing area during studies in 2007 / 2008, which is shown in Figures 4.8-7 to 4.8-9.



LEGEND

Thinhorn Sheep Key Areas[1]

- Spring Lambing - Survey Data & Local Knowledge
- Winter Range - Survey Data & Local Knowledge
- Early Winter Rut - Survey Data
- Movement Corridor - Local Knowledge

Mineral Licks[1]

- Local Knowledge

- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Wildlife Key Area Inventory (Government of Yukon 2009)
Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Thinhorn Sheep Wildlife Key Areas

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_SheepWKA.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	September 13, 2011

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Figure 4.8-6

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Spring – Lambing

In May and early June, pregnant ewes occupy lambing sites which include high precipitous terrain (YG Environment 2007a). Lambs are born in late May and early June. Based on surveys conducted in the area, lambing does occur within the WRSA (EBA 2008d, Appendix F1; EBA 2011b, Appendix F3). Sheep distribution during spring lambing is shown in Figure 4.8-7. Table 4.8-11 summarizes sheep observations recorded during spring surveys within the WRSA. Sheep are sensitive to air traffic, year round. During the lambing period, sheep are extremely sensitive to disturbance (MERG 2002).

Table 4.8-11: Summary of Spring Sheep Observations

Survey	Date	Total	Nursery	Lambs	Rams	Other
Yukon Renewable Resources (1989)	June 1988	38	22	7	9	-
Spring Mixed Aerial Reconnaissance (EBA 2008d)	June 27, 2007	33	22	9	0	2
Grizzly Bear Den Emergence Survey (EBA 2011b)	April 28, 2011	10	0	0	10	0
Grizzly Bear Den Emergence Survey (EBA 2011b)	May 13, 2011	4	-	-	-	4
Grizzly Bear Den Emergence Survey (EBA 2011b)	May 26, 2011	23	13	1	5	4
Total		**108**	**57**	**17**	**24**	**10**

Summer

Observations of sheep within the WRSA in the summer period are summarized in Table 4.8-12. Sheep have been observed during all aerial surveys conducted each summer. The distribution of these observations is shown on Figure 4.8-8.

Table 4.8-12: Summary of Summer Sheep Observations

Survey	Date	Total	Nursery	Lambs	Rams	Other
Caribou Post Calving Survey (EBA 2008d)	July 27, 2007	36				
Aerial Ungulate Survey (EBA 2008d)	July 25, 2008	34	25	1		8
Post Calving/lambing Survey (EBA 2011b)	July 30 and 31, 2010	58			4	54
Total		**128**	**25**	**1**	**4**	**62**

Winter

A number of winter range WKAs for sheep are located within the WRSA (Figure 4.8-9). Winter surveys conducted in the WRSA include a winter ungulate survey (March, 2008) and an early winter moose survey (November, 2010). A total of 20 sheep were observed during the late winter survey (EBA 2008d; Appendix F1). The majority of these sheep were not identified to sex or maturity, with the exception of nine rams. This survey is discussed in further detail in EBA 2008d (Appendix F1). No sheep were observed during the early winter moose survey. However, the lack of sheep observations may be because typical sheep habitat was not surveyed.

Mineral Licks

Mineral licks composed of high calcium–phosphate or calcium–magnesium concentrations are an important habitat feature (Bowyer and Leslie 1992), particularly for ewe groups, as they provide an essential mineral component to the diet of sheep. Typically, well-established sheep trails lead to licks, which are used most frequently in the spring and early summer. A total of eight mineral licks are known to occur within the WRSA, of which five are located within or immediately adjacent to the Ketza River Claim Block (Figure 4.8-6) (YG Environment 2010a).



LEGEND

- Sheep Distribution[1]
- **Thinhorn Sheep Key Areas[2]**
- Spring Lambing - Survey Data
- Spring Lambing - Local Knowledge
- Migration Corridor
- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Distribution based on field survey results (EBA)
2. Wildlife Key Area Inventory (Government of Yukon 2009)
Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Spring Thinhorn Sheep Distribution

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_SheepSpring.mxd

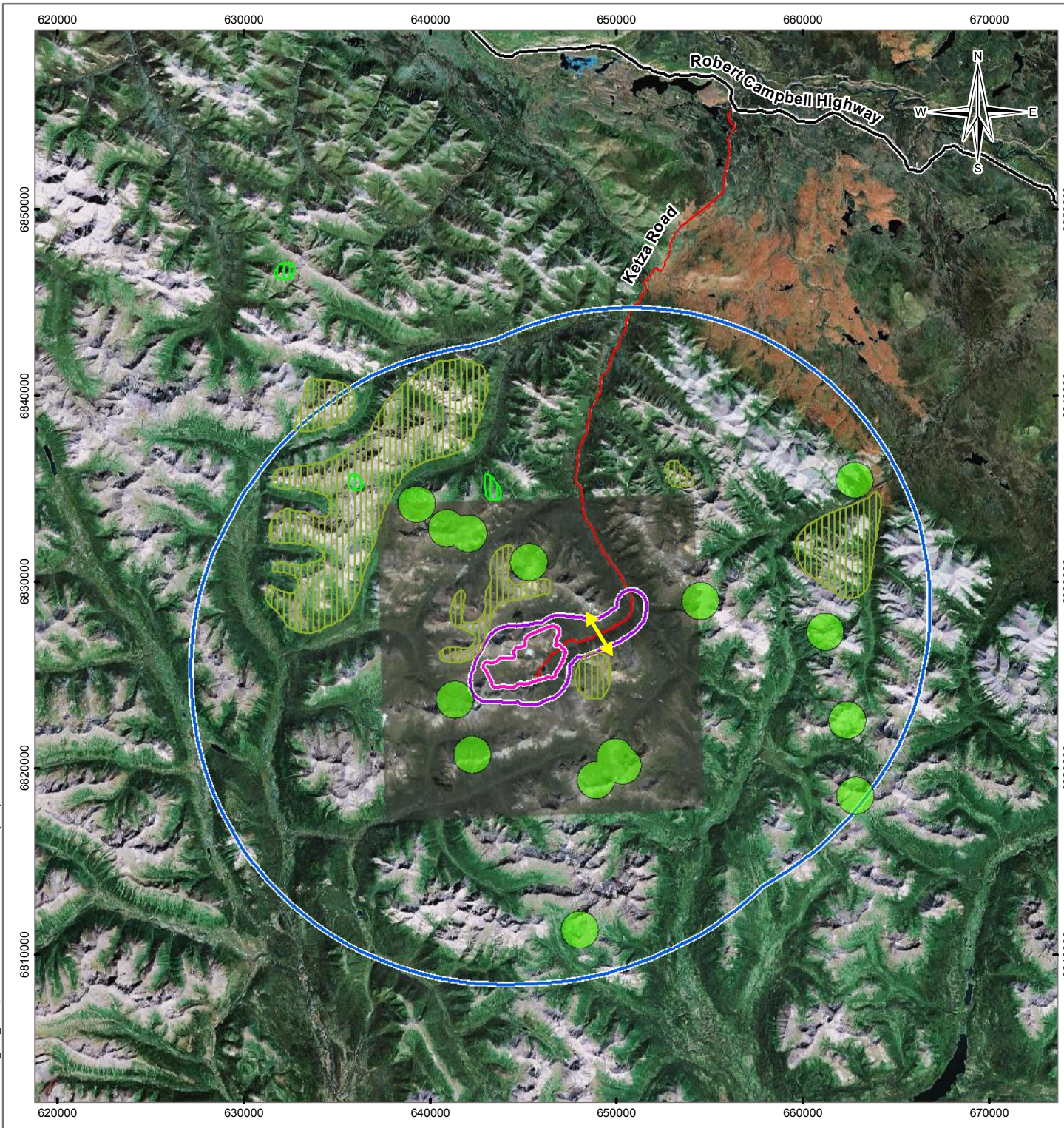
PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	September 13, 2011

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Figure 4.8-7

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LEGEND

- Sheep Distribution[1]
- **Thinhorn Sheep Key Areas[2]**
- Spring Lambing - Survey Data
- Spring Lambing - Local Knowledge
- Migration Corridor
- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Distribution based on field survey results (EBA)
2. Wildlife Key Area Inventory (Government of Yukon 2009)
Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Summer Thinhorn Sheep Distribution

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_SheepSummer.mxd

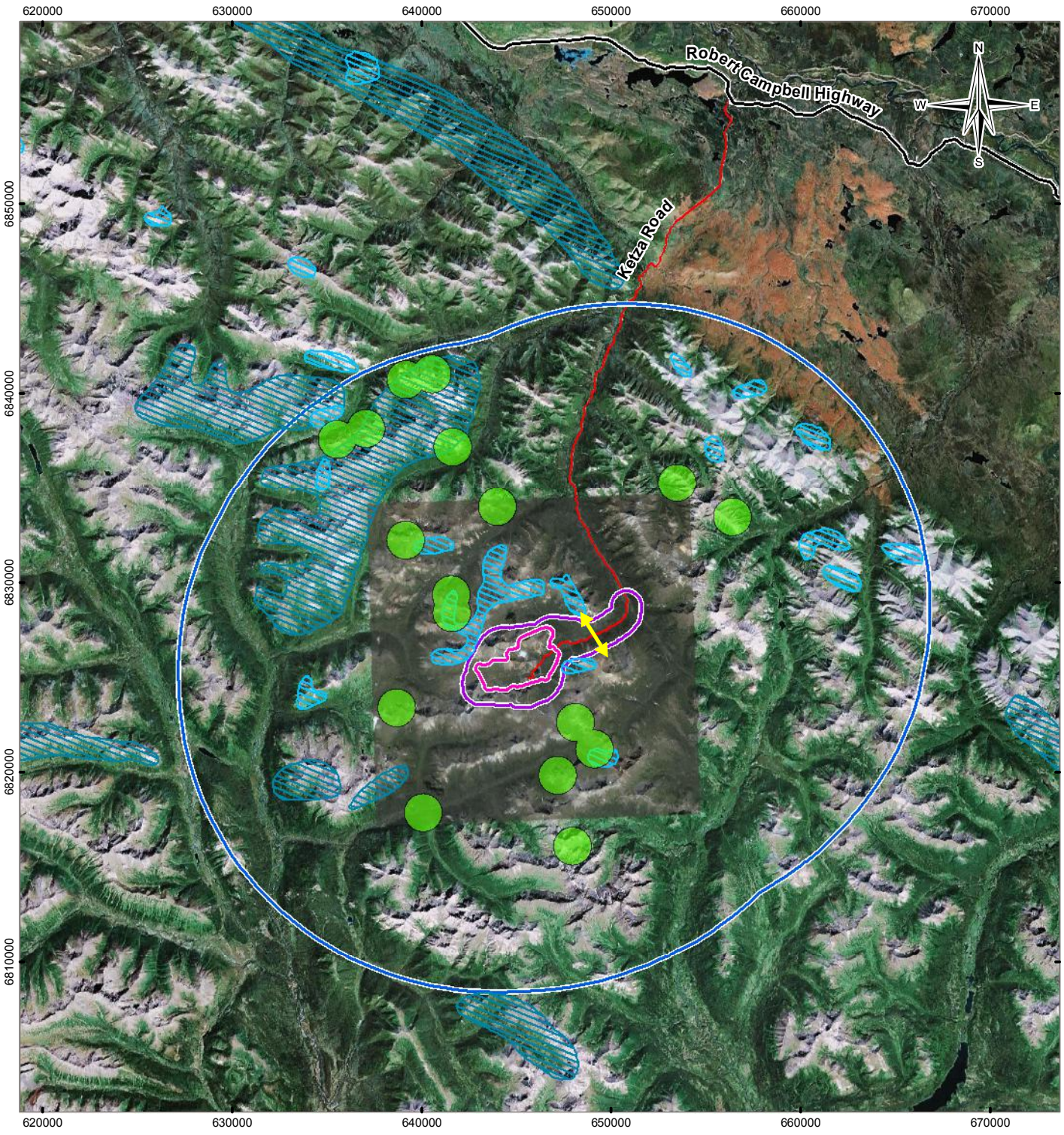
PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	September 13, 2011

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Figure 4.8-8

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LEGEND

- Sheep Distribution[1]
- **Thinhorn Sheep Key Areas**[2]
- Winter Range - Survey Data
- Winter Range - Local Knowledge
- Migration Corridor
- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Distribution based on field survey results (EBA)
2. Wildlife Key Area Inventory (Government of Yukon 2009)
Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Winter Thinhorn Sheep Distribution

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_SheepWinter.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	September 13, 2011

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Figure 4.8-9

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4.8.2.4 Mule Deer (*Odocoileus hemionus*)

Table 4.8-13 describes the conservation status of mule deer.

Table 4.8-13: Conservation Status – Mule Deer

System	Status
Species at Risk Act	Unlisted
COSEWIC	Not Evaluated
Wildlife Act (Yukon)	Specially Protected

Mule Deer are considered to be at their northern-most range in the Yukon, and are designated as a Specially Protected species under the *Wildlife Act* (Yukon). Based on range maps, Mule Deer have the potential to occur within the study area, however their presence has not been confirmed. In the Yukon, Mule Deer are concentrated primarily in areas adjacent to Whitehorse, Carmacks and Ross River (CPAWS 2002). Mule deer occupy habitats characteristic of dry grasslands, aspen stands, white spruce and pine. However, preferred habitats are considered to be limited in the Yukon, including the WRSA (CPAWS 2002). No Mule Deer were observed during the Ketza Wildlife Baseline Program.

4.8.2.5 Grizzly Bear (*Ursus arctos*)

Table 4.8-14 describes the conservation status of grizzly bear.

Table 4.8-14: Conservation Status – Grizzly Bear

System	Status
Species at Risk Act	Unlisted
COSEWIC	Species of Special Concern
Wildlife Act (Yukon)	Not Listed

Population Status

Nationally, Grizzly Bears are listed as a species of Special Concern (COSEWIC 2010), but are not listed under the federal *Species at Risk Act*.

Grizzly Bears are known to occupy the entire Yukon Territory; however, they typically occur at relatively low densities. Approximately 6,000 to 7,000 Grizzly Bears are present within the Yukon, of which, approximately 473 (7 to 8% of the population) are believed to occur within the Pelly Mountain Ecoregion (YG Environment 2007a; Bear Management Team 1997). Grizzly Bear population densities vary throughout their range in relation to topography, cover, food abundance and behaviour (Pasitschniak-Art 1993). Grizzly Bear densities within the Pelly Mountain Ecoregion are estimated at 15 bears per 1,000 km^2 (Bear Management Team 1997).

General Life History and Habitat Requirements

Grizzly Bears occupy a home range that varies in size based on the individual bear (i.e., adult male, adult female with or without cubs), and food quality and quantity. Home ranges may vary from year to year (Miller et al. 1982). Males typically occupy larger home ranges compared to females. The minimum home range size for male grizzly bears in the Yukon averages 1,682 km^2, as compared to 491 km^2 for females

(Bear Management Team 1997). These large home ranges reflect the importance of multiple food sources (Bear Management Team 1997) and plant phenology.

In the Yukon, Grizzly Bears enter winter dens in October, and remain for six to seven months before emerging in late March to May (YG Environment 2007a; EBA 2011b). Grizzly Bear habitat use outside of the denning season is complex, and is a function of many factors including plant phenology and the availability of mammalian prey.

Grizzly Bear habitat selection in the Yukon is summarized by YG Environment (2007a). Grizzly Bears are known to favour alpine areas in June and July, as well as river flood plains in late July, in response to availability of food sources such as grasses, horsetails and soapberries (YG Environment 2007a; Miller et al. 1982). In addition, Grizzly Bears use subalpine areas in August, both alpine and subalpine areas equally in September, and higher elevation habitat types until October prior to denning (Miller et al. 1982). With the onset of winter, Grizzly Bears begin to gain weight during the fall (bear weight either remains stable or is lost during all other seasons) (YG Environment 2007a). Fall feeding periods are therefore critical for the survival and reproductive success of Grizzly Bears in the Yukon.

Dens are commonly located on south and southeast facing slopes at treeline and above, but may occur on any aspect (YG Environment 2007a; Miller et al. 1982; EBA 2011b). In the Mackenzie Mountains, Miller et al. (1982) documented 17 of 22 Grizzly Bear dens in alpine habitat, three in subalpine habitat, and two in white spruce forest habitats (boreal high zone). Similar denning habitat selection is assumed for the study area.

In the Yukon, Grizzly Bears are considered to be an important social and economic resource, and in response, Bear Management Principles have been developed to help conserve populations. These principles focus primarily on harvesting levels, managing sustainable harvests, and conserving populations from negative impacts associated with land use development (Bear Management Team 1997). The Bear Management Principles focus on identifying key Grizzly Bear areas and managing these habitats effectively.

Local Distribution and Habitat Use

The Ketza Road travels through the Boreal-high Bioclimate Zone, which follows the Ketza River. The KRP is located within the Subalpine and Alpine Bioclimatic Zones. Although no WKAs for Grizzly Bears overlap with the WRSA, Grizzly Bears do occur in the KRP. Twelve Grizzly Bears have been observed during the wildlife baseline program (Figure 4.8-10).

At the recommendation of YG Department of Environment, a Grizzly Bear Cumulative Effects Assessment (CEA) model was developed for the KRP, and den emergence surveys were conducted in spring 2011 (EBA 2011c, Appendix F4). As is the case with all modelling efforts, this was an attempt to simulate the effects of a highly complex environment in which cumulative effects of environmental, social and individual variations on habitat use are not well understood. The KRP Grizzly Bear CEA model, while not definitive, does indicate that no cumulative effects are anticipated; and provides information for more effective scheduling of mine activities in space and time to minimize any potential effects on habitat and Grizzly Bear use of that habitat. A complete discussion of the CEA model, results, and conclusions is provided in Appendix F4.

The den emergence study was conducted in April and May, 2011. During three single day surveys, seven Grizzly Bear dens were located within a 6 km radius of the mine footprint. Six of the dens were active during the 2010/2011 denning season and all of the dens were located in either alpine or subalpine habitat. The den emergence surveys are described in further detail in EBA (2011b; Appendix F3). The locations of the dens are show on Figure 4.8-10. One den, which was active in 2010/2011 is located within the mine footprint. However, the denning habitat model, completed as part of the CEA model, indicates that denning habitat is not limited within the WRSA.

4.8.2.6 Black Bear (*Ursus americanus*)

Table 4.8-15 describes the conservation status of black bears.

Table 4.8-15: Conservation Status – Black Bear

System	Status
Species at Risk Act	Unlisted
COSEWIC	Not Evaluated
Wildlife Act (Yukon)	Not Listed

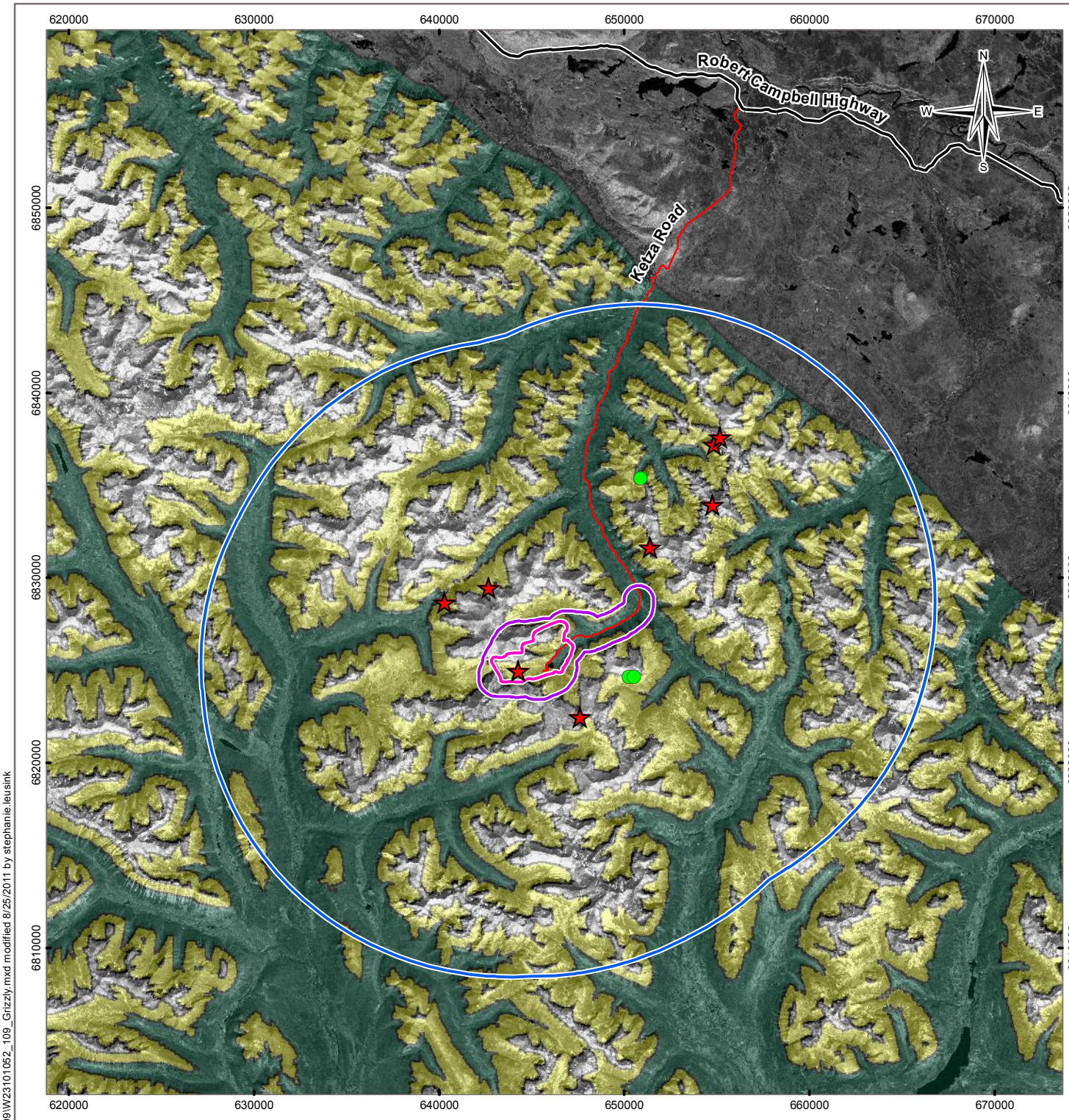
Black Bears occur throughout much of the boreal forests in the Yukon, north to the tree line near Old Crow and they predominately live in forested areas. Because the Yukon is very mountainous, Black Bears are confined to river valleys and other forested habitat, and rarely occur in subalpine and alpine habitats (YG Environment 2011b).

Black Bear habitat quality is based primarily on the abundance of seasonal food. Black Bears will occupy a variety of habitat types in search of food. In the spring, bears feed on early-emerging vegetation in areas such as roadsides and wetlands that are dominated by grasses, sedges, cottongrass, and horsetails. They may also be found at sites that have over-wintered berries. In summer, bears typically consume a variety of vegetation such as grasses, sedges, horsetails, and other forbs. Insect activity peaks during the summer, and Black Bears feed heavily on colonies of ants, bees and wasps. During the fall, their diet shifts as the nutritional quality of many plants decline and berries become ripe.

Disturbed habitats, including burned areas, are known to provide good Black Bear habitat. Bears benefit from sites that have been burned at least 20 years prior (Laviviere 2001). These regenerating sites commonly provide summer and fall forage such as berries and ants in downed and burnt trees. They also benefit from areas with high moose densities and increased calf productivity, which are often associated with burns. Black Bears are omnivores and although their diet consists primarily of vegetation, meat such as winter killed ungulates, ungulate calves, insects and fish, can be locally important.

Black Bears typically dig dens in till material or den in upturned tree roots. Black Bears can be expected to den in the boreal forested habitat within the WRSA. The abundance and habitat potential for Black Bears in LSA is considered to be moderate to low the majority of the habitat within the LSA is alpine and subapline, with few large trees. The majority of suitable habitat is with the valley bottoms adjacent to Ketza River and Cache Creek.

Seven Black Bears were observed in the WRSA during the Wildlife Baseline Program. Six of these observations were made in 2007 by employees of KRH (EBA 2008d, Appendix F1). Most Black Bear observations on site were in forested areas or areas with tall shrubs.



LEGEND

- Den Locations[1]
- **Bear Observations**[1]
  - 2011
- **Bioclimate Zone**
  - Alpine
  - Boreal-High
  - Subalpine
- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Den locations and bear observations based on field survey results (EBA)
Base data source: Yukon Geomatics

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Grizzly Bear Observations and Den Locations

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_Grizzly.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	July 26, 2011

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Figure 4.8-10

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4.8.2.7 Grey Wolf (*Canis lupus*)

Table 4.8-16 describes the conservation status of grey wolves.

Table 4.8-16: Conservation Status – Grey Wolf

System	Status
Species at Risk Act	Unlisted
COSEWIC	Not Evaluated
Wildlife Act (Yukon)	Not Listed

Grey Wolf populations in the Yukon are considered healthy and are estimated at 4000 to 5000 animals. The world-wide population in estimated at 150,000 animals. Wolves inhabit most areas within the Territory, with the exception of the Kluane Icefields. Wolf distribution is linked to prey distribution. Their main prey species are Moose, caribou, and Thinhorn Sheep (YG Environment 2011c).

Like most carnivores, wolves can be sensitive to disturbance, especially during reproduction (Chapman 1977). However, their high productivity and dispersal capabilities translate into a resiliency to sustained levels of moderate human disturbance (Weaver et al. 1996). A wolf control program was conducted between 1983 and 1989 near the KRP to increase the population size of the Finlayson Woodland Caribou Herd. During this time, approximately 85% of the local wolf population was removed (Larsen and Ward 1995).

The WRSA does provide habitat and suitable prey for wolves. Wolves have been observed in the WRSA on multiple occasions, as indicated by the survey data summarized in Table 4.8-17. During the early winter geospatial Moose survey, conducted in November, 2010, a pack of wolves were observed feeding on a Moose calf.

Table 4.8-17: Grey Wolf Observations, Ketza Wildlife Baseline Program (2007 – 2011)

Year	Number of Wolf Observations
2007	7
2008	0
2010	5
2011	2

Source: [1]EBA 2007 [2] EBA 2011a [3] EBA 2011b

4.8.2.8 Wolverine (*Gulo gulo*)

Table 4.8-18 describes the conservation status of wolverines.

Table 4.8-18: Conservation Status – Wolverine

System	Status
Species at Risk Act	Unlisted
COSEWIC	Special Concern
Wildlife Act (Yukon)	Not Listed

Nationally, the wolverine is listed as a species of Special Concern by COSEWIC (2010); however, they have not been designated under SARA.

Population Status and Regional Harvest Data

The population of Wolverines in the Yukon is unknown; the highest Wolverine density was estimated at 1 wolverine/180 km^2 in the southwestern Yukon (YG Environment 2007a). Wolverines live at naturally low population densities and have large home ranges to exploit sufficient and diverse food resources. Male Wolverine home ranges vary in size from 300 – 500 km^2; whereas, female home ranges vary from 100 – 350 km^2 (YG Environment 2007a).

General Life History and Habitat Requirements

In the Yukon, Wolverines occur in all habitat types, including forests, forested valleys, subalpine, alpine and arctic tundra; however, they are most abundant in mountainous regions that include a multitude of habitat types (YG Environment 2007a). Wolverines predominantly rely on scavenged food items throughout their home range, including remains from wolf kills (Pasitschniak-Arts and Larivière 1995). This scavenging lifestyle also dictates large seasonal movements (Pasitschniak-Arts and Larivière 1995). Wolverines are active throughout the year, predominantly at night; however, some day-time activity is common for this species (Pasitschniak-Arts and Larivière 1995).

In general, Wolverines are thought to use higher elevations in the summer (Subalpine and Alpine Bioclimate Zones), and lower elevations in the winter (Boreal-high Bioclimate Zone) (Pasitschniak-Arts and Larivière 1995). Small mammals (including voles, marmots and ground squirrels), caribou calves, sheep lambs, roots, berries and insects are eaten when available (YG Environment 2007a; Pasitschniak-Arts and Larivière 1995). Wolverine predation on Moose and Caribou has also been documented; however, it is believed predation of large ungulates is rare and is thought to occur principally under deep snow conditions that hinder ungulate movement (Pasitschniak-Arts and Larivière 1995).

Natal dens are constructed by pregnant females, often in the snow, to give birth and continue to be used during lactation (Pasitschniak-Arts and Larivière 1995). Birthing typically can occur from January to April; however, most give birth before late March (Pasitschniak-Arts and Larivière 1995).

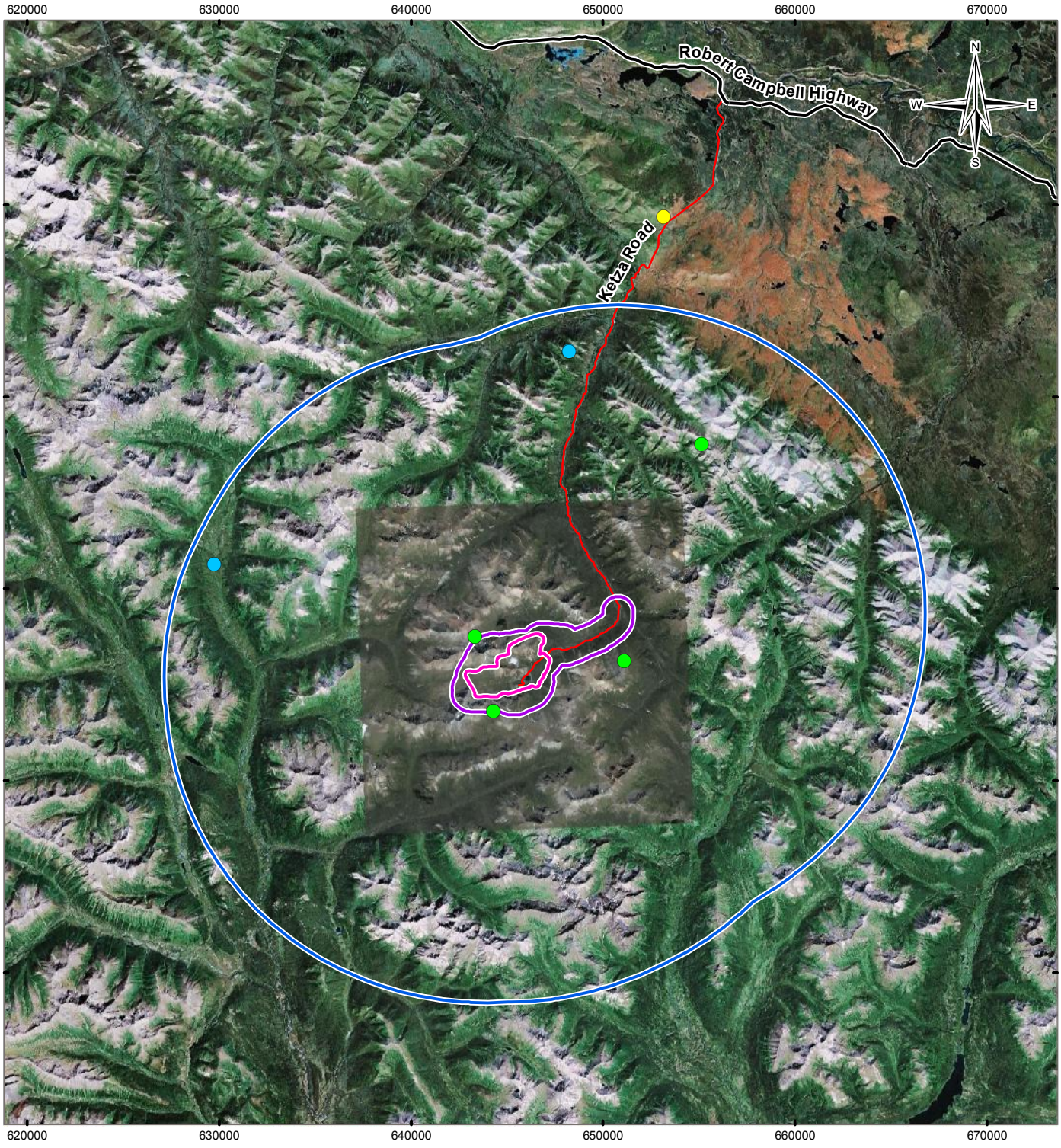
Wolverines have a naturally low reproductive potential, and appear sensitive to human developments, particularly during denning periods (Weaver 2001). As a result, diversity of food items and availability of ungulate carrion are critical in the distribution, survival and reproductive success of this species (Weaver 2001).

Local Distribution and Habitat Use

Based on known information and observations made during aerial baseline surveys, Wolverines occur, and natal dens have been observed within the WRSA year round. Nine Wolverines observations were made in the WRSA during the Wildlife Baseline Program between 2007 and 2011 (Appendix F; Table 4.8-19), and one Wolverine observation was made by KRH employees. The distribution of Wolverine observations is shown on Figure 4.8-11.

Table 4.8-19: Wolverine Observations, Ketza Wildlife Baseline Program (2007 – 2011)

Year	Number of Wolverine Observations
2007	1 and sign
2008	1
2010	2 and sign
2011	5 and sign
Total	**9**



LEGEND

Wolverine Observations[1]

- 2008
- 2010
- 2011

- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Wolverine observations based on field survey results (EBA)
Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Wolverine Observations

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:300,000
4 2 0 4 8
Kilometres

FILE NO. W23101052_109_Wolverine.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.109	SL	SB	LM	0

OFFICE	DATE
EBA-VANC	July 26, 2011

eba A TETRA TECH COMPANY

Figure 4.8-11

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4.8.2.9 Small Mammals

Small mammals are a large and diverse group of species, with varying life histories and habitat requirements, making generalization difficult. For this report, small mammals include commercial furbearing species such as the Beaver, Muskrat, Fox, Marten and Lynx, as well as other less well known non-game species such as bats, shrews, voles and ground squirrels.

General Life History and Habitat Requirements

Small mammals are likely to occur in all habitat types within the WRSA including the alpine, subalpine and boreal high biogeoclimatic zones. Species occupancy of these Bioclimate Zones depends on food resources, protective cover, predators, climate and permafrost.

Small mammals are vital components in the health of natural ecological systems. Species such as voles, lemmings, Snowshoe Hares, ground squirrels and Hoary Marmots are important prey species for a number of larger predators including Grizzly Bears, Lynx, and raptors, and 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, Lynx and Snowshoe Hare are harvested and considered important economic species. These commercial species are expected to occur throughout most of the boreal high biogeoclimatic zone within the WRSA.

Population Status and Regional Harvest Data

Population densities for small mammals in the Yukon are relatively unknown. A total of 39 species occur, or have the potential to occur, in the WRSA. These species are listed in Table 4.8-2.

Although no surveys targeting small mammal were conducted as part of the Ketza Wildlife Baseline Program, the following species have been observed within the WRSA: Red Fox, Hoary Marmot, Arctic Ground Squirrel, Red Squirrel, Porcupine, and Pine Marten. Some of these species were observed during the winter track surveys conducted in 2008 (EBA 2008d; EBA 2011a; EBA 2011b; Appendices F1 to F3, respectively).

As previously mentioned, several small mammals are harvested in the Yukon. Specific harvest levels within the study area are relatively unknown. Harvest data from the Ross River area (registered trapping concession #405) indicated that over 36, 000 small mammals were harvested from the Ross River area between 1980 and 2006 (YG unpublished data). Table 4.8-20 summarizes the small mammal harvest data.

Table 4.8-20: Summary of Small Mammal Harvest Data, Ross River Area (1980 – 2006)

Species	Total Number Harvested	Species	Total Number Harvested
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

Source: YG 2006 Unpublished Data

4.8.3 Birds

Table 4.8-21 lists the birds that occur, or have the potential to occur, in the WRSA.

Table 4.8-21: Birds That Occur, or Have the Potential to Occur, in the Wildlife Regional Study Area

Common Name	Scientific Name
Waterfowl and Water Birds	
Red-throated Loon	*Gavia stellate*
Pacific Loon	*Gavia pacifica*
Common Loon	*Gavia immer*
Horned Grebe	*Podiceps auritus*
Red-necked Grebe	*Podiceps grisegena*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Canada Goose	*Branta canadensis*
Trumpeter Swan	*Cygnus buccinator*
Tundra Swan	*Cygnus columbianus*
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Harlequin Duck	*Histrionicus histrionicus*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Long-tailed Duck	*Clangula hyemalis*
Bufflehead	*Bucephala albeola*
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Ruddy Duck	*Oxyura jamaicensis*
Sora	*Porzana carolina*
American Coot	*Fulica americana*
Sandhill Crane	*Grus canadensis*

Table 4.8-21: Birds That Occur, or Have the Potential to Occur, in the Wildlife Regional Study Area

Common Name	Scientific Name
Black-bellied Plover	*Pluvialis squatarola*
American Golden-Plover	*Pluvialis dominica*
Semipalmated Plover*	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Wandering Tattler*	*Tringa incana*
Spotted Sandpiper*	*Actitis macularia*
Whimbrel	*Numenius phaeopus*
Hudsonian Godwit	*Limosa haemastica*
Sanderling	*Calidris alba*
Semipalmated Sandpiper	*Calidris pusilla*
Western Sandpiper	*Calidris mauri*
Least Sandpiper*	*Calidris minutilla*
Baird's Sandpiper	*Calidris bairdii*
Pectoral Sandpiper	*Calidris melanotos*
Upland Sandpiper	*Bartramia longicauda*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Common Snipe	*Gallinago gallinago*
Wilson's Snipe*	*Gallinago delicata*
Red-necked Phalarope	*Phalaropus lobatus*
Red Phalarope	*Phalaropus fulicarius*
Bonaparte's Gull	*Larus philadelphia*
Mew Gull	*Larus canus*
Herring Gull	*Larus argentatus*
Glaucous Gull	*Larus hyperboreus*
Arctic Tern	*Sterna paradisaea*
Raptors	
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Northern Harrier*	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Northern Goshawk*	*Accipiter gentilis*
Red-tailed Hawk	*Buteo jamaicensis*
Rough-legged Hawk*	*Buteo lagopus*
Golden Eagle*	*Aquila chrysaetos*
American Kestrel*	*Falco sparverius*
Merlin	*Falco columbarius*

Table 4.8-21: Birds That Occur, or Have the Potential to Occur, in the Wildlife Regional Study Area

Common Name	Scientific Name
Gyrfalcon*	*Falco rusticolus*
Peregrine Falcon	*Falco peregrinus anatum/tundrius*
Great Horned Owl	*Bubo virginianus*
Snowy Owl	*Bubo scandiacus*
Northern Hawk Owl*	*Surnia ulula*
Great Gray Owl	*Strix nebulosa*
Short-eared Owl	*Asio flammeus*
Boreal Owl	*Aegolius funereus*
Upland Birds	
Ruffed Grouse	*Bonasa umbellus*
Spruce Grouse	*Falcipennis canadensis*
Willow Ptarmigan*	*Lagopus lagopus*
Rock Ptarmigan*	*Lagopus mutus*
White-tailed Ptarmigan	*Lagopus leucura*
Blue Grouse*	*Dendragapus obscurus*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Passerines	
Rock Dove	*Columba livia*
Mourning Dove	*Zenaida macroura*
Common Nighthawk	*Chordeiles minor*
Rufous Hummingbird	*Selasphorus rufus*
Belted Kingfisher	*Ceryle alcyon*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
American Three-toed Woodpecker	*Picoides dorsalis*
Black-backed Woodpecker	*Picoides arcticus*
Northern Flicker*	*Colaptes auratus*
Pileated Woodpecker	*Drycopus pileatus*
Olive-sided Flycatcher*	*Contopus cooperi*
Western Wood-Pewee	*Contopus sordidulus*
Alder Flycatcher*	*Empidonax alnorum*
Least Flycatcher*	*Empidonax minimus*
Hammond's Flycatcher	*Empidonax hammondii*
Say's Phoebe*	*Sayornis saya*
Northern Shrike	*Lanius excubitor*
Warbling Vireo	*Vireo gilvus*
Gray Jay*	*Perisoreus canadensis*
Black-billed Magpie	*Pica hudsonica*

Table 4.8-21: Birds That Occur, or Have the Potential to Occur, in the Wildlife Regional Study Area

Common Name	Scientific Name
Common Raven*	*Corvus corax*
Horned Lark*	*Eremophila alpestris*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Bank Swallow	*Riparia riparia*
Cliff Swallow*	*Petrochelidon (Hirundo) phyrrhonota*
Barn Swallow	*Hirundo rustica*
Black-capped Chickadee*	*Poecile atricapilla*
Boreal Chickadee*	*Poecile hudsonica*
Red-breasted Nuthatch	*Sitta canadensis*
American Dipper	*Cinclus mexicanus*
Ruby-crowned Kinglet*	*Regulus calendula*
Mountain Bluebird	*Sialia currucoides*
Townsend's Solitaire*	*Myadestes townsendi*
Gray-cheeked Thrush*	*Catharus minimus*
Swainson's Thrush*	*Catharus ustulatus*
Hermit Thrush*	*Catharus guttatus*
American Robin*	*Turdus migratorius*
Varied Thrush*	*Ixoreus naevius*
American Pipit*	*Anthus rubescens*
Bohemian Waxwing	*Bombycilla garrulus*
Tennessee Warbler*	*Vermivora peregrina*
Orange-crowned Warbler*	*Vermivora celata*
Yellow Warbler	*Dendroica petechia*
Yellow-rumped Warbler*	*Dendroica coronata*
Townsend's Warbler	*Dendroica townsendi*
Blackpoll Warbler*	*Dendroica striata*
Northern Waterthrush*	*Seiurus noveboracensis*
Common Yellowthroat*	*Geothlypis trichas*
Wilson's Warbler*	*Wilsonia pusilla*
Western Tanager	*Prianga ludoviciana*
American Tree Sparrow*	*Spizella arborea*
Chipping Sparrow*	*Spizella passerina*
Savannah Sparrow*	*Passerculus sandwichensis*
Fox Sparrow*	*Passerella iliaca*
Lincoln's Sparrow*	*Melospiza lincolnii*
White-crowned Sparrow*	*Zonotrichia leucophrys*
Golden-crowned Sparrow*	*Zonotrichia atricapilla*

Table 4.8-21: Birds That Occur, or Have the Potential to Occur, in the Wildlife Regional Study Area

Common Name	Scientific Name
Dark-eyed Junco*	*Junco hyemalis*
Lapland Longspur	*Calcarius lapponicus*
Snow Bunting	*Plectrophenax nivalis*
Red-winged Blackbird	*Agelaius phoeniceus*
Rusty Blackbird	*Euphagus carolinus*
Brown-headed Cowbird	*Molothrus ater*
Gray-crowned Rosy Finch*	*Leucosticte tephrocotis*
Pine Grosbeak	*Pinicola enucleator*
Purple Finch*	*Carpodacus purpureus*
Red Crossbill	*Loxia curvirostra*
White-winged Crossbill	*Loxia leucoptera*
Common Redpoll*	*Carduelis flammea*
Hoary Redpoll	*Carduelis hornemanni*
Pine Siskin	*Carduelis pinus*
Evening Grosbeak	*Coccothraustes vespertinus*

*Species observed in the study area by EBA during the Ketza Wildlife Baseline Programs 2007-2011

Source: YG Environment 2003

4.8.3.1 Waterfowl and Water Birds

Table 4.8-22 identifies waterfowl and water birds of conservation concern.

Table 4.8-22: Waterfowl and Water Birds of Conservation Concern

Species	*Species at Risk Act*	COSEWIC	*Wildlife Act* (Yukon)
Horned Grebe	No Status	Special Concern	Not Listed
Harlequin Duck	Special Concern	Special Concern	Not Listed
Barrow's Goldeneye	Special Concern	Special Concern	Not Listed

The term "waterfowl" is used in a general sense. Waterfowl typically refers to swans, geese and ducks (Anseriformes) and species within this order are grouped together and treated collectively. This section also includes loons (Galviformes), and grebes (Podicipediformes). Water Birds include rails and cranes (Gruiformes), and shorebirds, gulls and terns (Charadaformes).

A total of 62 waterfowl and water bird species occur, or have the potential to occur, in the WRSA during spring, summer and fall (YG Environment 2003). Five of these species have been observed in the WRSA during the Wildlife Baseline Program (Table 4.8-21 and Table 4.8-22). Alexander et al. (2003) reported that the Yukon "makes a very substantial contribution to the waterfowl resources of North America".

The occurrence and abundance of waterfowl varies throughout the spring, summer and fall periods. In the spring, waterfowl migrate throughout the Yukon and can be observed in relatively large numbers prior to departing for breeding territories. In the summer months, smaller numbers of waterfowl are observed on nesting territories. By fall, waterfowl congregate, forming rafts on staging ponds and lakes, prior to departing to the wintering grounds.

The first Trumpeter Swans are observed as early as March; however, peak waterfowl spring migration occurs from April to early May (Alexander et al. 2003). By the end of May, many waterfowl pairs have bonded and are incubating eggs (Alexander et al. 2003). By July, males collect into post-nuptial molting groups or "molting rafts" prior to fall migration (Alexander et al. 2003). Waterfowl are commonly observed in southern Yukon until late September to October; however, a few remain at open water areas until November (Alexander et al. 2003). Some Common Goldeneyes and Common Mergansers may over-winter in areas where water remains open (Alexander et al. 2003).

Waterfowl occur most often in wetlands, ponds and lakes, and in rivers and streams in the valley bottoms located in the boreal-high Bioclimate Zone. Waterfowl may also occur at higher elevation lakes and ponds; however, lake productivity at such elevations is typically lower than in the valley bottoms.

A number of waterfowl were reported by Rand (1946) within marshy lakes that lie within the Pelly River Valley, including Horned Grebes, Mallards, Green-winged Teal, Pintail, American Wigeon, Northern Shoveler and Lesser Scaup. These species are assumed to commonly occur within the WRSA wherever appropriate habitat exists. Wetland and lake habitat does not exist within the LSA, with the exception of the existing Canamax TSF. However, no waterfowl have been documented using this TSF.

Early migrant shorebirds, such as gulls, begin arriving in the Yukon in April, but peak migration occurs during the first three weeks of May (Alexander et al. 2003). Egg laying and fledging occurs in June, and by the end of July many of the adults begin gathering at rich feeding areas (staging areas) prior to fall migration in August and September (Alexander et al. 2003). However, a few shorebirds lag behind and can still be observed in southern Yukon in early October prior to freeze up.

Shorebirds are found in or near mudflats, streams / rivers, flood zones, wetlands, ponds and lake margins. These habitats occur most commonly in the valley bottoms of the Boreal-high Bioclimate Zone.

Lesser Yellowlegs, Mew Gulls and Bonaparte Gulls were common at marshy lakes within the Pelly River Valley (Rand 1946). This report also noted that Spotted Sandpipers were commonly observed in the Yukon. These species are assumed to commonly occur within the WRSA wherever appropriate habitat exists. At Macmillan Pass in the Mackenzie Mountains, shorebirds constituted 15% of the total bird species composition during breeding bird surveys conducted in 1972 and 1982 (AMAX 1983). Shorebirds were considered evenly distributed throughout the ponds and sedge meadow wetlands in the MacTung area, primarily in the boreal high valley habitats (AMAX 1983). Least Sandpiper and Wilson's Snipe were documented in the WRSA during the Wildlife Baseline Program.

4.8.3.2 Raptors

Table 4.8-23 lists the raptors of conservation concern.

Table 4.8-23: Raptors of Conservation Concern

Species	*Species at Risk Act*	COSEWIC	*Wildlife Act* (Yukon)
Short-eared Owl	Special Concern	Special Concern	Specially Protected
Peregrine Falcon (*anatum* subspecies)	Threatened	Special Concern	Specially Protected
Gyrfalcon	Not Listed	Not at Risk	Specially Protected

A total of 18 raptor species (osprey, eagles, hawks, falcons and owls) occur, or have the potential to occur, within the WRSA (Table 4.8-21); of these the Peregrine Falcon, Gyrfalcon and the Short-eared Owl have special conservation status (Table 4.8-22). All birds of prey are considered to be Specially Protected under the *Wildlife Act* (Yukon).

Many of the raptors occurring in the Yukon are migratory. Golden Eagles begin to arrive in the Yukon as early as March; however, many of the hawks and eagles arrive in April (Alexander et al. 2003). Fall migration for many of the raptors occurs from late August to November but some species leave later in the season, such as the Bald Eagle, who may be observed as late as December in areas with open water.

Other species, such as the Gyrfalcon, Northern Goshawk, Boreal Owl, Great Grey Owl, Great Horned Owl and Northern Hawk Owl commonly over-winter within the Yukon. In addition, there are approximately 20 records of Golden Eagles over-wintering in southern Yukon, including a record near the study area. Rare occurrences of other raptor species over-wintering in southern Yukon have also been documented, including the Short-eared Owl, depending on food availability (Alexander et al. 2003).

Rand (1946) reported Northern Goshawk, Great Horned Owl and Northern Hawk Owl were fairly common and widespread in the forests along the Canol Trail, north of the KRP. These species are assumed to be fairly common in the Boreal-high Bioclimate Zone within the WRSA, as well as Bald Eagles and Boreal Owls. Infrequent observations of other raptor species such as Red-tailed Hawks, Sharp-shinned Hawks and American Kestrels are expected to occur within the forested boreal high zone. In addition, Peregrine Falcon, Gyrfalcon and Golden Eagles may be observed in the high boreal habitats along steep cliffs along major rivers. Cliff habitat high above the Ketza River does exist.

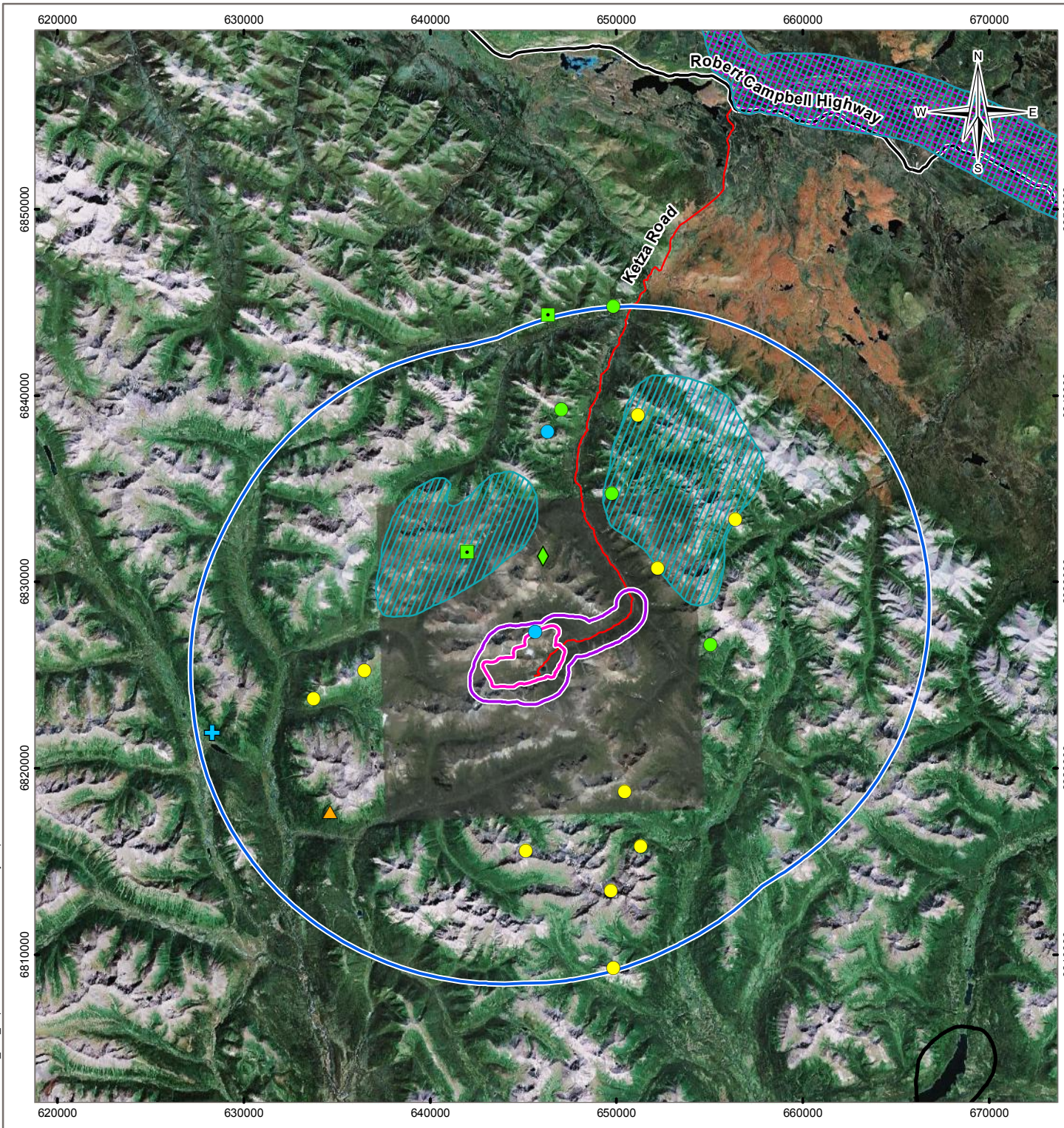
Species expected to occur in alpine and subalpine habitats include Short-eared Owls, Golden Eagles, Peregrine Falcons, Rough-legged Hawks and Gyrfalcons. In addition, the American Kestrel and Merlin may also be observed nesting in the subalpine and hunting in alpine habitats (Alexander et al. 2003).

Raptors that have been observed in the area include Gyrfalcon, American Kestrel, Golden Eagle, Northern Hawk Owl, Northern Harrier, Northern Goshawk, and Rough-legged Hawk. These observations are shown in Figure 4.8-12.

Golden Eagle (*Aquila chrysaetos*)

Two WKAs for Golden Eagle summer nesting habitat have been identified within the WRSA: one in the northwest corner of the KRH Claim Block near Cloutier Creek (approximately 5 km northwest of the Site), and the second approximately 7 km northeast of the Site (outside the Ketza River Claim Block) (Figure 4.8-12;(YG Environment 2010b). Two other WKAs for Golden Eagle summer / nesting ranges are known to occur near Rader Lake (approximately 100 km northeast of the KRP), and along the Pelly River (approximately 10 km northeast of the study area) (YG Environment 2010b).

Golden Eagles arrive in southern Yukon anywhere between early to late March (if not over-wintered) and depart to wintering grounds by late September or October (Alexander et al. 2003). It is assumed some Golden Eagles may remain throughout the winter during high Snowshoe Hare densities (Alexander et al. 2003).



LEGEND

Raptor Species[1]

- B-Raptor sp.
- Golden Eagle
- Northern Goshawk
- Northern Hawk Owl
- Rough-legged Hawk

Observation Year[1]

- 2007
- 2008
- 2010
- 2011

Raptor Key Areas (summer nesting)[2]

- Peregrine Falcon
- Golden Eagle
- Unspecified Raptor
- Project Footprint
- Local Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway

NOTES
1. Raptor observations based on field survey results (EBA)
2. Wildlife Key Area Inventory (Government of Yukon 2009)
Base imagery: Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Raptor Observations

PROJECTION UTM Zone 8				**DATUM** NAD27	**CLIENT** Ketza River Holdings
Scale: 1:300,000 — 4 2 0 4 8 — Kilometres					
FILE NO. W23101052_109_Raptor.mxd					eba A TETRA TECH COMPANY
PROJECT NO. W23101052.109	**DWN** SL	**CKD** SB	**APVD** LM	**REV** 0	**Figure 4.8-12**
OFFICE EBA-VANC	**DATE** July 26, 2011				

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Primary habitats for nesting and foraging include alpine and subalpine zones (Kochert et al. 2002). Golden Eagles typically nest on south facing cliff ledges, which are commonly re-used for many decades; however, a report of a tree nest has been reported near Ross River (Alexander et al. 2003). Nesting densities of Golden Eagles vary throughout the Yukon and are influenced by prey density and nesting habitat availability. Estimated densities in the Selwyn Mountains were one active nest per 392 km^2 (Alexander et al. 2003). Based on the Yukon Raptor Population Monitoring Database, Golden Eagles occupying territories in southern Yukon lay eggs in May (Alexander et al. 2003). Eggs are hatched in the first week of June, and the young remain in the nest until sometime after early August (Alexander et al. 2003).

Golden Eagles are sensitive to human disturbances during the nesting and breeding season (approximately April to late August). The Ketza Road travels approximately 1 km from the nearest known Golden Eagle WKA (YG Environment 2010b). Golden Eagles may use the road for hunting. Golden Eagles have been observed (n=28) and nests have been identified within the WRSA. These observations are described in further detail in EBA (2008d), EBA (2011a) and EBA (2011b) which are included in Appendix F.

Peregrine Falcon (*anatum*)

Peregrine Falcons (*anatum* subspecies) are listed as Threatened under SARA Schedule I, and are Specially Protected under the *Wildlife Act* (Yukon).

Monitoring and recovery programs of Peregrine Falcons (*anatum* subspecies) have occurred in the Yukon, including a local captive breeding program in the Yukon River area. However, no surveys or monitoring programs have occurred within the WRSA.

Peregrine Falcons commonly arrive in the Yukon in April; by mid-October most of the Peregrine Falcons have left for their wintering grounds (Alexander et al. 2003). Peregrines have two main habitat requirements: nesting sites, which are commonly located along cliff ledges typically near water; and access to prey species. Nesting territories, which are actively guarded, can extend up to 1 km from the nest. Their home range overlaps the nesting range and can extend up to 27 km from the nest. Peregrines mainly hunt other birds in the air; so open landscapes such as grasslands, alpine tundra and waterways are important hunting areas. In addition to natural nesting substrates, Peregrine Falcons have been known to nest on man-made structures such as buildings.

Known Peregrine Falcon nesting sites have been documented within the Peel ecoregion, and historically Peregrine Falcons were known to nest within the Southern Lakes ecoregion, south of the study area (CPAWS 2002). Rand (1946) reported Peregrine Falcons were observed along the Pelly and Macmillan Rivers in the Yukon. In addition, key Peregrine Falcon areas have been identified along the Pelly River, approximately 10 km northeast of the WRSA. Peregrine Falcons may use areas designated as WKAs for Golden Eagle as nesting habitat for both species is similar (Figure 4.8-12).

Although no Peregrine Falcons have been observed and no nest sites have been documented within the WRSA, nesting may occur as suitable nesting and feeding habitat exists throughout the WRSA.

A recovery plan for Peregrine Falcons was developed by the Canadian Wildlife Service in 1988. The mandate of the Peregrine Falcon Recovery Plan was to reintroduce or increase the wild populations to self-sustaining levels and eventually remove the species from the endangered list. In 1999, the Peregrine Falcon (*anatum*) was down-listed from endangered to threatened status (COSEWIC 2010). Recovery of Peregrine Falcon populations in the Yukon has met the Recovery Plan objectives (YG Environment 2007b).

Gyrfalcon (*Falco rusticolus*)

Gyrfalcons are considered Secure by COSEWIC, but are Specially Protected under the *Wildlife Act* (Yukon).

Gyrfalcons are year round residents to the Yukon; however, southern migrations may occur if prey populations (particularly ptarmigan) are low. Primary prey of Gyrfalcons includes ptarmigan, waterfowl, other birds including passerines, and some small mammals (Clum and Cade 1994).

Gyrfalcons are associated with arctic and alpine tundra (Alpine Bioclimate Zone), and commonly occupy territories that are close to rivers (Clum and Cade 1994). Known breeding habitat in mountainous terrain in the Richardson and Mackenzie Mountains commonly includes alpine habitat above timberline (Clum and Cade 1994). Breeding habitat may occur in the Alpine Bioclimate Zone throughout the entire study area, particularly in areas designated as Golden Eagle WKAs by the YG Department of Environment (Figure 4.8-12).

Breeding and wintering territories are centered on nest sites or scrapes. Favoured scrape sites include cliff ledges with overhangs. Gyrfalcons will use abandoned stick nests of Golden Eagles, Rough-legged Hawk or Common Raven (Alexander et al. 2003). Winter ranges for resident Gyrfalcons are the same as the breeding ranges (Clum and Cade 1994; Alexander et al. 2003).

Breeding densities of Gyrfalcons have been estimated for the North Slope, central Yukon, Coast Mountains, and along the Yukon – Northwest Territories border. Breeding densities along the eastern Territorial border were 0.6 pairs per 1,000 km^2 (lowest) and 1-4 pairs per 1,000 km^2 in the Coast Mountains (Alexander et al. 2003).

Nest / scrape sites can be occupied most of the year. In the Yukon, unpaired birds were reported to occupy nests / scrapes in January, and pairs have been recorded at nest/scrape sites as early as February (Clum and Cade 1994). Egg-laying occurs from April 3 – 28 in the Yukon, and hatching occurs 34 to 36 days later (Alexander et al. 2003). Chicks fledge 45 to 50 days after hatch and are independent approximately 4 weeks following fledging (Clum and Cade 1994).

Gyrfalcon may use WKAs for Golden Eagle and Peregrine Falcon, and have similar nesting habitat requirements (Figure 4.8-12). A Gyrfalcon has been observed in the WRSA, but no nesting sites have been documented (EBA 2011b).

Short-eared Owl (*Asio flammeus*)

Short-eared Owl is designated as a species of Special Concern and is listed under SARA Schedule III. A re-assessment of this species' status must be completed by COSEWIC to ascertain the level of protection afforded under SARA. Following a re-assessment, a management plan may become legislated to protect the Short-eared Owl.

Short-eared Owls are associated with open habitats such as tundra, alpine tundra, open wetland and meadow habitats (Alexander et al. 2003; Wiggins et al. 2006). Subalpine shrub habitats are commonly used for hunting (Alexander et al. 2003). Breeding has been confirmed in the northern and central portions of Yukon (Alexander et al. 2003); and evidence of breeding was reported by AMAX (1983) in the MacTung area.

Short-eared Owls are commonly observed in southern Yukon in April, and the last observations are commonly in late October to November, although migrant Short-eared Owls may be seen throughout the entire Yukon (Alexander et al. 2003). To date, Short-eared Owls have not been recorded within WRSA.

4.8.3.3 Upland Birds

Upland birds include grouse, ptarmigan and pheasants. Seven upland bird species (Ruffed, Spruce, Blue and Sharp-tailed Grouse, and Willow, Rock, and White-tailed Ptarmigan) occur, or have the potential to occur, in the WRSA (Table 4.8-21). None of these species are of conservation concern. Species observed in the WRSA are Willow Ptarmigan, Rock Ptarmigan and Blue Grouse.

Ptarmigan have been regularly observed in the subalpine and alpine habitat within the WRSA. Grouse typically occupy more forested habitat, and have been documented in boreal high forested habitats within the LSA (EBA 2008d, Appendix F1).

4.8.3.4 Passerines

Table 4.8-24 lists the passerines of conservation concern.

Table 4.8-24: Passerines of Conservation Concern

Species	*Species at Risk Act*	COSEWIC	*Wildlife Act* (Yukon)
Olive-sided Flycatcher	Schedule 1	Threatened	Not Listed
Common Nighthawk	Schedule 1	Threatened	Not Listed
Rusty Blackbird	Schedule 1	Special Concern	Not Listed
Savannah Sparrow (*princeps* subspecies)	Schedule 1	Special Concern	Not Listed

A total of 74 passerine species (including the common raven) occur, or have the potential to occur, in the WRSA (Table 4.8-21). Most of these passerine species are migrants, and reside in the area during breeding. Within the WRSA, 38 passerines have been observed during the Wildlife Baseline Program, most of which were documented during the breeding bird survey conducted in June 2007 (EBA 2008d) and August 2008 (EBA 2011b). Both of these reports are included in Appendix F.

Early migrant passerines, such as Mountain Bluebirds, American Tree Sparrows, White-crowned Sparrows and Yellow-rumped Warblers arrive approximately in late April; however, the majority of passerines, including most warblers, arrive in May (Alexander et al. 2003). Late migrant passerines such as the Chipping Sparrow and Alder Flycatcher arrive in early June (Alexander et al. 2003). By early June, many of the passerine species are incubating eggs; or some of the eggs have already hatched and the adults are actively collecting food. Fall migration typically peaks in August for many passerine species; however, a few remain until September (some species remain longer if they can exploit available bird feeders). A few passerines, such as the Boreal Chickadee and Hoary Redpoll, remain throughout the winter in southern Yukon.

Passerines occur throughout all terrestrial habitat types in the WRSA from forested valleys to rocky slopes of the mountains. At Macmillan Pass in the Mackenzie Mountains, east of the WRSA, birds within the Emberizidae family (Sparrows, Lapland Longspurs, Snow Buntings and Dark-eyed Juncos) comprised over 42% of the total species composition in studies by AMAX (1983).

Passerines are a large and diverse group of birds, and each species has different foraging, nesting and habitat requirements, making generalization difficult. For ease of presentation, passerines are discussed based on favoured broad Bioclimate Zones. Three Bioclimate Zones occur within the WRSA: Alpine, Subalpine and Boreal-high. A number of factors affect the presence, diversity and abundance of bird species in each of these Bioclimate Zones, including food resources, competition with other birds, habitat heterogeneity/vegetation diversity and weather (Er 2001; Sabo and Homes 1983). However, some species are associated with specific communities that can occur in all three zones. For example, the White-crowned Sparrow is associated with open habitats (e.g., open shrub, open forests, alpine tundra and river / lake edges) that occur in boreal high, subalpine and alpine zones (Alexander et al. 2003).

Species commonly occurring in alpine zones are characterized as ground nesters and feeders. These species construct nests on barren, rocky-sloped, vegetated terrain and near snow fields. Some passerine species common to alpine zones include the Lapland Longspur, Snow Bunting, Wandering Tattler and Grey-crowned Rosy Finch (Rand 1946). However, habitat selection within alpine zones varies with each species. For example, Snow Buntings favour exposed rock areas, while Lapland Longspurs favour alpine meadows, and Wandering Tattlers prefer gravel areas along creeks, rivers and lakes above the treeline (Hussell and Montgomerie 2002; Gill et al. 2002; and Alexander et al. 2003).

Subalpine Bioclimate Zones comprise a transition zone between the boreal high valley and the alpine tundra zones. These habitats are dominated by shrubs and pockets of stunted spruce and fir trees. Passerines commonly observed at the treeline include the Tree Sparrow and Golden-crowned Sparrow (Rand 1946; Alexander et al. 2003). These species commonly occur at or above the treeline where open shrub, open tree, and/or krummholz vegetation layers exist (Alexander et al. 2003). Most other species occurring in subalpine zones can also be found in appropriate habitats within the Boreal-high Bioclimate Zone.

The Boreal-high Bioclimate Zone, prevalent in the high valley systems within the WRSA, includes heterogeneous habitats such as riparian, closed forest and open forests. This diversity within the Bioclimate Zone provides for a diverse assemblage of bird species. Birds that favour wetland, shrubby, treed and edge habitats can be found within boreal high zones within the study area. For instance, species associated with riparian willow habitats in the boreal high zone include Blackpoll Warbler, Northern Waterthrush, Yellow Warbler and Wilson's Warbler (Alexander et al. 2003). In addition, treed habitats within the Mackenzie Mountains were reported to commonly support Olive-sided Flycatcher, Boreal Chickadee, Swainson's Thrush, Ruby-crowned Kinglet, Bohemian Waxwing and Dark-eyed Junco (Rand 1946). Some other bird species that occur in Boreal-high Bioclimate Zones include Fox Sparrow, White-throated Sparrow and Rusty Blackbirds (Alexander et al. 2003). The Olive-sided Flycatcher is a threatened species (COSEWIC 2010) and has been observed in the WRSA (EBA 2008d; Table 4.8-24).

Early descriptions of the bird life in the Yukon included limited diversity and abundance. Rand (1946) indicated there were a few areas that were exceptions, including the marshy lakes within the Pelly River valley (approximately 35 km northeast of the KRP). Willow/ alder dominated habitat surrounds these marshy lakes and support many Yellow Warblers, Orange-crowned Warblers, Fox Sparrow, White-crowned Sparrow, Alder Flycatchers and Rusty Blackbirds (Rand 1946). These species are assumed to be common within the WRSA wherever appropriate habitat exists.

Horned Lark (*Eremophila alpestris*)

The Horned Lark occurs throughout the Yukon and is often associated with dry tundra areas and dry lowland meadows. It is a migratory species and usually arrives in the Yukon between mid-April and the third week in May and departs between July and early September. The Horned Lark typically nests on dry alpine tundra, which does occur within the WRSA. During migration, this species uses open areas in the alpine and lowland (Sinclair et al. 2003).

The Horned Lark has been documented in the WRSA (EBA 2008d, Appendix F1).

Olive-sided Flycatcher (*Contopus cooperi*)

The Olive-sided Flycatcher has been assessed by COSEWIC (2010) as "Threatened" under Schedule 1 of SARA (Table 4.8-24). In the north, potential threats to the population include: fire suppression practices and extreme weather during breeding (CWS and GNWT ENR 2008).

Typical Olive-sided Flycatcher habitat includes regenerating forests after a forest fire, and open areas (including man made openings) with surrounding large trees and standing snags (CWS and GNWT ENR 2008). Olive-sided Flycatchers forage from a high prominent perch from which they pursue flying insects such as bees, wasps and ants once sighted. Olive-sided Flycatchers typically arrive in the Yukon in mid-May and depart late July and August (Sinclair et al. 2003; CWS and GNWT ENR 2008). For unknown reasons, Olive-sided Flycatcher populations have declined considerably, particularly in its southern range.

Olive-sided Flycatcher habitat exists in the WRSA but is not abundant. The Olive-sided Flycatcher was recorded in the WRSA during the breeding bird surveys in 2007 (EBA 2008d Appendix F1).

Common Nighthawk (*Chordeiles minor*)

The Common Nighthawk has been assessed by COSEWIC (2010) as "Threatened" under Schedule 1 of SARA (Table 4.8-24). A large decline in their population has been shown over the past 30 years across much of Canada (CWS and GNWT ENR 2010b).

Common Nighthawks migrate into the Yukon in late May to breed (Sinclair et al. 2003). Preferred habitat includes: open forests; forest clearings; recent burn areas; rock outcrops; wetlands and marshes; lakeshores and gravel areas (including airports, quarries and roads; Sinclair et al. 2003). Nests are prepared directly on soil, sand, gravel and bare rock. Common Nighthawks are insectivores, and actively pursue flying insects at dawn and dusk, particularly over bodies of water.

Common Nighthawk feeding and breeding habitat exists within the WRSA but is not abundant. The Common Nighthawk has not been observed in the WRSA.

Rusty Blackbird (*Euphagus carolinus*)

The Rusty Blackbird has been assessed by COSEWIC (2010) as "Special Concern" under Schedule 1 of SARA (Table 4.8-24).

Rusty Blackbirds are found in wetland habitats and along the edges of ponds or lakes with standing dead trees, marsh grasses and shrubs (Alexander et al. 2003; Shaw 2006). Rusty Blackbird breeding has been confirmed near Ross River (Alexander et al. 2003), and they are expected to occur within the WRSA in the

Boreal-high Bioclimate Zone. Rusty Blackbirds typically arrive in southern Yukon in mid-April, and depart by October; however, there are two records of Rusty Blackbirds over-wintering in the Yukon at Teslin and Whitehorse (Alexander et al. 2003).

No Rusty Blackbirds have been observed within the WRSA.

Savannah Sparrow (*Passerculus sandwichensis princeps*)

The Savannah Sparrow (subspecies *princeps*) has been assessed by COSEWIC (2010) as "Special Concern" under Schedule 1 of SARA (Table 4.8-24).

The Savannah Sparrow commonly occurs throughout the Yukon and is typically associated with grassy and low shrub areas at both low and high elevations. It is a migratory species, arriving in late April to early May and departing August to September. This species usually breeds in grasslands and areas with low shrubs, including airstrips in Ross River and along the North Canol Road (Sinclair et al. 2003).

The Savannah Sparrow has been documented in the WRSA (EBA 2011a, Appendix F2; EBA 2011b, Appendix F3).

4.8.4 Amphibians

Table 4.8-25 describes the conservation status of Wood Frogs.

Table 4.8-25: Conservation Status – Wood Frog

System	Status
Species at Risk Act	Unlisted
COSEWIC	Not Evaluated
Wildlife Act (Yukon)	Not Listed

A single amphibian species, the Wood Frog (*Rana sylivatica*) occurs within the study area (YG Environment 2005). Wood Frog populations are considered Secure in Canada, and therefore have no special management strategies associated with the population.

Wood Frogs are considered to be common throughout most of the Yukon, and can be found in or near permanent, semi-permanent and temporary water bodies throughout the forested Boreal-high Bioclimate Zone. These frogs also use forest habitats away from water all year round. Wood frogs hibernate through the winter under leaf litter; and following emergence in the spring, they congregate at water bodies to breed. Breeding occurs during a brief period, one or two weeks, from mid-April to June (sometimes before all pond ice has melted).

Although no Wood Frogs were observed during baseline programs, they are assumed to occur throughout the Boreal-high Bioclimate Zone within the study area, wherever appropriate habitat exists.

4.9 Surface Water Quality

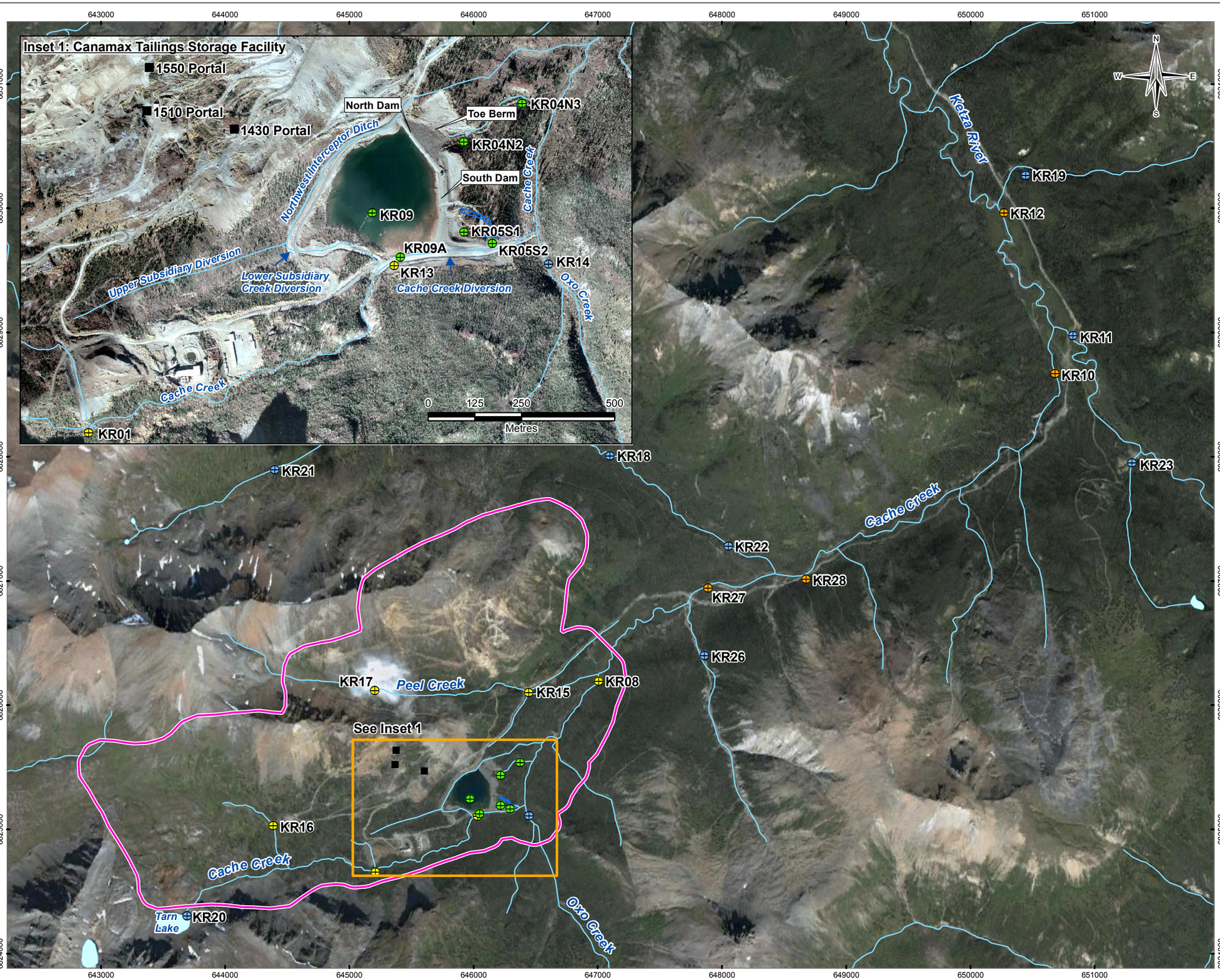
4.9.1 Introduction

Surface water quality has been assessed in the Project Footprint and the Surface Water RSA to establish existing conditions. The Project Footprint is defined in Figure 4.9-1; the Surface Water RSA is defined as the surface water within the same drainage to a maximum of 15 km downstream (Figure 4.9-2); and the Beyond-Surface Water RSA is the area outside of the Surface Water RSA.

The Project Footprint and Surface Water RSA have numerous tributaries (some unnamed) that eventually flow into Ketza River, which flows into the Pelly River. Water quality data have been collected from 26 surface water sampling stations within the Project Footprint and Surface Water RSA (Figure 4.11-1 and Table 4.9-1) between 1988 and 1996 and between 2005 and 2011. Water sampling stations are located in the Canamax TSF, in Ketza River and five of Ketza River's tributaries (Tarn Lake, Cache Creek, Oxo Creek, Peel Creek and Misery Creek). From March 1988 until December 1994 water samples were collected monthly. The sampling frequency increased in 1995 to twice per month. Sampling then stopped from January 1996 until July 2005. From July 2005 until July 2007 sampling continued at a minimum frequency of twice per month. Since August 2007, the sampling frequency has been monthly for water sampling stations not regulated in the previous Water Licence and twice per month for the stations regulated by the previous Water Licence (Schedule A, Part III). Summaries of surface water quality results are located in Appendix G.

Additional mining activity has historically occurred in the Project Footprint and Surface Water RSA; therefore, the current conditions may include impacts from historical operations and may not be representative of pristine conditions. Water quality sampling stations have been selected to represent locations upstream, at and downstream of historically impacted areas. The following is the site specific definition of those categories:

- Background Station - Background Stations were selected as stations that are upgradient of water bodies prior to entering the Local Study Area. Background Stations are upstream of known areas of historical developments (buildings and excavations). Two stations in this category are potentially impacted from Surface Water RSA Historic Activities (KR11 is downstream of mining activity not related to Ketza River Property and KR23 is at a historical adit not related to Ketza River Property)
- On Site - Stations located within the Local Study Area. These stations are likely to have had historic activities in their vicinity (including, but not limited to drilling, underground workings and road work):
  - TSF Area – Stations located within the approximate mine exploration activity area, which are within 300 m of the Canamax TSF. These include a station in the Canamax TSF and at the groundwater seepage points from the TSF.
  - Non TSF Area - Stations located within the approximate mine exploration activity area, which are not in or adjacent to the Canamax TSF.
- Receiving Environment - Stations located downgradient of the Project Footprint.



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LEGEND

- Project Footprint
- Background Water Quality Station
- On Site: Effluent Water Quality Station
- On Site: Non-Effluent Water Quality Station
- Receiving Environment Water Quality Station
- Portal
- Emergency Spillway
- Drainage
- Waterbody

NOTES

Base data source: Imagery from Google Earth Pro (August 10, 2005)

STATUS

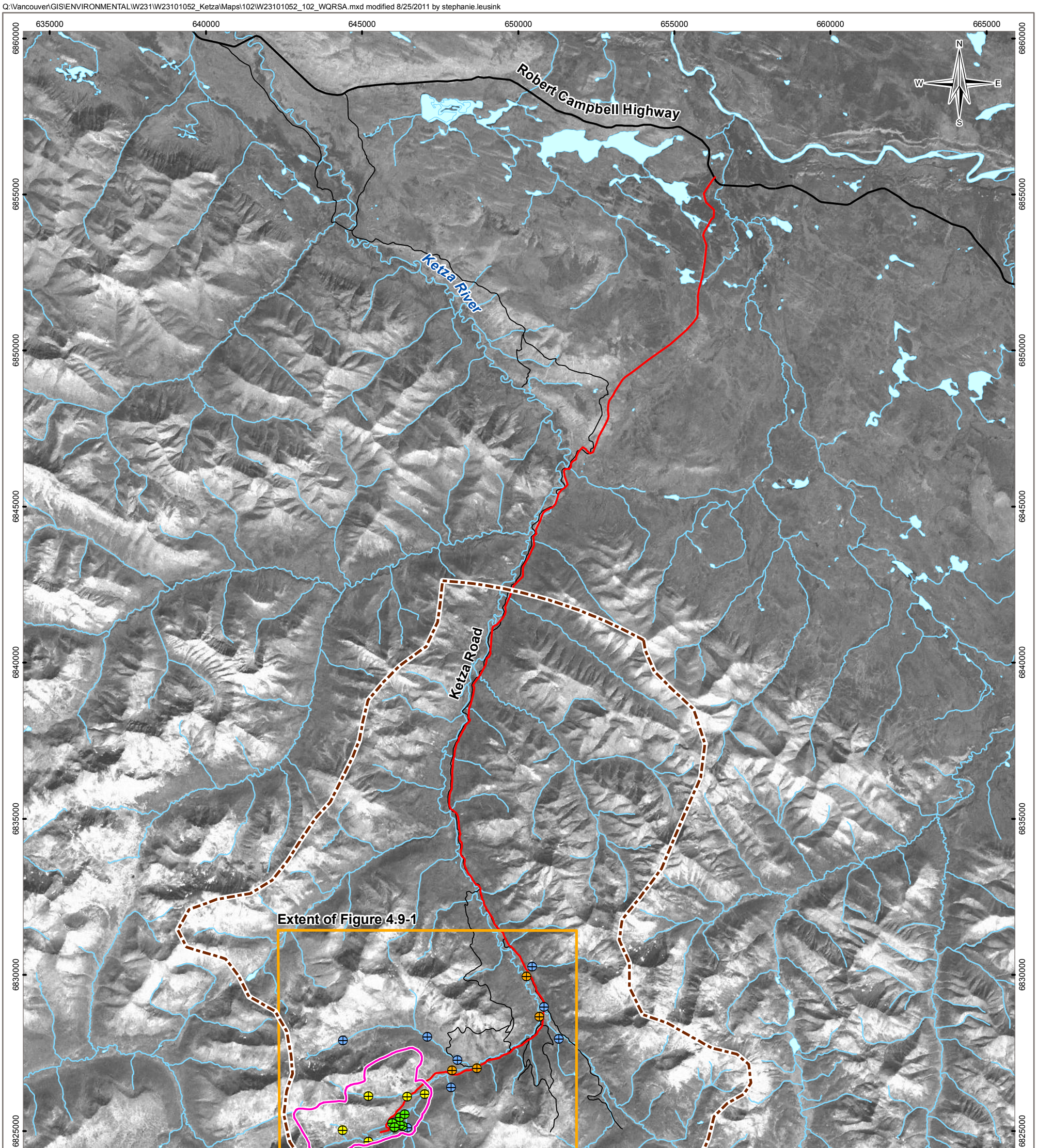
ISSUED FOR USE

KETZA RIVER PROJECT

Surface Water Quality Sampling Stations and Project Footprint

PROJECTION UTM Zone 8	**DATUM** NAD27	**CLIENT** Ketza River Holdings	
Scale: 1:30,000 (500 250 0 500 Metres)			
FILE NO. W23101052_102_WQStations.mxd			
PROJECT NO. W23101052.102	**DWN** SL / **CKD** NJ / **APVD** NJ / **REV** 0	eba A TETRA TECH COMPANY	**Figure 4.9-1**
OFFICE EBA-VANC	**DATE** July 26, 2011		

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LEGEND

- Background Water Quality Station
- On Site: Effluent Water Quality Station
- On Site: Non-Effluent Water Quality Station
- Receiving Environment Water Quality Station
- Project Footprint
- Surface Water Quality Regional Study Area
- Ketza Road
- Robert Campbell Highway
- Minor Road
- Drainage
- Waterbody

NOTES
Base data source: Geomatics Yukon; NTS 1:50,000

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Surface Water Quality Regional Study Area

PROJECTION: UTM Zone 8			DATUM: NAD27		CLIENT: Ketza River Holdings
Scale: 1:125,000 (2 1 0 2 Kilometres)					eba A TETRA TECH COMPANY
FILE NO.: W23101052_102_WQRSA.mxd					
PROJECT NO.: W23101052.102	DWN: SL	CKD: NJ	APVD: NJ	REV: 0	Figure 4.9-2
OFFICE: EBA-VANC	DATE: July 26, 2011				

A summary of the stations monitored in each category is presented in Table 4.9-1.

Table 4.9-1: Summary of Surface Water Quality Stations and Sampling Events

Station	Water Body	Study Area	Location in Relation to Mine Exploration Activity Area [1]	Number of Sampling Events [2]	Dates [3]
KR01	Cache Creek	Local	On Site: Non TSF Area	155	March 1, 1988 to March 22, 2011
KR04N2	Seepage	Local	On Site: TSF Area	100	October 12, 2005 to March 23, 2011
KR04N3	Downstream of Seepage	Local	On Site: TSF Area	104	August 4, 2005 to March 5, 2011
KR05S1	Seepage	Local	On Site: TSF Area	95	August 4, 2005 to March 22, 2011
KR05S2	Downstream of Seepage	Local	On Site: TSF Area	103	August 4, 2005 to March 22, 2011
KR08	Cache Creek	Local	On Site: Non TSF Area	156	March 1, 1988 to March 22, 2011
KR09	Canamax TSF	Local	On Site: TSF Area	109	July 19, 2005 to March 23, 2011
KR10	Cache Creek	Regional	Receiving Environment	74	October 25, 2005 to March 22, 2011
KR11	Ketza River	Regional	Background	74	October 25, 2005 to March 22, 2011
KR12	Ketza River	Regional	Receiving Environment	74	October 25, 2005 to March 22, 2011
KR13	Cache Creek	Local	On Site: Non TSF Area	75	July 19, 2005 to March 22, 2011
KR14	Oxo Creek	Regional	Background	66	October 25, 2005 to March 23, 2011
KR15	Peel Creek	Local	On Site: Non TSF Area	83	July 19, 2005 to March 22, 2011
KR16	Cache Creek Source Waters	Local	On Site: Non TSF Area	80	July 19, 2005 to March 23, 2011
KR17	Peel Creek	Regional	On Site: Non TSF Area	30	August 4, 2005 to September 21, 2010
KR18	Misery Creek	Regional	Background	34	August 4, 2005 to September 21, 2010
KR19	Unnamed Creek	Regional	Background	38	August 15, 2005 to January 6, 2011
KR20	Tarn Lake	Regional	Background	40	December 6, 2005 to February 18, 2011
KR21	Misery Creek	Regional	Background	18	September 18, 2006 to September 21, 2010
KR22	Misery Creek	Regional	Background	33	September 18, 2006 to January 6, 2011
KR23	Silver Valley Portal	Regional	Background	39	October 3, 2006 to January 6, 2011
KR26	Unnamed Creek	Regional	Background	5	November 30, 2010 to March 23, 2011
KR27	Ketza River	Regional	Receiving Environment	5	November 30, 2010 to March 23, 2011
KR28	Ketza River	Regional	Receiving Environment	5	November 30, 2010 to March 23, 2011

Notes:
1- TSF Area indicates the water sampling stations within approximately 300 m of the Canamax TSF.
2- Corresponds to the maximum number of sampling events; not all parameters were analysed at each sampling event.
3- Discontinuous sampling events throughout this time period; sampling occurred mostly on a monthly or biweekly basis, although some months and/or years are missing.

4.9.1.1 Adit Portal Water

Four potential surface waterbodies are around the Canamax adit portals (1430 Portal, 1510 Portal and 1550 Portal; Figure 4.9-1). These locations are inspected annually during a geotechnical inspection, and discussed in the Geotechnical Investigation Reports (EBA 2009a and 2010). During these inspections, no surface water has been observed at the 1550 Portal. Seepage was observed once at the 1430 Portal (estimated to be less than 1 L/s). At the time, the adit was plugged by ice and the seepage was believed to be a result of the melt water draining away. Air flow around the ice plug indicated that there may be some ponded water behind the plug, but it would not be a significant volume. The water from here enters a culvert which goes underneath an exploration road, daylights then seeps. Seepage was observed twice at the 1510 Portal (estimated to be less than 1 L/s and less than 5 L/s). These have been observed to be ephemeral water seeps.

Due to the low volumes of flow, their ephemeral nature, and the fact that within 10 m of surfacing, these re-infiltrate into the ground, the seepage from these portals is not thought to be a significant influence to the water quality in the LSA. Therefore, seepage water quality is not discussed further in the surface water quality summary of existing conditions.

4.9.1.2 Ketza Road

The Ketza Road crosses surface water and runs parallel to surface water in the Project Footprint, Surface Water RSA and beyond Surface Water RSA. Operation and maintenance of the road has been ongoing since its construction prior to Canamax mining activity in the Project Footprint. Surface water quality is not monitored along the Ketza Road as its operation and maintenance is not considered to have a significant effect on surface water quality.

4.9.2 Surface Water Quality Monitoring Sample Collection Method

Surface water quality sample bottles are provided by the environmental testing laboratory (Exova (formerly Norwest Laboratories (Norwest) and Bodycote) or Maxxam Analytics (Maxxam)). The bottles are labelled with the sampling station's ID and the date of the sample. A new pair of nitrile gloves is worn by the sampler at each sampling station. The standard sampling procedure is for samplers to stand onshore or downstream of the sample collection point to avoid stirring up sediment from the bottom.

The sampling methods follow appropriate container, preservation, and holding times required by Norwest, Exova or Maxxam (summarized in Table 4.9-2). The sampler rinses the bottles (with the exception of the dissolved metals bottle) three times with sample water prior to sampling. Samples are collected at each location from the approximate center of the water column to their maximum capacity, leaving no air space. Filtering and preservation is carried out in the field in accordance with the analytical laboratory's requirements.

Table 4.9-2: Surface Water Quality Sample Collection Requirements

Analysis	Container	Preservation Methods	Holding Time
Routine chemistry (Exova)	500 ml Plastic	Keep cold	28 Days
Nutrients (Exova)	250 ml Plastic	2 ml 25% Sulphuric Acid	28 Days
Dissolved metals (Exova)	250 ml Plastic	Field Filtered, 5 ml 20% Nitric Acid	6 Months
Total metals (Exova)	250 ml Plastic	5 ml 20% Nitric Acid	6 Months
Dissolved metals (Maxxam)	125 ml Plastic	Filter (0.45 um) Nitric Acid with < pH 2	6 Months
Total metals (Maxxam)	125 ml Plastic	Nitric Acid with < pH 2	6 Months
Cyanide (Maxxam)	125 ml Plastic	Sodium Hydroxide with > pH 12	14 Days
Ammonia (Maxxam)	125 ml Plastic	Sulphuric Acid with > pH 12	14 Days
Total Suspended Solids (Maxxam)	1 L Plastic	Keep cold	7 Days
Routine water chemistry (Maxxam)	1 L Plastic	Keep cold	14 Days

During water quality sampling by KRH, the following parameters are measured at each station: in-situ water temperature, pH, electrical conductivity and total dissolved solids. This information is recorded from a Hanna multimeter (Combo HI98129). The meter is calibrated according to instrument requirements each day before use and through the day if false readings are suspected by the sampler.

Sample bottles were placed in a cooler with a frozen ice pack to keep the samples at approximately 4°C. The ice pack was replaced as needed. The samples were shipped to either Exova in Vancouver, BC. (between July 2005 to May 2010) or to Maxxam in Burnaby, BC. (since June 2010) for laboratory testing as soon as possible after the sampling event.

The samples were analyzed for total metals, dissolved metals, hardness, total alkalinity, total sulphate, nitrogen-nitrate and nitrogen-nitrite. The analytical laboratories were certified for these analyses under the Canadian Association for Laboratory Accreditation Inc. certification (started in 2010). Prior to 2010 the laboratories were certified under the Canadian Association for Environmental Analytical Laboratories. Details on analytical methods are included in the analytical reports, which were submitted with the monthly previous Water Licence reports from 2007 until 2011 to the Yukon Water Board.

4.9.3 Surface Water Quality Monitoring Results

All of the water quality results were compared to the Canadian Council of Ministers of the Environment (2003a) Canada Water Quality Guideline for the Protection of Aquatic Life (CCME ALG) and the percentage of samples for each station that had concentrations that exceeded CCME ALG was determined and categorized as “always”, “frequently”, “occasionally”, “rarely” or “never” exceeded the CCME ALG. These categories are defined as follows:

- Always: 100% of the analytical results exceed the parameter-specific CCME ALG
- Frequently: greater than 50% of the analytical results exceed the parameter-specific CCME ALG
- Occasionally: 30 to 50% of the analytical results exceed the parameter-specific CCME ALG
- Rarely: between 0% and 30% of the analytical results exceed the parameter-specific CCME ALG
- Never: 0% of the analytical results exceed the parameter-specific CCME ALG.

Phosphorus, total cyanide and total suspended solids (TSS) were addressed differently as they don't have discrete applicable CCME ALG. Phosphorus results were summarized and discussed according to nutrient enrichment CCME ALG (ultra-oligotrophic to hyper eutrophic). Total cyanide (strong acid dissociable cyanide and weak acid dissociable cyanide (including free cyanide)) results were summarized and compared to the CCME ALG for cyanide as free CN. Use of this CCME ALG is a conservative comparison since free CN is only one component of the result. TSS results were summarized and compared to the Metal Mining Effluent Regulations (MMER) lowest allowable concentration (maximum authorized monthly mean concentration). These parameters are discussed separate from other chemicals.

Parameters categorized as "rarely" exceeding the CCME ALG (fewer than 30% of samples exceeded the parameter-specific CCME ALG) at all stations were not considered to be of concern for existing surface water quality conditions and were not considered further. Parameters categorized as always, frequently or occasionally exceeded a CCME ALG were evaluated in more detail to determine if historical activities in the Project Footprint have impacted water quality in the region. The further analysis was completed as follows:

- Average concentrations and their errors (standard deviations + and – the average concentration) were plotted for each area (On Site: Non TSF, On Site: TSF and Receiving Environment) and compared. Concentrations of a parameter were deemed to be significantly different between areas if the standard deviations did not overlap.
- Seasonal and temporal trends were determined by plotting concentrations. The resulting graphs were reviewed to determine seasonal trends and if changes in concentrations have been observed during the monitoring period (1988 to present).

Water from the Canamax TSF has been discharged into Cache Creek to maintain the structural integrity of the embankment dam. This has been done sporadically in the summer months since 2007 and in accordance with the previous Water Licence. The effect of the discharge on downstream water quality was examined by comparing average concentrations of arsenic (total; and standard deviation ranges) during discharge and non-discharge periods between areas with surface water downstream. Concentrations of arsenic were deemed to be significantly different between areas if the standard deviations did not overlap.

4.9.3.1 Comparison to CCME Water Quality Guidelines for the Protection of Aquatic Life

Water quality sampling results at KRP are presented in Appendix G1.

Background Water Quality

Table 4.9-3 summarizes the percentage of samples with concentrations that exceeded CCME Water Quality Guidelines for the Protection of Aquatic Life for parameters measured at Background Stations.

Table 4.9-3: Percentage of Samples that Exceeded CCME Guidelines for Parameters Measured at Background Stations

Stations	Always (100% of samples)	Frequently (Greater than 50% of samples)	Occasionally (30 - 50% of samples)	Rarely (Less than 30% of samples)
KR11	None	None	Ammonia	Aluminum, ammonia (as N), arsenic, cadmium, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR14	None	Cadmium and selenium	None	Aluminum, ammonia, ammonia (as N), arsenic, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, silver, thallium, TSS and zinc
KR18	Aluminum, ammonia, arsenic and pH	Cadmium, copper, nickel, selenium and zinc	None	Ammonia (as N), cyanide, iron, lead, mercury, molybdenum, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), silver, TSS and thallium
KR19	None	None	Ammonia	Aluminum, ammonia (as N), arsenic, cadmium, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR20	None	Cadmium	Aluminum and ammonia	Ammonia (as N), arsenic, copper, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR21	Arsenic	Selenium	None	Aluminum, ammonia, ammonia (as N), cadmium, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, silver, thallium, TSS and zinc
KR22	Arsenic	Aluminum, cadmium, copper and zinc	Ammonia and selenium	Ammonia (as N), cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, silver, TSS and thallium
KR23	Arsenic	Ammonia (as N) and cadmium	Ammonia, lead, iron and silver	Aluminum, copper, cyanide, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, thallium, TSS and zinc
KR26	None	None	Ammonia, iron and TSS	Aluminum, arsenic, cadmium, copper, cyanide, lead, mercury, molybdenum, nickel, nitrate (as NO_3), nitrite (as NO_2^-), pH, selenium, silver, thallium and zinc

Phosphorus concentrations indicate the water quality is mesotrophic.

Maximum concentrations of total cyanide occasionally exceeded the CCME ALG for free CN (except at KR26); however, their average concentrations did not.

The two Background Stations (KR11 and KR23) which were potentially affected by historic mining activities in the RSA have similar concentrations to other Background Stations. This indicates that if historical activities occurred upstream of these stations they are not likely to be currently altering water quality.

On Site: Non Tailings Storage Facility Area

Table 4.9-4 summarizes the percentage of samples with concentrations that exceeded CCME Water Quality Guidelines for the Protection of Aquatic Life for parameters measured at the On Site: Non TSF Area Stations.

Table 4.9-4: Percentage of Samples that Exceeded CCME Guidelines for Parameters Measured at On Site: Non Tailings Storage Facility Stations

Stations	Always (100% of samples)	Frequently (Greater than 50% of samples)	Occasionally (30 - 50% of samples)	Rarely (Less than 30% of samples)
KR01	None	Arsenic	None	Aluminum, ammonia, ammonia (as N), cadmium, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR08	None	Arsenic	None	Aluminum, ammonia, ammonia (as N), cadmium, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR13	Arsenic	None	Cyanide	Aluminum, ammonia, ammonia (as N), cadmium, copper, iron, lead, mercury, molybdenum, nickel ,nitrate (as N) nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR15	None	Aluminum, arsenic, cadmium, copper, iron, and zinc	Cyanide	Ammonia, ammonia (as N), lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium and TSS
KR16	Arsenic	Selenium	None	Aluminum, ammonia, ammonia (as N), cadmium, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrite (as N), nitrate (as N), nitrate (as NO_3), nitrite (as NO_2^-), pH, silver, thallium, TSS and zinc
KR17	Arsenic	Selenium	Ammonia	Aluminum, ammonia (as N), cadmium, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, silver, thallium, TSS and zinc

Phosphorus concentrations indicate the water quality is mesotrophic.

On Site: Tailings Storage Facility Area

Table 4.9-5 summarizes the percentage of samples with concentrations that exceeded CCME Water Quality Guidelines for the Protection of Aquatic Life for parameters measured at the On Site: TSF Area Stations.

Table 4.9-5: Percentage of Samples that Exceeded CCME Guidelines for Parameters Measured at On-site: Tailings Storage Facility Area Stations

Stations	Always	Frequently	Occasionally	Rarely
	(100% of samples)	(Greater than 50% of samples)	(30 - 50% of samples)	(Less than 30% of samples)
KR04N2	Arsenic	Ammonia, ammonia (as N) and cyanide	Copper	Aluminum, cadmium, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR05S1	Arsenic	Ammonia, ammonia (as N) and cyanide	Cadmium and iron	Aluminum, copper, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR09	Arsenic	Ammonia (as N)	Ammonia and copper	Aluminum, cadmium, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR04N3	Arsenic	Ammonia, ammonia (as N) and cyanide	None	Aluminum, cadmium, copper, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR05S2	Arsenic	Ammonia and cyanide	Ammonia (as N)	Aluminum, cadmium, copper, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc

Phosphorus concentrations indicate the water quality is mesotrophic. TSS maximum concentrations indicate that the Metal Mining Effluent Regulation (MMER) standard is occasionally exceeded at all On Site: TSF Area Stations. TSS average concentrations at these stations are below the MMER standard. Cyanide total maximum concentrations occasionally exceeded the CCME ALG for free CN (except at KR09). Cyanide average concentrations did not exceed the CCME ALG at most On Site: TSF Area Stations, with the exception of KR09.

Receiving Environment Surface Water

Table 4.9-6 summarizes the percentage of samples with concentrations that exceeded CCME (2003a) Water Quality Guidelines for the Protection of Aquatic Life for parameters measured at Receiving Environment Stations.

Table 4.9-6: Percentage of Samples that Exceeded CCME Guidelines for Parameters Measured at Receiving Environment Stations

Stations	Always	Frequently	Occasionally	Rarely
	(100% of samples)	(Greater than 50% of samples)	(30 - 50% of samples)	(Less than 30% of samples)
KR10	None	Aluminum, arsenic, cadmium and iron	Ammonia and copper	Ammonia (as N), cyanide, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR12	None	Aluminum and cadmium	None	Ammonia, ammonia (as N), arsenic, copper, cyanide, iron, lead, mercury, molybdenum, nickel, nitrate (as N), nitrate (as NO_3), nitrite (as NO_2^-), pH, selenium, silver, thallium, TSS and zinc
KR27	Aluminum, arsenic, cadmium, iron and zinc	None	Ammonia and copper	Cyanide, lead, mercury, molybdenum, nickel, nitrate (as NO_3), nitrite (as NO_2^-), pH, selenium, silver, thallium and TSS
KR28	Iron	Aluminum, arsenic, cadmium and zinc	Ammonia	Copper, cyanide, lead, mercury, molybdenum, nickel, nitrate (as NO_3), nitrite (as NO_2^-), pH, selenium, silver, thallium and TSS

Phosphorus concentrations indicate the water quality is mesotrophic.

4.9.3.2 Comparison between Areas

Parameters categorized as “occasionally”, “frequently” or “always” exceeding CCME ALG at On Site and Receiving Environment Stations in water quality samples collected as part of the monitoring program at the mine, were compared between areas in the Project Footprints and Surface Water RSA. Average and standard deviation values for each of the parameters and areas were graphed (presented in Figures 4.9-3 to 4.9-14). Lead, nickel and pH were not graphed as they were found to exceed the CCME ALG at only one sampling station.

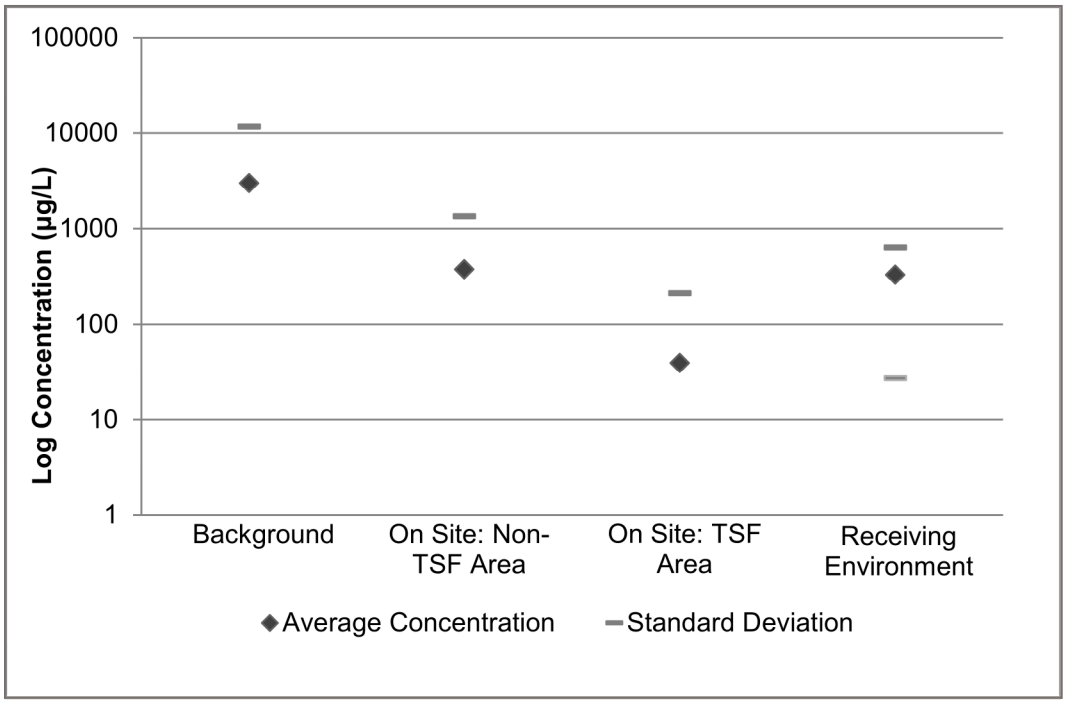


Figure 4.9-3: Average Concentrations of Aluminum from Surface Water Samples

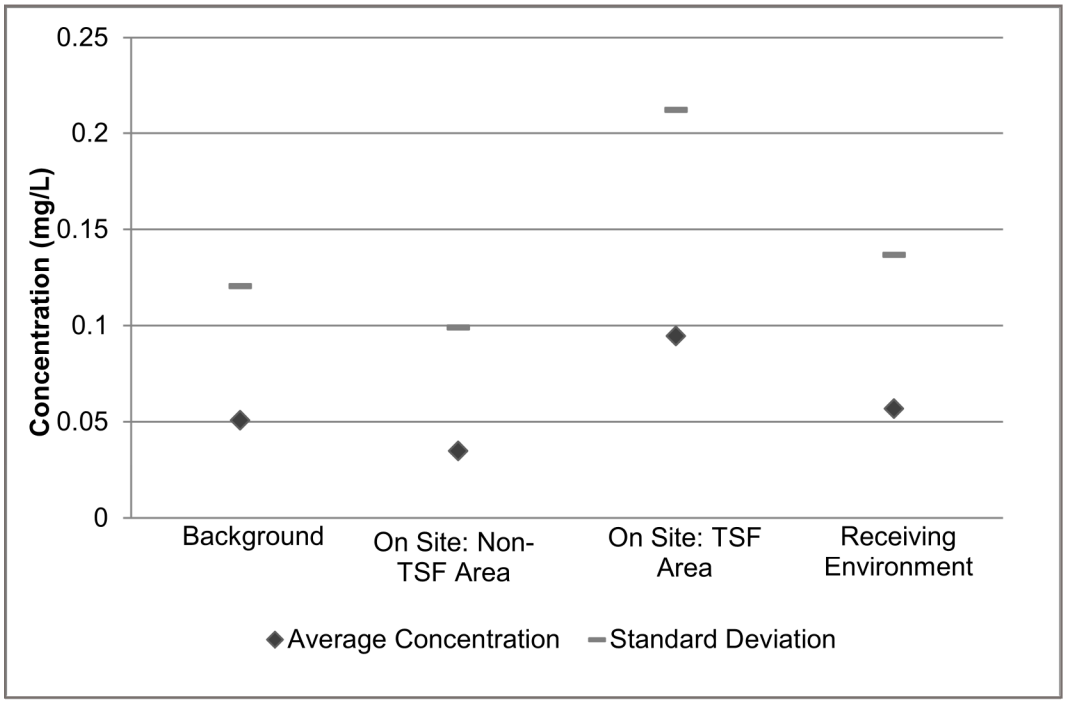


Figure 4.9-4: Average Concentrations of Ammonia from Surface Water Samples

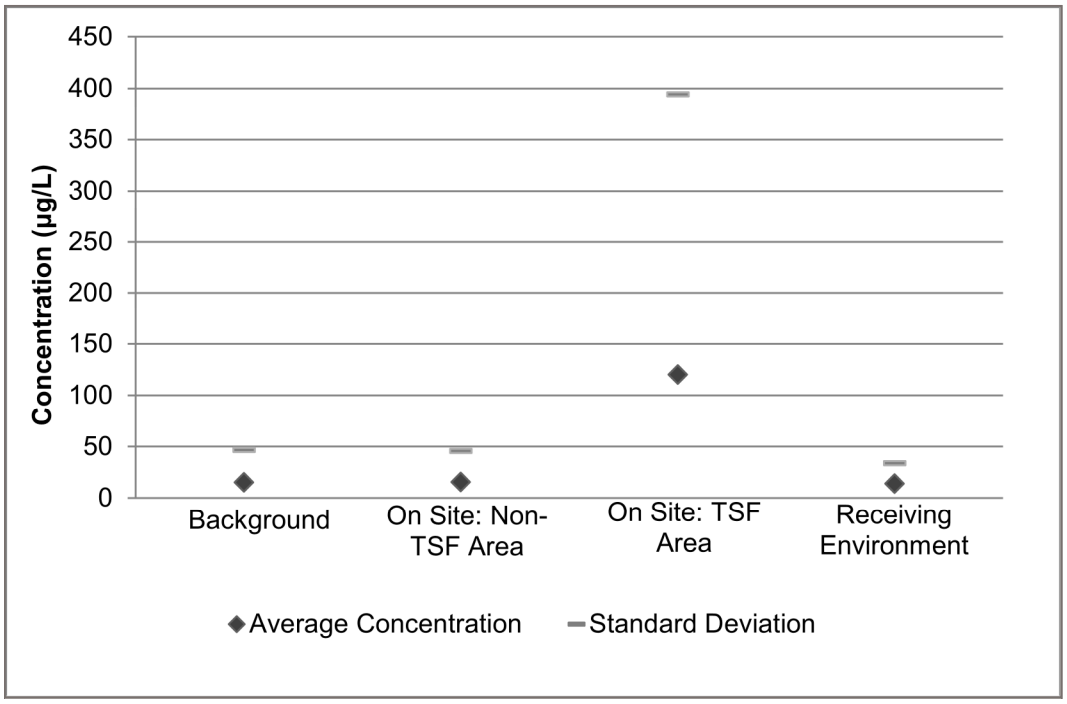


Figure 4.9-5: Average Concentrations of Ammonia (as N) from Surface Water Samples

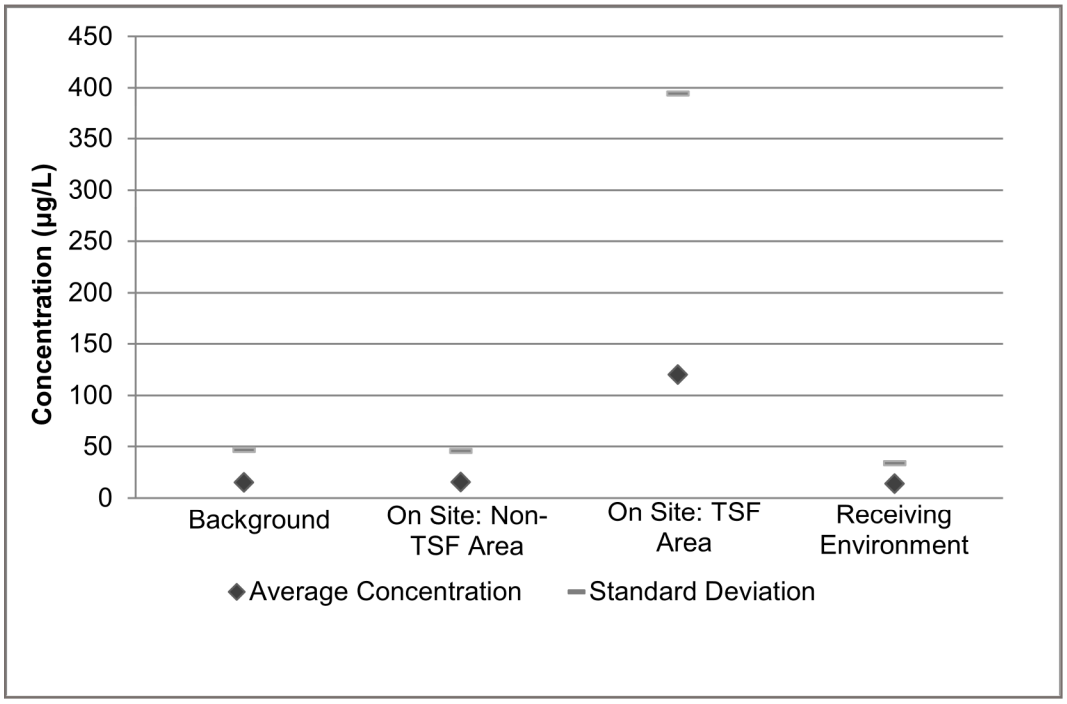


Figure 4.9-6: Average Concentrations of Arsenic from Surface Water Samples

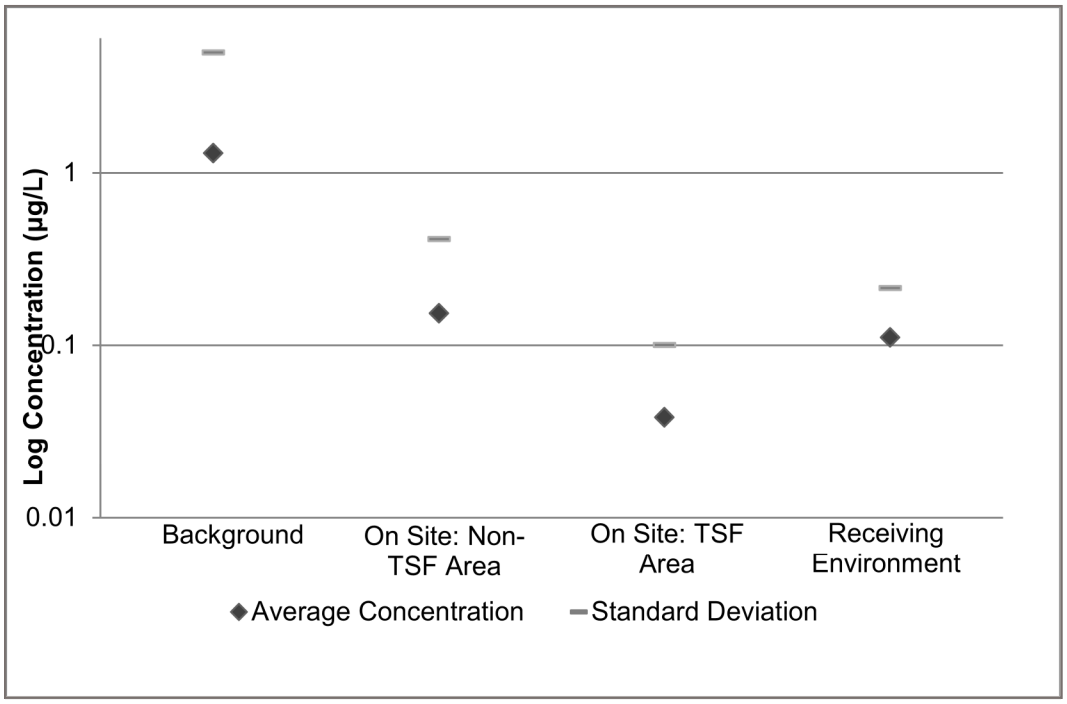


Figure 4.9-7: Average Concentrations of Cadmium from Surface Water Samples

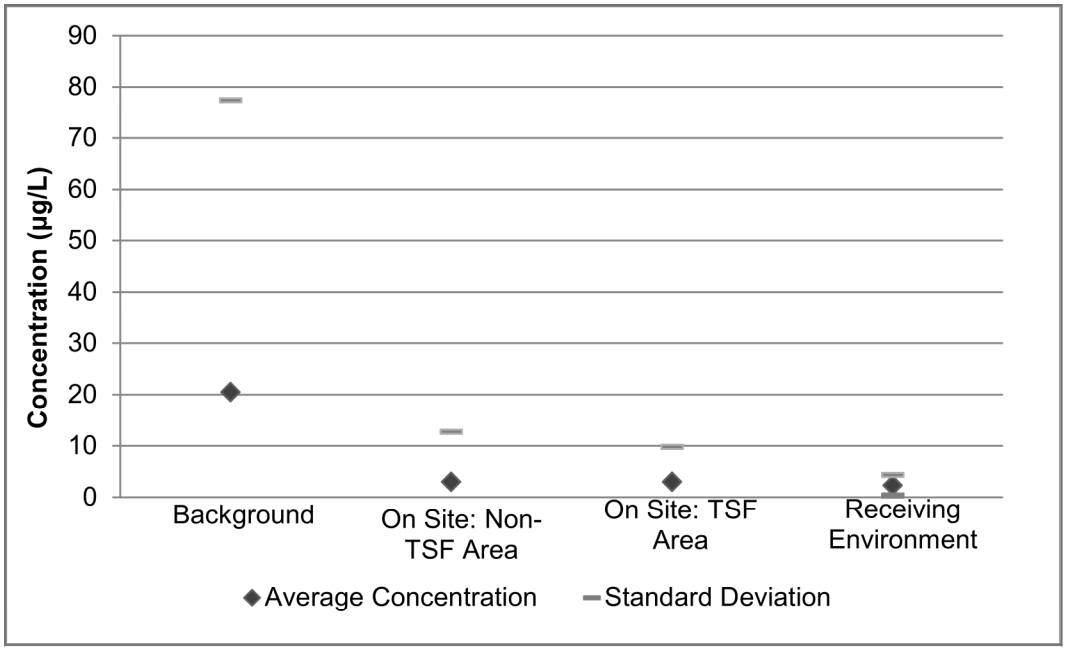


Figure 4.9-8: Average Concentrations of Copper from Surface Water Samples

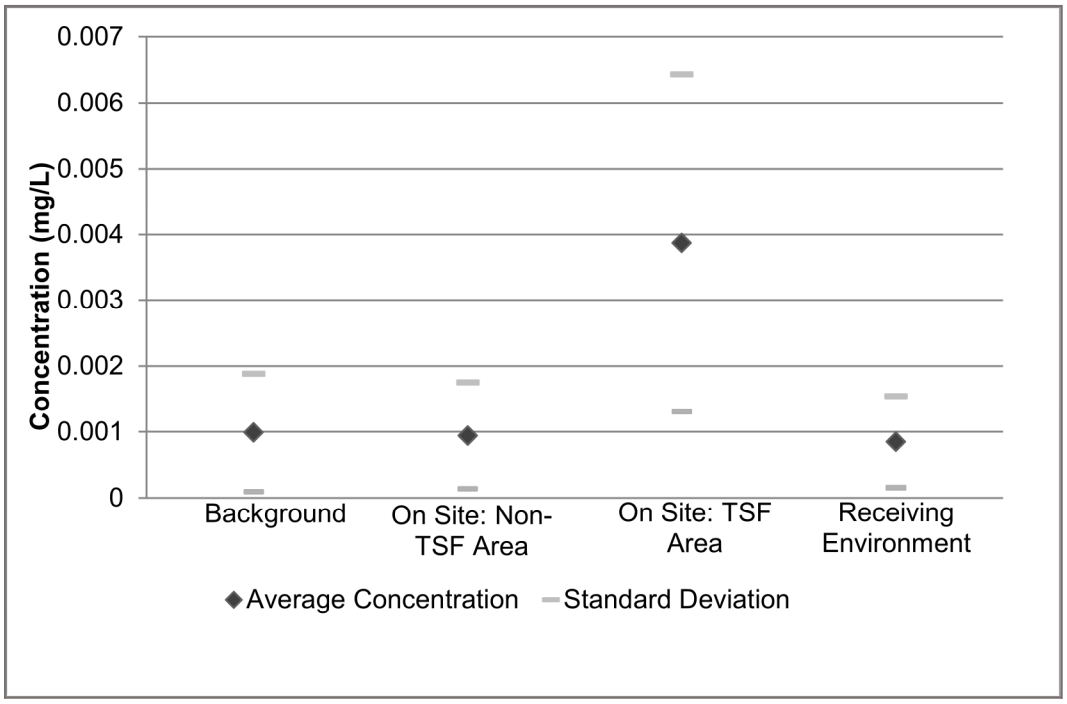


Figure 4.9-9: Average Concentrations of Cyanide(Total) from Surface Water Samples

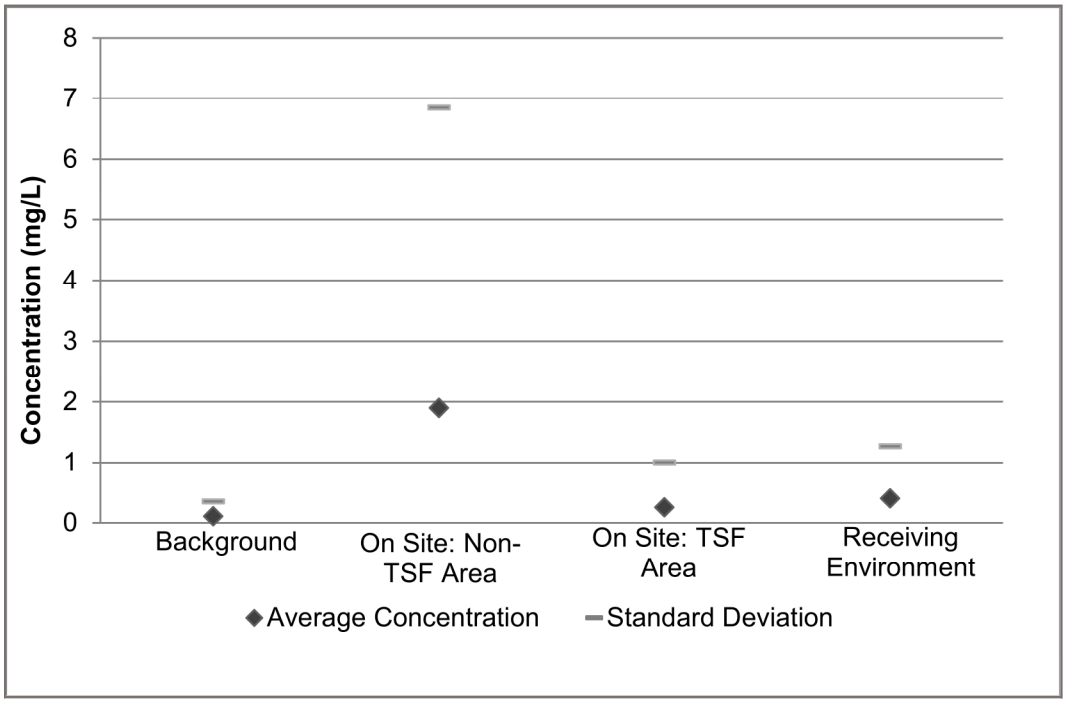


Figure 4.9-10: Average Concentrations of Iron from Surface Water Samples

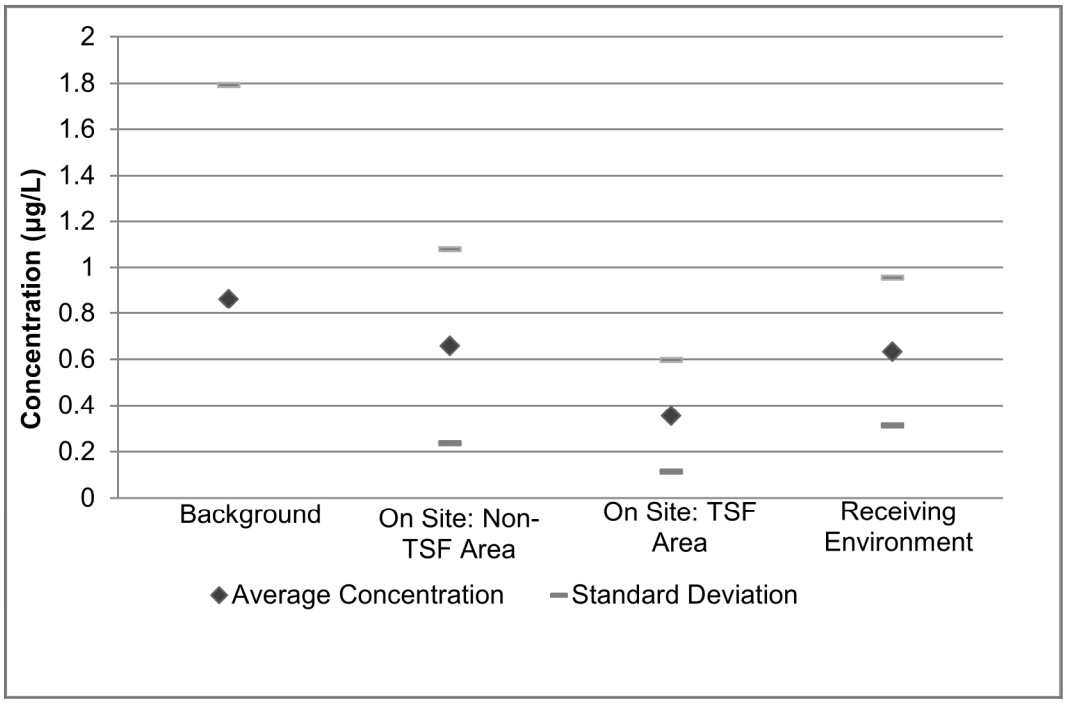


Figure 4.9-11: Average Concentrations of Selenium from Surface Water Samples

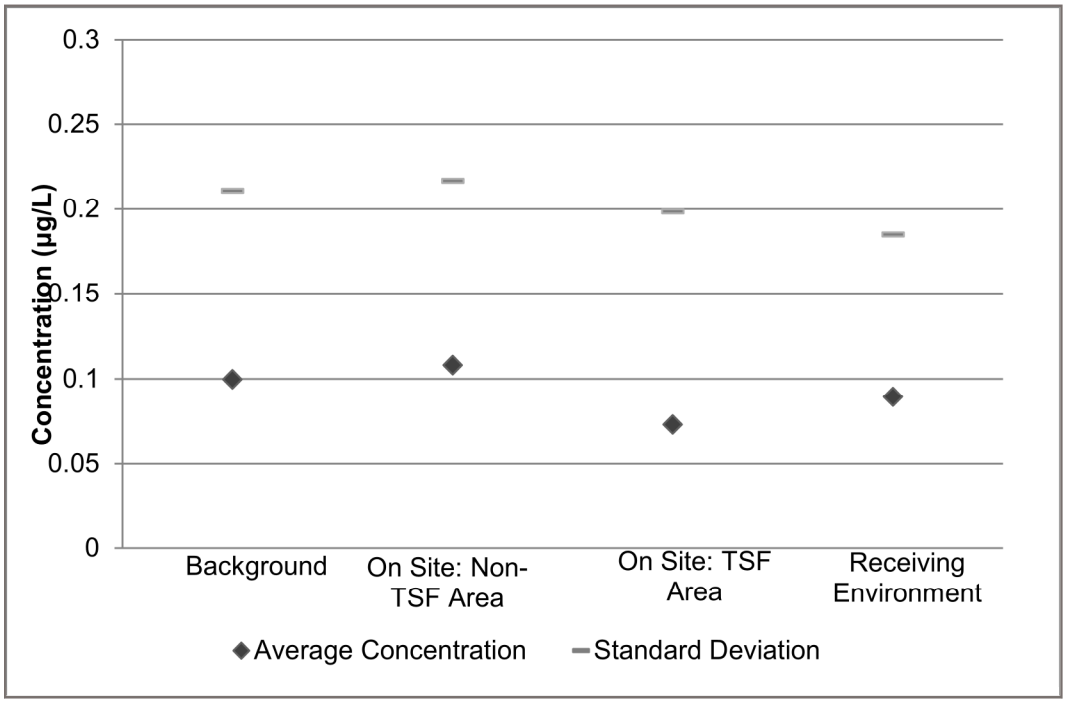


Figure 4.9-12: Average Concentrations of Silver from Surface Water Samples

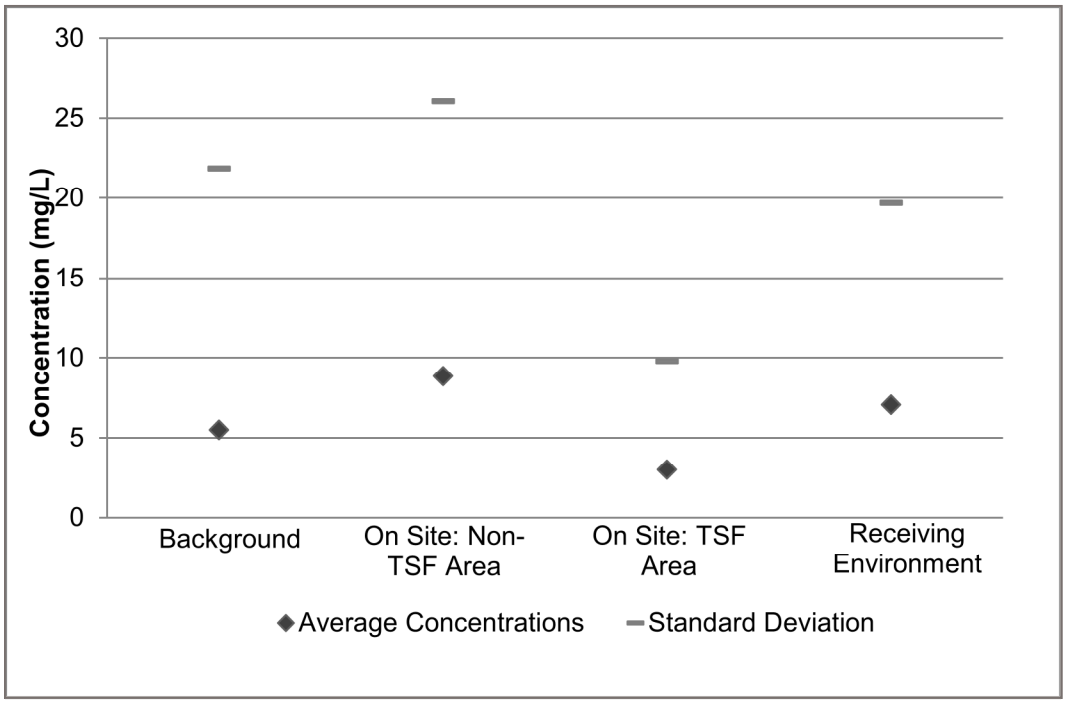


Figure 4.9-13: Average Concentrations of Total Suspended Solids from Surface Water Samples

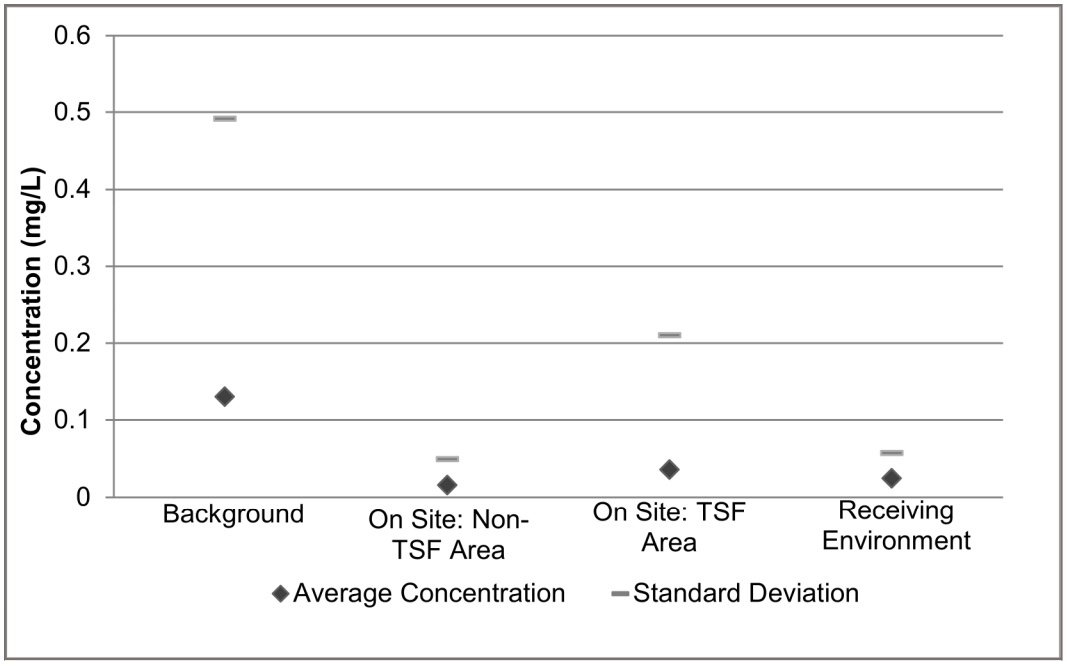


Figure 4.9-14: Average Concentrations of Zinc from Surface Water Samples

No plotted parameter concentrations were significantly different between areas. This was because the range of standard deviations for each of the areas overlapped. The large standard deviation ranges are likely a result of high variation between sampling locations within each area.

Minor differences between parameter concentrations were observed. Of note, the Background area has slightly higher concentrations of aluminum, cadmium, copper, nickel, selenium and zinc. The On Site: TSF area had slightly higher concentrations of ammonia (as N), arsenic and total cyanide. The On Site: Non TSF area had slightly higher concentrations of iron.

Average arsenic (total), ammonia (as N) and cyanide total concentrations and standard deviations indicate that there is not a significant water quality impact from the Canamax TSF Area on other waterbodies within the Project Footprint and Surface Water RSA.

4.9.3.3 Seasonal and Temporal Trends in Surface Water Quality

No chronological trends were noted for chemicals that were found to exceed the CCME ALG (or MMER standard) in more than 30% of the sampling events at Background, On Site: Non TSF Area, On Site: Non TSF Area Stations or Receiving Environment Stations.

No seasonal trends were noted for chemicals that were found to exceed the CCME ALG (or MMER standard) in more than 30% of the sampling events at Background, On Site: Non TSF Area or On Site: Non TSF Area Stations. Seasonal trends were observed at Receiving Environment Stations for arsenic and cadmium:

- Arsenic concentrations were higher from May to October and lower in November to March
- Cadmium concentrations are higher from September to November.

4.9.3.4 Canamax Tailings Storage Facility Discharge

Average total arsenic concentrations at On Site: TSF Area, On Site: Non-TSF Area and Receiving Environment Stations did not differ significantly between periods of TSF discharge versus periods of non-discharge (Table 4.9-7). This indicates that discharge from the Canamax TSF (similar to previous Water Licence requirements) did not significantly affect downstream water quality.

Table 4.9-7: Comparison of Average Total Arsenic Concentrations During Canamax Tailings Storage Facility Discharge and Non-Discharge Periods

Area	Average Total Arsenic Concentrations During TSF Discharge Periods			Average Total Arsenic Concentrations During TSF Non-Discharge Periods		
	Average (µg/L)	Standard Deviation (µg/L)		Average (µg/L)	Standard Deviation (µg/L)	
		Upper	Lower		Upper	Lower
On Site: TSF	215.01	444.61	<0	228.09	459.13	<0
On Site: Non TSF	21.45	41.32	1.58	28.65	70.16	<0
Receiving Environment	8.09	12.48	3.70	9.19	52.53	<0

4.9.4 Summary of Surface Water Quality Existing Conditions

A review of the water quality sampling results from KRP compared to the CCME (2003a) ALG indicates that:

- Eight chemicals are never or rarely found in high concentrations
  - Mercury, molybdenum, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2^-), phosphorus and thallium.
- Fifteen chemical and physical parameters are found occasionally, frequently or always in high concentrations
  - Aluminum, ammonia, ammonia (as N), arsenic, cadmium, copper, cyanide total, iron, lead, pH, nickel, selenium, silver, TSS and zinc
    - Lead concentrations, nickel concentrations and pH levels at Background Stations were unique. At these stations alone, they exceed the CCME ALG (Lead occasionally exceeds at KR23, nickel frequently exceeds at KR18 and pH is always below the CCME ALG at KR18)
    - The remaining parameter concentrations did not vary significantly between areas. Only minor differences were identified
    - The Background area has slightly higher concentrations of aluminum, cadmium, copper, nickel, selenium and zinc
    - The On Site: TSF area had slightly higher concentrations of ammonia (as N), arsenic and total cyanide
    - The On Site: Non TSF area had slightly higher concentrations of iron
    - There is not a significant water quality impact from the Canamax TSF Area on other waterbodies within the Local and Regional Study Areas
- The parameters which exceeded the CCME ALG do not have significant seasonal concentration changes (except potentially arsenic and cadmium down gradient of the Project Footprint)
- The parameters which exceeded the CCME ALG do not have significant concentration changes since 2005
- Discharge from the Canamax TSF (similar to previous Water Licence requirements) has not significantly affected downstream water quality.

4.10 Hydrology

4.10.1 Hydrological Setting

The KRP is within the South Mountain Hydrological Zone of the Yukon River Basin. The Local Study Area (LSA) for the Project lies at the headwaters of Cache Creek, an eastward flowing tributary of the Ketza River which, in turn, is a tributary of the Pelly River.

Within the Cache Creek Watershed (4,274 ha), there are three creeks and associated sub-watersheds: Oxo Creek (432 ha), Peel Creek (274 ha) and Misery Creek (1,431 ha). The three creeks are principal tributaries of Cache Creek.

The majority of creek alignments are in their natural condition. One exception is the set of diversion ditches that divert upper Cache Creek flows around the existing Canamax TSF, before merging back with Cache Creek approximately 300 to 400 m downstream (Figure 4.10-1).

The majority of discharges from the Canamax TSF have occurred during the high flow months and seepage from the Canamax TSF drains into Cache Creek.

4.10.2 Streamflow and Runoff

Flows associated with Cache Creek and its tributaries tend to be seasonally distinct and associated with temperature conditions; this seasonal cycle is the characteristic pattern of the hydrological regime for mountainous creeks in the Yukon. During winter periods (November to April), creeks are frozen and have very low flows. Spring (May to July) brings warmer temperatures, melting snow and ice and there are associated very high flows as the accumulated winter snowpack melts. During summer and fall (August to October), flows typically recede gradually until winter sets in. During the summer and fall period, stream flows are affected by a combination of rainfall events, melting of any remaining seasonal snowpacks, and groundwater inflows.

Flow data were obtained from an ongoing monthly monitoring program, as well as historical data provided by Yukon Nevada Gold Corp (YNG), an SRK report (1996) and YG Department of Environment (Water Resources) monitoring stations within the Cache Creek Watershed. All available flow data were obtained through instantaneous measurements (i.e., there are no continuous flow monitoring data for the Cache Creek Watershed).

Figure 4.10-1 shows the location of all monitoring stations, and Table 4.10-1 summarizes the available data, by station according to month, as used in the analysis. In total, 142 historical flow measurements from nine monitoring stations (ie. KR01, KR08, KR10, KR11, KR12, KR13, KR14, KR15, KR22) were collected to assist with characterizing the local hydrological regime.

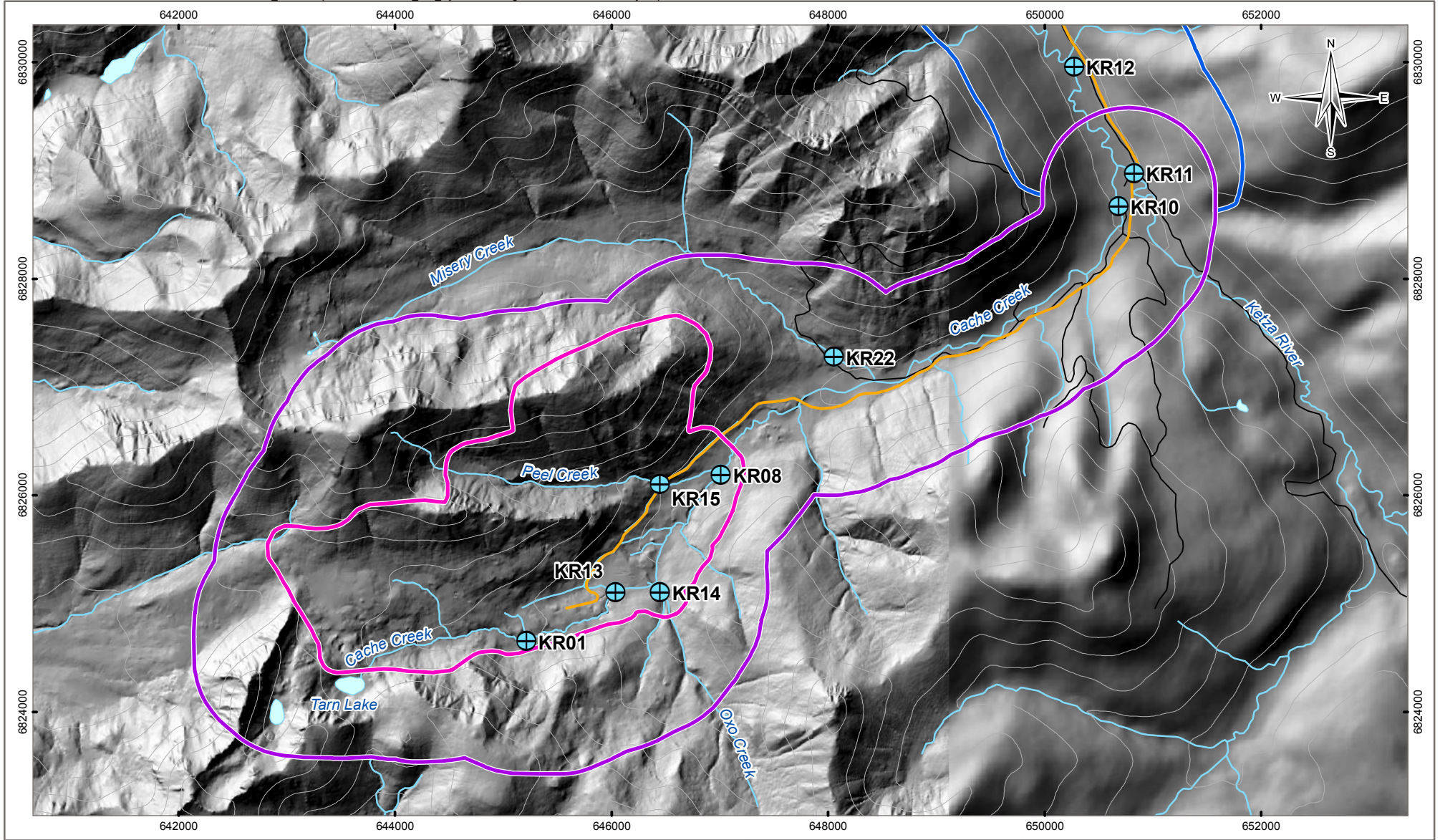
Table 4.10-1: Summary of Available Flow Monitoring Data for Cache Creek Watershed

Monitoring Station	Source**	Number of Measurements*											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
KR01	1, 2, 3	1	1	2		3	6	4				1	1
KR08	1, 2, 3, 4	2	1	3	3	7	8	7	6	6	5	2	1
KR10	1, 3, 4	2		1	2		1	1		1		2	1
KR11	1, 2, 4	2		1	2			2	1	2	1	2	2
KR12	1, 3, 4	2	1	2	2	2	1	1	3	1		1	
KR13	1, 4	1	1	1	1		3		2	1		1	1
KR14	1, 4	1		1	1		1	2		1	1	1	1
KR15	1, 3	1			1		1					1	1
KR22	1	1										1	1
Total		13	4	11	12	12	21	17	12	12	7	12	9

Note: * Total Number of Measurements per Month

** Sources: 1. EBA (ongoing sampling); 2. SRK (1996); 3. YNG; 4. YG, Department of Environment, Water Resources

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LEGEND

- Hydrology Monitoring Station
- Project Footprint
- Local Study Area
- Ketza Road Study Area
- Ketza Road
- Minor Road
- Contour (100 m)
- Watercourse
- Waterbody

NOTES
Base data source: NTS 1:50,000; Aero Geometrics, Ltd.

STATUS
ISSUED FOR USE

Scale: 1:50,000
1 0.5 0 1
Kilometres

PROJECTION	DATUM
UTM Zone 8	NAD27

FILE NO.
W23101052_114_HydroMonitoring.mxd

CLIENT
Ketza River Holdings

eba A TETRA TECH COMPANY

KETZA RIVER PROJECT

Hydrology Monitoring Stations

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	August 30, 2011

Figure 4.10-1

Given the limited amount of data available to assess annual flow distributions for each location, all available data were combined by using pro-rated flows based on corresponding contributing areas. The combined set of data enabled us to obtain an average monthly flow in $m^3/d/ha$ that was applicable to the Cache Creek watershed.

The average monthly flows for each month were then plotted to create a yearly runoff hydrograph per unit area of the LSA (Figure 4.10-2). The hydrograph can be applied to catchment areas within the Cache Creek watershed, to estimate runoff flows. Table 4.10.2 summarizes the average baseline flows at Peel Creek (near confluence with Cache Creek), Cache Creek at monitoring station KR10, and Ketza River at monitoring station KR12.

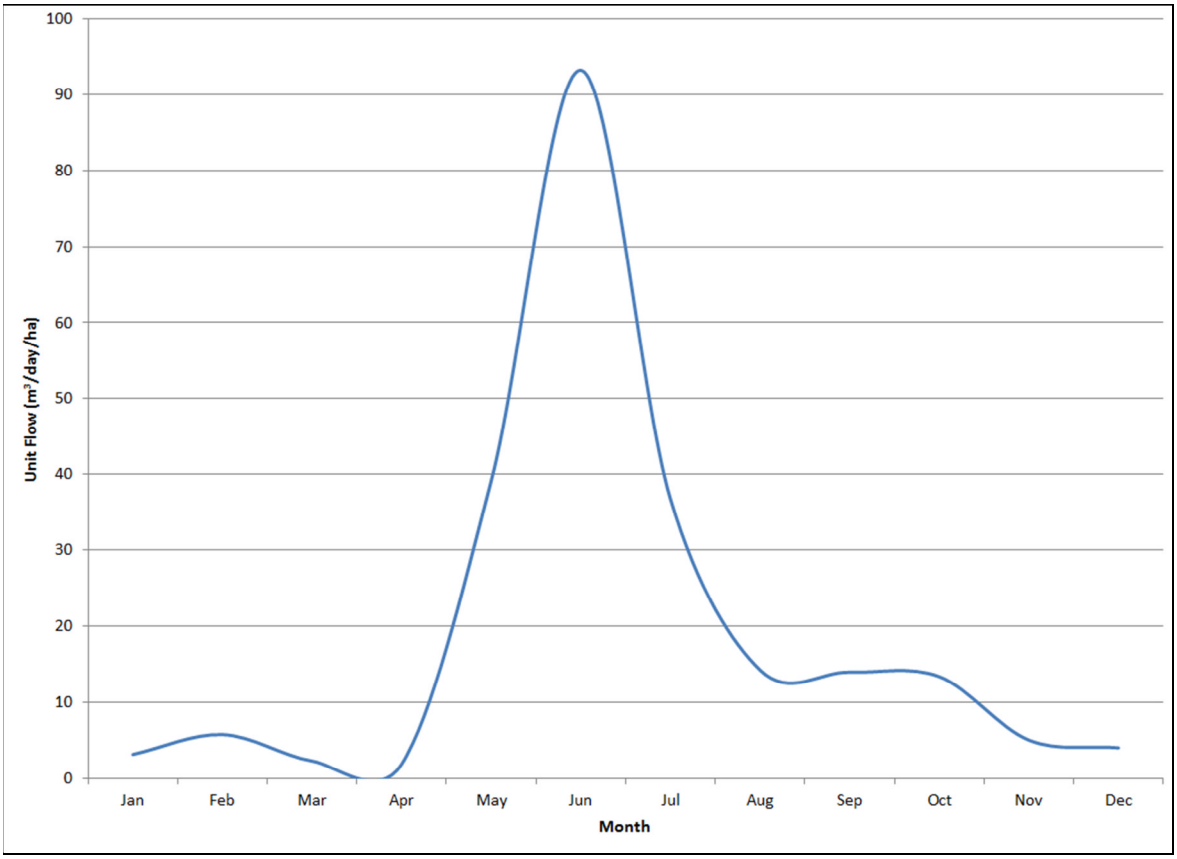


Figure 4.10-2: Average Monthly Flow Hydrograph per Unit Area for the Ketza River Project Local Study Area

Table 4.10-2: Baseline Average Monthly Flows (m^3/d) for Cache Creek and Ketza River

Month	Peel Creek (274 ha)	Cache Creek - KR10 (4274 ha)	Ketza River - KR12 (9,551 ha)
January	860	13,417	29,984
February	1,575	24,571	54,909
March	623	9,721	21,722
April	512	7,986	17,846
May	10,737	167,486	374,277
June	25,535	398,302	890,076
July	10,055	156,843	350,493
August	3,899	60,826	135,927
September	3,822	59,611	133,210
October	3,660	57,087	127,571
November	1,378	21,490	48,024
December	1,100	17,156	38,338

In addition to establishing baseline runoff conditions, an understanding of the natural monthly variability of flows in a stream is relevant when evaluating downstream residual impacts. Other authors, (i.e., Poff and Ward, 1989; Chiew and McMahon, 1993; McMahon and Finlayson, 2003) have suggested that the coefficient of variation (CV) (standard deviation/mean) can be used to assess temporal variabilities within a flow dataset. In order to evaluate the CV for monthly flows, long term data is required.

As noted previously, limited flow data are available in the Cache Creek Watershed, thus data from nearby stations were evaluated to supplement the local flow analysis. Historical hydrometric data were obtained from eleven regional hydrometric stations from the Water Survey of Canada (2011) as summarized in Table 4.10-3. These stations were selected based on their watershed area, length of data set, and distance to the Project's LSA. For each of these stations, the average monthly flow was obtained in order to estimate the average yearly hydrograph per unit area. The resulting hydrographs were plotted together and compared to the Cache Creek hydrograph.

As shown in Figure 4.10-3, three stations were then selected to supplement the flow analysis based primarily on the similarity of the hydrograph shape compared to the Cache Creek hydrograph. Shape is a relevant factor because it provides an indication of the hydrological regime pattern of the contributing watershed. In this case, it is important that the selected streams exhibit a flow regime typical of mountainous creeks in the Yukon.

Table 4.10-3: Regional Hydrometric Data Near the Ketza River Project Local Study Area

Station ID	Station Name	Drainage Area (Km^2)	Distance to KRP (Km)	Period of Record	Years of Peak Flow Data	Status
09AD001	Nisutlin River above Wolf River	8030	130	1979 - 1994	17 Daily, 16 Instant.	Inactive
09AD002	Sidney Creek at km 46 South Canol Road	372	90	1982 - 1994	13 Daily, 13 Instant.	Inactive
09AG001	Big Salmon River near Carmacks	6760	140	1951 - 1998	38 Daily, 36 Instant.	Inactive
09AG003	South Big Salmon River below Livingstone Creek	515	120	1982 - 1998	14 Daily, 13 Instant.	Inactive
09BA001	Ross River at Ross River	7250	50	1958 - 2010	47 Daily, 40 Instant.	Active
09BB001	South MacMillan River at km 407 Canol Road	997	175	1974 - 1998	22 Daily, 19 Instant.	Inactive
09BB002	MacMillan River near the Mouth	13800	230	1984 - 1998	12 Daily, 13 Instant.	Inactive
09BC001	Pelly River at Pelly Crossing	49000	50	1951 - 2010	56 Daily, 46 Instant.	Active
09BC002	Pelly River at Ross River	18400	50	1951 - 1977	19 Daily, 14 Instant.	Inactive
09BC004	Pelly River below Vangorda Creek	22100	100	1970 - 2010	37 Daily, 34 Instant.	Active

The CV of the three selected regional hydrometric station was evaluated for each month to illustrate the expected variability of flows within a month. To evaluate the natural variability of flows in the LSA, the average of the regional monthly CVs was obtained.

Table 4.10-4 summarizes the variability (+/-) around the mean monthly flows for the LSA, showing that there is year to year natural variability of flows in the LSA. Based on the analyses conducted here, monthly variability ranges from an estimated low of 31% (in June) to estimated highs of over 40% (in April, July, October and November).

Table 4.10-4: Natural Variability of Local Flows (+/- Percentage of Monthly Variability)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
09AD001	27%	18%	18%	41%	33%	31%	44%	27%	34%	33%	43%	44%
09AD002	21%	19%	26%	48%	38%	29%	43%	29%	43%	41%	37%	27%
10AB003	57%	66%	59%	44%	40%	35%	45%	37%	30%	54%	43%	36%
LSA Site	**35%**	**34%**	**34%**	**44%**	**37%**	**31%**	**44%**	**31%**	**36%**	**43%**	**41%**	**35%**

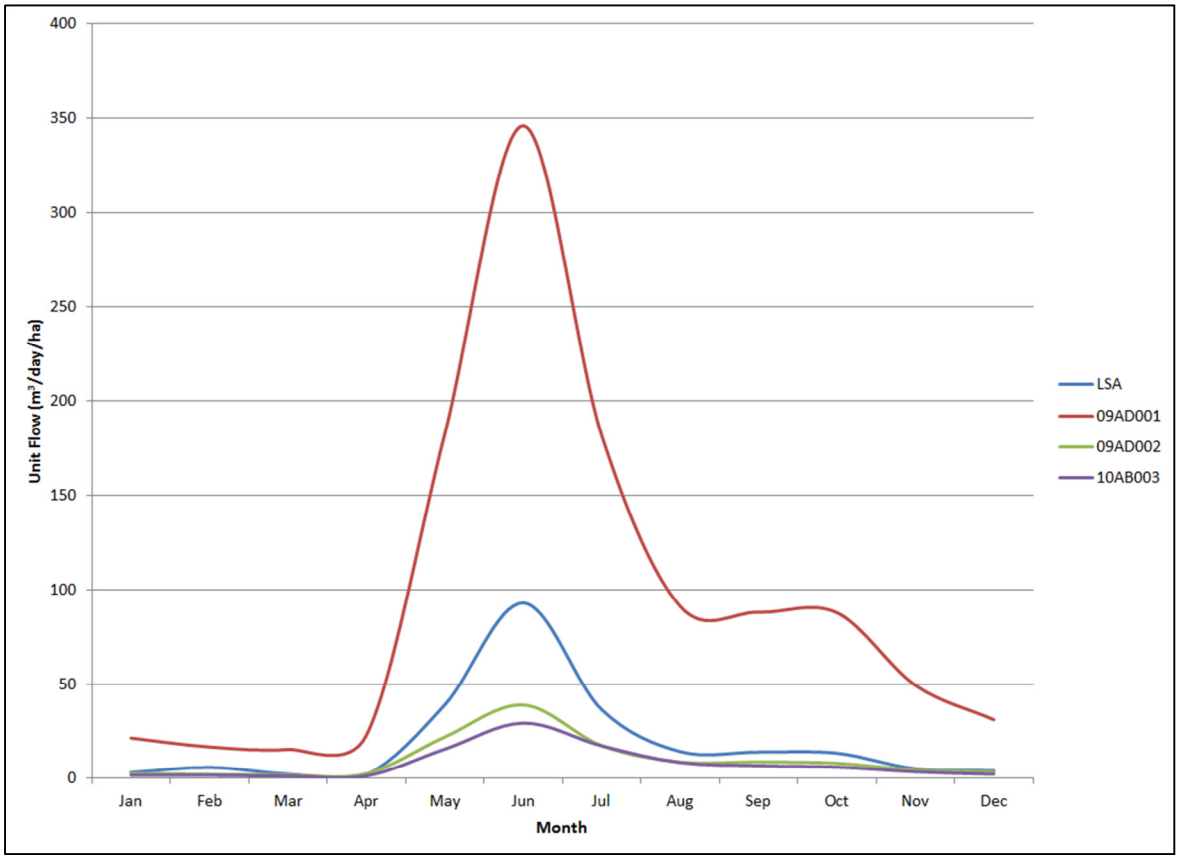


Figure 4.10-3: Local Study Area Hydrograph Comparison to Regional Hydrograph

4.11 Hydrogeology

This section describes the hydrogeological baseline conditions at the Site.

The hydrogeological regime includes the distribution, quantity and quality of groundwater flowing through porous unconsolidated and/or fractured bedrock subsurface materials. 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 KRP area have been used to develop a conceptual hydrogeological model of the KRP area which describes the baseline groundwater conditions before potential alteration by mining activities.

A Detailed Hydrogeological Assessment (DHA) was conducted to assess the groundwater conditions at the Site. 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 under YESAA. The DHA report is presented in Appendix H1.

The Site encompasses the area of the mine including all major mine components and areas downgradient of mine infrastructure to the area downgradient of the water retention pond. The extent of the LSA is shown in Figure 4.11-1. The Site is comprised of the Cache Creek and Peel Creek valleys and the mountain ranges between these two valleys and to the north of Peel Creek valley, including the ore deposit, the existing camp and mine infrastructure, and the areas of new mine facilities.

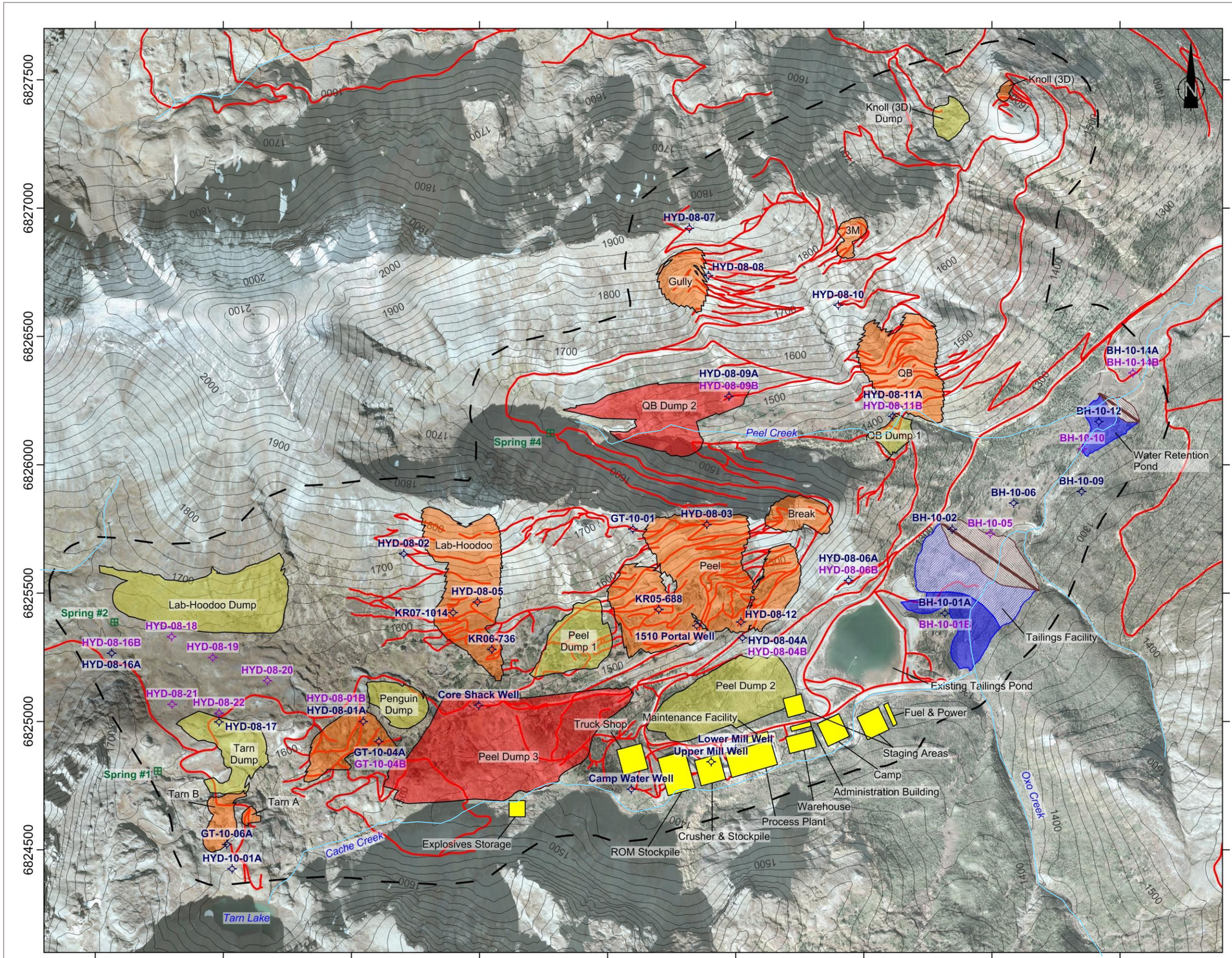
Geologically, the Site can be divided into the limestone dominated Manto Zone (Tarn, Penguin, Lab-Hoodoo pits and dumps, Peel dumps, and southwestern part of the Peel pit) and the argillite dominated Shamrock Zone (northwestern part of the Peel pit, and Break, Gully, QB, 3M, and Knoll pits and dumps, and the existing and proposed TSFs). The Manto and Shamrock Zones are divided by the Peel Fault striking WNW–ESE through the Peel pit. Figure 4.11-2 shows the extent of the Manto and Shamrock Zones in the KRP.

4.11.1 Hydrogeological Data for the Site

The hydrogeological program involved the following baseline data collection:

- Observations during the drilling of groundwater monitoring wells using diamond drilling, auger, or Becker Hammer drilling methods at key locations in the KRP area
- Logging drill core
- Hydraulic testing (packer tests, slug tests and pumping tests)
- Monitoring well installations, instrumentation installations and monitoring
- Groundwater sampling and chemical analysis.

In addition to five existing water supply wells, a total of 32 new groundwater observation wells were installed in the KRP area to study the hydrogeological regime, and in particular, the groundwater conditions in areas of mine infrastructure. Two existing exploration drill holes (KR05-688 and KR07-1014) were also completed as monitoring wells. Figure 4.11-1 shows the locations of all groundwater observation wells for this study. At some of the observation well locations, nested standpipe piezometers were installed in the same borehole. 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 15 to 200 metres below ground surface (m bgs) while shallow piezometers are installed within the overburden, typically at depths of less than 10 m bgs. Table 4.11-1 provides details of the groundwater observation wells along with measured groundwater elevations at different dates.



LEGEND

- Site Boundary

Proposed Infrastructure

- Buildings
- Pit Shells
- Waste Rock Dumps (NAG)
- Waste Rock Dumps (PAG/NAG)
- Tailings Storage Facility / Water Retention Pond
- Existing Road
- Contour (20 m)
- Watercourse
- Waterbody
- Bedrock Monitoring Well
- Overburden Monitoring Well
- Spring

NOTES

Base data source: 1:50,000 NTS
Imagery source: Aero Geometrics, Ltd

STATUS

ISSUED FOR USE

KETZA RIVER PROJECT

Site Plan Showing Monitoring Well Locations

250 125 0 250
Metres

CLIENT: Ketza River Holdings

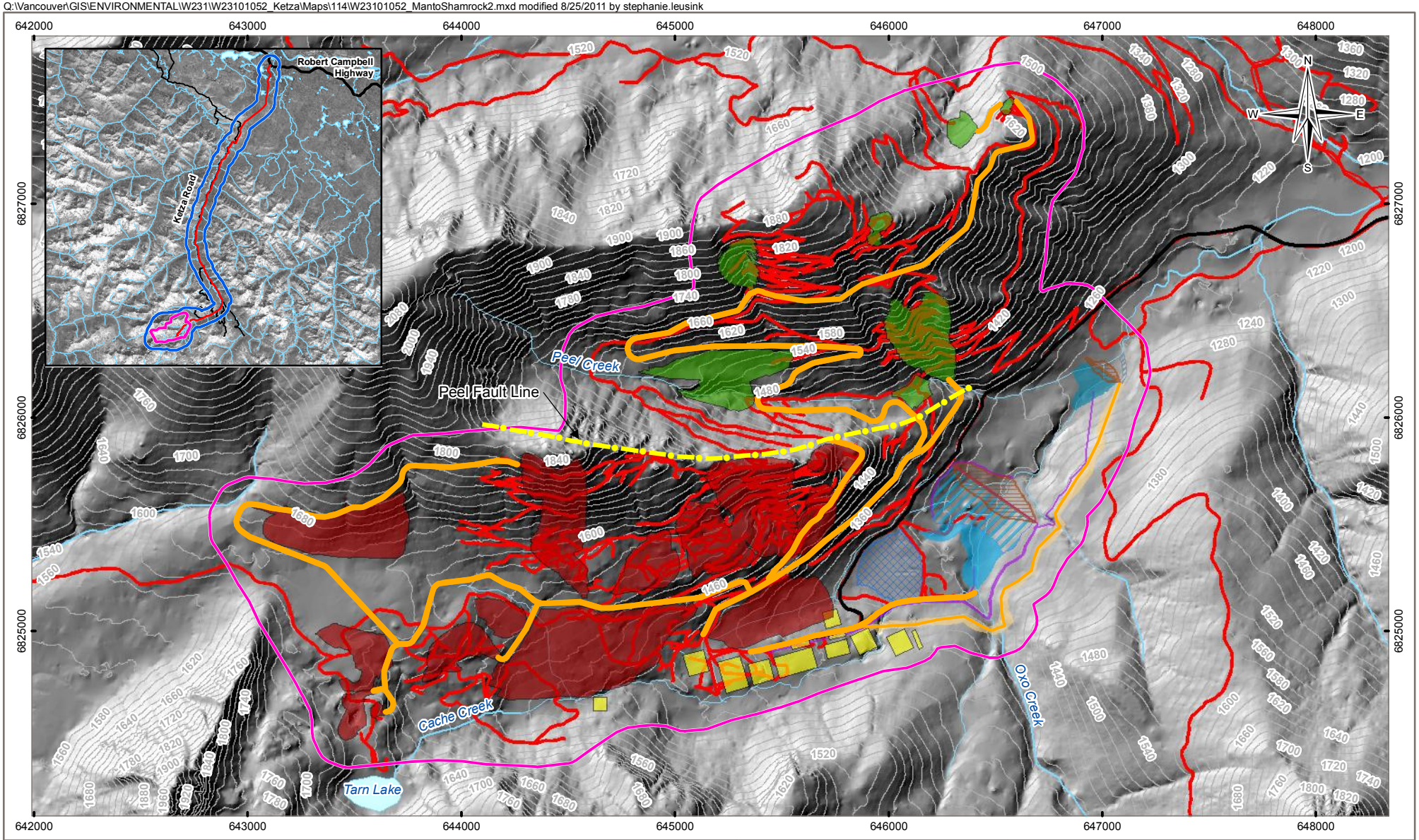
eba A TETRA TECH COMPANY

FILE NO.				
W23101052_104_MonitoringWells.cdr				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
W23101052.104	SK	RMM		1
OFFICE	**DATE**			
EBA-WHSE	August 3, 2011			

Figure 4.11-1

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LEGEND

- Peel Fault Line
- **Pit/Waste Dump Zone**
- Manto Zone
- Shamrock Zone
- Project Footprint
- Ketza Road
- Proposed Haul Roads
- Existing Road
- Contour (20 m)
- Watercourse
- Waterbody

NOTES
1. Base data source: 1:50,000 NTS
2. Imagery and contours provided by Aero Geometrics, Ltd
3. For detailed infrastructure footprint, see Figure 6.2-1

STATUS
ISSUED FOR USE

Scale: 1:25,000

500 250 0 500

Meters

PROJECTION	DATUM
UTM Zone 8	NAD27

FILE NO.
W23101052_MantoShamrock2.mxd

CLIENT
Ketza River Holdings

eba A TETRA TECH COMPANY

KETZA RIVER PROJECT

Plan Map Showing Open Pits, Waste Dumps and Peel Fault

PROJECT NO.	DWN	CKD	APVD	REV
V15101019.002	SL	JN	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 4.11-2

Drill cores were retrieved from all diamond drill holes (DDHs) and the core was logged for lithology and geotechnical properties, such as percent 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 4.11-3 shows the well log for HYD-08-01 as an example from the DHA report (see the DHA report in Appendix H1 for a complete set of well logs).

Hydraulic packer tests were conducted in most 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, constant rate pumping tests and slug 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 4.11-2.

Groundwater level measurements in both shallow and deep monitoring wells provided the necessary information required to interpret the groundwater flow regime (groundwater flow direction and hydraulic gradients). A map showing the hydraulic head contours deduced from observed groundwater elevations is provided in Figure 4.11-4.

Groundwater samples were collected from selected observation wells to assess baseline hydrogeochemistry (see Appendix H1). All samples were analyzed for chemical parameters, including field chemical parameters (pH, temperature, electrical conductivity, and dissolved oxygen), major cations and anions, and total and dissolved metals. The hydrogeochemical results were then compared to applicable water quality standards and guidelines to identify exceedances.

4.11.2 Hydrogeochemistry

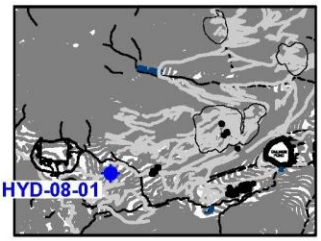
A summary of groundwater chemistry at the Site is provided in Appendix H1. The results suggest that groundwater within the KRP area has concentrations of TDS ranging from 87 to 3,280 mg/L, with most samples having a concentration less than 500 mg/L. The pH values range from 3.6 to 8.2 with most samples having a near neutral pH between 7 and 8. Hardness ranges from about 0.7 to 2,980 mg/L with most samples having a hardness of less than 500 mg/L. Dissolved oxygen concentrations ranged from 1.11 to 13.3 mg/L with values above 5 mg/L typically occurring in shallow overburden wells. An exception was at the Upper Mill Well, which is influenced by inflow from a shallow aquifer (as indicated by observations of water flowing in the well), and HYD-08-06A, which is a relatively shallow bedrock well (20.4 m bgs). The groundwater temperatures varied between 0.3°C to 9.1°C with the maximum temperature occurring in KR06-914 in August 2007 and the lowest temperature observed in HYD-10-01A during February 2011. A temperature of 10.4°C was observed in Spring #2, during August 2007. Variations in temperatures likely result from a shallow water component influenced by seasonal air and shallow soil temperature changes.

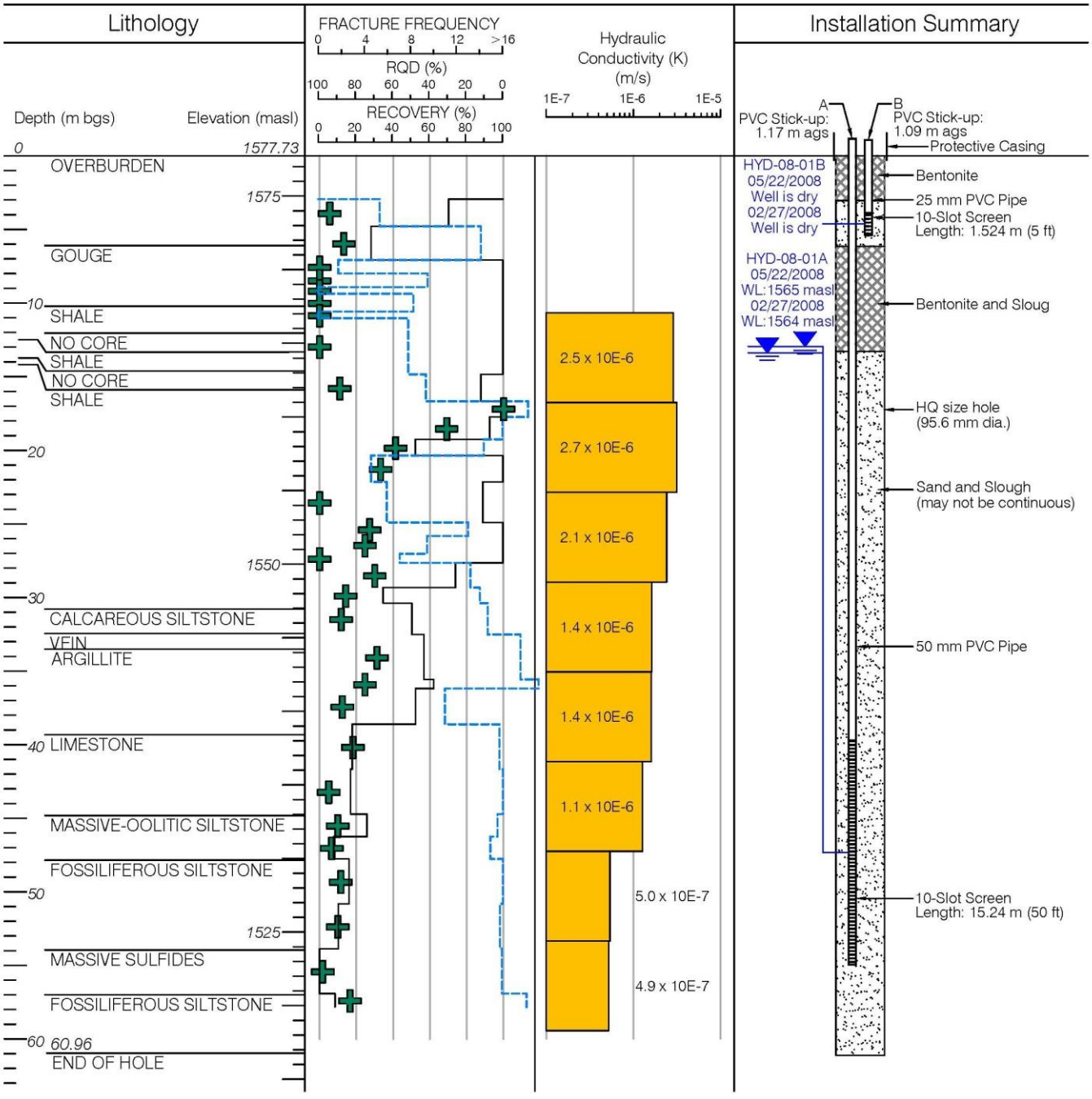
The following locations show greater variation from the majority of samples:

- Spring #1: Hardness of 667 mg/L; TDS of 780 mg/L
- HYD-08-11A: pH readings display values as low as 3.6 to 4.5; TDS varying from 684 to 1,060 mg/L
- HYD-08-06A: Hardness of 610 to 940 mg/L; TDS of 756 to 1,210 mg/L
- HYD-10-01A: Hardness of 2,980 mg/L, TDS of 3,280 mg/L.

BOREHOLE LOG

PROJECT NAME:	Detailed Hydrogeological Assessment	BOREHOLE NO.:	HYD-08-01
LOCATION:	Ketza River Mine	PROJECT NO.:	W23101050.003
CLIENT:	Ketza River Holdings	GROUND ELEVATION:	1577.73 masl
DRILL TYPE:	DDH - Hardrock Drilling	UTM (NAD27, Zone 8):	6825000 N; 644046 E
DRILL DATE:	February 22. 2008		
DRILL SIZE:	HQ	TREND/PLUNGE:	181°/-82.3°





LEGEND

- Fracture Frequency (No. Fractures/m)
- Recovery (%)
- Rock Quality Designation (RQD; %)

CLIENT

Ketza River Holdings

KETZA RIVER PROJECT

Borehole Log
HYD-08-01

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.104	CB	SK		1

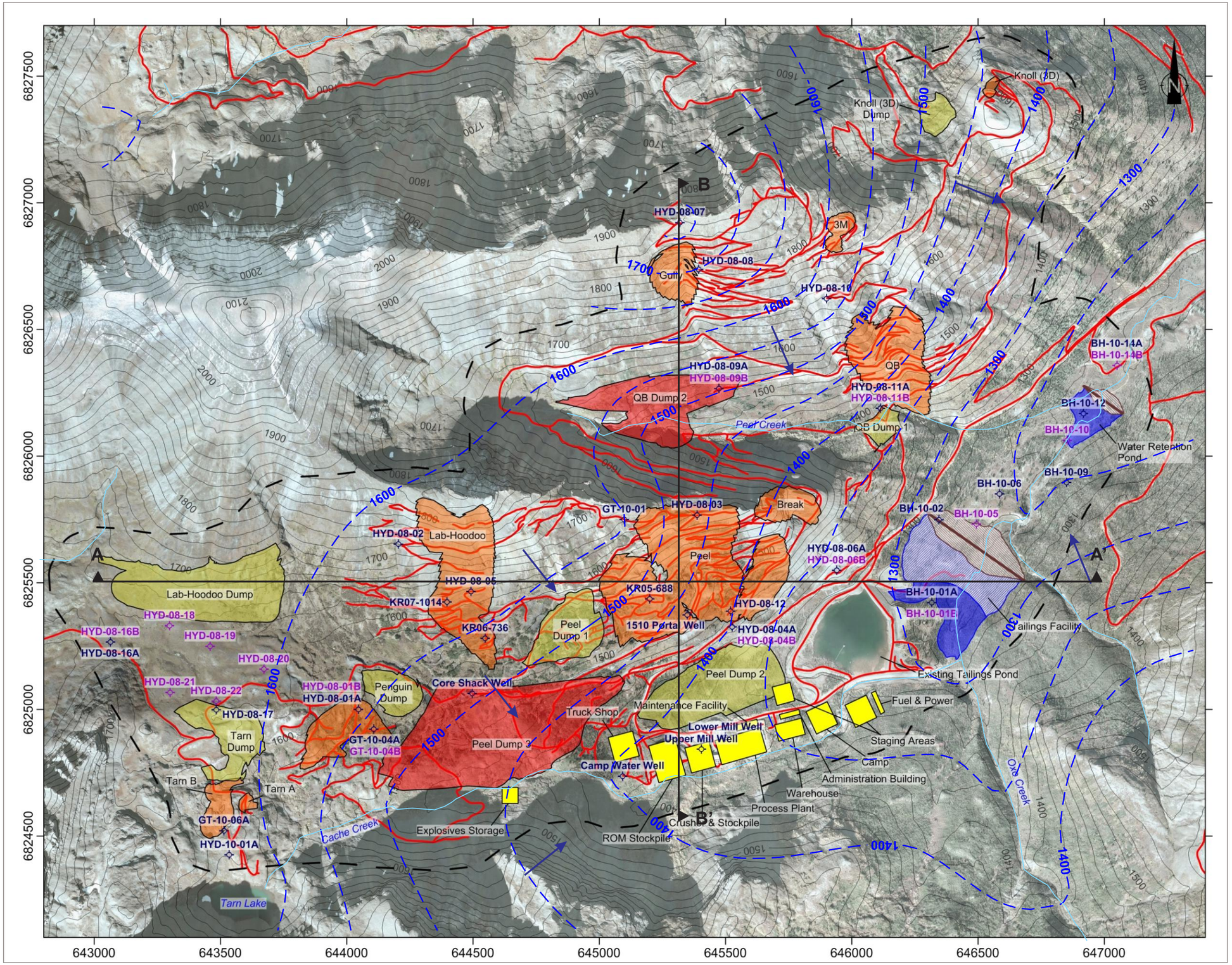
OFFICE	DATE
EBA-WHSE	August 3, 2011

Figure 4.11-3

STATUS
ISSUED FOR USE

eba
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LEGEND

- Site Boundary

Proposed Infrastructure

- Buildings
- Pit Shells
- Waste Rock Dumps (NAG)
- Waste Rock Dumps (PAG/NAG)
- Tailings Storage Facility / Water Retention Pond
- Existing Road
- Contour (20 m)
- Watercourse
- Waterbody
- Hydraulic Head Contour (m asl), Feb 2011
- Groundwater Flow Direction
- Bedrock Monitoring Well
- Overburden Monitoring Well
- Cross Section Line

NOTES

Base data source: 1:50,000 NTS
Imagery source: Aero Geometrics, Ltd

STATUS

ISSUED FOR USE

KETZA RIVER PROJECT

Groundwater Contours

250 125 0 250
Metres

CLIENT: Ketza River Holdings

eba A TETRA TECH COMPANY

FILE NO.				
W23101052_104_GWContours.cdr				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
W23101052.104	SK	RMM		1
OFFICE	**DATE**			
EBA-WHSE	August 3, 2011			

Figure 4.11-4

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Table 4.11-1: Groundwater Well Summary

Well ID	Date of Well Completion	UTM NAD27, Zone 8		Elevation	Measured Depth	True Vertical Depth	Screen Length	TPVC	TOC	Trend	Plunge	Date of Water Level Measurement	Depth to Water	Groundwater Elevation	Date of Water Level Measurement	Depth to Water	Groundwater Elevation	Date of Water Level Measurement	Depth to Water	Groundwater Elevation	Date of Water Level Measurement	Depth to Water	Groundwater Elevation	Date of Water Level Measurement	Depth to Water	Groundwater Elevation	Remarks
		Easting	Northing																							
		m	m	m asl	m bgs	m bgs	m	m ags	m ags			Summer 2007	m bgs	m asl	Winter 2008	m bgs	m asl	Spring 2008	m bgs	m asl	Summer 2010	m bgs	m asl	Winter 2011	m bgs	m asl	
KR05-688	27-May-2008	645200	6825437	1,533.38	69.64	69.64	12.19	1.26	1.30	-	-90.0	1-Aug-2007	41.80	1,491.58	-	-	-	27-May-2008	29.98	1,503.40	28-Jul-2010	45.80	1,487.58	20-Feb-2011	49.73	1,483.65	
KR07-1014	N/A	644397	6825425	1,612.00	16.40	16.40	-	-	-	-	-90.0	1-Aug-2007	10.60	1,601.40	-	-	-	27-May-2008	5.80	1,606.20	-	-	-	-	-	-	
Lower Mill Well	9-Aug-1987	645499	6824891	1,372.50	52.10	52.10	-	-	0.40	-	-90.0	-	1.15	1,371.35	21-Feb-2008	1.89	1,370.61	-	-	-	-	-	-	21-Feb-2011	2.12	1,370.38	Well blocked
Upper Mill Well	N/A	645404	6824843	1,381.53	74.65	74.65	-	-	0.58	-	-90.0	-	2.02	1,379.51	21-Feb-2008	1.84	1,379.69	27-May-2008	0.40	1,381.13	-	-	-	21-Feb-2011	3.06	1,378.47	
1510 Portal Well	8-Aug-1987	645348	6825374	1,495.45	92.58	92.58	-	-	0.11	-	-90.0	2-Aug-2007	62.49	1,432.96	-	-	-	24-May-2008	56.03	1,439.42	28-Jul-2010	64.19	1,431.26	-	-	-	
Core Shack Well	N/A	644497	6825063	1,521.67	39.19	39.19	-	-	0.27	-	-90.0	-	17.43	1,504.24	1-Mar-2008	27.78	1,493.89	21-May-2008	29.21	1,492.47	28-Jul-2010	31.13	1,490.55	20-Feb-2011	14.25	1,507.42	
Camp Water Well	11-Aug-1987	645092	6824737	1,409.50	99.06	99.06	-	-	0.32	-	-90.0	-	-	-	1-Mar-2008	18.51	1,390.99	20-May-2008	20.24	1,389.26	-	-	-	21-Feb-2011	18.99	1,390.51	
HYD-08-01A	27-Feb-2008	644046	6825000	1,577.73	54.95	54.45	15.24	1.17	1.30	181.0	-82.3	-	-	-	27-Feb-2008	13.37	1,564.48	22-May-2008	12.99	1,564.87	28-Jul-2010	12.04	1,565.80	22-Feb-2011	16.72	1,561.17	
HYD-08-01B	27-Feb-2008	644046	6825000	1,577.73	6.52	6.46	1.52	1.09	1.30	181.0	-82.3	-	-	-	-	-	-	22-May-2008	1.22	1,576.52	28-Jul-2010	1.47	1,576.28	22-Feb-2011	2.98	1,574.78	
HYD-08-02	10-Mar-2008	644204	6825653	1,718.68	166.73	164.35	6.10	1.17	1.19	75.9	-80.3	-	-	-	10-Mar-2008	137.16	1,583.48	25-May-2008	124.35	1,596.11	28-Jul-2010	137.83	1,582.82	-	-	-	
HYD-08-03	3-Mar-2008	645387	6825768	1,615.85	149.35	146.45	6.10	-	1.46	195.8	-78.7	-	-	-	-	-	-	24-May-2008	-	-	28-Jul-2010	DRY	-	-	-	-	Well is dry
HYD-08-04A	26-Feb-2008	645526	6825326	1,426.69	100.47	100.04	6.10	1.12	1.25	58.7	-84.7	-	-	-	27-Feb-2008	16.08	1,410.69	24-May-2008	17.68	1,409.09	28-Jul-2010	23.70	1,403.09	20-Feb-2011	26.74	1,400.07	
HYD-08-04B	26-Feb-2008	645526	6825326	1,426.69	4.07	4.05	1.52	1.30	1.44	58.7	-84.7	-	-	-	-	-	-	24-May-2008			28-Jul-2010	DRY	-	20-Feb-2011	FROZEN	-	
HYD-08-05	20-Mar-2008	644492	6825466	1,614.91	99.67	99.33	10.67	1.23	1.30	65.4	-85.3	-	-	-	19-Mar-2008	37.00	1,578.03	25-May-2008	35.08	1,579.95	28-Jul-2010	35.23	1,579.80	20-Feb-2011	37.54	1,577.50	
HYD-08-06A	28-Feb-2008	645941	6825549	1,347.66	20.42	20.34	3.05	0.91	1.12	83.8	-84.8	-	-	-	1-Mar-2008	5.88	1,341.80	24-May-2008	6.18	1,341.51	29-Jul-2010	6.63	1,341.06	19-Feb-2011	6.91	1,340.78	
HYD-08-06B	28-Feb-2008	645941	6825549	1,347.66	2.55	2.54	1.52	0.90	1.12	83.8	-84.8	-	-	-	-	-	-	24-May-2008	-	-	29-Jul-2010	DRY	-	19-Feb-2011	FROZEN	-	Well is dry
HYD-08-07	26-Feb-2008	645319	6826923	1,875.27	163.68	158.61	6.10	1.30	1.37	176.6	-75.7	-	-	-	-	-	-	27-May-2008	-	-	29-Jul-2010	108.30	1,770.32	-	-	-	Well blocked (ice)
HYD-08-08	29-Feb-2008	645394	6826737	1,784.95	102.72	101.75	15.24	-	1.57	281.0	-82.1	-	-	-	-	-	-	27-May-2008	96.23	1,689.63	29-Jul-2010	89.23	1,696.56	-	-	-	
HYD-08-09A	4-Mar-2008	645474	6826267	1,520.36	60.05	59.63	6.10	0.85	1.16	251.7	-83.2	-	-	-	5-Mar-2008	23.90	1,496.62	27-May-2008	2.60	1,517.78	29-Jul-2010	17.93	1,502.55	-	-	-	
HYD-08-09B	4-Mar-2008	645474	6826267	1,520.36	2.37	2.35	1.52	0.98	1.16	251.7	-83.2	-	-	-	-	-	-	27-May-2008	0.95	1,519.41	29-Jul-2001	DRY	-	-	-	-	
HYD-08-10	2-Mar-2008	645900	6826622	1,657.53	111.86	110.57	3.05	1.28	1.30	54.4	-81.3	-	-	-	5-Mar-2008	71.27	1,587.08	27-May-2008	52.59	1,605.54	29-Jul-2010	77.40	1,581.02	-	-	-	
HYD-08-11A	6-Mar-2008	646114	6826189	1,390.03	30.78	30.59	15.24	1.00	1.14	17.5	-83.7	-	-	-	7-Mar-2008	15.61	1,374.51	24-May-2008	8.88	1,381.20	29-Jul-2010	12.57	1,377.54	-	-	-	
HYD-08-11B	6-Mar-2008	646114	6826189	1,390.03	7.09	7.04	1.52	1.00	1.14	17.5	-83.7	-	-	-	-	-	-	24-May-2008	-	-	29-Jul-2010	DRY	-	-	-	-	Well is dry
HYD-08-12	27-Feb-2008	645520	6825388	1,446.54	16.13	16.07	3.05	1.20	1.23	46.8	-85.0	-	-	-	-	-	-	24-May-2008	-	-	28-Jul-2010	DRY	-	-	-	-	Well is dry
HYD-08-16A	21-May-2008	643064	6825266	1,636.70	60.16	59.99	12.19	1.16	1.19	81.9	-85.7	-	-	-	-	-	-	26-May-2008	10.87	1,625.87	28-Jul-2010	8.86	1,627.87	22-Feb-2011	14.08	1,622.66	
HYD-08-16B	21-May-2008	643064	6825266	1,636.70	7.70	7.67	1.52	1.16	1.19	81.9	-85.7	-	-	-	-	-	-	26-May-2008	-	-	28-Jul-2010	7.61	1,629.12	22-Feb-2011	FROZEN	-	Well is dry
HYD-08-17	23-May-2008	643484	6824999	1,621.99	40.09	40.02	12.19	0.98	1.20	86.7	-86.7	-	-	-	-	-	-	26-May-2008	1.60	1,620.39	28-Jul-2010	2.06	1,619.94	21-Feb-2011	2.72	1,619.28	
HYD-08-18	23-May-2008	643298	6825331	1,635.00	1.38	1.38	1.52	0.78	-	-	-90.0	-	-	-	-	-	-	26-May-2008	-	-	28-Jul-2010	DRY	-	-	-	-	Well is dry
HYD-08-19	25-May-2008	643459	6825250	1,632.00	4.59	4.59	1.52	0.79	0.83	-	-90.0	-	-	-	-	-	-	26-May-2008	2.01	1,629.99	28-Jul-2010	3.45	1,628.55	-	-	-	
HYD-08-20	25-May-2008	643672	6825159	1,628.00	4.52	4.52	1.52	0.70	0.83	-	-90.0	-	-	-	-	-	-	26-May-2008	1.97	1,626.03	28-Jul-2010	DRY	-	23-Feb-2011	DRY	-	
HYD-08-21	23-May-2008	643300	6825067	1,626.00	4.36	4.36	1.52	0.73	0.65	-	-90.0	-	-	-	-	-	-	26-May-2008	1.53	1,624.48	28-Jul-2010	2.78	1,623.22	-	-	-	
HYD-08-22	26-May-2008	643483	6825033	1,624.00	4.52	4.52	1.52	0.75	0.80	-	-90.0	-	-	-	-	-	-	26-May-2008	-0.07	1,624.07	28-Jul-2010	1.06	1,622.94	-	-	-	Artesian well
HYD-10-01A	13-Aug-2010	643535	6824426	1,655.00	70.00	69.73	12.19	0.98	1.03	80.0	-85.0	-	-	-	-	-	-	-	-	-	14-Aug-2010	26.05	1,629.05	22-Feb-2011	36.91	1,618.23	
GT-10-01	2-Aug-2010	645099	6825750	1,665.00	201.78	194.90	15.24	?	?	110.0	-75.0	-	-	-	-	-	-	-	-	-	14-Aug-2010	111.51	1,557.29	-	-	-	
GT-10-04A	8-Aug-2010	644107	6824922	1,552.00	76.81	74.19	12.19	1.15	1.15	305.0	-75.0	-	-	-	-	-	-	-	-	-	14-Aug-2010	9.78	1,542.55	22-Feb-2011	17.37	1,535.22	
GT-10-04B	8-Aug-2010	644107	6824922	1,552.00	5.45	5.45	3.05	1.05	1.15	-	-90.0	-	-	-	-	-	-				14-Aug-2010	DRY	-	22-Feb-2011	5.39	1,546.61	
GT-10-06A	11-Aug-2010	643514	6824522	1,642.00	61.57	59.47	-	-	-	280.0	-75.0	-	-	-	-	-	-	-	-		7-Aug-2010	14.50	1,627.99	-	-	-	Thermistor installed
BH-10-01A	5-Dec-2010	646317	6825423	1,292.66	20.13	20.13	3.05	0.88	-	-	-90.0	-	-	-	-	-	-	-	-		-	-	-	19-Feb-2011	10.41	1,282.25	
BH-10-01B	5-Dec-2010	646317	6825423	1,292.66	10.75	10.75	3.05	0.80	-		-90.0	-	-	-	-	-	-				-	-	-	19-Feb-2011	10.67	1,281.99	
BH-10-02	4-Dec-2010	646345	6825749	1,281.74	14.09	14.09	3.05	0.86	-	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	5.58	1,276.17	
BH-10-05	30-Nov-2010	646493	6825731	1,267.78	8.53	8.53	3.05	0.66	-	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	4.74	1,263.04	
BH-10-06	2-Dec-2010	646585	6825851	1,270.58	21.10	21.10	3.05	0.97	-	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	8.22	1,262.37	
BH-10-08	16-Nov-2010	646715	6825984	1,264.04	22.88	22.88	?	0.61	-	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	22.95	1,241.09	
BH-10-09	24-Nov-2010	646850	6825896	1,264.96	13.26	13.26	3.05	0.84	-	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	10.71	1,254.26	
BH-10-10	12-Nov-2010	646853	6826063	1,234.98	5.94	5.94	3.96	0.76	-	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	1.43	1,233.55	
BH-10-12	13-Nov-2010	646918	6826168	1,233.86	16.62	16.62	3.05	0.69	-	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	3.53	1,230.33	
BH-10-14A	27-Nov-2010	647051	6826358	1,215.49	15.90	15.90	3.05	0.65	0.76	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	3.03	1,212.46	
BH-10-14B	27-Nov-2010	647051	6826358	1,215.55	6.82	6.82	3.05	0.71	0.756	-	-90.0	-	-	-	-	-	-	-	-	-	-	-	-	19-Feb-2011	3.84	1,211.71	

Notes:
m asl - metres above sea level
m ags - metres above ground surface
m bgs - metres below ground surface
N/A and ' - not available/does not exist
TPVC - top of PVC
TOC - top of casing

Table 4.11-2: Hydraulic Test Results

Well ID	Geology Zone	Area of Proposed Mine Infrastructure	Packer Test Results				Pumping Test Results
			Test Interval		Hydraulic Conductivity		
			From	To	Average	Geometric Mean	
			m bgs	m bgs	m/s	m/s	m/s
HYD-08-04A	Manto Zone	Peel Pit	-	-	-	-	2E-08
GT-10-01		Peel Pit	112	119	2E-07	1E-07	-
			136	147	3E-08		-
			155	171	4E-07		-
			161	171	2E-08		-
			190	200	4E-07		-
GT-10-02		Peel Pit	179	187	1E-07		-
KR05-688		Peel Pit	-	-	-	-	3E-08
Core Shack Well		Peel Dump 3	-	-	-	-	4E-06
HYD-08-05		Lab-Hoodoo Pit	37	43	2E-07	4E-07	2E-06
			43	49	1E-07		
			49	55	1E-07		
			55	62	1E-07		
			62	68	1E-07		
			68	74	8E-07		
			74	80	5E-07		
			80	86	1E-06		
			86	92	2E-06		
			92	98	1E-06		
HYD-08-16		Lab-Hoodoo Dump	10	16	3E-06	3E-06	4E-06
			16	22	4E-06		
			22	28	4E-06		
			28	34	3E-06		
			34	40	3E-06		
			40	46	3E-06		
			46	52	2E-06		
			52	59	2E-06		
HYD-08-01		Penguin Pit	11	17	2E-06	1E-06	4E-06
			17	23	3E-06		
			23	29	2E-06		
			29	35	1E-06		
			35	41	1E-06		
			41	47	1E-06		
			47	53	5E-07		
			53	59	5E-07		
GT-10-04		Penguin Pit	20	31	3E-08	2E-07	-
			40	51	2E-06		-
			65	75	8E-08		-
GT-10-06		Tarn Pit	22	27	5E-07		-
			43	60	<1E-08		-
HYD-08-17		Tarn Dump	4	10	<1E-08	4E-07	1E-06
			10	16	3E-06		
			16	22	4E-07		
			22	28	5E-07		
			28	34	4E-08		
			34	40	2E-06		
HYD-08-21		Tarn Dump	-	-	-	-	9E-07
HYD-08-22		Tarn Dump	-	-	-	-	6E-05
HYD-10-01		Between Tarn Pit and Tarn Lake	10	20	1E-08	2E-08	-
			22	33	3E-08		-
			34	45	<1E-08		-
HYD-08-08	Shamrock Zone	Gully Pit	77	83	2E-06	2E-06	2E-06
			83	89	2E-06		
			89	95	2E-06		
			95	101	2E-06		
HYD-08-11		QB Pit / QB Dump1	11	17	3E-06	3E-06	3E-07
			17	23	4E-06		
			23	29	3E-06		
HYD-08-09A		QB Dump 2	-	-	-	-	4E-07
BH-10-01		Tailings	18	21	<1E-08		-
BH-10-06		Tailings	14	17	2E-07	2E-07	-
			14	22	<1E-08		-
			15	22	1E-07		-
BH-10-09		Tailings	9	15	1E-06	4E-07	-
			12	15	1E-07		-
BH-10-14		Tailings	9	12	3E-07	3E-07	-
			10	16	2E-07		-
Upper Mill Well		Mill	-	-	-	-	1E-06
Lower Mill Well		Mill	-	-	-	-	2E-06

4.11.2.1 Major Ion Chemistry and Hydrochemical Facies

The groundwater samples can be classified based on their major ion chemical composition, taking into account all major anions and cations exceeding 10 meq-%[1]. The water type or hydrochemical facies is determined by listing the ions with concentrations greater than 10 meq-% in decreasing order (cations are listed first). Figure 4.11-5 shows a trilinear Piper Plot illustrating the major ion chemistry and hydrochemical facies for all groundwater samples collected. The water type of each sample is also presented in Appendix H1.

Calcium is the dominating cation in the majority of the samples. Magnesium was found in concentrations exceeding 10 meq-% in about 80% of the samples. Samples from KR05-688, Spring #1, Spring #2, HYD-08-01B, HYD-08-05A, HYD-08-06A, HYD-08-16A, HYD-08-21, HYD-08-22, BH-10-02, BH-10-06 did not contain magnesium in excess of 10 meq-%. Magnesium was the dominating cation found in water from HYD-10-01A. Dissolved iron was found in concentrations very close to and exceeding 10 meq-% in samples from HYD-08-11A and sodium was found in concentrations very close to 10 meq-% in samples from BH-10-14A and exceeding 10 meq-% in samples from BH-10-06.

The dominating anions in the samples collected at the Site are bicarbonate and sulphate. Bicarbonate is the dominating anion in about 70% of the samples collected. Bicarbonate is the only anion exceeding 10 meq-% in samples from KR06-914, Spring #2, HYD-08-16A, HYD-08-21, and HYD-08-22. Sulphate is the dominating anion in about 30 percent of the samples collected. Sulphate is the only anion exceeding 10 meq-% in samples from Spring #4, HYD-08-06A, HYD-08-09A, HYD-08-11A, HYD-10-01A and BH-10-09.

The chemical composition of groundwater strongly depends on the local and upgradient aquifer lithologies. As groundwater flows through an aquifer it assumes and continuously evolves a characteristic chemical composition due to interaction 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 different hydrochemical facies of the groundwater samples from the Site widely coincide with the aquifer lithology indicated on the Bedrock Geology Map (Figure 4.3-2). Samples from wells that are located within the Lab-Hoodoo Dump area are outside and upstream of the mineralized area, and represent calcium - bicarbonate ($Ca\text{-}HCO_3$) or calcium – magnesium - bicarbonate ($Ca\text{-}Mg\text{-}HCO_3$) type waters.

Samples collected from the mineralized Tarn, Penguin, and Peel areas, and from the downstream areas within Cache Creek valley are mostly of calcium – magnesium – bicarbonate – sulphate ($Ca\text{-}Mg\text{-}HCO_3\text{-}SO_4$) type. Samples from the Shamrock zone (Gully, QB, and 3M), however, exhibit $Ca\text{-}Mg\text{-}SO_4$ water types, lacking a significant bicarbonate component. Hence, all groundwater samples collected from mineralized areas – unlike those from outside and upstream of mineralized areas – contain a significant amount of sulphate. The sulphate most likely results from the oxidation of sulphide minerals which are abundant within the ore bodies. Oxidation of sulphide minerals, mainly consisting of pyrrhotite, pyrite, and arsenopyrite, releases sulphate, iron, and arsenic into the groundwater. However, iron can form

1 The unit meq-% represents the percentage of cations and anions calculated from their milliequivalents per litre (meq/L). The unit meq/L is the molar concentration multiplied by the charge of the ions.

(oxy)hydroxide precipitates in the presence of oxygen, and arsenic can be partly immobilized by absorption onto iron (oxy)hydroxide mineral surfaces.

Bicarbonate is the dominating anion in the groundwater samples from the Manto zone and in the samples from the Cache Creek valley which is in agreement with the main aquifer lithology consisting of limestone and calcareous argillite. By contrast, groundwater samples from the Shamrock zone have low concentrations of bicarbonate, corresponding to the local aquifer lithology which is mainly composed of argillite.

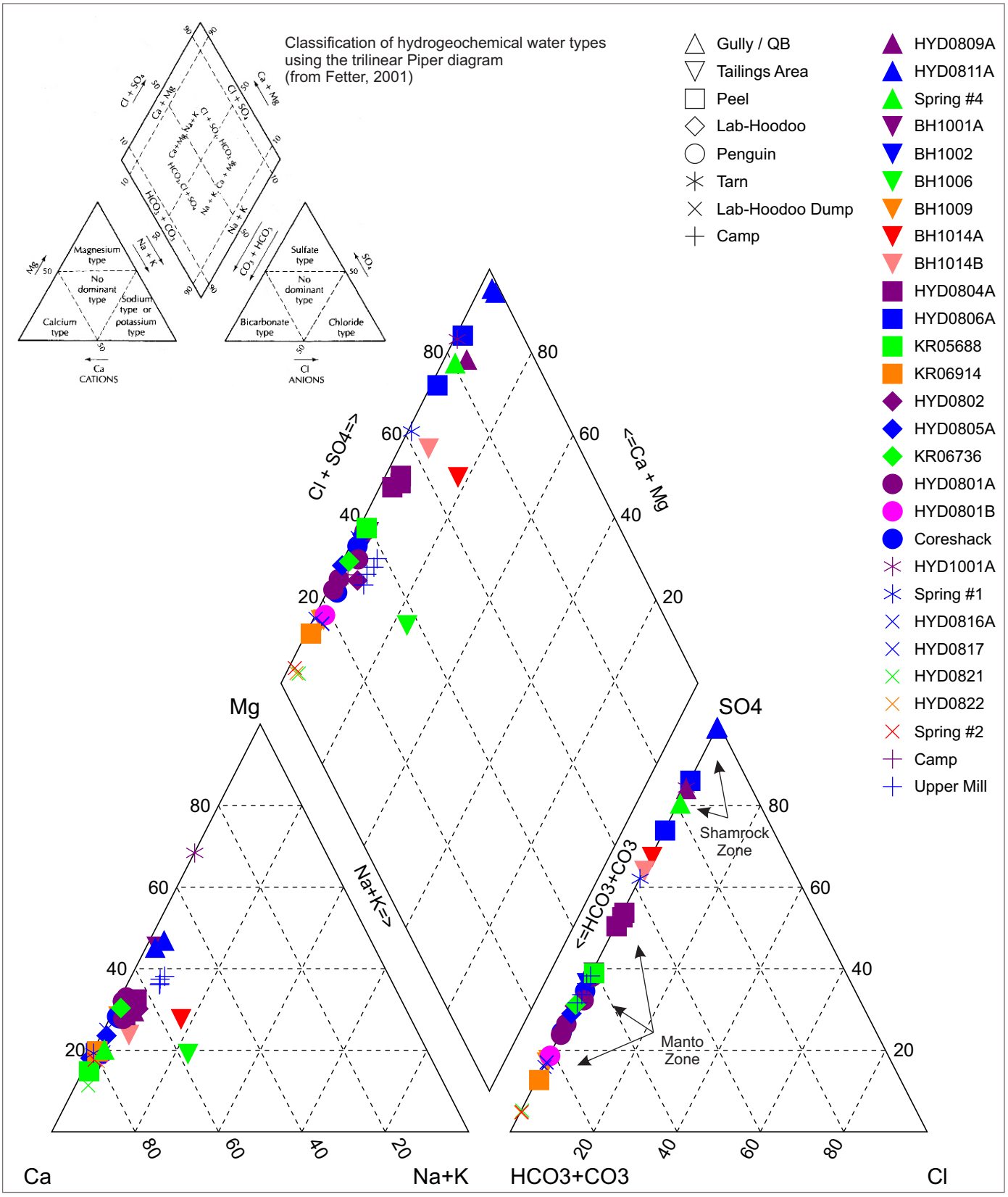
4.11.2.2 Comparison of Project Area Hydrogeochemistry with Guidelines and Standards

All groundwater samples were analyzed for their concentrations of total and dissolved metals. The following guidelines and standards were used for comparison (note that MMER and CCME ALG apply to surface water only and are used here for reference purposes only):

- Yukon Contaminated Sites Regulations (CSR): Aquatic Life Standards – these apply to groundwater and surface water at the Site; however, background concentrations must be taken into consideration. In accordance with the standards, when comparing metals concentrations, total metals are used for surface water sample comparison, and dissolved metals concentrations for groundwater are compared with these standards. In accordance with Part 2 of the CSR: "A site is not a contaminated site if the site does not contain any contaminant with a concentration greater than or equal to the local background concentration of that contaminant"
- MMER – maximum authorized monthly mean concentration in discharge (to surface water) from an active mine site (**reference only**)
- MMER – maximum authorized concentration in a grab sample from discharge (to surface water) at an active mine site (**reference only**)
- CCME ALG (**reference only**).

Many dissolved metal concentrations exceeded the CCME ALG values and some also exceeded CSR standards and MMER guidelines. All exceedances are marked in Appendix H1, and dissolved metals exceeding the guidelines are discussed below:

- **Aluminum** concentrations in both samples from observation well HYD-08-11A located in the Shamrock zone exceeded the CCME ALG value of 0.1 mg/L.
- **Arsenic** concentrations exceeded the CCME ALG value of 0.005 mg/L, in most of the groundwater samples except for those from the western part of the KRP area, including the observation wells HYD-08-16, HYD-08-21, and Spring #2, and the southeast side of Cache Creek at BH-10-09. Arsenic concentrations also exceeded the CSR guideline value of 0.05 mg/L in 19 of the 48 samples taken (including 13 of the 29 sampling locations). Samples from observation wells HYD-08-01B (1 of 1), HYD-08-04A (1 of 2) HYD-08-05A (2 of 2), HYD-10-01A (1 of 1), BH-10-14A (1 of 1), in the Penguin Zone also exceeded the MMER guideline value of 0.5 mg/L, and a sample obtained from well HYD-08-09A in the Shamrock zone fell only slightly below that guideline value. Generally, the highest arsenic concentrations were measured within the Penguin and Shamrock zones.



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CLIENT
Ketza River Holdings

KETZA RIVER PROJECT

Piper Plot

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.104	SK	RMM		0

OFFICE	DATE
EBA-WHSE	July 26, 2011

STATUS
ISSUED FOR USE

eba
A TETRA TECH COMPANY

Figure 4.11-5

- **Cadmium** concentrations in samples from the wells HYD-08-09A, HYD-08-11A, and HYD-08-16A exceeded the CCME ALG value, which depends on the individual hardness of the water sample. The samples obtained from wells HYD-08-09A and HYD-08-11A also exceeded the CSR guideline for cadmium of 0.0005 mg/L. The observation wells HYD-08-09A and HYD-08-11A, which exceeded the CCME ALG and CSR guideline for cadmium, are both located within the Shamrock zone. Observation well HYD-08-16A, whose water sample exceeded only the CCME ALG, is located west of the Lab-Hoodoo dump upgradient of the exploration zones.
- The **chromium** concentration in the sample from well HYD-08-01A slightly exceeded the CCME ALG guideline value of 0.001 mg/L for hexavalent chromium, and part of the other samples have detection limits above that guideline value. However, all measured chromium concentrations and detection limits fall below the CCME ALG value of 0.0089 mg/L for trivalent chromium. The high iron concentrations in most of the samples indicate reducing in situ conditions, suggesting that chromium mainly occurs in the reduced trivalent oxidation state.
- **Cobalt** concentrations in both samples from observation well HYD-08-11A (Shamrock zone) exceeded the CSR guideline value of 0.009 mg/L, and the cobalt concentration in the sample from well KR06-914 (Penguin zone) was equal to the CSR guideline value.
- **Copper** concentrations in the samples from well HYD-08-11A (Shamrock zone) exceeded both CCME ALG and CSR guideline values of 0.002-0.004 and 0.05-0.09, respectively, which depend on the individual hardness of the sample.
- **Iron** concentrations in most samples exceeded the CCME ALG value of 0.3 mg/L with the highest concentrations occurring in the Shamrock, Tarn, and Penguin zones, and considerably lower iron concentrations in the Peel zone.
- **Mercury** concentrations exceeded the CCME ALG value of 0.000026 mg/L at the Camp well, Upper Mill well, and Spring #4. However, the Upper Mill well has been re-sampled twice and mercury concentrations in both samples, in the subsequent sampling, fell below the CCME ALG value.
- **Nickel** concentrations in the samples from observation well HYD-08-11A (Shamrock zone) exceeded the CCME ALG value of 0.15 mg/L.
- The **silver** concentration in the second sample taken from observation well HYD-08-11A (Shamrock zone) exceeded the CCME ALG value of 0.0001 mg/L.
- **Zinc** concentrations in samples from the Core Shack well, Camp well, HYD-08-02, HYD-08-11A, HYD-08-21, and KR05-688 exceeded the CCME ALG value of 0.03 mg/L.

To summarize, dissolved metal concentrations in most of the groundwater samples collected at the Site exceeded one or more CCME ALG values. It should be noted, however, that the CCME ALG only apply to surface water and are therefore included here for reference purposes only.

Samples from the following sample locations exceeded CSR guidelines for:

- **Arsenic**: KR05-688, KR06-736, KR-06-914, Upper Mill well, Coreshack well, Camp Water well, Spring #1, Spring #4, HYD-08-01A, HYD-08-01B, HYD-08-02, HYD-08-04A, HYD-08-05A, HYD-08-06A, HYD-08-09A, HYD-08-11A, HYD-08-22, HYD-10-01A, BH-10-01A, BH-10-02, BH-10-06, BH-10-14A, BH-10-14B
- **Cobalt**: KR06-914, HYD-08-11A
- **Cadmium**: HYD-08-09A, HYD-08-11A
- **Copper**: HYD-08-11A.

4.11.2.3 Seasonal Variability of Groundwater Chemistry

Several observation wells were sampled during multiple sampling events. In general, multiple samples collected from the same wells at different times of the year showed very similar chemical compositions as indicated by samples plotting closely together in the trilinear Piper Plot (Figure 4.11-5)

Variability in the chemical composition at the different sampling locations is further detailed below:

- KR06-736 in August 2007 and May 2008: Major ion and arsenic concentrations in this well changed only slightly between sampling events.
- Upper Mill Well in August 2007, March 2008, May 2008 and February 2011: Major ion and arsenic concentrations changed only slightly over time in this well.
- Core Shack Well in August 2007, March 2008 and May 2008: From the August 2007 to March 2008 sampling events the magnesium concentration in this well increased about 1.5-fold. Other major ion concentrations (Ca, HCO_3 and SO_4) remained relatively constant as did the arsenic concentration.
- HYD-08-01A in February 2008, May 2008 and February 2011: From May 2008 to August 2008 an approximate 1.5-fold increase in sulphate concentration was observed in this well. February 2011 samples show concentrations similar to the May 2008 levels, suggesting some seasonal variability in this parameter. Other major ion concentrations were relatively stable between the different sampling events. The arsenic concentration increased about 2.5-fold in this well from May 2008 to August 2008. The February 2011 arsenic concentrations in this well show about a two-fold decrease from the May 2008 values suggesting seasonal variability in this parameter.
- HYD-08-04A in March 2008, May 2008 and February 2011: The major ion chemistry at this site remained relatively constant over all three sampling events, while the arsenic concentration showed some variability, with levels in May 2008 about 0.5-fold lower than in March 2008 and levels in February 2011 similar to those in March 2008.
- HYD-08-05 in May 2008 and February 2011: Alkalinity and calcium concentrations in this well increased by about 1.5-fold from May 2008 to February 2011. Other major ion concentrations (SO_4 and Mg) were similar in both samples. The arsenic concentration increased by about 4.5-fold from the May 2008 to the February 2011 sample, indicating variability in this parameter at this location.

- HYD-08-06A in March 2008 and February 2011: Sulphate, calcium and magnesium concentrations at this location decreased by about 1.5-fold from March 2008 to February 2011. The arsenic concentration was similar in the two samples.
- HYD-08-11A in March 2008 and May 2008: Sulphate and magnesium concentrations at this site decreased by about 1.5-fold from March 2008 to May 2008. Iron concentrations decreased by about 17-fold and arsenic concentration decreased by about 24-fold over this period.
- HYD-08-16A in May 2008 and February 2011: Major ion concentrations were fairly similar in both samples. Arsenic concentration increased by about two-fold from the May 2008 sampling event to the February 2011 sampling.

All other sampling points have only been sampled once so far for the purpose of this assessment or due to restricted site access during winter months. Table 4.11-3 provides details of the ongoing baseline groundwater monitoring at the Site.

4.11.2.4 Conceptual Baseline Hydrogeological Model

The conceptual baseline hydrogeological model is intended to conceptually describe the existing local hydrogeological conditions at the KRP 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 KRP 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 aquifers consist of various 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 KRP area are discussed in more detail in the following sections. Figure 4.11-6 presents conceptual hydrogeological cross-sections through the KRP area (the cross-section lines are shown on Figure 4.11-4).

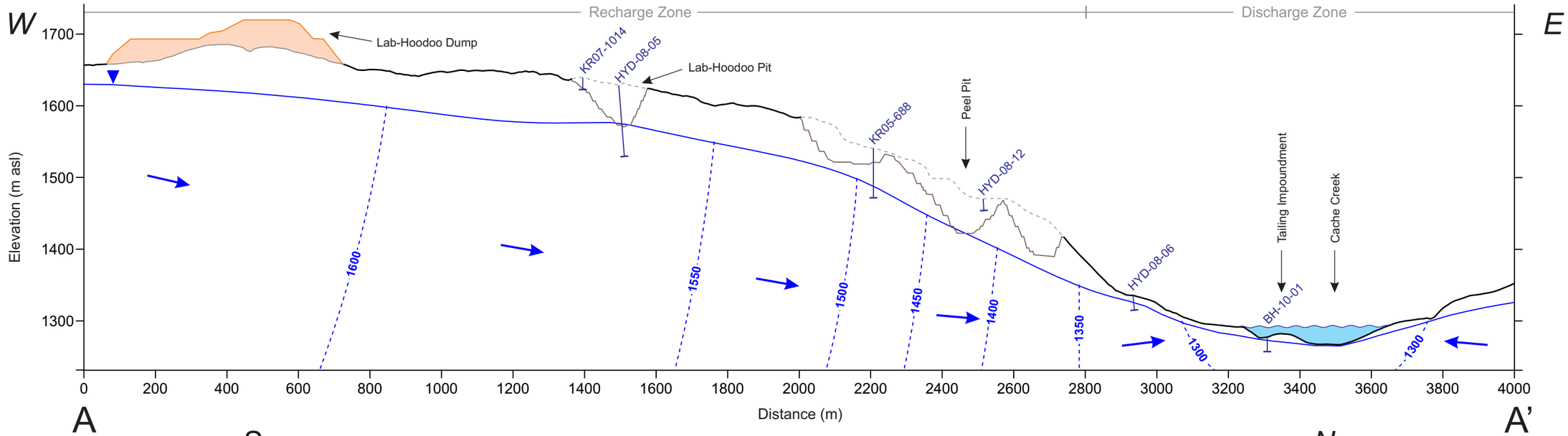
4.11.2.5 Overburden Aquifer

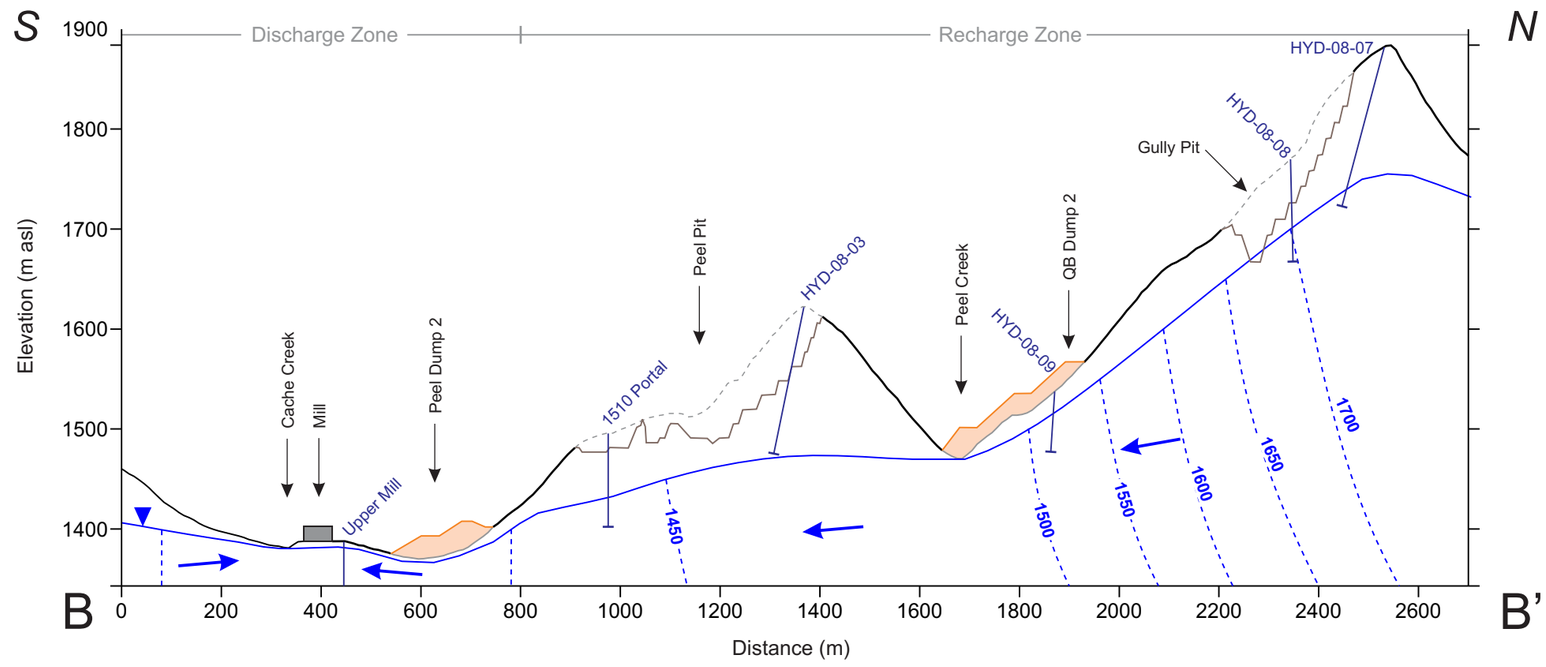
Upper slopes and mountain ridges in the area are predominantly talus or rock outcrop. The area is dominated by weathered, frost-shattered and colluviated bedrock. Glacial activity has over-steepened the valley walls. Fans, cones and abundant talus slopes have formed at the base of these over-steepened slopes. The valley bottom is primarily a veneer of colluvium or weathered bedrock with discontinuous pockets of till veneer overlying limestone bedrock. Near the valley sideslopes, colluvium has accumulated from rockfall, avalanching and other mass movement processes. Discontinuous areas of highly permeable glaciofluvial outwash and alluvium may be encountered on the valley floor. Glacial outwash sands and gravels or terminal moraine form a portion of the existing tailings impoundment and are found in the Cache Creek valley downstream of the mine site in the area of the TSF. The mill and camp site are located on a wide, valley-centre ridge of glacial moraine material.

Table 4.11-3: Ongoing Quarterly Groundwater Monitoring

Well ID	Date of Well Completion	UTM NAD27, Zone 8		Elevation	True Vertical Depth	Water Level Monitoring	Water Quality Monitoring	Remarks
		Easting	Northing					
		m	m	m asl	m bgs			
KR05-688	27-May-2008	645200	6825437	1533.38	69.64	X	X	
KR07-1014	N/A	644397	6825425	1612.00	16.40	X		
Lower Mill Well	9-Aug-1987	645499	6824891	1372.50	52.10	X		Well blocked
Upper Mill Well	N/A	645404	6824843	1381.53	74.65	X	X	
1510 Portal Well	8-Aug-1987	645348	6825374	1495.45	92.58	X		
Core Shack Well	N/A	644497	6825063	1521.67	39.19	X	X	
Camp Water Well	11-Aug-1987	645092	6824737	1409.50	99.06	X		
HYD-08-01A	27-Feb-2008	644046	6825000	1577.73	54.45	X	X	
HYD-08-01B	27-Feb-2008	644046	6825000	1577.73	6.46	X	X	
HYD-08-02	10-Mar-2008	644204	6825653	1718.68	164.35	X		
HYD-08-03	3-Mar-2008	645387	6825768	1615.85	146.45	X		Well is dry
HYD-08-04A	26-Feb-2008	645526	6825326	1426.69	100.04	X	X	
HYD-08-04B	26-Feb-2008	645526	6825326	1426.69	4.05	X	X	
HYD-08-05	20-Mar-2008	644492	6825466	1614.91	99.33	X	X	
HYD-08-06A	28-Feb-2008	645941	6825549	1347.66	20.34	X	X	
HYD-08-06B	28-Feb-2008	645941	6825549	1347.66	2.54	X	X	Well is dry
HYD-08-07	26-Feb-2008	645319	6826923	1875.27	158.61	X		Well blocked (ice)
HYD-08-08	29-Feb-2008	645394	6826737	1784.95	101.75	X		
HYD-08-09A	4-Mar-2008	645474	6826267	1520.36	59.63	X	X	
HYD-08-09B	4-Mar-2008	645474	6826267	1520.36	2.35	X	X	
HYD-08-10	2-Mar-2008	645900	6826622	1657.53	110.57	X	X	
HYD-08-11A	6-Mar-2008	646114	6826189	1390.03	30.59	X	X	
HYD-08-11B	6-Mar-2008	646114	6826189	1390.03	7.04	X	x	Well is dry
HYD-08-12	27-Feb-2008	645520	6825388	1446.54	16.07	X		Well is dry
HYD-08-16A	21-May-2008	643064	6825266	1636.70	59.99	X	X	
HYD-08-16B	21-May-2008	643064	6825266	1636.70	7.67	X	X	Well is dry
HYD-08-17	23-May-2008	643484	6824999	1621.99	40.02	X	X	
HYD-08-18	23-May-2008	643298	6825331	1635.00	1.38	X	X	Well is dry
HYD-08-19	25-May-2008	643459	6825250	1632.00	4.59	X	X	
HYD-08-20	25-May-2008	643672	6825159	1628.00	4.52	X		
HYD-08-21	23-May-2008	643300	6825067	1626.00	4.36	X		
HYD-08-22	26-May-2008	643483	6825033	1624.00	4.52	X		Artesian well
HYD-10-01A	13-Aug-2010	643535	6824426	1655.00	69.73	X	X	
GT-10-01	2-Aug-2010	645099	6825750	1665.00	194.90	X		
GT-10-04A	8-Aug-2010	644107	6824922	1552.00	74.19	X		
GT-10-04B	8-Aug-2010	644107	6824922	1552.00	5.45	X		
GT-10-06A	11-Aug-2010	643514	6824522	1642.00	59.47	X		Thermistor installed
BH-10-01A	5-Dec-2010	646317	6825423	1292.66	20.13	X	X	
BH-10-01B	5-Dec-2010	646317	6825423	1292.66	10.75	X	X	
BH-10-02	4-Dec-2010	646345	6825749	1281.74	14.09	X	X	
BH-10-05	30-Nov-2010	646493	6825731	1267.78	8.53	X		
BH-10-06	2-Dec-2010	646585	6825851	1270.58	21.10	X	X	
BH-10-08	16-Nov-2010	646715	6825984	1264.04	22.88	X		
BH-10-09	24-Nov-2010	646850	6825896	1264.96	13.26	X	X	
BH-10-10	12-Nov-2010	646853	6826063	1234.98	5.94	X		
BH-10-12	13-Nov-2010	646918	6826168	1233.86	16.62	X		
BH-10-14A	27-Nov-2010	647051	6826358	1215.49	15.90	X	X	
BH-10-14B	27-Nov-2010	647051	6826358	1215.55	6.82	X	X	

Notes: m asl - metres above sea level
m bgs - metres below ground surface
N/A - not available





LEGEND

- Groundwater Table
- 1600 — Inferred Groundwater Equipotential Contour (m asl)
- Groundwater Flow Direction
- Groundwater Monitoring Well with Well ID

NOTES

- 2x Vertical Exaggeration
- Based on hydraulic heads observed in bedrock monitoring wells in February 2011.
- Note that groundwater flow direction is not parallel to orientation of cross sections.

STATUS
ISSUED FOR USE

CLIENT
Ketza River Holdings

KETZA RIVER PROJECT

Hydrogeological Cross Sections

eba A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.104	SK	RMM		0

OFFICE	DATE
EBA-WHSE	July 26, 2011

Figure 4.11-6

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Geotechnical investigations conducted near the existing TSF and in the area of the Lab-Hoodoo dump indicate that bedrock is generally encountered at depths ranging from just over 1 to 15 m bgs. A thick (up to 8.5 m) blanket of colluvium was reported at the northern abutment of the tailings dam and consists of silty sand and angular gravel with some cobbles and occasional boulders. Outwash deposits south of the TSF are 5 to 8 m in thickness and consist of sand and gravel with some silt, cobbles and boulders to silty sand and gravel with some cobbles and occasional boulders. Field observation indicated that alluvial or glaciofluvial materials can be found at a depth varying from 4.6 to 8.4 m bgs west of the TSF, and consist of silty sand to silty sand and gravel with occasional layers of clean sand and gravel and occasional cobbles. Boreholes adjacent to Cache Creek report compact sandy (25-35%) gravel (48-62%) with some silt (10-15%) at depths of up to 7.3 m. Field observations from boreholes located in the Cache Creek valley northwest of the existing tailings dam indicate that the overburden sediments there range from 4.9 to 18.9 m in thickness and consist of clay, clayey till, sand and gravel, and silty till of variable composition.

Field observations from boreholes located in the vicinity of the TSF indicate that overburden sediments range from about 5 to 20 m in thickness and consist mainly of clay and silt till with sand and gravel layers or lenses. At numerous locations, Cache Creek has incised into thick glacial till deposits to form steep stream escarpments. Downstream of the TSF, a prominent moraine, forming a portion of the north Cache Creek Valley hill slope at the terminus of a hanging valley, is breached by Peel Creek.

The Site is located within the zone of widespread discontinuous permafrost. Zones of permafrost are known to be present in the mine area and permafrost was observed on the north slope of the Cache Creek Diversion. 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.

4.11.2.6 Bedrock Aquifers

The KRP is underlain by a conformable sequence of Lower Cambrian carbonate and clastic sedimentary rock units that are unconformably overlain by black shale of Late Cambrian age. Gold mineralization at the Site occurs within the manto replacement deposits along permissive horizons within Lower Cambrian Limestone in the Cache Creek valley. The manto deposits occur on the southern flank of the Ketza Uplift, a domed feature likely underlain by mid-Cretaceous intrusive rocks. Gold-bearing massive sulphide deposits of pyrrhotite, pyrite and arsenopyrite have been oxidized and the gold values enriched within structural zones or panels where normal faulting cross cuts the stratigraphy.

A Lower Cambrian limestone sequence of thickness ranging from 120 to 180 m is host to all replacement type manto mineralization on the claims. Field observations from drill core and outcrops indicate that the limestone unit is grey, clean and uniformly bedded, with distinctive Archeocyathid fossils occurring near the top of the unit. Distinct beds of massive fine-grained light grey limestone, blue fine grained crystalline limestone, thin and wispy silt banded limestone, and silty black limestone. The unit is locally dolomitized, with recrystallization and orange weathering in the vicinity of mineralization. The lower contact is gradational and arbitrarily defined where the well bedded limestone becomes the major component. The limestone is resistant and forms prominent cliffs and ridges throughout the region.

The stratigraphic sequence is disrupted by thrust faults and related folds, cut by multiple sets of steeply dipping normal faults. Faulting near the deposits is complex and interpreted to have controlled the location of the mineralization by providing conduits for the oxidizing fluids. Intense folding has resulted in overturned stratigraphy on fold limbs.

The bedrock aquifer is overlain by the overburden aquifer in areas where overburden exists, i.e., mainly in the valley bottoms and lower slopes. In other areas without overburden cover, the bedrock aquifer extends to the ground surface. The bedrock aquifer is highly heterogeneous given the occurrence of different lithologies and tectonic discontinuities (joints and faults), which often control groundwater flow through the bedrock aquifer.

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 Project are summarized in Table 4.11-2 and ranged from $< 1\times10^{-8}$ to 4×10^{-6} m/s. This fairly narrow range of hydraulic conductivity values (about two orders of magnitude) suggests that groundwater flow through the rock mass is not controlled by a few hydraulically-conductive discontinuities (which typically have hydraulic conductivities many orders of magnitude higher than the bulk of the rock mass).

4.11.2.7 Groundwater – Surface Water Interaction

The main surface water feature in the KRP area is Cache Creek which originates from Tarn Lake and flows through the southern and eastern part of the Site (Manto Zone). Peel Creek, which drains most of the northern part of the Site (Shamrock Zone), joins Cache Creek downstream of the Canamax TSF. Cache Creek flows into Ketza River downstream of the LSA. Cache Creek is the main receiving surface water body for groundwater discharging from shallow and deep aquifers in the LSA. EBA interprets that groundwater discharge from all areas of mine infrastructure, including open pits, underground workings, camp and mill Site, and TSF will ultimately discharge to Cache Creek. Shallower groundwater is likely discharging to Cache Creek within the Site area, whereas deeper groundwater may discharge to Cache Creek downstream of the Site area, closer to the confluence with the Ketza River.

Groundwater from areas of most mine infrastructure including all central mine facilities (camp, mill, TSF) and the open pits, underground workings, and waste rock dumps of the Manto Zone (Tarn, Penguin, Lab-Hoodoo pits and dumps, and the southwestern part of the Peel pit) is likely discharging directly to Cache Creek. Groundwater originating from mining areas in the Shamrock Zone (Break, Gully, 3M, and QB pits and dumps, and the northeastern part of the Peel pit), may discharge to Peel Creek before it flows into Cache Creek. Some groundwater from the underground workings below the Peel and Lab-Hoodoo open pits and from the Break open pit areas, may flow in a northerly direction and contribute to the groundwater discharging to Peel Creek. Groundwater in the area of the Knoll open pit flows north or northeast and discharges to Misery Creek or directly to Cache Creek further downstream.

4.11.2.8 Groundwater Flow Regime Summary

The LSA is bordered by surface water divides to the north, west, and south. The regional groundwater flow divide is assumed by EBA to coincide with surface water divides (i.e., groundwater from the LSA ultimately discharges to Cache Creek).

The general groundwater flow direction mimics surface topography. Deep groundwater flows from the highest areas of the Manto and Shamrock Zones toward the Cache Creek and Peel Creek valleys (Figures 4.11-4 and 4.11-6). Shallow groundwater flow within the overburden aquifer is not depicted on Figure 4.11-6. Shallow groundwater is characterized by local, small-scale flow cells within the overburden sediments, with its flow direction closely following local topography and bedrock surface.

Groundwater recharge typically occurs at higher elevations with groundwater ultimately discharging to surface water bodies at lower elevations in valleys. 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 0.08 in the area of the Lab-Hoodoo Pit (i.e., the hydraulic head decreases by 8 m over a distance of 100 m in the direction of groundwater flow), to about 0.4 in in the area of the QB Pit (Figure 4.11-4). Based on the hydraulic conductivities obtained from hydraulic tests (see Table 4.11-2), the hydraulic gradients inferred by EBA from groundwater level measurements, and assuming a bulk bedrock porosity of about 0.05-0.15 (Domenico and Schwartz 1998; Freeze and Cherry 1979), the mean flow velocity of groundwater in the bedrock aquifer is estimated to range from about a few tens of metres to several hundred metres per year. The estimated flow velocities appear to be reasonable for the type of bedrock encountered in the Site area. The steep terrain, especially in the area of the pits, causes large hydraulic gradients and associated fast groundwater flow velocities.

4.12 Aquatic Ecosystems and Fisheries Resources

This section provides aquatic and fisheries information for the KRP and the associated receiving aquatic environment. Cache Creek is the main creek that flows through the Site and joins the Ketza River. The subsections that follow describe the available historical and current information regarding the aquatic resources of the Cache Creek and Ketza River systems (along with several tributaries of Cache Creek), including fish and fish habitat, benthic invertebrate, periphyton, and stream sediment information. This section is organized by:

- Fish and Fish Habitat
- Aquatic Ecosystem – Benthic Macroinvertebrate and Periphyton
- Aquatic Ecosystem - Stream Sediment Metals and Particle Size.

More recent fish and aquatic information collected as part of the KRP environmental baseline studies are detailed in the following reports, which are included as Appendix I:

- 2007 Environmental Baseline Studies: Aquatic Resources Program (EBA 2008e, Appendix I1)
- 2007 Fisheries Study of Cache Creek Watershed (EDI 2007, Appendix I2)
- 2010 Environmental Baseline Assessment: Fisheries Study (EBA 2011d, Appendix I3).

An aquatic environment study, including benthic invertebrate, sediment and periphyton analysis, was completed in 2007 with the goal of updating and expanding existing information collected during previous studies in the area (EBA 2008c). This information was collected to satisfy the requirements for ongoing aquatic environment monitoring as outlined in KRH's care and maintenance Water Licence, and to provide current baseline information for the KRP. Fisheries information for this area was collected in 2007 by Environmental Dynamics Inc. (EDI; EDI 2007). This information was augmented with additional fish and fish habitat studies in 2010 (EBA 2011d).

4.12.1 Regional Setting

The KRP is located in the Saint Cyr Range Ecodistrict of the Pelly Mountain Ecoregion in the Boreal Cordillera Ecozone (Smith et al. 2004), in a subalpine / alpine valley at the headwaters of Cache Creek, a tributary of the Ketza River (Figure 4.12-1). The KRP is located entirely within the Pelly River drainage, but borders on the headwaters of the Yukon River drainage, both components of the Yukon River Watershed.

The KRP lies within the Ketza River drainage basin, and is characterized by numerous tributaries (some unnamed) that eventually flow into Ketza River, which flows into the Pelly River (Figure 4.12-1). These include Misery Creek, Peel Creek, Subsidiary Creek and Oxo Creek.

4.12.2 Baseline Study Program

The most recent fisheries baseline assessment was completed in May, 2010 (EBA 2011d). To maximize sampling effort within the entire Project footprint, sites were chosen along the Ketza River, Cache Creek and tributaries of Cache Creek. Fish sampling was also completed in July 2007, and again in September 2007 by EDI (EDI 2007;Table 4.12-1).

In August 2007, EBA carried out sampling for the aquatics baseline program including sediment size and metals analysis, periphyton and benthic macroinvertebrate sampling, and habitat mapping (Table 4.12-1). Sampling was conducted during the yearly late summer low-flow period, when the effects of high runoff on sediments, macro invertebrates and periphyton were reduced.

Table 4.12-1: Summary of Fisheries / Aquatics Baseline Study Components

Year	Watercourses	Study Program
Aquatic Environment Baseline Studies		
2007	Ketza River, Cache Creek and Tributaries	EBA conducted benthic invertebrate and periphyton sampling along with sediment size and metals analysis
Fisheries Baseline Studies		
2007	Ketza River, Cache Creek and Tributaries	EDI conducted fish sampling and fish habitat assessments and collected water quality readings
2010	Ketza River, Cache Creek and Tributaries	EBA conducted fish sampling and fish habitat assessments and collected water quality readings

643000 644000 645000 646000 647000 648000 649000 650000 651000

6830000 6829000 6828000 6827000 6826000 6825000 6824000

Misery Creek
Ketza River
Cache Creek
Peel Creek
Subsidiary Creek
Cache Creek
Tarn Lake
Oxo Creek

N W E S

LEGEND

- Project Footprint
- Local Study Area
- Ketza Road
- Contour (20 m)
- Watercourse
- Waterbody
- Vegetation

NOTES
Base data source: NTS 1:50,000

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Fish and Aquatic Resources Study Area

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:30,000
500 250 0 500
Metres

FILE NO. W23101052_108_StudyAreas.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.108	SL	AC	LM	0

OFFICE EBA-VANC
DATE July 26, 2011

eba A TETRA TECH COMPANY

Figure 4.12-1

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4.12.3 Fish and Fish Habitat

4.12.3.1 Historical Studies and Existing Information

Several historical fisheries assessments have been carried out for the Ketza River area, in particular near the confluence with the Pelly River. In general, the fisheries value of the Ketza River is higher at the river mouth where it joins the Pelly River. Chinook Salmon (*Oncorhynchus tshawytscha*) are known to migrate, spawn and rear in the Pelly River. A wide range of species use the Ketza river including, but not limited to, Humpback Whitefish (*Coregonus pidschian*), Broad Whitefish (*Coregonus nasus*), Round Whitefish (*Prosopium cylindraceum*), Northern Pike (*Esox lucius*), Inconnu (*Stenodus leucichthys*), Least Cisco (*Coregonus sardinella*), Long Nosed Sucker (*Catostomus catostomus*), Slimy Sculpin (*Cottus cognatus*), and Arctic Grayling (*Thymallus arcticus*) (Northern Natural Resources Ltd 1977; BC Research 1986; Godin and Mackenzie-Grieve 1984; Norecol 1986; Osborne 1991; DRO 1991).

One of the earliest fisheries studies conducted for the Ketza River was part of a comprehensive survey of water bodies associated with a proposed pipeline route in the Yukon (Northern Natural Resource Services Ltd. 1977). During that study, the Ketza River was surveyed in August, 1977. Nine Arctic Grayling were captured by gillnet and seine net, and 11 Slimy Sculpin were captured by gee traps and seine nets. The fish captured were primarily adults; therefore the authors concluded that high water velocity may reduce the rearing capacity for small fish. The authors also stated that local information indicated that salmon do not spawn in the Ketza River.

During 1980-1981, a fisheries study was conducted as part of the proposed Iona Silver Mine project (BC Research 1986). The Iona property is located at the headwaters of Cache Creek and the Ketza River, downstream from the then Canamax claims on Cache Creek. Falling silver prices in the early 1980s resulted in the proponent abandoning plans for the Iona Mine project.

Based on sampling in June of 1981, it was determined that fish use of the Ketza River upstream and downstream of the confluence with Cache Creek was low (BC Research 1986). Only 38 fish were captured in gill nets and fish traps over five days (28 Arctic Grayling and 10 Round Whitefish). Beaver were numerous throughout the area during the study period and dams across the Ketza River functioned as barriers to fish passage. Habitat and fish abundance was not expected to differ downstream or seasonally. Overall, the Ketza River was identified as a low productivity system and the report concluded that a sensitive or productive fishery did not likely exist in the river within a reasonable distance of the Site. While no sampling was conducted on Cache Creek, it was assumed that it was even less likely to support a fishery because of steep gradients along its channel.

A 1984 baseline report of the Iona Silver Mine area (Godin and Mackenzie-Grieve 1984) included fisheries sampling and tissue analysis. Slimy Sculpin were captured in Cache Creek. The sculpins exhibited elevated levels of most metals in tissue samples, which is comparable to another study of Prickly Sculpin (Cottus asper) exposed to waste from TSFs from a large copper/lead/zinc mine (Reid and McGreer 1983). Arctic Grayling were also captured in the Ketza River and were found to have tissue metal concentrations that were 2-5 times greater than background levels for fish in the Pelly River drainage (Archibald 1981). This study was conducted prior to commercial production at the Canamax Project, which commenced in 1988. Grayling typically spend only the summer months in small streams, unless suitable deep water over-

wintering habitat is available, and then retreat to major rivers to over-winter. The authors were therefore unable to establish a relationship between metal concentrations in fish tissues and those in the system. However, it was thought that these results may have been related to naturally high levels of metals in Cache Creek and the Ketza River.

Norecol (1986) conducted a fisheries assessment of Cache Creek for the Canamax Project prior to mine operation. The study included a habitat assessment of six stream reaches and electrofishing at four sites in Cache Creek. Gee traps were also set in the Ketza River at the mouth of Cache Creek. Fish were only captured at the Cache Creek – Ketza River confluence (one Arctic Grayling and 16 Slimy Sculpin). No fish were caught at any of the other sites; therefore the authors concluded that fish only use Cache Creek system at its mouth and the stream has limited fisheries values above its confluence with the Ketza River.

Norecol (1986) characterized Cache Creek as a moderate-gradient mountain stream dominated by riffles and large substrate. Fish cover was generally limited. Cache Creek provided little spawning, rearing, overwintering and holding / feeding habitat, except for areas within reaches one, two and three, which occurred immediately upstream from the Ketza River confluence. That study found that Cache Creek is accessible to fish from its mouth upstream to the camp area. Upstream of the camp, Cache Creek drops steeply over bedrock at the headwater tarn, which was identified as the only barrier to fish passage on Cache Creek. While no samples were taken or analyses conducted, the density of instream algae and benthic invertebrates was observed to be low. This, in combination with low water temperature, suggested that Cache Creek was a low productivity stream.

In 1990, Canamax applied to the Yukon Water Board to amend their Water Licence, authorizing them to mine and process sulphide ore. The potential impacts of mine operation upon fish resources in Cache Creek were reviewed as part of the application process. That review and subsequent Water Board hearings raised questions as to the validity of the company's conclusions about fish resources in Cache Creek based on the Norecol report (1986). The fisheries resources of Cache Creek downstream from the Canamax mill site were of particular interest. The location for discharge of mine effluent was based on the conclusions from the Norecol report (1986), which stated that fish use of Cache Creek is confined to a short section near its mouth. Thus, effluent standards to protect aquatic life were not applied to the segment of Cache Creek between its confluence with the Ketza River and the point where mine effluent was discharged. Canamax suggested that the results of Norecol's (1986) study were sufficient grounds to allow that reach of Cache Creek to be used as a mixing zone in order to achieve non-toxic effluent quality at the first reported occurrence of fish downstream, at the Ketza River confluence.

Reviewing agencies of the Environmental Assessment and Review Process (EARP), DFO and YG Fish and Wildlife Branch stated that results from the Norecol report (1986) needed to be augmented by monitoring in order to validate the conclusions. In addition, the RRDC citizens disagreed with findings of the report, which stated that fish are not present in Cache Creek between the effluent discharge site and the confluence with the Ketza River. RRDC citizens indicated that Chinook Salmon occur in Cache Creek (Harper 1991). Therefore, methods for an expanded fisheries resources study were proposed (Harper 1991).

An investigation of the distribution of Chinook Salmon in the Ketza River was conducted by DFO in 1991 (DFO 1991a). Sampling took place during July and August. Roe baited gee traps were set at eight stations on the Ketza River up to the confluence with Cache Creek for periods between 41-46 hours each time. Sixty-five Slimy Sculpin and one Arctic Grayling were captured on the first survey, and 17 Slimy Sculpin captured on the second survey. Slimy Sculpin were captured upstream of their Station 8 located at the confluence with Cache Creek. No Chinook Salmon were captured. The authors concluded that juvenile Chinook Salmon were likely absent from the Ketza River during summer 1991. However the presence of numerous Slimy Sculpin indicated that there are winter flows in the river and that the water quality of the Ketza River supports fish.

Another fisheries assessment of Cache Creek was conducted by the Fisheries Branch of Renewable Resources, DFO, RRDC and Canamax Resources Inc. during July and August 1991 (Osborne 1991; DFO 1991a). The study was initiated by the EARP to assess the Canamax Resources Ltd. application to renew its Water Licence. Sampling was conducted in the same reaches as identified by Norecol (1986) and methods included electrofishing and stop nets, as well as gillnet sets at the mouth of Cache Creek immediately upstream of the Ketza River.

A total of 18 fish were caught by electrofishing over the two sample periods and another three fish were observed but not captured. In July 1991, three Slimy Sculpin, two Round Whitefish, and three Arctic Grayling were observed or captured during electroshocking. In August 1991, five Slimy Sculpin, and eight Arctic Grayling were captured. In July 1991, nine Arctic Grayling and one Round Whitefish were captured by gillnet. Fish were caught near the mouth of Cache Creek and also upstream as far as Reach 5. Osborne (1991) concluded that the Arctic Grayling taken from Cache Creek appeared to be holding in undercut banks. The distribution of undercut banks and pools was generally low in Cache Creek, and accordingly the number of Arctic Grayling in the system was low and fish were widely distributed. In addition, resting places were found to be limited. A gradient of approximately 3.5 to 4% did not seem to deter movement of Arctic Grayling to the upper reaches of Cache Creek. Slimy Sculpin appeared to utilize slower velocity water located in the lower reaches of the creek. In July 1991, no fish were found above the last bridge across Cache Creek, which is located about 2.5 km downstream from the mine, whereas in August 1991, several Grayling were captured above the last bridge across Cache Creek.

According to a letter from DFO (1991b), based on field studies from the summer of 1991 and on information from similar streams in the area, the fish species expected to use Cache Creek include Arctic Grayling and Round Whitefish. All grayling and whitefish above the first reach are expected to be large mature adults. Arctic Grayling are expected to migrate upstream after spawning in the spring; Round Whitefish are expected to use the creek for summer feeding prior to migrating to spawning grounds in the autumn. Sub-adult grayling and whitefish are anticipated to use the first reach of Cache Creek. Young-of-the-year fish of either species are not expected to be present and individuals will probably be at least in their second year (DFO 1991b).

According to several reports, fish use within the Ketza River system near the Cache Creek confluence was limited and had low productivity. Cache Creek was assumed to be even less likely to support fish because of steeper gradients and limited fish cover. Little spawning, rearing, over-wintering and holding / feeding habitat was found in Cache Creek. The majority of fish found in the Cache Creek system included Slimy

Sculpin and Arctic Grayling (Northern Natural Resources Ltd 1977; BC Research 1986; Godin and Mackenzie-Grieve 1984; Norecol 1986; Osborne,1991; DFO 1991a).

The following tables summarize fish capture studies (Table 4.12-2) and stream habitat assessments (Table 4.12-3) completed for Cache Creek and the Ketza River between 1981 and 1992.

Table 4.12-2: Summary of Fish Capture Studies for Cache Creek and Ketza River (1981 – 1992)

Study Reference	Sample Sites	Date of Survey	Fish Captured	
			#	Species
BC Research Record # 116	Ketza River, FS 1	June 1981	0	
	Ketza River, FS 2		5	Arctic Grayling
	Ketza River, FS 3 (close to Cache Creek mouth, upstream)		0	
	Ketza River FS 4 (close to Cache Creek mouth, downstream)		2 3	Round Whitefish Arctic Grayling
	Ketza River, FS 5		1	Round Whitefish
	Ketza River, FS 6		1 1	Arctic Grayling Round Whitefish
	Ketza River, FS 7		3 2	Arctic Grayling Round Whitefish
	Ketza River, FS 8		0	
	Ketza River FS 9		11 2	Arctic Grayling Round Whitefish
	Ketza River, FS 10		4 2	Arctic Grayling Round Whitefish
	Ketza River FS 11		0	
	Ketza River, FS 12		1	Arctic Grayling
Norecol 1986 Record #8	F1, Cache Creek, 3km upstream from mouth	July 1986	0	
	F2, Mouth of Cache Creek		1 16	Arctic Grayling Slimy Sculpin
	F3, 3.7 km upstream of mouth		0	
	F4, 2 km below existing camp		0	
DFO and Department of Renewable Resources, 1991 (same reaches as Norecol 1986) Record #120, #121	Cache Creek, Reach 1, Station 1	July 9-12, 1991	1 1 1	Slimy Sculpin Round Whitefish Arctic Grayling
	Cache Creek Reach 2, Station 2		2	Slimy Sculpin
	Cache Creek Reach 3, Station 3		1	Arctic Grayling
	Cache Creek Reach 4, Station 4		1 1	Arctic Grayling Round Whitefish
	Cache Creek Reach 5, Station 5		0	
	Cache Creek Reach 5, Station 6		0	
	Cache Creek Reach 5, Station 7		0	

Table 4.12-2: Summary of Fish Capture Studies for Cache Creek and Ketza River (1981 – 1992)

Study Reference	Sample Sites	Date of Survey	Fish Captured	
			#	Species
	Cache Creek Reach 5, Station 8		0	
	Cache Creek Reach 5, Station 9		0	
	220 m upstream from Cache Creek mouth (Gill net)		2	Arctic Grayling
DFO and Department of Renewable Resources, 1991 (same reaches as Norecol 1986) Record #120, #121	Cache Creek Reach 1, Station 1	August 19-22, 1991	5	Slimy Sculpin
	Cache Creek Reach 2, Station 2		0	
	Cache Creek Reach 3, Station 3		1	Arctic Grayling
	Cache Creek Reach 4, Station 4		3	Arctic Grayling
	Cache Creek Reach 5, Station 5		1	Arctic Grayling
	Cache Creek Reach 5, Station 6		0	
	Cache Creek Reach 5, Station 7		1	Arctic Grayling
	Cache Creek Reach 5, Station 8		1	Arctic Grayling
	Cache Creek Reach 5, Station 9		1	Arctic Grayling
DFO October 1991	Ketza River, Station 1	July 1991, August 1991	2	Slimy Sculpin
	Ketza River, Station 2		9	Slimy Sculpin
	Ketza River, Station 3		35	Slimy Sculpin
	Ketza River, Station 4		3 1	Slimy Sculpin Arctic Grayling
	Ketza River, Station 5		7	Slimy Sculpin
	Ketza River, Station 6		3	Slimy Sculpin
	Ketza River, Station 7		2	Slimy Sculpin
	Ketza River, Station 8		21	Slimy Sculpin

Table 4.12-3: Summary of Historic Stream Habitat Assessments for Cache Creek and Ketza River

Study Reference	Location	Habitat Features	Overall Fish Habitat Quality
Norecol 1986	Cache Creek, reach 1	Shallow riffles and glides, 0.7% gradient, cobble side bars, small and medium sized gravel substrate, channel unconfined, limited instream cover	Low fish habitat capability
	Cache Creek, reach 2	Cascading turbulent flow over large substrates, stepped profile, gradient 4%, channel often confined by valley walls, large boulders create pools and instream cover, other cover is limited	Moderate feeding and holding habitat, otherwise low capability
	Cache Creek, reach 3	Pool riffle sequences, gradient 0.8%, large pools, gravel and cobble substrates, numerous gravel and sand side bars, willow riparian zone, good fish cover (undercut banks, pools, woody debris and overhangs)	Moderate fish capability
	Cache Creek, reach 4	Wide braided channel, gradient 0.7%, shallow riffles, gravel substrates, no cover	Low fish capability
	Cache Creek,	Fast flowing riffles, large gravel, cobble and boulder	Low fish capability

Table 4.12-3: Summary of Historic Stream Habitat Assessments for Cache Creek and Ketza River

Study Reference	Location	Habitat Features	Overall Fish Habitat Quality
	reach 5	substrate, gradient 2.5%, channel confined upstream, several side and mid bars, some side channels, limited cover from overhanging willows	
Norecol 1986	Cache Creek, reach 6	Turbulent cascading flow over large substrates, gradient 8%, channel often confined in narrow valley, dense overhanging vegetation, limited cover	Low fish capability
Environment Canada 1992	Cache Creek, 1 km downstream of Tarn Lake	Braided stream, large angular substrate, fine sediments along edges, dense willow on riparian zone	
	Cache Creek, below mine/mill site	Small cobble. Disturbed right bank	
	Misery Creek, 500 m upstream of Cache Creek	Large cobble, small pockets of finer sediments	
	Cache Creek, 700 m upstream of Ketza River	Stable banks with grass, willow and spruce, little overhanging vegetation, small boulders and cobble	
	Ketza River, 250 m upstream of West fork	Braided watercourse with willow and spruce, stable stream banks, medium rounded gravel mixed with fine sands	Appears suitable fish habitat
	Ketza River, 750 m upstream of unnamed creek #4	Large and medium boulders, some silt on quiet areas, well defined stream banks with spruce and willows	Appears to be good fish habitat

4.12.3.2 Assessment Methods

2007 EDI Fisheries Sampling Program

Previous studies have shown that fish densities and fish habitat values were generally low in the Cache Creek watershed, and very limited information is available for smaller tributaries within the watershed. No historical studies have found any evidence of juvenile Chinook in the area. The 2007 sampling program conducted by EDI was designed to build on past knowledge and provide additional information on the fish and fish habitat value of the Cache Creek watershed (EDI 2007). The study was designed with three main objectives:

- Determine if juvenile Chinook Salmon are using Cache Creek and the Ketza River near the mouth of Cache Creek
- Determine the relative densities of fish within all reaches of Cache Creek
- Determine fish presence / no detection within several tributaries to Cache Creek that may be subject to future development.

To assess the presence / absence of juvenile Chinook Salmon in the vicinity of Cache Creek, extensive minnow trapping using methods that target juvenile Chinook Salmon was conducted in the Ketza River upstream (within 100 m) and downstream (within 4 km) of Cache Creek confluence. The lowest reach of Cache Creek was also sampled, with multiple minnow traps set in each area in July and September. Electrofishing was completed in the lowest reach.

Cache Creek was divided into 6 reaches[2]. Norecol Environmental Consultants had previously divided the creek into 5 reaches (1 – 5); however, sampling undertaken in July indicated that the creek would be better represented by 6 distinct reaches (Reach 1 was split into two reaches, 0 and 1), each composed of unique habitat (Figure 4.12-2). A fisheries habitat assessment was conducted along each reach to determine what habitat was present. Initially an enclosed sample length of 50 - 100 m was to be sampled using three - pass electrofishing in each reach; however, when this approach failed to capture significant numbers of fish in both July and September visits, methods were changed to attempt to electrofish as much of the creek as possible. Baited minnow traps (with roe or krill) were also set in all reaches of the stream, as well as in Tarn Lake, at the headwaters of Cache Creek.

A number of tributaries to Cache Creek were assessed for the presence of fish and fish habitat suitability. These tributaries included Peel Creek, an unnamed tributary to Cache Creek (Tributary 6), Subsidiary Creek, Oxo Creek, and a small unnamed tributary to Oxo Creek (Figure 4.12-2). Fish habitat was assessed in these streams and in their relevant stream reaches. Fish presence / absence was determined, where possible, through electrofishing and minnow trapping, and assessment of barriers and habitat quality.

2007 EBA Aquatic Baseline Sampling Program

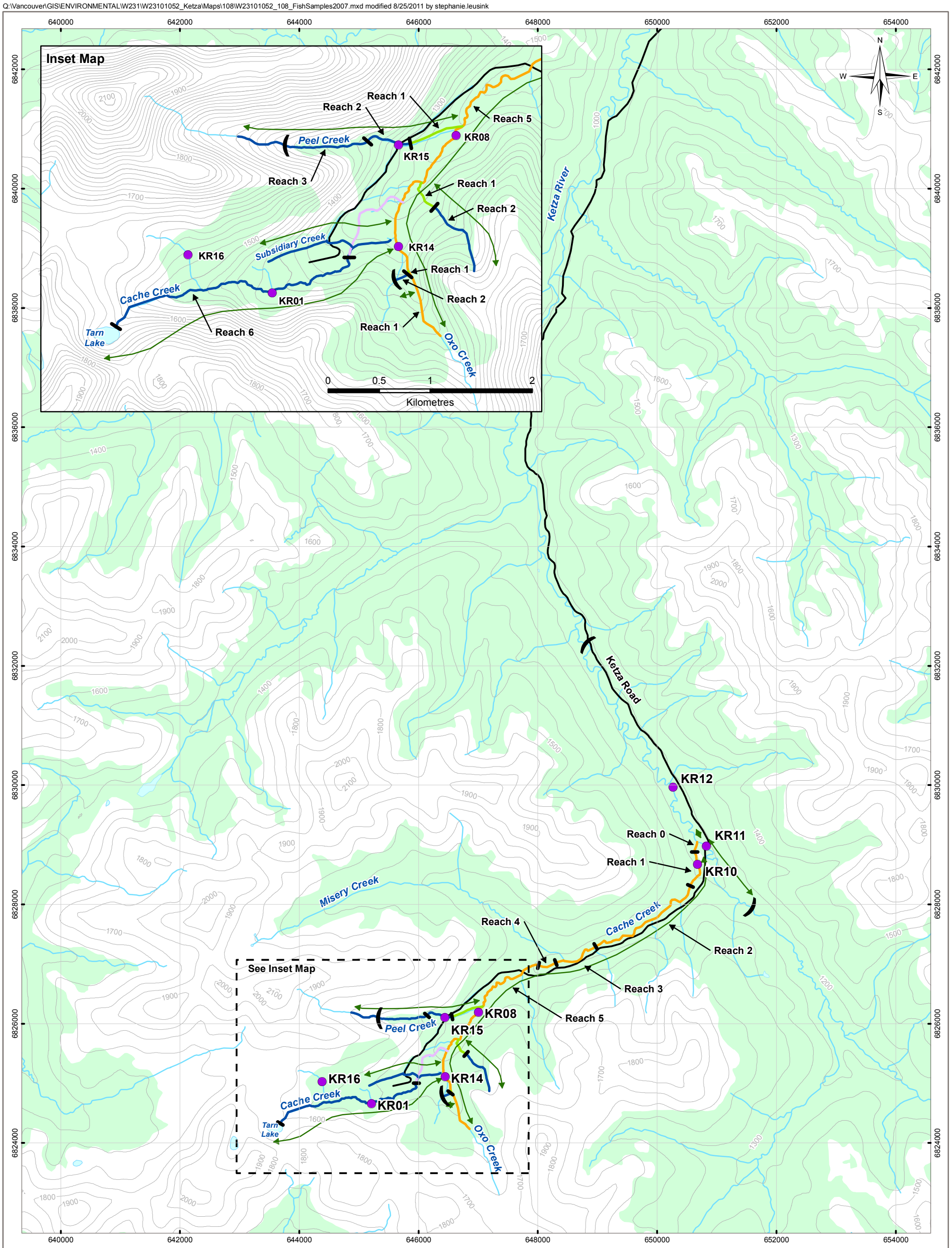
In addition to the 2007 EDI fisheries study program, EBA was retained by KRH to conduct specific aquatic baseline studies to satisfy the requirements for ongoing aquatic environment monitoring associated with the care and maintenance of the previous Water Licence (# QZ04-063)for the Canamax TSF and to provide updated baseline information for the KRP area. EBA undertook aquatic studies comprised of sediment, periphyton and benthic invertebrate sampling at eight sampling locations that included Cache Creek, Oxo Creek, Peel Creek and the Ketza River as shown in Figure 4.12-2. Fish habitat characterization was conducted in accordance with applicable aspects of the *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures* (RIC 1998), as well as the *Guide to the Code of Practice for Watercourse Crossings* (Alberta Environment 2001).

At each site, EBA established a cross section at a representative location, where wetted width, bankfull width, depth profile, and bank characteristics were measured using a tape measure, survey rod, and a clinometer. In situ water quality parameters were measured including pH (using Hanna HI 98127 instrument), dissolved oxygen concentration (mg/l and % saturation; using YSI 556 instrument), turbidity (using Hanna HI 98703 instrument) and temperature. Stream velocities were measured at 25%, 50%, and 75% of the wetted width.

Within the reach representative of the cross section, the distribution of habitat units (e.g., riffle, pool, run, cascade, etc.) was estimated and recorded, as well as the relative stream substrate composition (e.g., silt, sand, gravel, cobble, etc.). Additionally, the amount and composition of fish habitat cover components were recorded, including instream and overstream vegetation, undercut banks, woody debris, deep or turbulent water, etc.

2 A reach is defined as a relatively homogenous section of a stream having a sequence of repeating structural characteristics or processes and fish habitat types

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LEGEND

- Habitat Assessment Locations
- Limit of Assessment
- Sampled Reach
- Reach Break

Stream Classification

- Fish Bearing Stream
- Defaulted Fish Bearing Stream
- Non-Fish Bearing Stream
- Old Stream Path (Cache Creek)
- Stream (Not Assessed)
- Ketza Road
- Contour (20 m)
- Vegetation
- Waterbody

NOTES
Base data source: NTS 1:50,000

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Receiving Environment 2007 Fish Sampling Locations

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:60,000
1 0.5 0 1
Kilometres

FILE NO.
W23101052_108_FishSamples2007.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.108	SL	AC	LM	0

OFFICE	DATE
EBA-VANC	July 26, 2011

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Figure 4.12-2

For each watercourse or stream the BC Forest Practices Code *Riparian Management Area Guidebook* (BC MOF 1995; Table 4.12-4) was used to determine the riparian class for each stream. This system is based on the relative width of the stream and its fish bearing status based on a minimum sampling effort. The breakdown of riparian classes is as follows:

Table 4.12-4: BC Forest Practices Code Stream Riparian Classes

Riparian Class	Average Channel Width (m)	Fish Present?
S1 large rivers	≥ 100	**Yes**
S1 (except large rivers)	>20	**Yes**
S2	> 5 ≤ 20	**Yes**
S3	1.5 ≤ 5	**Yes**
S4	1.5	**Yes**
S5	>3	No
S6	≤ 3	No

Source: BC MOF 1995

Finally, each site was assessed for habitat quality in relation to key potential fish species and life history functions (e.g., spawning, migration, over-wintering, and nursery / feeding habitats).

2010 EBA Fisheries Study Program

The 2010 fisheries study program focused on Cache Creek, the Ketza River and its tributaries located downstream from the Site. The objectives of the study were to:

- Determine presence and distribution of fish in the Cache Creek and Ketza River drainages
- Conduct fish habitat suitability assessments
- Determine presence of Arctic Grayling in the proposed study area during early spring spawning.

Sampling was conducted at a total of 11 sampling stations (Figure 4.12-3) downstream of the Site. To maximize sampling effort within the entire footprint area, seven sites on the Ketza River and four sites on Cache Creek were sampled (Table 4.12-5).

Table 4.12-5: Summary of Study Sites and Sampling Effort for 2010 Field Program

Site No.	UTM Zone	Coordinates	Watercourse	Description and Sampling/Survey Effort
1	08V	650488 E 6829538 N	Ketza River	Lowland / Low gradient area downstream of Ketza Road crossing. Effort: water quality readings, electrofishing, visual surveys and habitat surveys.
2	08V	650945 E 6828576 N	Ketza River	Lower gradient area upstream of Ketza Road crossing (not under influence of Cache Creek). Effort: water quality readings, visual surveys and habitat surveys.
3	08V	650545 E 6828669 N	Cache Creek	Area of Cache Creek upstream of airstrip area. Site re-defined further downstream as Site #6. Effort: Brief habitat survey, site re-defined as #6.

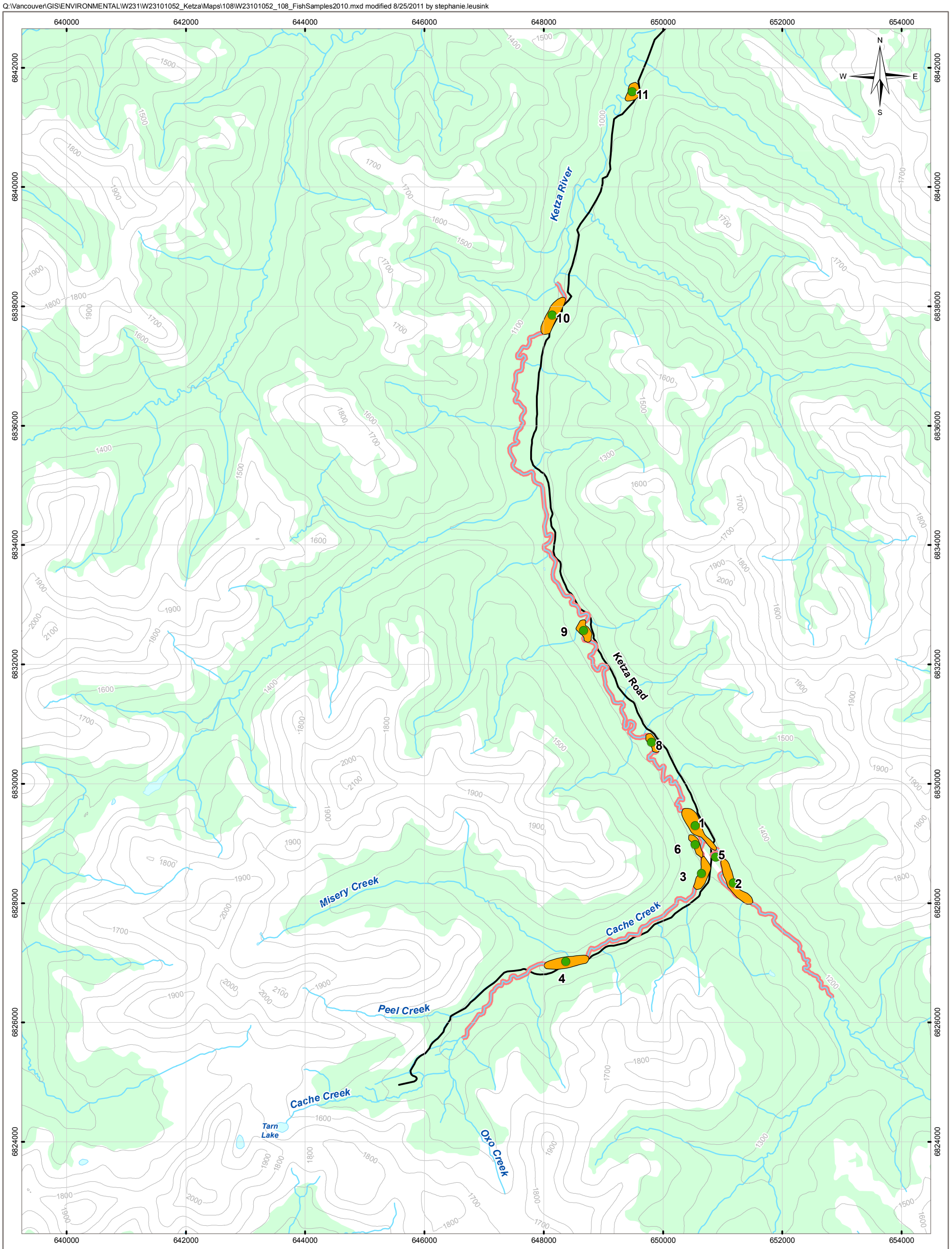
Table 4.12-5: Summary of Study Sites and Sampling Effort for 2010 Field Program

Site No.	UTM Zone	Coordinates	Watercourse	Description and Sampling/Survey Effort
4	08V	648826 E 6827415 N	Cache Creek	Central Cache Creek downstream of first bridge. Area of lower gradient. Effort: Water quality readings, visual surveys and habitat surveys.
5	08V	650676 E 6829186 N	Ketza River	Ketza River at Ketza Road crossing. Effort: water quality readings.
6	08V	650244 E 6829665 N	Cache Creek	Downstream extent of Cache Creek, from the airstrip to the Ketza River confluence. Effort: water quality readings, electrofishing, visual surveys and habitat surveys.
7	08V	646161 E 6825321 N	Cache Creek	Diversion channel of Cache Creek at the TSF, upstream of Oxo Creek. Effort: water quality readings.
8	08V	649668 E 6830981 N	Ketza River	Area of the Ketza River, roughly 2 km downstream of the Cache Creek confluence. Effort: water quality readings and electrofishing.
9	08V	648556 E 6832809 N	Ketza River	Area of the Ketza River, roughly 4 km downstream of the Cache Creek confluence. Effort: water quality readings and electrofishing.
10	08V	648089 E 6838043 N	Ketza River	Area of the Ketza River, roughly 10 km downstream of the Cache Creek confluence. Effort: water quality readings and electrofishing.
11	08V	649413 E 6841840 N	Ketza River	Area of the Ketza River, roughly 15 km downstream of the Cache Creek confluence. Effort: water quality readings and electrofishing.

Water quality parameters were measured at 10 of the 11 stations (Figure 4.12-4), excluding site three (Table 4.12-5). Parameters measured included water temperature, dissolved oxygen, turbidity, electrical conductivity, salinity and pH. Water quality values were recorded after readings stabilized. For turbidity, a known volume of water was collected in a clean, glass cuvette. The cuvette was wiped free of fingerprints, oil and dirt and inserted into the turbidity meter. Readings were recorded.

EBA and ELR conducted an intensive assessment of fish presence in the LSA. The fisheries assessment was conducted at Sites 1, 6, 8, 9 and 11 (Figure 4.12-4) using a Smith-Root LR24 backpack electrofisher. A two person crew assessed fish presence by conducting a full channel sweep in a continuous motion moving from downstream to upstream. Total effort (duration in seconds), distance, as well as general habitat characteristics (change in the slope, substrate, confinement and flow) were recorded. Visual surveys were completed at Sites 1, 2, 4 and 6.

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LEGEND

- 2010 Study Site Locations
- 2010 Focal Study Areas
- 2010 Study Area Extent
- Ketza Road
- Contour (100 m)
- Watercourse
- Vegetation
- Waterbody

NOTES
Base data source: NTS 1:50,000

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Receiving Environment
2010 Fish Sampling Locations

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:60,000
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Kilometres

FILE NO. W23101052_108_FishSamples2010.mxd

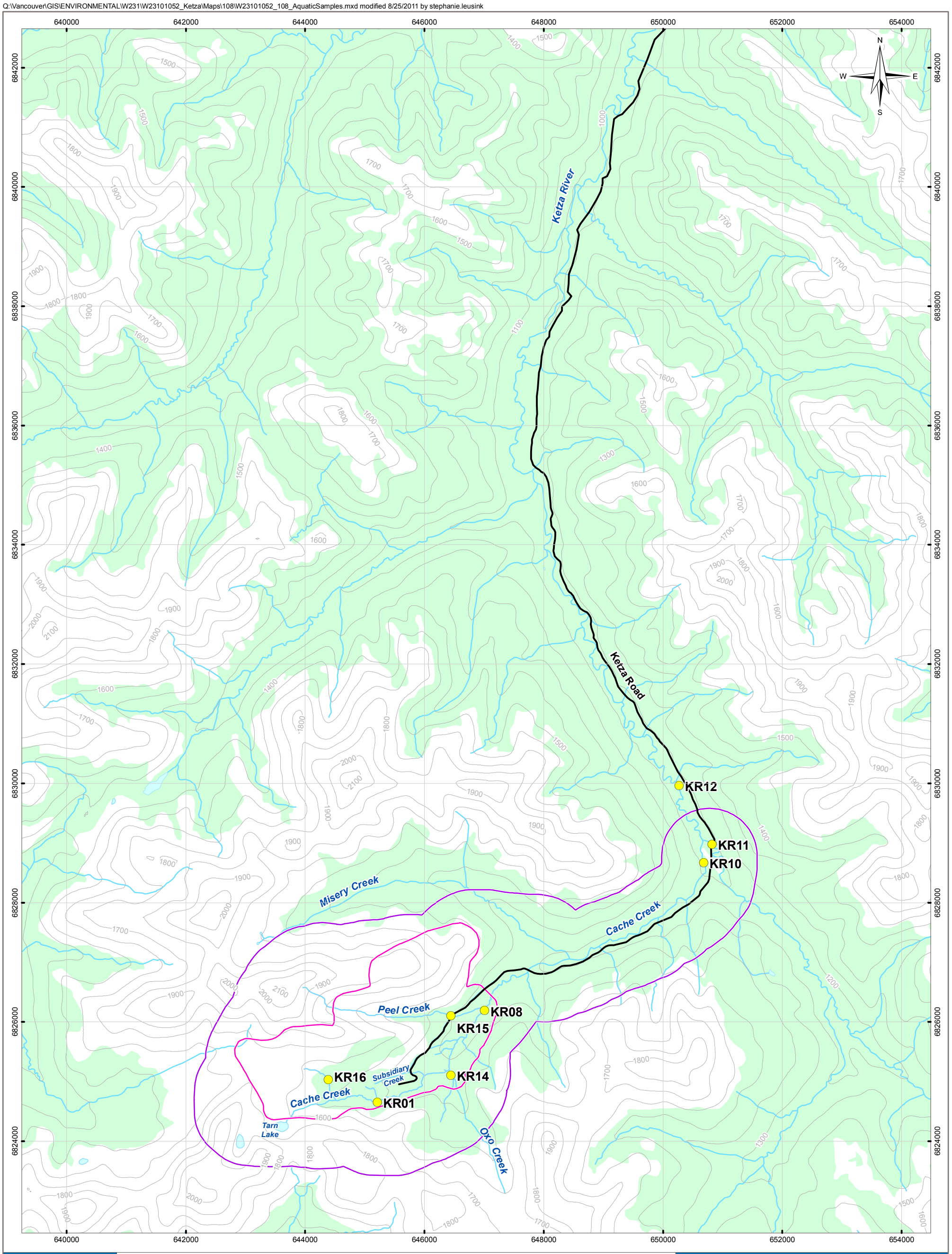
PROJECT NO.	DWN	CKD	APVD	REV
W23101052.108	SL	AC	LM	0

OFFICE	DATE
EBA-VANC	July 26, 2011

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Figure 4.12-3

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LEGEND

- 2007 Aquatic Sampling Locations
- Project Footprint
- Local Study Area
- Ketza Road
- Contour (100 m)
- Watercourse
- Waterbody
- Vegetation

NOTES
Base data source: NTS 1:50,000

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Receiving Environment Aquatic Sample Locations

PROJECTION: UTM Zone 8	DATUM: NAD27			CLIENT: Ketza River Holdings
Scale: 1:60,000 (1 0.5 0 1 Kilometres)				
FILE NO.: W23101052_108_AquaticSamples.mxd				eba A TETRA TECH COMPANY
PROJECT NO.: W23101052.108	DWN: SL	CKD: AC	APVD: LM	REV: 0
OFFICE: EBA-VANC	DATE: July 26, 2011			Figure 4.12-4

Fish habitat assessments were performed at Sites 1, 2, 3, 4 and 6 (Figure 4.12-4) to determine suitability of spring fish spawning habitat. At each watercourse a length of channel ranging from 100 to 400 m was assessed (according to channel width), and the following habitat data were recorded:

- 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).

Additionally, EBA assessed sample points on main stems or other tributaries along the Ketza River and Cache Creek (habitat, fish presence, or water quality) to allow further determination of potential impacts from indirect (downstream) effects, and to refine the fish bearing status of a particular tributary.

For each watercourse or stream, the BC Forest Practices Code *Riparian Management Area Guidebook* (BC MOF 1995) was used to determine the riparian class for each stream.

4.12.3.3 Ketza River Results

Fish Presence, Abundance, and Distribution

During the 2010 spring fisheries assessment, 12 Slimy Sculpin in the Ketza River were captured during electrofishing (EBA 2011d; Appendix I3). No fish were observed during the visual survey. One additional sighting of a presumed Arctic Grayling was recorded during electrofishing, however the species was not confirmed. A summary of the total spring electrofishing effort, catch results and fish observations is provided in Table 4.12-6.

Table 4.12-6: Spring 2010 Electrofishing Effort, Catch Results and Fish Observations for Ketza River

Site	Date	Watercourse	Time Elapsed (24 hr)	Effort Type	Total Seconds	No. of Fish Captured or Observed
1	May 23	Ketza River	0:32:00	Electrofishing	219	4 Slimy Sculpin
1	May 23	Ketza River	0:51:00	Electrofishing	504	1 Slimy Sculpin
1	May 22	Side Channel of Ketza River	0:19:00	Visual		
1	May 22	Ketza River	0:17:00	Visual		
1	May 24	Side Channel of Ketza River	0:13:00	Visual		
1	May 24	Ketza River	0:23:00	Visual		

Table 4.12-6: Spring 2010 Electrofishing Effort, Catch Results and Fish Observations for Ketza River

Site	Date	Watercourse	Time Elapsed (24 hr)	Effort Type	Total Seconds	No. of Fish Captured or Observed
2	May 23	Ketza River	0:37:00	Visual		
2	May 23	Side Channel of Ketza River		Visual		
2	May 23	Ketza River		Visual		
2	May 23	Side Channel of Ketza River		Visual		
8	May 24	Ketza River	0:39:00	Electrofishing	508	7 Slimy Sculpin
9	May 24	Ketza River	0:13:00	Electrofishing	168	
10	May 24	Ketza River	0:29:00	Electrofishing	417	1 Arctic Grayling (unconfirmed)
11	May 24	Ketza River	0:21:00	Electrofishing	326	

In July 2007, one large adult Arctic Grayling was observed in the Ketza River downstream of Cache Creek in July 2007 and Slimy Sculpin were captured throughout the Ketza River and lower parts of Cache Creek. (Table 4.12-7). No juvenile Chinook Salmon were captured or observed at any location during the 2007 study (EDI 2007).

Table 4.12-7: Ketza River Fish Sampling (July and September 2007)

Date	Location		Capture Method	Total Effort	Fish captured
July 2007	Ketza River	Upstream of Cache Creek	5 Baited Minnow Traps	143.28 hr	10 Slimy Sculpin
		Downstream	5 Baited Minnow Traps	105.00 hr	3 Slimy Sculpin
September 2007	Ketza River	Upstream of Cache Creek	2 Baited Minnow Traps	40.61 hr	1 Slimy Sculpin
		Downstream	8 Baited Minnow Traps	190.29 hr	8 Slimy Sculpin

Habitat Availability and Character

Site 1 (immediately upstream of the confluence with Cache Creek) along the Ketza River (Figure 4.12-4) is primarily run-riffle-pool habitat (40%, 40% and 20%, respectively). River channels are 5- 8 m wide, up to 2 m deep, with irregular meandering. Many undercut banks with deep side channel pools are present. The stream exhibits a moderate gradient with gravel and cobble substrate, limited amounts of debris, and sediment deposition in side pools. The degree of channel braiding and gradient is variable. Side channels of the Ketza River contain a series of beaver ponds with no apparent access for fish to upper areas of these ponds.

The river channel at Site 2, downstream of the confluence with Cache Creek, (Figure 4.12-4) was distinct with moderate flows and sand, gravel and some cobble substrate. River gradient is moderate with undercut banks. Forest cover and complexity was higher at Site 2 in comparison with downstream areas. River pools are limited along this section of the river. The side channel was 175 to 225 cm wide and 10 to 15 cm deep with shallow riffles and glides. There was low turbidity during sampling. A tributary flowing in from the east was observed. The main channel also becomes less distinct approximately 30 m upstream from the site.

The river width at Site 8 was approximately 6 to 10 m wide with an irregular meandering channel. Lower velocities were observed in comparison with other sites on the Ketza River. Turbidity was high during sampling (14.5 NTU) with many deposits of new fine materials. The river exhibits excellent pool and undercut bank habitat within the vicinity of Site 8. Fast water with a relatively high gradient was observed at Site 9. Stream substrate consisted of boulders and cobble material.

The section of river near Site 10 had a higher gradient, consisting of rocks, riffles and rapids. Many small pools and eddies were present near the shore. The current was strong with good visibility. Stream substrates consisted of boulders (80%) and cobble (20%) material with undercut banks and many overturned trees. Eddies and small drops within the stream were present on the section of river near Site 10. A large side channel was observed at the site, as well as large main stem pools. Overall this section was considered to be good pool habitat for fish.

Transect KR11 (near Site 5) is located on the Ketza River, near the Cache Creek confluence (Figure 4.12-2). KR11 was sampled on August 9, 2007. At the time of sampling the bankfull and wetted widths were 660 cm and 560 cm, respectively, and the mean channel depth was measured at 43 cm. Velocity was measured to be 0.67 to 1.6 m/s and the estimated discharge was 1.97 m^3/s. Approximately 80% of the aquatic habitat was riffle, 10% run, 55% pool and 5% rapid/cascade.

At this location the channel meandered irregularly, was decoupled and unconfined with occasional islands and sidebars. At this site the stream was generally wide with an open riparian zone that was dominated by lowland willow shrubs with mosses, horsetails, sedges and soapberry.

Water quality was found to be within a suitable range to support fish and fish habitat. Dissolved oxygen was found to be 9.59 mg/L or 80.5% saturation. Conductivity was 319 µS/cm and the pH was slightly basic at 8.6. Water temperature at the time of sampling was 7.7 °C.

The substrate at KR11 was dominated by small cobbles (40%) but was well graded with a mixture of fines, small and large gravel and large cobbles. The left bank was measured at 40 cm tall with a 42° slope while the right bank was 42 cm tall with a 46° slope. Both banks were considered to be stable. Fish habitat was primarily overstream vegetation and provided a total of 3% cover.

Transect KR12 is located on the Ketza River, downstream of the Cache Creek confluence (Figure 4.12-2). At this location the channel meandered irregularly, was coupled and had an unconfined channel with side bars and occasional islands. At this site the stream was wide with a balance of fast and slow water. Riparian vegetation included willow, sedges, gramminoids and various herbs with some mature trees. Overhanging vegetation was minimal, providing little shade or cover.

KR12 was sampled August 10, 2007. At the time of sampling, the bankfull and wetted widths were 1,420 cm and 1,337 cm, respectively and the mean channel depth was measured at 34.3 cm. Velocity was measured to be 0.47 to 0.88 m/s and the estimated discharge was 2.93 m^3/s. Approximately 45% of the aquatic habitat was riffle, 45% run and 10% pool.

Water quality was found to be within a suitable range to support fish and fish habitat. Dissolved oxygen was found to be 10.64 mg/L or 81.7% saturation. Conductivity was 365 µS/cm and the pH was slightly basic at 8.7. Water temperature at the time of sampling was 4.3 °C.

Substrate at KR12 was a well graded mixture of fines, small and large gravel and small cobbles. The left bank was measured at 42 cm tall with a 35° slope while the right bank was 5 cm tall with a 5° slope. Both banks were considered stable. Fish habitat cover was limited, and was comprised of overstream vegetation (2%) and undercut banks (1%).

Stream Riparian Class

The riparian classification for the Ketza River is S2 (i.e., > 5 m ≤ 20 m and fish bearing).

Stream Crossing Data

The only major water course crossing on the Ketza River is along the Ketza Road. No background information was available for this crossing.

4.12.3.4 Cache Creek Results

Fish Presence, Abundance, and Distribution

Table 4.12-8 summarizes the fish sampling and resulting captures for the 2010 fish sampling program in Cache Creek.

Table 4.12-8: Summary of Spring 2010 Electrofishing Effort, Catch Results and Fish Observations for Cache Creek

Site	Date	Watercourse	Time Elapsed (minutes)	Effort Type	Total Seconds	No. of Fish Captured or Observed
6	May 22	Cache Creek	41	Visual		None
4	May 24	Cache Creek	39	Visual		None
6	May 23	Cache Creek	36	Electrofishing	1115 (18.6 min)	None
6	May 24	Cache Creek	18	Visual		None

Source: EBA 2011d

Table 4.12-9 summarizes fish sampling completed in Cache Creek in 2007 by EDI (2007). No juvenile Chinook Salmon were captured or observed at any location covered by this study.

Table 4.12-9: Aquatic Sampling in Lower Cache Creek During July and September 2007

Date	Location	Capture Method	Total Effort	Fish Captured
July 2007	Cache Creek, lower reach	5 Baited Minnow Traps	104.99 hr	2 Slimy Sculpin
	Cache Creek, lower reach	Electrofishing	2156 sec* (35.9 min)	None
September 2007	Cache Creek, lower reach	4 Baited Minnow Traps	95.21 hr	3 Slimy Sculpin
	Cache Creek, lower reach	Electrofishing	1368 sec (22.8 min)	None

Source: EDI 2007

Note: * Effort in seconds is estimated from actual time spent electrofishing (84 min) as second counter was not working.

Reach 0 is the most downstream reach of Cache Creek, where it flows into the Ketza River. Minnow trapping and electrofishing were conducted in this reach in both July and September 2007 (Figure 4.12-3) . Low densities of Slimy Sculpin were captured in this section of Cache Creek through minnow trapping (Table 4.12-10).

Table 4.12-10: Summary of Sampling at Reach 0, Cache Creek

Survey Date	12 July 2007	12 September 2007
Water Temperature	6.7°C	3.6°C
Average Stream Gradient	1.5%	--
Channel Width	14.8 m	--
Sampling Methods (and Effort)	Baited Minnow Traps – 104.99 hr Electrofishing - 2156 sec* (35.9 min)	Baited Minnow Traps - 95.21 hr Electrofishing 1368 sec (22.8 min)
Fish Species Captured	2 Slimy Sculpin	3 Slimy Sculpin
Fish Bearing Status	Fish Bearing	

Source: EDI 2007

Note: * Effort in seconds is estimated from actual time spent electrofishing (84 min) as second counter was not working.

Reach 1 was visited in both July and September 2007; minnow trapping was conducted in both seasons, enclosed three pass electrofishing was conducted in July, and a 200 m section of the reach was electrofished again in September. A number of Slimy Sculpin were captured along this reach through minnow trapping; however, three-pass electrofishing carried out in July 2007 failed to capture any fish (total sampling time 84 minutes). While sculpin were present, they appeared to be present in lower densities compared to the Ketza River (Table 4.12-11).

Table 4.12-11: Summary of Sampling at Reach 1, Cache Creek

Survey Date	12 July 2007	12 September 2007
Water Temperature	5.9°C	2.8°C
Conductivity	--	700 µS
Average Stream Gradient	4%	--
Channel Width	12.1 m	--
Sampling Methods (and Effort)	Electrofishing: Pass 1: 882 sec* (14.7 min) Pass 2: 720 sec* (12.0 min) Pass 3: 617 sec* (10.3 min)	2 Baited Minnow Traps - 42.75 hr Electrofishing - 770 sec (12.8 min)
Fish Species Captured	None	1 Slimy Sculpin
Fish Bearing Status	Fish Bearing	

Source: EDI 2007

Note: * Effort in seconds is estimated from actual time spent electrofishing (Pass 1 – 32 min; Pass 2 – 28 min; Pass 3 – 24 min) as second counter was not working.

Three-pass electrofishing was conducted on Reach 2 in July, and both minnow trapping and electrofishing was conducted in September, 2007. Slimy Sculpin were captured in this reach in both July and September and one Grayling (fork length 218 mm) was captured in September (Table 4.12-12).

Table 4.12-12: Summary of Sampling at Reach 2, Cache Creek

Survey Date	12 July 2007	12 September 2007
Water Temperature	8.2°C	--
Average Stream Gradient	4.75%	--
Channel Width	9.0 m	--
Sampling Methods (and Effort)	Electrofishing: Pass 1: 565 sec* (9.4 min) Pass 2: 514 sec* (8.6 min) Pass 3: 642 sec* (10.7 min)	2 Baited Minnow Traps – 42.16 hr Electrofishing – 1,144 sec (19.1 min)
Fish Species Captured	2 Slimy Sculpin	1 Arctic Grayling 1 Slimy Sculpin
Fish Bearing Status	Fish Bearing	

Source: EDI 2007

Note: * Effort in seconds is estimated from actual time spent electrofishing (Pass 1 – 22 min; Pass 2 – 20 min; Pass 3 – 25 min) as second counter was not working.

In Reach 3, minnow trapping and electrofishing were conducted in July, and three pass electrofishing occurred in September 2007. No fish were captured within this reach during either sampling period. Because fish were previously observed in this reach in 1991 it was assumed to be fish bearing (Table 4.12-13).

Table 4.12-13: Summary of Sampling at Reach 3, Cache Creek

Survey Date	12 July 2007	12 September 2007
Water Temperature	5.6°C	8.5°C
Conductivity	--	618 µS
Average Stream Gradient	2.75%	--
Channel Width	8.6 m	--
Sampling Methods (and Effort)	5 Baited Minnow Traps – 103.75 hr Electrofishing – 2,827 sec* (47.1 min)	Electrofishing: Pass 1: 628 sec (10.5 min) Pass 2: 591 sec (9.9 min) Pass 3: 624 sec (10.4 min)
Fish Species Captured	None	None
Fish Bearing Status	Fish Bearing	

Source: EDI 2007

Note: * Effort in seconds is estimated from actual time spent electrofishing (110 min) as second counter was not working.

No fish were caught in either July or September sampling events in Reach 4, by any sampling method, including three pass electrofishing (Table 4.12-14). Osborne (1991) captured one Round Whitefish (fork length 324 mm) and 4 Arctic Grayling (206-384 mm) by electrofishing within this reach in 1991. Because fish were captured in this reach in 1991, it was presumed to be fish bearing.

Table 4.12-14: Summary of Sampling at Reach 4, Cache Creek

Survey Date	12 July 2007	12 September 2007
Water Temperature	6.8°C	4.1°C
Conductivity	--	580 µS
Average Stream Gradient	2.5%	--
Channel Width	28.7 m (area with wide floodplain)	--
Sampling Methods (and Effort)	Electrofishing – 1,413 sec* (23.6 min)	Baited Minnow Trap – 42.16 hr Electrofishing: Pass 1: 407 sec (6.8 min) Pass 2: 402 sec (6.7 min) Pass 3: 459 sec (7.7 min)
Fish Species Captured	None	None
Fish Bearing Status	Fish Bearing	

Source: EDI 2007

Note: * Effort in seconds is estimated from actual time spent electrofishing (55 min) as second counter was not working.

Reach 5 was extensively electrofished in both July and September and minnow trapped in September 2007. Four of Arctic Grayling (all small adults) were electrofished near the mouth of Oxo Creek in both July and September. No fish were captured above the short portion of steep narrow channel (Table 4.12-15).

Table 4.12-15: Summary of Sampling at Reach 5, Cache Creek

Survey Date	12 July 2007	11 September 2007
Water Temperature	7.1°C	7.2°C
Conductivity	--	534 µS
Average Stream Gradient	3%	--
Channel Width	4.0 m	--
Sampling Methods (and Effort)	Electrofishing – 2,056 sec* (34.3 min)	4 Baited Minnow Traps – 81.33 hr Electrofishing – 1,263 sec (21.1 min)
Fish Species Captured	1 Arctic Grayling (electrofishing)	3 Arctic Grayling (electrofishing)
Fish Bearing Status	Fish Bearing	

Source: EDI 2007

Note: * Effort in seconds is estimated from actual time spent electrofishing (80 min) as second counter was not working.

Sampling effort in Reach 6 included both electrofishing and minnow trapping in September; no fish were captured. It should be noted that Tarn Lake upstream of this reach was also sampled with 4 minnow traps (for a total of 100.6 hours) with no fish being captured or observed (Table 4.12-16).

Table 4.12-16: Summary of Sampling at Reach 6, Cache Creek

Survey Date	14 July 2007	12 September 2007
Water Temperature	--	4.4 °C
Conductivity	--	438 µS
Average Stream Gradient	--	6.75%
Channel Width	--	3.1 m
Sampling Methods (and Effort)	--	4 Baited Minnow Traps – 95.59 hr, Electrofishing – 843 sec (14.1 min)
Fish Species Captured	--	None
Fish Bearing Status	Non-Fish Bearing	

Source: EDI 2007

An unnamed stream (Tributary 6) flows into Cache Creek approximately 700 m upstream of Peel Creek. Two reaches were identified and sampled with electrofishing but no fish were captured or observed.

Habitat Availability and Character

Along Reach 0, Cache Creek is a wide, shallow unconfined stream, with an average channel width of 14.8 m. This section of the creek provides moderate rearing habitat (for Salmonids) and there is some potential for overwintering habitat likely associated with deep pools. This reach is also a large deposition area, where a lower gradient allows for the deposition of gravel and fines traveling downstream from higher gradient areas upstream. Reach 0 of Cache Creek is likely used primarily as a rearing area for sculpin and a migration corridor for Arctic Grayling.

The lower section of Cache Creek is 1.5 to 2.0 m wide with gravel and fine substrates. Signs of heavy sediment deposition were observed. The lower 150 to 200 m of Cache Creek is deep and heavily channelized. Riparian vegetation is limited with only wetland plateaus and grasses.

Transect KR10 is located on Cache Creek just upstream of the Ketza River confluence (Figure 4.12-2). At this location the channel was irregular, decoupled and unconfined with side bars and occasional islands. At this site the stream was generally wide with fast flowing water. The riparian vegetation consisted of horsetails, grasses, and willow within a floodplain riparian area. Tall shrubs and occasional mature trees provide some overhanging vegetation and contribute organic material and shade to the stream.

KR10 was sampled August 9, 2007. At the time of sampling, the bankfull and wetted widths were 12.85 m and 6.31 m respectively and the mean channel depth was measured at 2.97 m. Velocity was measured to be 0.88 to 1.22 m/s and the estimated discharge was 1.91 m^3/s. Approximately 80% of the aquatic habitat was riffle, 5% cascade/rapid, 5% pool and 10% run.

Water quality was found to be within a suitable range to support fish and fish habitat. Dissolved oxygen was found to be 9.69 mg/L or 81.8% saturation. Conductivity was 401 µs and the pH was slightly basic at 8.7. Water temperature at the time of sampling was 8.0 °C.

The substrate at KR10 was fairly well graded with 35% small cobble, 25% large gravel, 25% fines, 10% small gravel and 5% large cobble. The left bank was 10 cm high with an 18° slope while the right bank measured 5 cm high with a 27° slope. Both banks were considered stable. Fish habitat cover was limited, with a total of 8% and was comprised primarily of overstream vegetation.

Reach 1 was characterized by moderate flows, with occasional pools separated by long riffle sections. The stream is occasionally confined along this reach. Because of the high velocity along this reach (especially during high flows), it's potential for use as spawning and rearing habitat for salmonids was considered to be moderate to low. There was also very little potential for overwintering habitat along this reach. Reach 1 of Cache Creek is likely used primarily as a rearing area for sculpin and a migration corridor for Arctic Grayling.

Reach 2 is confined in a gully with few pools and has high water velocities (especially in July). The bed material along this reach is dominated by cobble and gravel. The spawning potential for Arctic Grayling was considered to be low due to a lack of suitable bed material (with the exception of some small pockets). Rearing habitat is moderate; some suitable habitat was present near large boulders and along the creek margins. Overwintering habitat was low to moderate due to the general lack of deep pools.

The lower 200 m of Reach 3 had superior habitat, including more cover and pools, when compared to the rest of the reach. The remainder of the reach was characterized by swift flows and sections with long glides. There was a lack of suitable substrate for grayling spawning, and low to moderate potential for rearing due to limited cover along the majority of the reach. Overwintering potential is poor. Most likely this reach is primarily used as migratory habitat to access further upstream areas of Cache Creek.

Site 4, within Reach 3, was reassessed in 2010. Reach 3 of Cache Creek consisted of a series of braided channels with riffle-run habitats (80% and 20% respectively). Stream widths ranged from 2 to 5 m wide and 15 to 45 cm in depth. Flows were moderate to fast (0.75 to 1.25 m/s). Substrate consisted of cobble and gravel. No pools were observed. Riparian vegetation consisted mainly of willow.

Cache Creek becomes slightly braided through Reach 4. There is limited spawning potential within Reach 4 due to bed material composition (mainly cobble and gravel). Potential for grayling rearing habitat is moderate due to the presence of some cover, a number of pools, and moderate flow velocities. Overwintering potential is low due to shallow water. Similar to Reach 3, this reach is likely primarily used as migratory habitat to access upstream areas of Cache Creek.

Reach 5 of Cache Creek is generally unconfined, with an average channel width of 4.0 m. In lower parts of the reach inputs from Peel Creek have introduced red staining to the water and substrate. Based on general observations, there were notable differences in periphyton (attached algae) and invertebrate densities downstream of Peel Creek. Cache Creek upstream of Peel Creek had high levels of both periphyton and invertebrates compared to areas of Cache Creek downstream of this confluence. In addition, areas upstream of the mouth of Peel Creek had a number of pools, and both rearing and migration habitat potential; however, overwintering potential is poor. In the portion of Cache Creek that has been diverted around the Canamax TSF (in Reach 5), there is currently a high gradient section of channel that likely poses a migration barrier to fish. This section has a narrow channel with a gradient of 25% for a stretch of 30 m. While this is an anthropogenic barrier, a natural barrier was found approximately 400 m upstream at the upstream end of this reach. A cascade over bedrock, over 2 m in height was found in a canyon area upstream of the Canamax TSF.

Transect KR08 is located on Cache Creek, below the existing tailings dam and immediately upstream of the confluence of Peel Creek (Figure 4.12-3). At this location the channel was irregular, partially coupled and occasionally confined with no islands or side bars. The stream at this site was a complex system dominated by fast moving water and mid-sized substrates. The riparian zone is varied and is dominated by willow and birch with grasses, horsetails, and sedges. Limited overhanging vegetation contributes little organic material and shade to the aquatic environment.

KR08 was sampled August 9, 2007. At the time of sampling, the bankfull and wetted widths were 4.70 m and 4.58 m, respectively, and the mean channel depth was measured at 22 cm. Mean velocity was measured to be 0.26 to 0.75 m/s and the estimated discharge was 0.54 m^3/s. Approximately 70% of the aquatic habitat was riffle, 20% cascade/rapid, 5% run and 5% pool.

Water quality was found to be within a suitable range to support fish and fish habitat. Dissolved oxygen was found to be 10.03 mg/L or 80.2% saturation. Conductivity was 327 µS/cm and the pH was slightly basic at 8.7. Water temperature at the time of sampling was 5.9 °C.

The substrate at KR08 was dominated by small cobbles (65%) but was well graded with a mixture of fines, small and large gravel and large cobbles. Both banks were considered stable. Fish habitat cover was moderate, with a total of 35%. Fish habitat cover was comprised primarily of surface turbulence with a lesser component of overstream vegetation.

Cache Creek is confined for the majority of Reach 6 and there is a barrier to fish passage present near the lower end of the reach in the form of a cascade. Rearing habitat is fair; water velocities are generally high and there are limited pools. Areas with steep gradients are common throughout this reach. The average channel width in this reach is 3.1 m. There is some pea sized gravel present (suitable for Grayling spawning) and grayling spawning in this reach (below the cascade) is plausible provided flow and substrate are suitable. At this location the Cache Creek channel meanders irregularly, was partially coupled and confined with no side bars or islands. The stream at this site was generally fast moving with a well vegetated riparian zone. Overstream vegetation included tall shrub, herb, gramminoid and moss species. Overhanging vegetation provides both organic debris and shade to the stream. Overwintering habitat is poor due to shallow water and few deep pools. The barrier to fish passage (cascade) at the lower end of this reach, the lack of overwintering habitat and the fish sampling results combine to make this reach non-fish bearing.

KR01 (Figure 4.12-3) was sampled August 10, 2007. At the time of sampling, the bankfull and wetted widths were 2.75 m and 2.62 m, respectively, and the mean channel depth was measured at 18.3 cm. Mean velocity was measured to be 0.67 to 1.24 m/s and the estimated discharge was 0.47 m^3/s.

Water quality was found to be within a suitable range to support fish and fish habitat. Dissolved oxygen was found to be 9.2 mg/L or 79.2% saturation. The pH was slightly basic at 8.6. Water temperature at the time of sampling was 8.6°C.

The substrate at KR01 was well graded with 33% small gravel, 25% small cobble, 20% large cobble, 10% large gravel, 10% boulder and 2% fines. The banks were considered to be stable and measured 45 cm on the left bank and 80 cm on the right bank. Bank slopes were 35° and 80° for the left and right banks, respectively. Fish habitat cover was low with 8% surface turbulence, 5% overstream vegetation and 2% undercut banks.

In tributary A, the lower 300 m of Reach 1 was quite steep (14-18%), had very low flows and had poor habitat for fish at the time of survey. However, the reach is accessible to fish, especially during higher flows. As such, this reach should be considered fish bearing, although this should be confirmed by additional sampling, particularly under higher flows. Upstream of Reach 1, the gradient of the tributary channel increased to >20%. This, combined with poor stream channel morphology, makes this reach inaccessible to fish. This reach provides poor rearing habitat, no spawning or overwintering habitat. As such, this reach can be considered non-fish bearing.

Table 4.12-17 summarizes channel and habitat type for each reach in Cache Creek, based on channel width and gradient.

Table 4.12-17: Cache Creek Channel Type by Reach

Reach	Channel Type	Fish Bearing Status	Habitat Type
0	Riffle pool	Fish bearing	Rearing (sculpin)/ Migration (Grayling)
1	Cascade pool	Fish bearing	Rearing (sculpin)/ Migration (Grayling)
2	Cascade pool	Fish bearing	Rearing/Overwintering
3	Riffle pool – Cascade pool	Fish bearing	Migration corridor
4	Riffle pool – Floodplain	Fish bearing	Migration corridor
5	Riffle pool	Fish bearing	Rearing/Migration
6	Cascade pool	Non-fish bearing	Low potential

Source: EDI 2007

Stream Riparian Class

The riparian class for Cache Creek varies by reach. Reaches 1 through to 3 are classified as S2 (i.e., > 5 m ≤ 20m and fish bearing). Reach 4 contained a wider floodplain which will technically increase its classification to an S1. Reach 5 is an S3 fish bearing stream.

Stream Crossing Data

There is one existing crossing off the main Ketza Road along Cache Creek just upstream of Reach 4 (Figure 4.12-2).

4.12.3.5 Oxo Creek Results

Fish Presence, Abundance, and Distribution

Two adult Arctic Grayling (180 – 310 mm) were captured in Reach 1 of Oxo Creek (Figure 4.12-2). An unnamed tributary at Oxo Creek was also assessed (Tributary A). This stream runs into the left bank (looking downstream) of Oxo Creek approximately 200 m upstream of its mouth. The lower portion of Tributary A flows alongside Oxo Creek for 50 m before joining Oxo Creek. The lower reach of Tributary A was electrofished; however, no fish were captured (Table 4.12-18).

Table 4.12-18: Summary of Fish Sampling for Oxo Creek

Survey Date	12 July 2007	12 September 2007
Water Temperature	6.9°C	5.6°C
Conductivity	--	610 µS
Average Stream Gradient	9.75%	--
Channel Width	--	3.4 m
Sampling Methods (and Effort)	--	2 Baited Minnow Traps; 39.5 hr Electrofishing – 450 sec (7.5 min)
Fish Species Captured	--	2 Arctic Grayling (electrofished)
Fish Bearing Status	Fish Bearing	

Source: EDI 2007

Habitat Availability and Character

The stream had a moderate gradient ranging from 8-15%; however, generally had a well-developed cascade-pool morphology which allows for fish passage and use of this reach for rearing purposes.

Tributary A had poor to fair rearing habitat but will be accessible to fish from Oxo Creek. As such this short reach should be treated as a fish bearing reach.

Upstream of Reach 1, Tributary A had a steep gradient (>20%) and was not accessible to fish. In addition, the habitat quality was very poor as the stream was not big enough to form a well-developed cascade - pool morphology that could be utilized by fish. This reach was electrofished; no fish were captured or observed. This reach is non-fish bearing due to high gradient, poor habitat and fish sampling results.

Transect KR14 is located on Oxo Creek just upstream of the Cache Creek confluence (Figure 4.12-2). At this location the channel meanders irregularly, was partially coupled and confined with no side bars or islands. At this site the stream had a moderate gradient and larger substrate than the previous sites. Overstream vegetation included mosses, horsetails, willow and sedges. No aquatic vegetation was observed at this location.

KR14 was sampled August 9, 2007. At the time of sampling, the bankfull and wetted widths were 4.15 m and 3.64 m, respectively and the mean channel depth was measured at 2.17 m. Velocity was measured to be 0.07 to 0.39 m/s and the estimated discharge was 0.15 m^3/s. Approximately 35% of the aquatic habitat was cascade/rapid, 30% riffle, 30% pool and 5% run.

Water quality was found to be within a suitable range to support fish and fish habitat. Dissolved oxygen was found to be 10.22 mg/L or 81.9% saturation. Conductivity was 318 µS/cm and the pH was slightly basic at 8.7. Water temperature at the time of sampling was 5.5 °C.

The substrate at KR14 was fairly well graded. Boulders comprised 30% of the substrate while 20% was large cobble, 15% each of fines and large gravel and 10% each of small cobble and small gravel. The left bank measured 15 cm with a 40° slope, while the right bank was 22 cm with a 13° slope. Both banks were considered stable. Fish habitat cover was limited, with a total of 7% and was comprised of 5% overstream vegetation and 2% additional cover.

Based on channel gradient and channel width the channel type for each reach was determined. Table 4.12-19 provides a summary of channel type, fish bearing status and habitat type.

Table 4.12-19: Channel Type by Reach for Oxo Creek

Reach	Channel Type	Fish Bearing Status	Habitat Type
1	Step pool	Fish bearing	Rearing
2	Steep cascade	Non-fish bearing	Low potential

Source: EDI 2007

Stream Riparian Class

Based on the width of Oxo Creek and the presence of fish it is considered to be an S3 fish bearing stream.

Stream Crossing Data

No road crossings exist on Oxo Creek, therefore no background information was available.

4.12.3.6 Subsidiary Creek Results

Fish Presence, Abundance, and Distribution

Subsidiary Creek (see Figure 4.12-2) was sampled by electrofishing in July and September 2007. No fish were captured (Table 4.12-20).

Table 4.12-20: Summary of Fish Sampling for Subsidiary Creek

Survey Date	13 July 2007	
Reach	1	2
Water Temperature	8.6°C	7.2°C
Average Channel Gradient	1.7%	14%
Channel Width	2.6 m	4.2 m
Sampling Methods (and Effort)	Electrofishing – 514 sec* (8.6 min)	Electrofishing – 514 sec* (8.6 min)
Fish Species Captured	None	None
Fish Bearing Status	Non-fish Bearing	Non-fish Bearing

Source: EDI 2007

Note: * Effort in seconds is estimated from actual time spent electrofishing (20 min) as second counter was not working.

Habitat Availability and Character

Subsidiary Creek was assessed throughout most of its length. No fish were captured or observed in Subsidiary Creek (Table 4.12-20). Overall this stream currently has very limited suitability as fish habitat. Subsidiary Creek is quite small, and has been extensively altered in its lower reach where it has been diverted around the Canamax TSF. Subsidiary Creek drains into Cache Creek through a 32 m long culvert with a gradient of approximately 3%. This and other anthropogenic alterations to the lower reach of this stream currently limit potential use of this stream as fish habitat. However, upstream of this anthropogenic influence, the stream also has limited potential as fish habitat as it flows into Cache Creek upstream of the

anthropogenic cascade area beside the Canamax TSF. These factors combined with sampling results make this stream non-fish bearing.

Based on channel gradient and channel width the channel type for each reach was determined. Table 4.12-21 provides a summary of stream classification, fish bearing status and habitat type.

Table 4.12-21: Channel Type by Reach for Subsidiary Creek

Reach	Channel Type	Fish Bearing Status	Habitat Type
1	Riffle pool	Non-fish bearing	Low potential
2	Steep cascade	Non-fish bearing	Low potential

Source: EDI 2007

Stream Riparian Class

Based on the channel width measured along each reach and the lack of fish capture data for Oxo Creek, Reach 1 is considered to be an S6 non-fish bearing stream and Reach 2 is considered to be an S5 non-fish bearing stream.

Stream Crossing Data

No existing road crossing exist on this stream, therefore no background information was available.

4.12.3.7 Peel Creek Results

Fish Presence, Abundance, and Distribution

Fish sampling (electrofishing) of Peel Creek (see Figure 4.12-2) was conducted in July and September, 2007 in 3 reaches, and no fish were captured (Table 4.12-22).

Table 4.12-22: Summary of Fish Sampling for Peel Creek

Survey Date	12 July 2007 13 September 2007	12 July 2007	12 July 2007
Reach	1	2	3
Average Stream Gradient	8.3%	22.5%	10.5%
Dissolved Oxygen	29.5 mg/L	30.5 mg/L	30.3 mg/L
Channel Width	1.2 m	3.1 m	3.6 m
Sampling Methods (and Effort)	Electrofishing: 150 sec (2.5 min) 250 sec* (4.2 min)	Electrofishing: 100 sec (1.7 min)	--
Fish Species Captured	None	None	--
Fish Bearing Status	Fish Bearing	Non-fish Bearing (poor habitat)	

Source: EDI 2007

Note: * The second round of electrofishing was conducted September 13, 2007.

Habitat Availability and Character

Peel Creek was assessed throughout a significant portion of its length. Peel Creek generally has poor fish habitat, especially in the upper reaches. In addition, natural mineral inputs into the stream cause significant orange staining of the water and substrate, as well as the bed material of Cache Creek downstream of Peel Creek for several hundred metres. The lower reach (Reach 1), has a moderate gradient and poor rearing habitat for adult fish. Approximately 250 m upstream of its mouth, the gradient increases to 25% for 30 m. This gradient barrier makes the upper portion of the watershed inaccessible to fish. Upstream of this location (reaches 2 and 3) the stream is steep and has very poor fish habitat. No fish were captured or observed in any reach during July and September sampling events (Table 4.12-22). The lowest 250 m (Reach 1) of Peel Creek was defaulted to fish bearing; however, it is unlikely that it is used by fish due to poor water quality. Additional sampling will be necessary to confirm its fish bearing status. Due to the gradient barriers, poor habitat, and the absence of fish, the upper reaches (2 and 3) of Peel Creek can be considered non-fish bearing.

Transect KR15 is located on Peel Creek just upstream of the Cache Creek confluence and transect KR08 (Figure 4.12-2). At this location the channel meanders irregularly, was partially coupled and confined with no side bars or islands. The stream had a moderate gradient with fast flowing water. Woody debris and root systems were located within the wetted portion of the channel. Riparian vegetation was mostly herbaceous with willow, horsetails, and gramminoids. Overhanging vegetation provided abundant shade, cover and organic content functions to the aquatic habitat.

KR15 was sampled August 10, 2007. At the time of sampling, the bankfull and wetted widths were 3.00 m and 1.70 m, respectively and the mean channel depth was measured at 1.17 m. Velocity was measured to be 0.26 to 0.40 m/s and the estimated discharge was 0.06 m^3/s. pool.

Water quality was found to be within a suitable range to support fish and fish habitat. Dissolved oxygen was found to be 10.66 mg/L or 82% saturation. Conductivity was 405 µS/cm and the pH was slightly basic at 8.2. Water temperature at the time of sampling was 4.0°C.

The substrate at KR15 was fairly well graded. Small and large gravel and small and large cobbles comprised 90% of the substrate, in near equal components. Fines and boulders each comprised 5%. The left bank was measured at 22 cm high with a 13° slope while the right bank was 15 cm with a 10° slope. Both banks were considered to be stable. Fish habitat cover was abundant, and was comprised of 45% overstream vegetation and 10% surface turbulence.

Based on channel gradient and channel width, the channel type for each reach was determined. Table 4.12-23 provides a summary of stream classification, fish bearing status and habitat type.

Table 4.12-23: Channel Type by Reach for Peel Creek

Reach	Channel Type	Fish Bearing Status	Habitat Type
1	Step pool	Fish bearing	Low potential
2	Steep cascade	Non-fish bearing	Low potential
3	Steep cascade	Non-fish bearing	Low potential

Source: EDI 2007

Stream Riparian Class

Based on the channel width measured along each reach and the lack of fish capture data for Peel Creek. Reach 1 is considered to be an S6 non-fish bearing stream and Reach 2 is considered to be an S5 non-fish bearing stream.

Stream Crossing Data

There is a single crossing of the main mine road across Peel Creek. Information on this crossing is not available.

4.12.3.8 Unnamed Tributary to Cache Creek (KR16)

Habitat Availability and Character

Transect KR16 is located on an unnamed tributary near the headwaters of Cache Creek confluence (Figure 4.12-2). At this location the channel meandered irregularly, was partially coupled and confined with no side bars or islands. This stream was generally small but fast flowing with undercut banks. Riparian vegetation included willow, mosses, sedges, gramminoids and various herbs. Although mostly open, some overhanging vegetation was present.

KR16 was sampled in August, 2007. At the time of sampling, the bankfull and wetted widths were 0.96 m and 0.61 m, respectively, and the mean channel depth was measured at 10 cm. Velocity was measured to be 0.08 to 0.51 m/s and the estimated discharge was 0.0007 m^3/s. Approximately 60% of the aquatic habitat was riffle, 25% cascade/rapid, 10% pool and 5% run.

Water quality was found to be within a suitable range to support fish and fish habitat. Dissolved oxygen was found to be 8.66 mg/L or 76% saturation. Conductivity was 295 µS/cm and the pH was slightly basic at 8.7. Water temperature at the time of sampling was 9.6°C.

The substrate at KR16 was dominated by large cobble (40%) with a well graded mixture of fines, small and large gravel and small cobbles. The left bank was measured at 36 cm with a 75° slope while the right bank was 65 cm tall with a 75° slope. Both banks were considered to be stable. Fish habitat cover was limited, with a total of 15%. Fish habitat cover was comprised of 8% surface turbulence, 5% undercut banks and 2% overstream vegetation.

4.12.3.9 Discussion

The results of the 2007 field studies completed by EDI showed that the Cache Creek watershed has generally low fisheries productivity (EDI 2007). Results of fisheries sampling suggested that lower Cache Creek provides some year-round habitat for Slimy Sculpin, and that spring / summer seasonal rearing habitat for Arctic Grayling is most suitable in Cache Creek upstream of Peel or Oxo Creek confluences. Lower reaches were found to be generally unsuitable, and limited over-wintering habitat was observed. The authors speculated that most Arctic Grayling in the system likely return annually to the main stem of the Ketza River to over-winter. No evidence of juvenile Chinook Salmon was observed during these 2007 studies.

It appears that the most used, and likely the most valuable, habitat in Cache Creek is in Reach 5 upstream of the mouth of Peel Creek. The highest numbers of grayling were captured in this reach and in the lower portion (Reach 1) of Oxo Creek, which flows into Reach 5. It is interesting to note that Osborne (1991) also captured three Grayling in Reach 5 of Cache Creek, upstream of Peel Creek. This portion of the watershed appeared to have notable periphyton (attached algae) growth as well as an abundance of benthic invertebrates such as mayfly (Ephemoptera) and stonefly (Plecoptera) larvae. These indicators of productivity were not as abundant in Cache Creek immediately downstream of Peel Creek.

The natural barrier at the upstream end of Reach 5 prevents fish from using Cache Creek upstream of this point. Extensive fish sampling was conducted upstream (in Reach 6); no fish were captured or observed. Reach 6 did not contain any significant overwintering habitat and had a high gradient in many locations (>15%). It should be noted that there is a very steep and long cascade at the outlet of Tarn Lake (located upstream of Reach 6). Tarn Lake was sampled with minnow traps; no fish were captured.

The observations taken at the Ketza River Mine Study sites during 2010 spring sampling and assessment were consistent with prior observations at the site, suggesting that Cache Creek and the upper Ketza River are both relatively variable aquatic systems with respect to flow, turbidity, temperature, and sediment loading (EBA 2011d). The combination of these factors results in habitat characteristics that are not conducive to fish presence or spawning in spring due to the unpredictability of the systems. The key observations relevant to this conclusion include:

- High temperature variability on a daily basis
- Frequent increases in flow (i.e., flashiness of system)
- Heavy sediment loading and transport during melt or precipitation events (e.g., turbidity changing from 8 NTU to 145 NTU within hours)
- Evidence of heavy and frequent sediment deposition
- A lack of observed Arctic Grayling and few observed sculpin.

In general, all eight sites sampled by EBA in the 2007 study contained generally well graded substrate that could potentially provide fish habitat. As suggested by previous studies, mean water depth was generally below 30 cm so pools, and potentially even riffles, will likely freeze to bottom in winter months, excluding over-wintering habitat except in deep pools. The dominant type of cover encountered was overhanging vegetation and surface turbulence. Fast water, such as riffle or cascade / rapid, was often the dominant channel morphology. Riffle-run complexes are often utilized by fish for feeding while slower, gravelled areas are potential spawning grounds.

4.12.4 Aquatic Ecosystem – Benthic Macroinvertebrate and Periphyton

4.12.4.1 Historical Studies

Benthic Invertebrates

During 1980-1981, a number of studies were conducted as part of the proposed Iona Silver Mine (BC Research 1986) at the confluence of Cache Creek and the Ketza River, downstream from the then Canamax

claims on Cache Creek. The June 1981 field studies involved sampling of the Ketza River upstream and downstream from its confluence with Cache Creek. While benthic invertebrate samples were not collected, BC Research's (1986) preliminary qualitative observations of the Ketza River and its tributaries during June 1981 indicated that the river was relatively unproductive and low in benthic invertebrates. It was suggested that this may be due to abundant sand and fines filling the interstitial spaces between larger rocks and thus eliminating the habitat necessary for the establishment of benthic invertebrates. Low numbers of mayflies, stoneflies, chironomids (Chironomidae) and other common invertebrate fauna were observed on the underside of rocks. In addition, instream algae were essentially absent, which is another indication of a low productivity system.

A 1984 baseline report of the Iona Silver Mine area (Godin and Mackenzie-Grieve 1984) located downstream of the Ketza Mine area included studies on benthic invertebrates. A total of seven stations were sampled in triplicate with a Surber sampler. A total of 227 organisms comprising 38 taxa were collected. The densities calculated from a mean of 3 samples for each station showed a wide range of values. The highest density of organisms was found at Station 1 (269 individuals/m^2) while the lowest was at Station 2 with no organisms found. Station 3 had 57 individuals/m^2. The lowest densities were found at stations 2, 3 and 6 which were exposed to groundwater flowing from the mine audit. The average number of individuals for all stations was 116 per m^2, which is considered low. This may be due to differences in benthic habitat, varying levels of organic input, proximity to the mine adit, and variations in sampling procedures. Stations 1, 7 and 8 were located in riffle areas of Cache Creek and Ketza River, and were dominated by *Cinygmula* sp. (Ephemeroptera) which shared dominance at Station 5 with *Zapdada* sp. and *Alloperla* sp. (Plecoptera). Station 6, located on a groundwater flow from a mine audit, was dominated by *Pseudodiamesa* sp. (Chironomidae).

The Norecol (1986) study also reported low densities of benthic invertebrates in Cache Creek. This, in combination with low water temperature, resulted in the conclusion that this was a low productivity stream.

EC (1992) reported on the results of comprehensive baseline field work conducted in July 1981 and July 1987. The surveys included water quality sampling, sediment sampling, and benthic sampling. EC (1992) reported densities of invertebrates ranged from 187 organisms/m^2 at site 1 on Cache Creek, to 312 organisms/m^2 at Site 6 upstream on the Ketza River. At the two other stations sampled on Cache Creek (Sites 2 and 4), invertebrate densities ranged from 287 and 276 organisms/m^2, respectively. High variability in densities among sites is evident at similar sites between the 1981 studies and 1987 studies. Generally, the benthic invertebrate fauna was considered to be sparse and dominated by mayfly and stonefly species.

Periphyton

Periphyton includes the community of microbiota (including algae, bacteria, fungi, microinvertebrates and detritus) that grow attached to surfaces such as rocks or larger plants in aquatic ecosystems. Periphyton serves as an important food source for invertebrates and fish, and is an important indicator of water quality. Because periphyton is attached to the substrate, this assemblage is an effective integrator of physical and chemical disturbances to a given stream reach and is therefore a sensitive indicator of environmental change.

In a June 1981 study of the Ketza River upstream and downstream of the Cache Creek confluence, relative to the Iona Silver project, BC Research (1986) found little evidence of periphyton (algae) in the river, indicating low aquatic productivity. While no samples were taken or analysis conducted, Norecol (1986) also reported observations of low densities of periphyton in Cache Creek.

4.12.4.2 Assessment Methods

Benthic Invertebrates

Benthic invertebrate sampling was conducted by EBA in 2007 at all stations as shown in Figure 4.12-3. Sampling was conducted using a Hess substrate invertebrate sampler with an area of 0.086 m^2 and a mesh six of 363 µm. The sampler was inserted into the substrate to a depth of approximately 10 cm, and the substrate was washed for 5 minutes (according to methods by the BC Resources Inventory Committee (RIC) 1997). Contents were preserved on site in 80% ethanol 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 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 (EC 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.

Periphyton

Periphyton samples were collected at each of the eight sample sites in conjunction with other sampling to determine presence, abundance and characteristics. At each site, three separate rocks were randomly retrieved from riffle habitat (at least 1 m apart from each other). A standard size circle (5.5 cm diameter) was etched into the surface of each rock, following which the periphyton was scraped from inside each circle using a knife and small brush. The periphyton was washed into a labelled plastic bag using distilled water, following which the bags were foil wrapped to seal out light. Samples were immediately chilled, and packed into coolers for shipment under chain of custody to MB Laboratories of Sydney, BC. In the lab, periphyton were identified and enumerated, with colony estimates calculated per surface area unit. A sub-sample from each station was also sampled to assess the degree of primary production (Chlorophyll A and biomass).

4.12.4.3 Results

Benthic Invertebrates

The benthic community of the upper Ketza River was of generally low abundance and diversity, but with a taxonomic distribution characteristic of moderately healthy environments. EBA collected a total of

66 benthic organisms among three samples, resulting in a mean abundance and density of 22 individuals and 255.8 individuals/m^2, respectively. The dominant taxa in this area (Station KR11) were Plecoptera, Ephemeroptera, and Diptera (33.3%, 31.8%, and 31.8% respectively). The most abundant species were *Orthocladius* spp. (Diptera, mean abundance 3.67) and *Epeorus* spp. (Plecoptera, mean abundance 3.33). Mean species richness at FS6 was 10 per sample, and mean diversity (Simpson's index) was 0.38.

The benthic community in the lower reaches of the Ketza River was one of the least abundant sites sampled, with only nine individuals from seven taxonomic groups collected across three replicates. Most common were the Chironomidae, making up over half of the sample (66.7%), while single Ephemeroptera, Trichoptera, and Arachnida comprised the remainder. Mean abundance was three, and mean density was 34.8 individuals/m^2. Mean species richness at this station (KR12) was 2.6 per sample, and mean diversity was 0.53 (Simpson's index).

Periphyton

In the upper reaches of the Ketza River, the periphyton community composition was dominated by Navicula (49.8%) followed by Diatoma (28.3%) and Ceratoneis (18.9%). The density of periphyton cells in sample KR11 was 1220 per cm^2. Primary productivity was relatively low at 0.045 ug/cm^2 Chlorophyll *a*.

In the lower Ketza River (Station KR12), the periphyton community composition was similar to upstream areas as it was dominated by Navicula (39.4%) followed by Diatoma (38.3%) and Ceratoneis (22.0%). The density of periphyton was 5,830 cells per cm^2. The primary productivity at this site was 0.069 ug/cm^2 Chlorophyll *a*.

4.12.4.4 Cache Creek Results

Benthic Invertebrates

The benthic community in upper Cache Creek was generally low in abundance, but had a distribution of invertebrates representative of a moderately healthy aquatic community. EBA collected a total of 61 benthic organisms in two replicate samples, resulting in a mean abundance and density of 30.5 individuals and 355 individuals/m^2. The dominant taxa at this site were Plecoptera and Diptera (55.7% and 21.3%, respectively), with Arachnida, Ephemeroptera, Annelida and Trichoptera comprising the remaining components. Mean species richness at KR01 was nine per sample, and mean diversity was 0.28 (Simpson's index).

In central Cache Creek, the benthic community was similar to upstream areas, with a lower abundance of invertebrates. EBA collected a total of 51 benthic organisms among three samples, resulting in a mean abundance and density of 17.3 individuals and 201.5 individuals/m^2. The dominant taxa at this site were Plecoptera and Diptera (46.2% and 21.2%, respectively), with Ephemeroptera, Trichoptera, Arichnida, and Annelida comprising the remaining components. Mean species richness in this area (Station KR08) was seven per sample, and mean diversity was 0.30 (Simpson's index). The benthic community in lower Cache Creek was the simplest and least abundant of all sites, with only three individuals captured in three replicates. Two chironomids and one *Diamesa* spp. were sampled. Mean abundance and density at this site were found to be one individual and 11.6 individuals/m^2. Mean species richness was also one per sample, and mean diversity was 0.47 (Simpson's index).

Periphyton

In upper Cache Creek, the periphyton community composition was dominated by Ceratoneis (96.9%) followed by Navicula (2.3%). The density of periphyton in this area (Station KR01) was 49,843 cells per cm^2 and primary productivity at this site was relatively high at 0.194 ug/cm^2 Chlorophyll *a*.

In central Cache Creek, the periphyton community composition was dominated by Ceratoneis (83.9%) followed by Navicula (13.6%) and Acnanthes (2.0%). Periphyton density in this area (Station KR08) was 649,140 cells per cm^2 and primary productivity at this site was the highest at 0.235 ug/cm^2 Chlorophyll *a*.

The periphyton community in the lower reaches of Cache Creek was dominated by Ceratoneis (47.6%) followed by Navicula (45.1%) and Gomphonema (7.3%). No other genera were identified in this sample. The density of periphyton in the lower creek (Station KR10) was only 60 cells per cm^2. Accordingly, primary productivity was low at 0.005 ug/cm^2 Chlorophyll *a*.

4.12.4.5 Oxo Creek Results

Benthic Invertebrates

The benthic community at Oxo Creek was the most abundant of all sites, and had a high taxonomic diversity. EBA collected a total of 196 benthic organisms among three samples, resulting in a mean abundance and density of 65.3 individuals and 759.7 individual/m^2. The dominant taxa at this site were Plecoptera (45.9%), followed by Diptera (30.1%) and Ephemeroptera (12.8%). Arachnida, Trichoptera, and Collembola comprised the remainder. Mean species richness in this area (station KR14) was 13 per sample, and mean diversity (Simpson's index) was 0.21.

Periphyton

The periphyton community in Oxo creek was dominated by Ceratoneis (78.3%) followed by Gomphonema (18.0%) and Navicula (3.2%). The density of periphyton was 11,900 cells per cm^2 and the primary productivity was 0.022 ug/cm^2 Chlorophyll *a*.

4.12.4.6 Peel Creek Results

Benthic Invertebrates

The benthic community in Peel Creek (Station KR15) was among the poorest sampled, with only 11 individuals collected across three replicates from five taxa, and two of these were adult Dipterans, which were not included in subsequent analysis. Most common were Chironomidae and other Diptera, comprising 63.6% of the sample. Small numbers of Plectoptera and Arachnida were also sampled. Mean abundance was 4.5 and mean density was 42.6 individuals/m^2. Mean species richness at KR15 was 3.3 per sample, and mean diversity was 0.28 (Simpson's index).

Periphyton

No taxonomic information was available although primary productivity in Peel Creek was 0.131 ug/cm^2 Chlorophyll *a*. At this site and throughout Peel Creek, all areas of the streambed are covered by a thick iron-based precipitate (up to 1.5 cm thick). Consequently, samples collected from this site consisted primarily of this material, which made identifying or quantifying algal cells impossible in the laboratory.

4.12.4.7 Discussion

Benthic Invertebrates

Based on benthic collections at eight sample sites the benthic community was generally found to be representative of moderately unproductive aquatic ecosystems, with isolated effects from local development or geology (EBA 2008e). The 2007 results were similar to those previously recorded in the area in a number of past studies (BC Research 1986, Godin and Mackenzie-Grieve 1984, Norecol 1986, EC 1992). The overall mean abundance of organisms across eight sites in 2007 was found to be 290 individuals/m^2, compared to 211 individuals/m^2 in six sites by EC in 1987, and 108.4 individuals/m^2 in eight sites by EC in 1981 (Godin and Mackenzie-Grieve 1984, EC 1992). However, while these figures are unit-area corrected, EBA's sampling was performed using a Hess sampler while a Surber sampler was used in previous studies.

Sampling at two headwater stream areas within the LSA provided good baseline reference data representative of local productivity potentials levels (KR14 – Oxo Creek and KR16 – Tributary to Cache Creek). At these sites, EBA determined invertebrate densities of 759.7 and 678.3 individuals/m^2, respectively, with fauna dominated by Plecoptera, Ephemeroptera, Diptera, and Hydracarina. For the local area these observed densities are relatively high, however, ongoing water quality sampling by EBA (unpublished) has confirmed these tributaries to be relatively unaffected by base metal and acid contamination from local geological features.

Station KR01, which is located near the headwaters of Cache Creek, was the highest point on this stream system comparable with prior data. While only two samples could be collected from this site, EBA calculated a density of 354 individuals/m^2 (above average in the local area). As previously noted, the community at KR01 was not diverse, but dominated by Ephemeroptera and Plecoptera (*Alloperla fraternal* and *Zapada haysi/oregonensis*). Although previous studies found a broader taxonomic diversity in upper Cache Creek (dominated by Plecoptera and Diptera), density in 1987 was 183 individuals/m^2 .

EBA found a moderate abundance and diversity at Station KR08, which is located in central Cache Creek below the Canamax TSF, but upstream of tributaries that enter from the north that are negatively affected by local geology. Benthic density at this site was found to be moderate at 201 organisms/m^2, with a wide taxonomic diversity characteristic of less impacted systems. As with upstream areas, the Plecopterans *Alloperla fraternal* and *Zapada haysi/oregonensis* were relatively common, in addition to Ephemeroptera, Trichoptera, and Diptera. Benthic density in 2007 was calculated to be nearly double that observed in 1981 surveys. Although no density figures were available from 1995 surveys, the distribution of individuals and overall catch appeared comparable to that in 2007 (Godin and Mackenzie-Grieve 1984, EC unpublished data).

EBA noted marked reductions in both abundance and diversity in the tributaries directly influenced by local metals leaching and acid rock drainage. Station KR15 was located in Peel Creek, a tributary of central Cache Creek that is heavily influenced by iron. Density at this site was calculated at only 34.9 individuals/m^2, one of the lowest in the area. As expected, the taxa at this site were dominated by Diptera (which tend to be tolerant), however, a single Plecoptera was captured. No previous benthic data for this tributary could be found from which to make comparisons.

The lowest abundance observed in all samples was at Station KR10, located in Cache Creek immediately upstream from its junction with the Ketza River. Only three Diptera were sampled in three replicates, resulting in a density of only 11.6 individuals/m^2. Although prior studies commented on the generally poor environmental characteristics and low benthic abundance at this site, prior recorded densities were markedly higher than those observed by EBA (140 individuals/m^2 in 1981, and 291 organisms/m^2 in 1987 (BC Research 1986, Godin and Mackenzie-Grieve 1984, EC 1992). During field assessments at this site, however, the pronounced presence of fines and lack of interstitial spaces in stream cobbles and gravels was noted. Based on the data observed, there has been an apparently large reduction in the aquatic capacity at this site over the last 20 years. However, it cannot be determined whether this reduction may have resulted from a recent isolated event.

The poor benthic characteristics of Cache Creek continued downstream into the Ketza River at KR12. When benthic communities at stations KR11 and KR12 are compared, it is evident that the benthos in Ketza River upstream of the confluence of Cache Creek (KR11) is reasonably abundant and healthy since pollution intolerant organisms were present, such as stoneflies and mayfly larvae. At this site, a density of 255 organisms/m^2 was recorded, over four times the figure of 57.6 organisms/m^2 recorded in 1981. In contrast, Station KR12 located in the Ketza River but downstream of the confluence with Cache Creek had a density of only 34.8 individuals/m^2, compared to figures of 140 and 312 individuals/m^2 recorded in 1981 and 1987, respectively. While moderate numbers of both Ephemeroptera and Plecoptera were recorded in prior studies, the lower Ketza River is now dominated by Diptera.

Periphyton

Based on EBA's periphyton data collected in 2007, the central and upper reaches of Cache Creek had relatively high periphyton density and productivity (namely KR01, KR08, and to a lesser degree KR15). Oxo Creek (also in the upper Cache drainage) was found to have the second lowest productivity recorded, despite having an abundant benthic community. Station KR08 is located downstream of the Canamax TSF. Station KR10, also located within the main stem of Cache Creek but immediately above its confluence with the Ketza River, had the lowest periphyton density and productivity of all sites sampled during the 2007 program. Despite heavy iron precipitate, Station KR15 in Peel Creek was found to have higher productivity than lower Cache Creek or the Ketza River.

Stations KR11 and KR12, the two sites located within the Ketza River, were comprised of similar community structure and comparable periphyton productivity. The notable difference between these sites and the ones within the Cache Creek watershed, was the relative abundance of the three diatom genera Navicula, Diatoma and Ceratoneis (in descending order), whereas the general trend in the Cache Creek system in descending order of abundance was Ceratoneis followed by Navicula then Diatoma /

Gomphonema. Ceratoneis is generally considered to be a genus that is indicative of cold, fast flowing, clean waters.

A search of existing data for the study area revealed no prior periphyton analyses to which the 2007 results could be compared. In a June 1981 study of the Ketza River upstream and downstream of the Cache Creek confluence, relative to the Iona Silver project, BC Research (1986) found little evidence of periphyton (algae) in the river, indicating low aquatic productivity. While no samples were taken or analysis conducted, Norecol (1986) also reported low density of periphyton in Cache Creek.

4.12.5 Aquatic Ecosystem – Stream Sediment Metals and Particle Size

4.12.5.1 Historical Studies

Sediment metal analyses conducted in 1984 in the Iona Mine area downstream of the Ketza Mine indicated that arsenic levels ranged from 121.66 mg/kg to 563.0 mg/kg (Godin and Mackenzie-Grieve 1984). The highest reported level in Cache Creek sediments was 358 mg/kg. These levels are considered elevated but are not unexpected given that the area sampled has heavy mineralization, with naturally elevated levels of arsenic associated with the ore bodies. The highest chromium levels in the area were 49.6 mg/kg and 59.6 mg/kg whereas the highest chromium level in lower Cache Creek was 20 mg/kg.

Background copper levels in sediments ranged from 15.1-143.0 mg/kg. Iron concentrations ranged between 21,900 mg/kg and 68,600 mg/kg. Various minerals, including freibergite, siderite and pyrite are abundant in the area and contain iron. Lead concentrations ranged from a low of 21.6 mg/kg to a high of 1,199 mg/kg. Lead in lower Cache Creek sediment replicates ranged from 286 to 606 mg/kg. In areas where galena, a lead sulphide, is present, higher lead concentrations can be expected. Zinc ranged from 164 to172 mg/kg in lower Cache Creek sediment replicates.

EC (1992) reported on the results of comprehensive baseline field work conducted in July 1981 and July 1987. The surveys included water quality sampling, sediment sampling, and benthic sampling. While the study compares results from 1981 and 1987 field studies, results from the 1981 study were previously reported by Godin and Mackenzie –Grieve (1984) as previously summarized.

Sediment analyses were performed on subsamples using the size fraction smaller than 150 um. High concentrations of some metals (arsenic, cadmium, chromium, copper, lead, and zinc) were found in the sediments, in both the 1981 and 1987 studies. Considerable variability was noted in both studies, both among sites and among the three replicate samples at each site. The 1981 study revealed that these metal concentrations exceed the sediment quality standards. In the 1987 studies, marked increases in the levels of these metals in sediments, particularly lead and zinc were noted at comparable sites.

In the 1987 study, a mean arsenic level of 2,327 ug/g was recorded at Site 1 on upper Cache Creek. In 1987, a mean chromium level of 136 ug/g was recorded on lower Cache Creek. Copper levels in the sediments remained similar during the two study periods. In the 1987 study, average lead concentrations were considerably higher. Lead in lower Cache Creek sediment replicates ranged from 713 to 6,580 mg/kg. In 1987, iron concentrations ranged between 35,400 mg/kg and 256,000 mg/kg. In 1987, zinc ranged from 1,480 to 3,630 mg/kg in lower Cache Creek sediment replicates. This represents a greater than 10-fold increase in zinc from 1981 levels.

Sediment grain size analysis was conducted in the same study (Godin and Mackenzie-Grieve 1984). The highest percentage of particles for all replicates at all stations sampled were sized at <500 µm. However, data show considerable variation between replicate samples at specific stations. The authors suggested that this reflected the variability and problems associated with obtaining truly representative sediment samples. Because large gravel and cobble are removed during sampling, the results generally show a lower percentage of coarser materials than actually exists *in situ*.

Sediment particle size analysis conducted in July 1987 (EC 1992) indicated that there was considerable variation in percentage particle size among replicate samples, while the authors noted samples were unlikely to be truly representative, and some fine material was lost during sampling. However, the largest portion of material was equal to or greater than 2 mm (10 mesh sieve).

4.12.5.2 Assessment Methods

In 2007, EBA collected sediment samples from each of the eight stations within the study area (EBA 2008e).

The following eight sampling stations were established based on the requirements of sampling in the terms of KRH's previous Water Licence:

- One was located on Oxo Creek (KR 14) in the mine area. This tributary flows into the footprint from the south and is not influenced by current exploration activities
- Three stations were located on Cache Creek: KR01 was located in an upstream reach (immediately below the existing mill facility); KR08 was located downstream of the existing TSF; and, KR10 was located just above the confluence with Ketza River (below all infrastructure)
- Two stations were located in the Ketza River: KR11 was just upstream of the location where Cache Creek flows into the Ketza River; and, KR12 was further downstream of the confluence between the two systems
- One station located in an unnamed tributary to Cache Creek (KR16) which was established as a baseline site for water quality sampling, but is downstream from some exploration activity
- One station located in Peel Creek (KR15), which is within the mine footprint and downstream of exploration activities.

At each station, samples were collected from three separate depositional areas in the active channel, within approximately 30 m of the station. As per the Water Licence requirements, samples were collected at each chosen location using an aluminum scoop, by a collector wearing latex gloves. Samples were placed directly into sterile labelled 125 mL glass jars and kept refrigerated until being placed on ice in coolers for transport under chain of custody to Maxxam for analysis.

Following physical particle size separation, a sub-sample of sediments from the #100 sieve was analyzed by Maxxam Analytics for metals concentrations using Inductively Coupled Plasma Mass Spectroscopy (ICPMS) analysis, as well as loss on ignition (LOI) at 550°C. Results of the ICPMS analysis were compared to CCME ALG, as well as to British Columbia Water Quality Guidelines for the protection of aquatic life ((BCWQG) ; to provide a reference for those metals where no CCME ALG standard exists).

At the laboratory, samples were dried and screened using sieves ASTM mesh numbers 16, 30, 50, 100, 140, 200, 270 and 400. The percentage of total sample retained by each 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 sieve classes.

4.12.5.3 Results

Sediment Metals

In the upper reaches of Ketza River, arsenic, chromium, lead and zinc concentrations in all three samples collected at KR11 were above the comparable BCWQG and CCME ALG standards (Table 4.12-24). In lower Ketza Creek, arsenic concentrations in all three samples collected at KR12 were above the comparable standards and lead concentrations in Sample 1 and Sample 2 were above comparable standards.

Sediment Grain Size Distribution

Table 4.12-25 describe the physical sediment analysis results for KR01, KR08, KR10, and KR11. Samples taken from the lower Ketza River at KR11 (near the confluence with Cache Creek) showed a larger size distribution despite a similar low gradient reach to that at KR10 and KR12 (<10% silts). An increased proportion of clay and fine silts was observed along the Ketza River upstream of the confluence with Cache Creek at KR12 (Table 4.12-25).

4.12.5.4 Cache Creek Results

Sediment Metals

In upper Cache Creek, arsenic, copper, lead and zinc concentrations in all three samples were above the comparable standards (Sampling station KR01). Arsenic, copper and lead concentrations in all three samples collected at central Cache Creek (KR08) were above the comparable BCWQG and CCME ALG standards (Table 4.12-24). In addition, the zinc concentration from Sample 1 exceeded the comparable standard. At lower Cache creek, only arsenic concentrations from all three samples were above the comparable standards.

Sediment Grain Size Distribution

In the upper reaches of the Cache Creek system, sediments were generally dominated by relatively larger materials (>75% of sediment over 0.60 mm), while less than 10% consisted of fine silts and clays (Table 4.12-25. At KR08 (a lower gradient reach below the Canamax TSF), a slight increase in medium and smaller silts was observed. Near the confluence of Cache Creek with the Ketza River, the creek slope is reduced as it enters the Ketza River valley, allowing for the settling of finer sediments. Consequently, a marked increase in the proportion of fine silts and clays was observed at this station (50% silts or finer) and KR12 (further downstream; 75% silts or finer). Additionally, large particulates were primarily absent in these reaches.

Ketza River Holdings

Table 4.12-24: Stream Sediment Metals (2007)

Sample ID	KR01-S1	KR01-S2	KR01-S3	KR08-S1	KR08-S2	KR08-S3	KR10-S1	KR10-S2	KR10-S3	KR11-S1	KR11-S2	KR11-S3	KR12-S1	KR12-S2	KR12-S3	KR14-S1	KR14-S2	KR14-S3	KR15-S1	KR15-S2	KR15-S3	KR16-S1	KR16-S2	KR16-S3	BCWQG [1]	CCME [2]
Sampling Date	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/9/07	8/9/07	8/9/07	8/9/07	8/9/07	8/9/07	8/10/07	8/10/07	8/10/07	8/9/07	8/9/07	8/9/07	8/10/07	8/10/07	8/10/07	8/10/07	8/10/07	8/10/07		
Misc. Inorganics																										ISQG
Soluble (2:1) pH	8.3	8.4	8.01	8.22	8.15	8.14	8.24	8.16	8.14	7.86	8.09	8.07	8.06	8.05	8.17	8.41	8.51	8.27	7.21	7.35	7.16	8.24	8.31	8.41		
Total Metals by ICPMS (mg/kg)																										
Total Aluminum (Al)	9070	5750	7270	5700	6270	6720	5390	3540	3820	12400	10800	10200	4350	3780	4080	5370	4590	4120	9390	8680	27000	6500	5380	7010		
Total Antimony (Sb)	5.9	4.8	5.5	5.5	3.3	3.5	2.9	4.8	4.4	3.2	3	2.8	4.3	4.1	4.1	4.8	2.8	3.1	4.7	3.7	4	1.8	1.9	1.9		
Total Arsenic (As)	**625**	**559**	**730**	**135**	**110**	**118**	**77.6**	**42.1**	**46**	**38.1**	**34.9**	**39.4**	**47.1**	**49.3**	**44.8**	**34.6**	**30.4**	**44.3**	**1480**	**1470**	**1950**	**41.6**	**44.9**	**28.5**	5.9	5.9
Total Barium (Ba)	27.5	23.2	47.3	22.9	25.5	23	30.3	28.2	26.5	94.9	82.2	91.6	40.9	37.1	34.4	22.4	20.3	25.2	21	19.7	38.9	18.7	20.5	23.9		
Total Beryllium (Be)	0.3	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.4	0.4	0.4	0.2	0.2	0.2	0.4	0.3	0.8	0.1	0.3	0.2		
Total Bismuth (Bi)	2.5	5.3	4.9	0.7	1	0.7	0.2	0.2	0.2	0.6	0.2	0.2	0.3	0.3	0.3	0.2	0.1	0.2	13.3	18.1	7.7	0.2	0.5	0.2		
Total Cadmium (Cd)	1.02	1.17	1.22	0.88	0.73	0.77	0.37	0.21	0.24	0.6	0.67	0.73	0.28	0.31	0.26	1.55	1.59	1.69	1.01	0.83	2.84	0.53	0.5	0.46	0.6	0.6
Total Calcium (Ca)	76800	89200	86500	83800	78800	76100	80400	90100	93400	60600	51400	48300	80000	89200	86100	107000	126000	96400	4960	6370	8020	117000	87400	114000		
Total Chromium (Cr)	13	9	10	9	10	10	7	6	6	**73**	**51**	**53**	8	7	9	8	7	9	9	9	4	10	9	10	37.3	37.3
Total Cobalt (Co)	14.5	11.1	18.8	14.3	13.7	14.4	18.4	14.3	15.4	19.8	18.9	19.9	17.9	17.2	15.8	12	10.7	11.2	90.2	73.1	88.7	13.1	9.2	12.7		
Total Copper (Cu)	**47.9**	**54.9**	**58.2**	**46.3**	**39.7**	**42.8**	21.2	19.8	19.5	30.4	28.5	30.1	25	23.2	20.3	34.2	31	**39.3**	**75.5**	**69.5**	**170**	**36.1**	**41.4**	31	35.7	35.7
Total Iron (Fe)	41000	38200	41900	34100	33800	33800	41900	33000	35800	39800	39400	40500	36500	34800	35500	31100	26100	26100	60100	47300	251000	28000	25800	27900		
Total Lead (Pb)	**83.5**	**46.6**	**43.4**	**53.8**	**50.1**	**48.5**	34.3	31.3	30	**53.2**	**68.6**	**64.5**	**36.9**	**35.4**	32.5	**42.3**	**43.4**	**55**	19.3	28.5	11.3	12.1	11.5	12.9	35	35
Total Magnesium (Mg)	7050	6810	6700	10700	10300	10500	13900	16200	17100	24500	19100	18000	14700	16400	16400	14600	24400	14100	3950	4210	2020	6500	6400	6660		
Total Manganese (Mn)	878	708	1170	670	696	671	1180	798	833	748	768	822	780	858	772	604	652	535	602	506	439	405	344	481		
Total Mercury (Hg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.17	0.17
Total Molybdenum (Mo)	3.7	4.2	4.1	3.8	3.5	3.5	1.5	1.8	1.8	2.1	2	2.2	1.5	1.7	1.7	4.9	4.8	5.5	1.1	0.9	1.1	4.6	5	4.1		
Total Nickel (Ni)	37.2	34.8	41.6	37.3	37.2	37.8	31	26	27.2	54.3	51	51.6	29.8	30.5	28.8	43.2	41.6	40.8	48.1	39.7	38.8	31.1	41.3	34.1	75	
Total Phosphorus (P)	825	549	527	1360	1020	851	801	819	844	1260	1150	1080	661	719	792	1180	941	2810	828	874	403	2170	1200	1270		
Total Potassium (K)	371	186	273	<100	<100	<100	<100	<100	108	347	312	334	254	143	125	<100	<100	<100	389	320	205	<100	124	<100		
Total Selenium (Se)	0.6	1	0.8	1	0.8	0.6	<0.5	<0.5	<0.5	0.7	<0.5	0.8	<0.5	<0.5	<0.5	1	1	1	0.5	<0.5	0.8	1	1.7	0.9	5	
Total Silver (Ag)	0.29	0.32	0.37	0.25	0.25	0.24	0.18	0.33	0.19	0.28	0.23	0.26	0.25	0.21	0.2	0.35	0.27	0.36	0.28	0.25	0.37	0.21	0.31	0.22	0.5	
Total Sodium (Na)	104	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100		
Total Strontium (Sr)	132	131	126	130	134	126	181	181	183	142	136	132	170	184	184	161	173	137	22.8	27.5	50.1	184	123	163		
Total Thallium (Tl)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		
Total Tin (Sn)	0.6	0.4	0.8	0.1	0.3	0.3	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	<0.1	<0.1	<0.1	0.4	0.3	0.3	<0.1	0.3	<0.1		
Total Titanium (Ti)	38	37	27	12	8	20	10	13	9	199	112	100	15	13	25	8	5	5	24	23	22	6	5	20		
Total Vanadium (V)	14	14	14	15	15	14	10	10	9	49	41	38	9	10	10	13	16	16	7	7	5	12	18	12		
Total Zinc (Zn)	**141**	**151**	**136**	**123**	111	121	87	72	78	**157**	**174**	**175**	87	87	81	**132**	**149**	**148**	**171**	**133**	**374**	74	**157**	75	123	123
Total Zirconium (Zr)	12.5	21.5	10.6	28.1	25.7	25.4	26.7	27.3	26.8	24.7	23.3	23.6	20.9	21.7	28.9	23.3	21.9	20.8	9.9	8.6	6.6	14.6	19.8	12.8		

1 British Columbia Water Quality Guidelines 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 Indicates the applicable standard is lower than the detection limit.

"-" Indicates no analysis conducted or no applicable standard available.

BOLD indicates parameter exceeds BC Water Quality Guidelines

indicates parameter exceeds Canadian Environmental Quality Guidelines

Table 4.12-25: Physical Sediment Analysis Results

Sample ID	KR01			KR08			KR10			KR11		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Sampling Date	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/11/07	8/9/07	8/9/07	8/9/07	8/9/07	8/9/07	8/9/07
Physical Properties (% weight fraction)												
Loss on Ignition	3	5	7	4	4	15	2	3	3	3	4	4
Sieve - #16 (>1.18mm)	20	29	10	10	0.7	4	6.2	0.2	0.1	1.6	2.6	0.4
Sieve - #30 (>0.60mm)	39	44	28	38	15	16	9.5	0.5	0.4	9.1	16	9.2
Sieve - #50 (>0.300 mm)	26	14	30	38	52	39	15	1.4	0.8	26	41	44
Sieve - 100 Mesh (>.15 mm)	4.3	5.1	18	5.3	22	26	41	34	18	27	24	26
Sieve - #140 (>0.106mm)	6.5	4.6	5.1	3.9	5.7	5.4	14	27	30	14	7	8.5
Sieve - #200 (>0.075mm)	0.8	0.7	3.1	2.5	1.1	2.3	5.1	12	18	8.5	3.1	4.4
Sieve - #270 (>0.053mm)	1.3	1.2	3.1	1.1	1.3	3.3	4.9	13	18	7.6	3	4.3
Sieve - #400 (>0.030 mm)	0.7	0.5	1.4	0.6	1.2	1.6	2.1	7	7.6	3.4	1.3	1.6
Sieve - Pan	1.1	1.1	1.2	0.8	0.6	2	2.2	4.7	6.7	3.6	1.5	1.5
Loss on Ignition	4	4	3	48	4	5	7	4	13	4	4	5
Sieve - #16 (>1.18mm)	2.5	0.4	0.3	27	33	43	22	36	10	33	37	41
Sieve - #30 (>0.60mm)	3	1.1	0.4	37	33	31	31	38	22	30	29	33
Sieve - #50 (>0.300 mm)	3.3	0.8	0.6	15	12	5.4	24	2	25	18	14	11
Sieve - 100 Mesh (>.15 mm)	17	2.3	7.2	5.9	5.2	5.7	13	7.4	20	7.8	6.8	5.7
Sieve - #140 (>0.106mm)	19	20	24	7.8	7	7.1	3.5	13	10	2.9	3.5	2.6
Sieve - #200 (>0.075mm)	27	15	20	4	3.6	4.7	1.7	0.7	5.2	1.6	1.8	1.5
Sieve - #270 (>0.053mm)	16	28	25	1.5	3.8	2	1.9	2.5	4.8	2.1	2.3	2.4
Sieve - #400 (>0.030 mm)	6.4	16	13	0.8	0.6	0.7	1.1	0.4	2.2	1.6	2.4	1.4
Sieve - Pan	5.2	17	10	1.2	1.1	1.1	1.4	0.7	0.9	3.4	2.8	1.4

4.12.5.5 Oxo Creek Results

Sediment Metals

Arsenic, lead and zinc concentrations from all three samples collected at KR14 were above the BCWQG and CCME ALG . As well, copper concentrations in Sample 3 were above comparable BCWQG and CCME ALG (Table 4.14-24).

Sediment Grain Size Distribution

Sediments were generally dominated by larger materials in the lower reaches of the Cache Creek System (65 to 70% of sediment over 0.6 mm) with generally less than 5% fine silts and clays (Table 4.12-25).

4.12.5.6 Peel Creek Results

Sediment Metals

Arsenic, copper and zinc concentrations in all three samples collected at KR15 were above the comparable BCWQG and CCME ALG standards (Table 4.12-24).

Sediment Grain Size Distribution

Sediment grain size distribution was similar to that observed on Oxo Creek (Table 4.12-25).

4.12.5.7 Discussion

Sediment Metals

EBA found that the applicable CCME ALG standards were exceeded at each of the eight sites, for at least one metal (arsenic). Elevated copper levels were recorded in several sites in the Cache Creek system, as well as elevated lead in central Cache Creek and the Ketza River. Chromium and zinc levels were also elevated at several sites. Some of the metal concentration exceedances may be attributed to natural background levels. Arsenic is present naturally in the aquatic and terrestrial environments from weathering and erosion of rock and soil. In areas of arsenic-enriched bedrock, background concentrations can be significantly elevated. Since arsenic occurs naturally in gold ore and surrounding bedrock, it is not unexpected to find elevated levels of arsenic in the study area.

All three samples collected at each of the eight locations contained concentrations of arsenic well above the guidelines. The CCME ALG and BCWQG for arsenic is 5.9 mg/kg, while the CCME probable effect level (PEL) is 17 mg/kg. Arsenic concentrations at KR15 were the highest of all locations sampled, on average 277 times greater than CCME ALG / BCWQG and 96 times greater than the CCME PEL. Among the other seven sites, the arsenic concentration averaged 21 times greater than the guidelines[3].

Despite the high levels recorded, results from this study were generally lower than results from prior studies in the area. In the Iona Mine area downstream of the Ketza Mine area, sediment metal analysis in

[3] Average arsenic concentrations taken from all sites except KR15 divided by the guideline concentration of 5.9 mg/kg.

1981 (Godin and Mackenzie-Grieve 1984) indicated the highest reported level of arsenic in Cache Creek being 358 mg/kg. These levels are considered elevated but are not unexpected given that the area sampled has heavy mineralization, with naturally elevated levels of arsenic associated with the ore bodies. In upper Cache Creek, the 1987 study determined a mean arsenic level of 1,880 mg/kg. In comparison, EBA found 638 mg/kg in 2007 samples. In central Cache Creek an excellent time series exists, with samples in 1981, 1987, 1994 and 2005 ranging from 223.6 to 260 µg/g or mg/kg. 2007 samples in this area (KR08) averaged 121 mg/kg (EBA 2008e). Similarly, arsenic levels in lower Cache Creek and the Ketza River were lower than previously recorded samples. Moderate reductions were also noted in Oxo Creek and Peel Creek (KR14 and KR15).

The next most prevalent sediment metal was copper. All sites in Cache Creek system, including Oxo Creek and Peel Creek were above or near guideline concentrations. However, lower Cache Creek and the Ketza River were not elevated. Compared to historical values collected between 1981 and 2005, all values were found to be at lower concentrations (site KR08 was comparable to 1981 levels, but lower than subsequent readings).

Cadmium concentrations were found to be elevated in the upper Cache Creek system (KR01, KR08), Peel Creek, Oxo Creek, as well as the Upper Ketza River. In comparison to historical values, cadmium concentrations appear to be slightly elevated in the upper Cache Creek and Oxo Creek areas (KR14, KR01, KR08). However, values in Peel Creek, lower Cache Creek and the Ketza River have been reduced over time.

Lead concentrations are above guideline levels in Oxo Creek (KR14), Upper Cache Creek (KR01 and KR08), as well as the Ketza River (KR11, KR12;EBA 2008e). While lead concentrations in Peel Creek were below guideline levels, they were found to be elevated in comparison to samples in 2005. Central Cache Creek (KR08) was found to have lead concentrations similar to historic values, while all other sites were found to be reduced when in reference to prior levels.

Concentrations of zinc were found to be above CCME ALG levels in almost all areas in the upper Cache Creek system, including Peel Creek and Oxo Creek. Additionally, the upper Ketza River was found to have levels above CCME ALG. Despite these concentrations, they were found to have been reduced in every case in comparison to earlier values, and in some cases have reduced by a factor of 10 to 20.

Finally, chromium was above CCME ALG in the upper Ketza River (upstream from the Cache Creek system) (EBA 2008e). While all historical values in the Cache Creek and Ketza River systems had been above these guideline concentrations, all values in Cache Creek and the lower Ketza River were now found to be reduced compared to these historical studies. Reductions by as much as a factor of 20 were observed in comparison with results from 1981, 1987, and 1994 (Godin and Mackenzie-Grieve 1984; EC 1992; EC unpublished data).

Overall, EBA's results from the 2007 sampling suggest that most sediment metals concentrations are reduced in comparison with earlier recorded concentrations. In numerous cases, levels appear to be lower than those observed in 1981 baseline concentrations, although moderate inter-site variability in that study make long term trend comparisons difficult. Most interestingly, many concentrations have now been reduced in comparison to a large increase observed during the 1987 studies by EC (1992). For example, spikes in the concentrations of cadmium, lead and zinc can be observed in that study. The 1987 EC

sampling efforts followed an increase in mine pre-development in the study area (road development, clearing, grading, etc.), activities that may have mobilized local surface materials though erosion, sedimentation, and disturbance of watercourses. In addition to these studies, only a few direct comparisons were available from 1989, 1994, 2000, and 2005 data due to the inconsistency in sample collection sites and the wide variability in the seasonal collection of sediment samples (ranging from July 5 in 2005 to October 5 in 1994). However, despite this variability, general results from these studies do suggest relatively similar results in comparison to those in the 2007 EBA study.

In summary, EBA found the concentrations of several key metals to be highly elevated within the LSA. These results along with those of previous studies in the area suggest that a number of local factors may influence the availability of sediment metals in the LSA; including the breakdown and erosion of local natural mineralizations, past development activities, or other unknown factors.

Grain Size Distribution

The general pattern of distribution in grain sizes observed by EBA in the Cache Creek and Ketza River systems appeared to be tied to relative location (energy level) within this mountain watercourse system. Generally, only a moderate degree of variation in size distribution existed between sites in the upper system, including Cache, Oxo, and Peel creeks.

Generally, the results of the grain size distribution were consistent with that of a high energy / high slope system that transitions to a moderate energy system. Stations KR16, KR14, KR01, and KR15 (to a lesser extent) in the upper reaches of the Cache Creek system were dominated by relatively larger silt deposits representative of low stream orders and fast flows. At KR08 (a lower gradient reach below the Canamax TSF), a slight increase in medium and smaller silts was observed. Finally, an increased proportion of clay and fine silts is observed in both KR10 and KR12, where flows in Cache Creek and the Ketza River slow down and lose velocity in the Ketza River Valley. KR11, which represents the Ketza River immediately upstream of the confluence with Cache Creek, had a relatively larger distribution of particle sizes.

As in previous studies at this Site, some inter sample variability was noted between replicate samples at the same site. As shown in Table 4.12-26, the highest levels of variability were observed in samples from KR10 and KR12, the furthest downstream sampled in the Cache and Ketza systems. However, a moderate degree of variability is to be expected naturally in such systems.

In previous studies, such as that by Godin and Mackenzie-Grieve (1984), data showed considerable variation between replicate samples at specific stations. At that time, the authors suggested that this reflected the variability and problems associated with obtaining truly representative sediment samples. Because large gravel and cobble are removed during sampling, the results generally show a lower percentage of coarser materials than actually exists in situ. Similarly, sediment particle size analysis conducted in July 1987 (EC 1992) again indicated there to be considerable variation in percentage particle size among replicate samples, while the authors noted samples were unlikely to be truly representative, and that some fine material was lost during sampling. No material was removed during EBA's sampling in the 2007 study, and in light of the degree of variability reported in these previous studies, it appears that the 2007 samples were representative of the natural environment and as consistent as may be expected from such sampling.

Table 4.12-26: Coefficient of Variation Values from Grain Size Analysis Results

Site	Loss on Ignition	Sieve - #16 (>1.18mm)	Sieve - #30 (>0.60mm)	Sieve - #50 (>0.300 mm)	Sieve - #100 (>.15 mm)	Sieve - #140 (>0.106mm)	Sieve - #200 (>0.075mm)	Sieve - #270 (>0.053mm)	Sieve - #400 (>0.030 mm)	Sieve - Pan
KR01	0.40	0.48	0.22	0.36	0.84	0.18	0.89	0.57	0.55	0.05
KR08	0.83	0.96	0.57	0.18	0.62	0.19	0.39	0.64	0.44	0.67
KR10	0.22	1.61	1.51	1.40	0.38	0.36	0.55	0.55	0.54	0.50
KR11	0.16	0.72	0.35	0.26	0.06	0.37	0.53	0.48	0.54	0.55
KR12	0.16	1.16	0.90	0.96	0.85	0.13	0.29	0.27	0.42	0.55
KR14	1.32	0.24	0.09	0.45	0.06	0.06	0.14	0.50	0.14	0.05
KR15	0.57	0.57	0.26	0.76	0.47	0.55	0.93	0.50	0.74	0.36
KR16	0.13	0.11	0.07	0.25	0.16	0.15	0.09	0.07	0.29	0.41

Coefficient of Variation > 1.0

Coefficient of Variation >0.75, <1.0

In the upper reaches of the Cache Creek system, sediments were generally dominated by relatively larger materials (>75% of sediment over 0.60 mm), while less than 10% consisted of fine silts and clays. These results were similar to those of Godin and Mackenzie-Grieve (1984), who found the highest percentage of particles for replicates at upper stations sized at 0.50 mm. Similarly, the largest portion of material sampled by EC (1992) was equal to or greater than 2 mm (10 mesh sieve).

Further downstream in the system, the distribution of sediments followed a predicted change in distribution. By Station KR08 (below the Canamax TSF), there was an apparent decrease in the largest particle size group (>1.18 mm) and a related increase in the mid-range particle sizes (primarily 0.15 mm to 0.60 mm).

Near the confluence of Cache Creek with the Ketza River, the creek slope is reduced as it enters the Ketza River valley, allowing for the settling of finer sediments. Consequently, a marked increase in the proportion of fine silts and clays was observed at this station (50% silts or finer) and KR12 (further downstream; 75% silts or finer). Additionally, large particulates were primarily absent in these reaches. In contrast, samples taken from the lower Ketza River at KR11 (near the confluence with Cache Creek) showed a larger size distribution despite a similar low gradient reach to that at KR10 and KR12 (< 10% silts).

Overall, despite some natural variability between replicate samples, the distribution of sediments in the Cache Creek system was representative of that found in previous studies at the site. However, the marked difference in sediment levels between physically similar reaches in the Cache Creek and Ketza River systems suggests that Cache Creek may be subject to larger influxes of fine sediment from upstream sources. As noted in the previous studies, the observed fines in the lower Cache Creek and Ketza River system may be directly or indirectly influencing the health of the aquatic environment by filling interstitial spaces in the substrate or through metals contributions.

4.13 Heritage Resources

Heritage resources are defined under *YESAA* (2003) 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, paleontological, 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, paleontological, 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.

According to the YG, Department of Tourism and Culture (TC) (2010a), types of heritage resources that may relate to the KRP are:

- **Historic resources**: Human related features that include abandoned sites, human remains and burials, and objects greater than 45 years in antiquity. The most readily recognizable historic resources are often cabins, caches, graves, brush camps, and other man-made structures

- **Archaeological sites and resources**: These may include historic resources or may date to before European contact. Prehistoric archaeological resources may be located on or under the ground surface and typically contain the remains of ancient camps, hearths, stone tools and debris
- **Paleontological resources**: These are fossil and other remnants (bones, tusk, hair etc.) of extinct or prehistoric plants and animals.

In the Yukon Territory, heritage resources are protected under the Yukon *Historic Resources Act* (2002), Archaeological Sites Regulation (2003), and Chapter 13 of the Yukon First Nation Umbrella Final Agreement (1993). The destruction or alteration of a heritage resource is not permitted under the *Historic Resources Act* unless in accordance with a historic resources permit. Furthermore, according to the Quartz Mining Land Use Regulation (2003), any heritage resources must be immediately marked, protected from further disturbance, and reported to the appropriate authority (YG TC 2010b).

4.13.1 Human History Summary

The KRP is located in the traditional territories of the RRDC, LFN, and TTC. The RRDC and LFN are part of the Kaska Dena Nation and the TTC are Inland Tlingit (YG 2004a, 2004b).

4.13.1.1 Kaska Dena

The Kaska Dena Nation's traditional territory covers approximately 240,000 km^2 of land in southeast Yukon, southern Northwest Territories and northwest British Columbia (Kaska Dena Council 2011). The traditional language of the Kaska Dena Nation is Kaska, which is linguistically part of the Athapaskan language group (YG 2004a).

Prior to contact with Europeans, the Kaska lived a semi-nomadic lifestyle. They followed game and harvested various resources, depending on the seasons (YG 2004a; Salix 2007). The traditional economy of the Kaska included hunting, fishing, snaring, and gathering plants and building materials. Hunting ranges for large game animals, such as caribou, included the southern shores of rivers and marshes (Salix 2007). Hunting lookouts were often placed on prominent hillsides and terraces (McClellan 1975). Harvested wildlife were consumed for food and used to create clothing, shelter, and tools (YG 2004a). Ross River was originally used as a seasonal camp and gathering place for the Kaska (YG 2004a).

The Kaska established trading patterns with the Coastal Tlingit using Tagish middlemen (Dreyer and Meyers 2004). Meat, hides, clothing and fur were traded for coastal products such as fish oils and dried seaweed (Yukon First Nations 2011a). In the 1800s, the fur trade began between Kaska and non-aboriginal people and trading posts were established on the Kaska Dena's traditional territory (Weinstein 1992 as cited in Dreyer and Meyers 2004). By the early 1900s, a trading post was established near Ross River with the start of prospecting and mining in the area.

4.13.1.2 Teslin Tlingit

The traditional territory of the TTC covers approximately 10,000 km^2 within the Yukon Territory (TTC 2009). Originally from the coast of Alaska, the TTC trace their ancestry to the Coastal Tlingit (specifically the Taku Qwan) who migrated inland along the Taku River in the early eighteenth century, starting a way

of life separate from their coastal relatives (TTC 2011; YG 2004b). The Coastal Tlingit used the present day location of Teslin village as a summer campsite (Yukon First Nations 2011b).

By the mid-nineteenth century the Coastal Tlingit had increased their contact with the First Nations of the Yukon Plateau as they traded goods between the interior and the coast. Furs were brought to the coast and in return, the Coastal Tlingit brought European, Russian, American and coastal goods to the interior (TTC 2011; Yukon First Nations 2011b).

Over time, the Coastal Tlingit intermarried with Yukon First Nations, eventually becoming known as the Inland Tlingit. The Inland Tlingit followed a semi-nomadic, seasonal lifestyle of following game and harvesting resources, while continuing traditional coastal clan and potlatch systems (TTC 2011). In the 1940s, the Teslin Inland Tlingit permanently settled in the Village of Teslin (TTC 2011). The Teslin Tlingit speak the Tlingit language (YG 2004b).

4.13.2 Heritage Resources Assessments

Heritage resource assessments for the KRP were conducted by Salix Heritage Consulting (Salix) and Matrix Research Ltd (Matrix). Salix conducted an initial heritage resources assessment in 2007 under Permit 07-12ASR. In 2008, Matrix conducted an additional heritage resources impact assessment under Permit 08-05ASR to evaluate an expansion of the footprint area (Figure 4.13-1).

The goal of the heritage resource assessments was to identify heritage resources and assess the potential effects that the KRP could have on heritage resources. The heritage resources assessments were not, however, intended to evaluate traditional aboriginal use of the areas in which the KRP is proposed.

A summary of the methods used during the assessments and the findings are summarized in the following subsections. A copy of the Salix and Matrix assessments are provided in Appendices J1 and J2, respectively.

Traditional knowledge is an important source of cultural information. KRH is continuing to work with the RRDC to collect traditional knowledge about the area and to integrate that knowledge into the KRP plans. KRH has signed a *Traditional Knowledge Protocol* with the RRDC that ensures traditional knowledge is kept confidential.

4.13.2.1 Methods

The heritage resource assessments conducted in 2007 and 2008 included pedestrian field surveys and sub-surface testing in the KRP footprint and on the Ketza Road (Figure 4.13-1).

In 2007, Salix completed a surficial pedestrian survey of the KRP footprint to determine areas with high heritage potential such as south facing flat terraces, raised topographical features overlooking significant waterbodies, wetlands, and game habitats (Salix 2007). Terrain with moderate potential included terraces or raised features found beside or near significant hydrological features and wildlife migration routes. Areas that were deemed to have low heritage potential included marshy and swampy areas, low lying active river floodplains, moderate to steeply sloping hillsides, and areas not associated with extinct or extant aquatic features (Salix 2007). Salix performed sub-surface tests at sites that contained moderate or higher heritage resource potential (Photos 4.13-1 and 4.13-2). Sub-surface tests were excavated to a dimension of 40 cm by 40 cm and to a depth of 40 cm.

In 2008, Matrix completed a review of secondary information for heritage resource potential on the expanded KRP footprint areas. Maps, terrain models, orthophotos, ethnographies, histories, and archaeological reports were reviewed to evaluate the heritage resources potential in the expanded footprint for the KRP (Matrix 2008). The results of the review indicated that the majority of the expanded footprint exhibited low heritage resources potential due to the presence of steeply sloped terrain and lack of distinctive topographic features. Surveys were not planned in these areas. Sites were identified close to local hydrological features that exhibited high and moderate heritage resource potential (Matrix 2008). Matrix conducted a pedestrian survey and judgmental sub-surface surveys at these sites. The shovel tests were executed to a dimension of 30 cm by 30 cm and to a depth of 30 cm and the excavated material passed through a 6 mm steel mesh screen. Surface and subsurface exposures such as areas with minimal surface vegetation, tree throw depressions, and areas of past anthropogenic disturbance were visually inspected as encountered.

4.13.2.2 Findings

Salix and Matrix determined that the overall potential for the presence of heritage resources in the 2007 and 2008 KRP footprint is low. No heritage resource conflicts were identified with the KRP.

The 2007 and 2008 heritage resource assessments identified thirteen sites of interest in the KRP footprint and two sites of interest near the Ketza Road (Figures 4.13-1 and 4.13-2). The identified sites of interest were classified according to their heritage resource potential and the corresponding level of investigation conducted at each site was dependent upon the heritage resource classification. All identified sites in the KRP footprint received pedestrian surveys, however, only those with moderate or high potential received sub-surface testing (Figure 4.13-1).

In the KRP footprint, the surveys and testing determined:

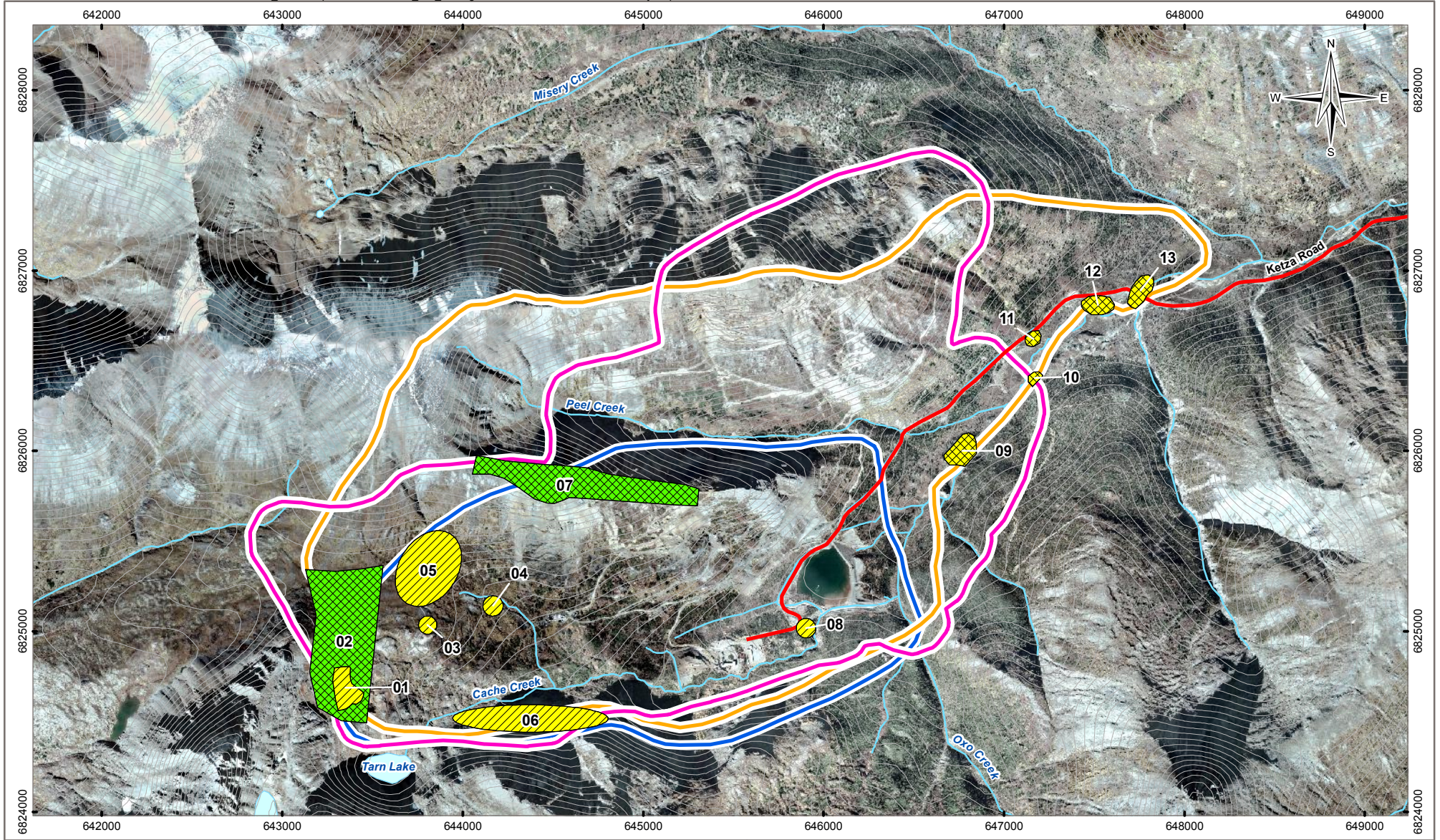
- Four sites had high heritage resource potential
- Seven sites had moderate heritage resource potential
- Two sites had low heritage resource potential.

Near the Ketza Road, outside of the KRP footprint, the surveys and testing determined:

- One site had high heritage resource potential
- One site had potential for modern resource remains.

Table 4.13-1 describes the location, terrain description, heritage resource potential, survey method and result of the heritage resources assessments at each site of interest.

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LEGEND

Survey Type

- Pedestrian and Sub-Surface
- Pedestrian

Year

- 2007
- 2008

- 2011 Project Footprint
- 2008 Project Footprint
- 2007 Project Footprint
- Ketza Road
- Contour (20 m)
- Watercourse
- Waterbody

NOTES
Base data source: NTS 1:50,000
Imagery provided by Aero Geometrics, Ltd.

STATUS
ISSUED FOR USE

Scale: 1:30,000
500 250 0 500
Metres

PROJECTION	DATUM
UTM Zone 8	NAD27

FILE NO.
W23101052_110_HeritageSitesLSA.mxd

CLIENT
Ketza River Holdings

eba A TETRA TECH COMPANY

KETZA RIVER PROJECT

Heritage Assessment Sites within the Project Footprint

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.110	SL	SB	JD	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 4.13-1

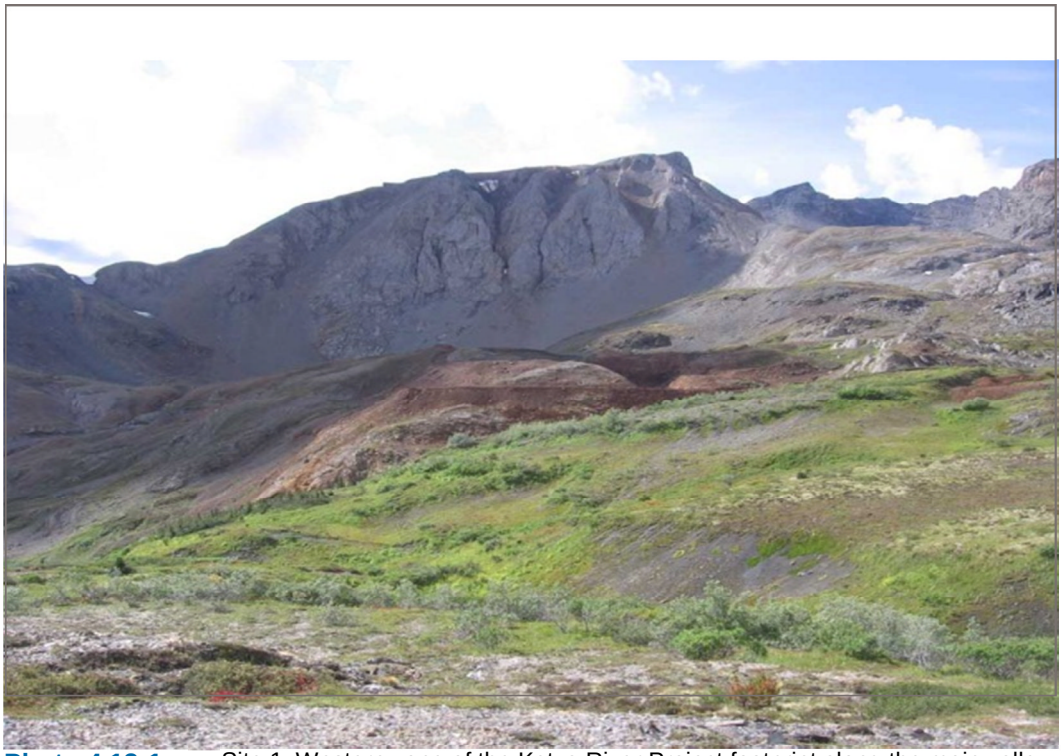


Photo 4.13-1: Site 1: Western zone of the Ketza River Project footprint along the main valley access road in the valley showing the knoll that was sub-surface tested (Salix 2007).



Photo 4.13-2: Site 1: Western zone of the Ketza River Project footprint along the main valley access road in the valley showing the knoll that was sub-surface tested. The direction of the photograph is south (Salix 2007).

Table 4.13-1: Results of Heritage Resources Assessments

Site	Location	Terrain description	Heritage Resource Potential (pre-survey)	Survey Method	Result
1	Western zone of the KRP footprint	Valley containing knolls, hydrological features, and a road. Specifically, the area was located on a knoll	Moderate	Pedestrian and sub-surface	No heritage resources identified
2	Western zone of the KRP footprint	Numerous ephemeral drainages and undulating surfaces	Low	Pedestrian	No heritage resources identified
3	Western zone of the KRP footprint	Valley containing knolls, hydrological features, and a road	Moderate	Pedestrian and sub-surface	No heritage resources identified
4	Western zone of the KRP footprint	Valley containing knolls, hydrological features, and a road	Moderate	Pedestrian and sub-surface	No heritage resources identified
5	Northwest zone of the KRP footprint; north hillslope	Steep slope facing south	Moderate	Pedestrian and sub-surface	No heritage resources identified
6	Southern end of the KRP footprint; south hillslope	Steep slope facing north	Moderate	Pedestrian and sub-surface	No heritage resources identified
7	Northwest zone of the KRP footprint	High alpine area mostly above treeline with no significant landforms	Low	Pedestrian	No heritage resources identified
8	Southern zone of the KRP footprint; south hillslope	Steep slope facing north	Moderate	Pedestrian and sub-surface	No heritage resources identified
9	Eastern zone of the KRP footprint between two tributaries of the Ketza River	Height of land between the two tributaries of the Ketza River	High	Pedestrian and sub-surface	No heritage resources identified
10	Eastern zone of the KRP footprint on the southeast side of an unnamed tributary of the Ketza River	Low terrace rising approximately 4 m above a stream; terrain already heavily impacted by development	High	Pedestrian and sub-surface	No heritage resources identified
11	Eastern zone of the KRP footprint on the northwest side of an unnamed tributary of the Ketza River	10 m high terrace above a tributary to the Ketza River in a previously disturbed location	Moderate	Pedestrian and sub-surface	No heritage resources identified
12	Eastern zone of the KRP footprint on the north side of an unnamed tributary of the Ketza River	Approximately 10 m high terrace above an unnamed stream. Three small knolls are situated on the terrace	High	Pedestrian and sub-surface	No heritage resources identified
13	Eastern zone of KRP footprint on the northwest side of a	A terrace that is approximately 10 m above an unnamed stream	High	Pedestrian and sub-surface	No heritage resources identified

Table 4.13-1: Results of Heritage Resources Assessments

Site	Location	Terrain description	Heritage Resource Potential (pre-survey)	Survey Method	Result
	tributary of the Ketza River				
14	West of the Ketza Road, outside of the KRP footprint	Modern airfield	Modern resource	Pedestrian	No heritage resources identified. Modern remains identified. Site is not in the KRP footprint
15	North of the Ketza Road, outside of the KRP footprint	Paleontological site	High	Not surveyed, as was previously excavated	Heritage resources not surveyed, site is not included in the KRP footprint

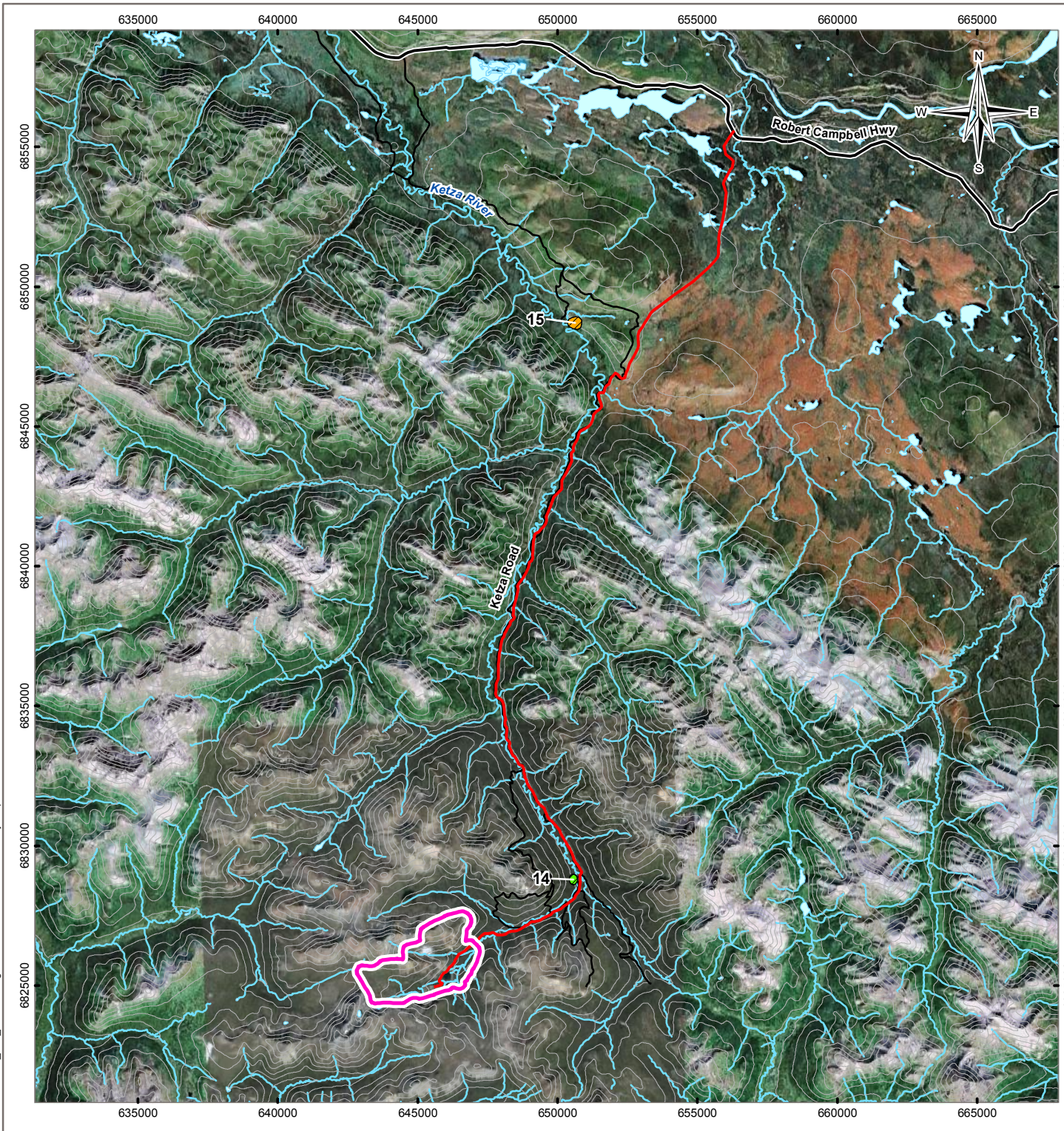
Source: Salix (2007); Matrix (2008)

Of the sites that received pedestrian surveys, further investigation by means of sub-surface tests were performed at eleven sites in the KRP footprint with high and moderate heritage resource potential (Figure 4.13-1). In the 2007 KRP footprint, seven sites were identified as moderate heritage resource potential and twenty-three subsurface tests were conducted on these sites. The 2008 KRP footprint identified four high heritage resource potential sites and one moderate heritage resource potential site. Forty-one subsurface tests were conducted on these sites.

A pedestrian survey was conducted at the airfield west of the Ketza Road (Site No. 14 in Figure 4.13-2). Visual inspection concluded that the site consisted of a modern storage cache and can midden (Photos 4.13-3 and 4.13-4). The remains appeared to be modern (less than 45 years old) and no historical value was attached.

One of the sites with high heritage resource potential is a previously excavated paleontological site containing ice age fossil remains (Jackson and Harrington 1991) near the Ketza Road, outside of the KRP footprint (Site No. 15 on Figure 4.13-2). The site is located more than 2 km from the road (Figure 4.13-2) and as such, was not surveyed during the heritage resource assessments. The paleontological site is not in conflict with the KRP due to its distance from the Ketza Road and from the KRP footprint.

The high, moderate, and low heritage resource potential sites in the KRP footprint did not result in any heritage resources being identified during pedestrian and sub-surface tests. Salix and Matrix determined that the overall potential for heritage resources in the 2007 and 2008 KRP footprint was low. Salix (2007) concluded that archaeological sites are rarely found in the sub-boreal environment typical of the KRP because people historically occupied that type of environment for only a short period of time. Additionally, the KRP is located in an area where past land use activities related to mining exploration and road construction have resulted in ground disturbance (Photos 4.13-5 and 4.13-6). Many areas in the KRP footprint were determined to have existing ground disturbance resulting in very little or no heritage resource potential.



LEGEND

Survey Type

- Pedestrian
- Not Surveyed

Year

- 2007

- 2011 Project Footprint
- Ketza Road
- Major Road
- Minor Road
- Contour (100 m)
- Watercourse
- Waterbody

NOTES
Base data source: NTS 1:50,000; Google Earth Pro

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Heritage Assessment Sites outside the Project Footprint

PROJECTION UTM Zone 8			**DATUM** NAD27		**CLIENT** Ketza River Holdings
Scale: 1:200,000 4 2 0 4 Kilometres					eba A TETRA TECH COMPANY
FILE NO. W23101052_110_Paleontological.mxd					
PROJECT NO. W23101052.110	**DWN** SL	**CKD** SB	**APVD** JD	**REV** 0	**Figure 4.13-2**
OFFICE EBA-VANC	**DATE** July 26, 2011				

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Photo 4.13-3: Site 14: Modern storage cache located south of the airfield along the Ketza Road (Salix 2007).



Photo 4.13-4: Site 14: Modern can midden located south of the airfield along the Ketza Road (Salix 2007).

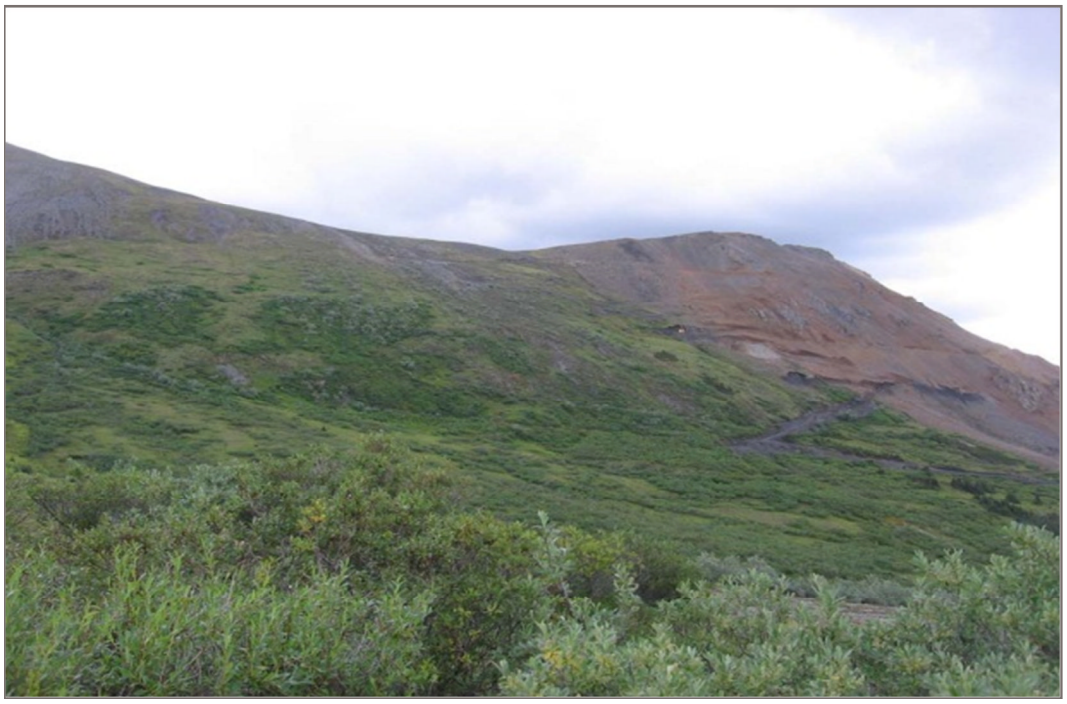


Photo 4.13-5: Site 5: Northwest corner of the Project; north hillslope. Previous road construction can be seen on the right side of the photo (Salix 2007).



Photo 4.13-6: Remains related to past mining activity at the Ketza River Project (Matrix 2008).

5.0 DESCRIPTION OF EXISTING SOCIO-ECONOMIC CONDITIONS

YESAB requests that proponents demonstrate an awareness of the background social and economic conditions against which the KRP will take place. Specifically, YESAB (2006) indicates that a general understanding is required of 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 background
- Relevant population or demographic characteristics (e.g., age, gender, education and employment distributions).

This Section describes existing socio-economic conditions for the components listed below, based on existing information available at the time the Project Proposal was assembled.

Socio-economic Components

- Project Area, Land and Resource Use
- Yukon
- Ross River
- Faro
- Watson Lake and Liard First Nation
- Teslin and Teslin Tlingit Council

The Yukon, and especially the territorial economy, is considered in detail because the KRP will have territory-wide economic effects and because the socio-economic baseline contrasts each community against the Yukon as a whole. Each community setting section (see below) has a greater focus on history, social infrastructure and social issues than the Yukon section because the potential for social effects is relatively more apparent at the community level. Ross River and Faro are treated in more detail than Teslin and Watson Lake because their proximity to the KRP will likely lead to greater influences, especially economic effects, in those two communities.

5.1 Project Area, Land and Resource Use

The KRP is located in the Pelly Mountains near the headwaters of Cache Creek, a tributary of the Ketza River, in south-central Yukon. The Project is approximately 40 km south of Ross River and is centered at 61º 32' N and 132º 13'W.

Access to the Project footprint (the Site) is via the Ketza Road from the Robert Campbell Highway. Although the Ketza Road is classified as a public road and is used by the general public, it is not maintained by YG. There are no data available on traffic or usage of the Ketza road.

The KRP is in Kaska traditional territory (and within an overlap of the TTC traditional territory) and the region's traditional land stewards reside in Ross River. Traditional subsistence hunting in the region is particularly important for the traditional land steward families. The Ketza Road also provides ready access for recreational hunting by non-aboriginal people. The KRP is located within the southern portion of the Ross River Group Trapline that is managed by the RRDC. Trapping activity in the region varies.

The KRP falls within Yukon outfitting concession #15, owned by Yukon Stone Outfitters Ltd. Yukon Stone has hunts in the general area of the KRP (though no closer than approximately 10 km) and occasionally uses the Ketza Road to bring horses in and out of the area.

The KRP is relatively remote and at high elevation; there is no agriculture or timber harvesting in the region and no known oil or gas exploration. The Pelly Mountains have seen considerable mineral exploration over the decades. There are no currently-operating mines in the area, and none have operated since the Canamax Ketza River Mine was shut down in November 1990. There are a number of other mineral properties and claims in the region of the KRP with the closest being the Silver Valley property (owned by YNG) located approximately 8 km east of the KRP.

5.2 Yukon

The Yukon is a large territory with a small population and the heavy reliance on government is typical of relatively remote jurisdictions across the circumpolar north. Although the Yukon has a variety of economic and industrial sectors, government, largely financed through federal transfers, is the largest sector. It can be said that Canadian sovereignty is the Yukon's largest export.

The Yukon's strong public sector and its continued growth through increased federal government transfers has provided economic stability but has done little to generate private sector economic diversification and exports. However, the importance of government, and of mining in the past, have resulted in the Yukon having high average or median incomes, typically among the highest in Canada.

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. The opening of the Faro mine in 1969, one of the world's largest lead-zinc producers, provided a significant boost and its series of closures and re-openings in the1980s and 1990s resulted in substantial alternating declines and increases in economic activity and population. Over the past four years the Yukon has been experiencing another boom in mineral exploration and the development of new mines.

Whitehorse, the territorial capital, has become increasingly important. Containing about three-quarters of the territorial population, it dominates the territorial economy. Most services are only available in Whitehorse. Rural communities, where the First Nation population is concentrated, are generally not benefiting from the high incomes and economic prosperity of the capital. The Yukon's 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 low educational levels.

In 1992, the Council for Yukon Indians (today the Council of Yukon First Nations) and the federal and territorial governments signed the Umbrella Final Agreement (UFA) to serve as the template for individual land claims agreements. Among the many provisions of that agreement is the creation of a new system of environmental and socio-economic assessment (*YESAA*), as well as the development of a self-government regime giving signatory First Nations a number of additional government powers. Most Yukon First Nations have signed a land claims agreement. However, notably for this KRP, both the RRDC and the LFN have not and remain Indian Act bands.

5.2.1 Yukon: Demographics

In December 2010 the Yukon Bureau of Statistics (2010b) estimated the population of the Yukon at 34,667, up 1.5% from a year earlier. The Yukon's population has been increasing since 2003, when 29,967 people lived in the territory, and has now passed its 1997 peak of 33,519. More than 75% of Yukoners live in Whitehorse or its immediate vicinity with most of the rest distributed in 16 small, widely scattered communities.

The territory's population is relatively evenly divided between men and women; there is no longer a frontier-style skew toward men. In the 2006 Census, 25.1% of respondents identified themselves as aboriginal.

The median age of the Yukon's population in 2006 was estimated by Statistics Canada to be 38.0, only slightly under the Canadian figure of 38.8 years and up sharply from the 2001 figure of 35.8. The territory therefore does not have an unusually young population. However, the Yukon has proportionately far fewer seniors aged 65 and up than the Canadian average (7.4% versus 13.2%) and very similar proportions of the population aged 19 and under (25.7% Yukon and 24.0% Canada). These figures point to a skew in the population structure toward working-aged adults with 66.3% of Yukoners between 20 and 64 years old compared to the Canadian figure of 61.9%.

5.2.2 Yukon: Labour Force and Employment

Since 2003 the Yukon has had an overall pattern of a growing labour force, growing levels of employment and falling levels of unemployment. In April 2011, the labour force had reached a record 20,000, with 18,700 employed, an unemployment rate of 6.5% and an employment rate of 71.4%. The current unemployment rate compares favourably to Canada's unemployment rate of 7.6% during the same month but is up from a low of 3.6% in January 2011.

The Yukon has tended to have a very high labour force participation rate. The 2006 Census found 78.1% of Yukoners aged 15+ in the labour force compared to only 66.8% for Canada as a whole. (This high rate is not a result of people choosing work over schooling. The proportion of people attending school full-time in the territory is almost identical to the Canadian average). By April 2011 the Yukon's participation rate had dropped to 76.3%, but it has been as high as 80.3% (in 1996).

The number of Yukoners directly employed by the federal, territorial, and municipal governments in the territory was 6,184 in December 2010. With that month's employed labour force estimated at 18,900, the three levels of government directly employ 32.7% of working Yukoners. If the employees of First Nation governments are added, that figure likely approaches or exceeds 35%. However, this percentage is down

considerably since 2007 when approximately 40% of the Yukon's labour force was directly employed by government.

5.2.3 Yukon: Earnings and Incomes

Average weekly earnings from employment are higher in the Yukon than in Canada as a whole. The difference between the territory's industrial aggregate weekly wage and the national average tends to be in the 10% range. The figures for February 2011 put average weekly earnings (including overtime) at $937 in the Yukon compared to the Canadian figure of $883, a difference of just over 6%.

The 2006 Census found that for those working full-time and year-round, average earnings in the Yukon were $53,111, or $1,890 higher than the Canadian average of $51,221. Yukon women working full-time and full-year do well, out-earning other Canadian women by $6,500 on average. However, 47% of Yukoners were working either seasonally or part-time in 2006 and their average earnings were only $23,560. These figures point to the conclusion that those Yukoners with full-time and year-round employment do well, but that there are many who are either seasonally employed or under employed.

The 2006 Census found a median total income of $31,352 in the Yukon, 22.4% higher than the Canadian median of $25,615. Yukoners rely more heavily on wages and salaries for their incomes, 83.9% versus the Canadian average of 76.2%, and less on government transfers such as pensions, unemployment insurance and social assistance (8.7% versus 11.1%).

5.2.4 Yukon: Education Levels

Yukoners are, on average, about as well educated as Canadians as a whole. The 2006 Census found that the proportion of those aged 15 years and older who have not yet completed high school was 22.7% in the Yukon compared with 23.8% for Canada as a whole. 11.8% of Yukoners over the age of 15 have trade certifications, compared to 10.8% for Canada as a whole. The proportion of older adults, those aged 35 to 64 years, with university degrees is almost identical for the Yukon and Canada (21.7% versus 21.1%, respectively).

5.2.5 Yukon: GDP and Inflation

In 2009 the Yukon's Gross Domestic Product (GDP) totalled $1.492 billion (measured in 2002 dollars to take out the effects of inflation). Real GDP growth has been strong, with an increase of 3.6% in 2009 following a revised 2.4% in 2008, 5.6% in 2007 and 5.4% in 2006.

The Territory's 2009 GDP by industry is summarized in Table 5.2-1.

Table 5.2-1: Yukon Industries as a Percentage of GDP (2009)

Industry	Percentage of GDP
Public administration	22.7%
Finance, insurance and real estate	18.1%
Mining and oil and gas extraction	8.0%
Health care and social assistance	7.8%
Construction	7.1%

Table 5.2-1: Yukon Industries as a Percentage of GDP (2009)

Industry	Percentage of GDP
Retail trade	6.0%
Educational services	5.9%
Other services	4.3%
Accommodation and food services	3.8%
Information and cultural industries	3.7%
Professional, scientific and technical services	2.6%
Transportation and warehousing	2.6%
Wholesale trade	2.5%
Utilities	2.3%
All others	2.6%

Inflation, as measured by the consumer price index, has been somewhat lower in Whitehorse than in Canada as a whole in 2010 and early 2011 after running higher than the national average for 2007 through 2009. (Note that inflation is measured for Whitehorse rather than the Yukon as a whole). The data for March 2011 show a 3.2% annual inflation rate in Whitehorse, 0.1% below the Canadian rate of 3.3%.

5.2.6 Yukon: Industrial Structure

As noted previously, the Yukon's industrial structure is heavily tilted to government and government-related industries. However, the resource sector, construction and tourism all play a role.

Federal government transfers to YG have been increasing, in part because of the devolution of some powers to the territorial government. Total transfers to YG were $473 million in 2003/04 and are expected to reach $690 million in 2010/11. Over 90% of the transfers are a result of territorial formula financing, a policy designed to fill the gap between the expenditure requirements and revenue-raising capacity of all of Canada's northern territories. Federal transfers account for approximately 86% of YG's revenues. 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 largely due to low mineral prices. 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 and mineral exploration expenditures began to rise and both have been soaring to new heights, driven by the rise in commodity prices and the discovery of the White Gold and Rau mining districts. The Yukon now has three operating hard-rock mines: the Minto copper-gold mine came into full production in late 2007, the Bellekeno silver-lead mine followed in late 2010, and the Wolverine lead-zinc mine is currently ramping up to commercial production. The total value of mineral production reached $251 million in 2009 and will be higher for 2010 and 2011. And total annual expenditures on mineral exploration have been running between $100 and $150 million annually.

A booming construction sector helped drive the Yukon's economy over the past decade. The total value of building permits issued rose to $116.7 million in 2009, more than double the already high average of approximately $56 million over the previous five years. Residential construction has been steadily strong, ranging between $28 million and $33 million annually. Government and institutional construction makes up most of the rest.

The Yukon's tourism industry has been relatively consistent over the past five years. The Yukon's Department of Tourism and Culture counted 311,544 visitors to the territory in 2010, an increase from the 282,874 visitors in 2009 but a decrease from the 329,203 vistors in 2007 (YG TC 2010c).

Manufacturing does not play a large role in the Yukon's economy, accounting for only 0.6% of GDP in 2009. Similarly, agriculture, forestry and fishing together account for a similar sliver of GDP at 0.2%. Total value of agricultural production in the Yukon is less than $5 million per year, and forestry has largely been confined to local fuel wood and very small-scale valued added milling for local consumption.

5.3 Ross River

Ross River is located on the south bank of the Pelly River near the confluence of the Ross and Pelly rivers (Figure 2.2-1). The South Canol Road runs through the community with a seasonal ferry providing access to the North Canol during the summer. The community is approximately 10 km from the Robert Campbell Highway. The community's proximity to the Site will likely make the community one of the most affected by the KRP.

5.3.1 Ross River: History

The confluence of the Ross and Pelly rivers has long been used as a gathering place for First Nation peoples, particularly in the late summer. The first permanent settlement was established in 1901 when Tom Smith started a small trading post on the north bank of the Pelly and called the spot Smiths Landing. That winter approximately 15 First Nation families over-wintered near the post, creating the beginnings of the permanent community of Ross River. By 1903 a second, rival, trading post was set up on the south bank of the Pelly opposite Smiths Landing. The settlement attracted an increasing number of people, mostly the Kaska but including many First Nation people from the Mackenzie River region who would travel over the divide to meet others, trade, and sometimes stay. By 1914 over 1,000 people were gathering at Ross River in the late summer. But a severe influenza epidemic in 1916 hit the community's First Nation people hard, and increasing economic activity and new trading posts along the Mackenzie River reduced the numbers of people gathering and settling at Ross River (Zanasi and Taggart 2006).

World War II and the years immediately following brought massive changes to Ross River. The building of the Canol road and pipeline between 1942 and 1944 brought a massive, but temporary, influx of outsiders to the area and the new road made the community much more accessible. The late 1940s and early 1950s also saw a collapse of fur prices and the permanent closure of most of the region's fur trading posts, including Pelly Banks, Sheldon Lake, Rose Point, Frances Lake and Macmillan River. By 1952 Ross River was designated as a band village and had the only remaining trading post in the region. The Canol Road shifted the commercial centre of the community to the south bank of the Pelly River at the new ferry crossing point and the federal government began pressuring the First Nation to move across the river from the Old Village. By the mid 1960s that pressure, and even the physical relocation of homes while their

owners were away in the bush, resulted in the complete abandonment of the Old Village and the community of Ross River assumed the shape it has today (Zanasi and Taggart 2006).

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 mine. Although RRDC people did work in mining exploration, it was RRDC citizens Arthur John, Jack Ladue, Robert Etzel and Joe Etzel who led Al Kulan to Vangorda Creek where he staked the first claims of what would become the Faro mine, the mining boom did little to benefit most of the First Nation(Zanasi and Taggart 2006).

The re-openings of the Faro mine and a smaller mining exploration boom in the 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 experience of being the indigenous population located in a region undergoing extended economic booms and gaining little economic benefit increased the determination of the RRDC to be at the centre of a long-term sustainable regional economy. Most recently, the development of a mining strategy for the community, *The Snow that Eats the Snow (A Mining Strategy for Ross River, Yukon Territory)* (RRDCEDP and RRMC 2004) and *Building on Strength: An Economic Development Strategy for Ross River* (Zanasi and Taggart 2006) reflect that determination.

5.3.2 Ross River: Demographics and Community Economy

Since the mid-1980s, Ross River's population has been about 350. In December 2010 the Yukon Bureau of Statistics (2010b) put the population of Ross River at 352. The 2006 Census reported a community population of 310, with over 85% self identifying as aboriginal people. The 2006 Census found that Ross River had very few people in their late teens and early 20s, the community was predominantly made up of middle-aged and older adults and some children.

In the 2006 Census, Ross River had proportionally many more single parent families than the Yukon as a whole, while matching the territorial pattern for couple families with and without children. Ross River had a very high proportion of residents who have not finished high school (50% of those aged 15 and over) and a very low proportion of university degree holders (4.3%) compared to the Yukon as a whole (23% and 17.8% respectively).

Statistics on the GDP of individual Yukon communities are not kept, but a reasonably good indicator of the size of the local money economy is aggregate personal income. In the 2008 tax year, Revenue Canada records that residents of Ross River reported a total of $6.52 million in income from all sources, up from $4.38 million in 2003. These figures indicate that Ross River residents have been increasing their incomes. It is important to note however, that this represents only the formal, dollar economy; the value of subsistence activities and any other unpaid work are not captured by dollar measures of economy size.

The Yukon Bureau of Statistics does not keep a spatial price index for Ross River. It is therefore extremely difficult to estimate how much greater the cost of living is in the community compared with Whitehorse. However, the YBS (2011a) does track gasoline and home heating fuel prices and the latest figures (for May 2011) show the price of regular gas is 3.7% higher in Ross River than Whitehorse while Arctic stove oil costs 1.8% more.

Various levels of government provide Ross River's economic base. The 2006 Census found 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 match the trades in numbers and include those working in the retail sector, daycare workers, restaurant and hotel workers and others. The next largest occupational group is in the social science, education and government service cluster.

Incomes in Ross River are far below the territorial average. The 2006 Census found the average individual income in Ross River was $26,000 compared to the Yukon average of $38,700. Average family income in Ross River was $50,900, only 40% of the Yukon figure of $86,000.

For 2010 the Yukon Bureau of Statistics (2011f) reported that Ross River has 14 businesses employing a total of 31 people based in the community.

5.3.3 Ross River: Social Infrastructure and Social Issues

Ross River is the home community of the RRDC, a Kaska First Nation and it is a predominantly aboriginal community. The RRDC 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.

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. YG maintains a health centre staffed with community nurse practitioners in the community. The Ross River School offers Kindergarten through Grade 10. A total of 63 students were enrolled in all grades in April 2011. Yukon College operates a satellite community campus in Ross River. The community campus provides academic upgrading courses, GED, computer training and various occupation-related courses in the community. The community lost its major recreational facility, the hockey rink, in a fire in 2010.

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.

Statistics Canada data indicates that Ross River suffers from high crime rates. In 2009 the overall rate of reported incidents was 60.9 per 100 inhabitants. Reported violent crime in 2009 was 12.4 reported incidents per 100 inhabitants.

5.4 Faro

Faro, located above the north bank of the Pelly River approximately 70 km west of Ross River, is the Yukon's newest community, built in 1969 to house the Faro mine workers and their families (Figure 2.2-1). The community's relatively short history has been marked by wild swings in population as the mine has opened and closed.

5.4.1 Faro: History

The claims that would become the Faro lead-zinc mine were first staked by Al Kulan in 1953 (the Vangorda deposit) and 1956 (Faro No. 1). Lack of funds, low metal prices, and the area's remoteness stopped further work and the claims were allowed to lapse. However, rising metal prices renewed interest in the area in the early 1960s and by 1965 extensive exploration showed clearly that the makings of a mine were present. Cyprus Anvil made the decision to go into production in 1967 and construction of the town began in the fall of 1968. In June of 1969, the first 50 houses were near completion when, on Friday the 13th, a forest fire roared through the area, destroying 48 houses. It was an inauspicious start, but the decision to rebuild on the same site was made immediately. Three months later, the first families moved into the new town of Faro.

Although the company owned nearly all the housing in the community and had built the recreation centre, Faro did not remain a company town for long. The town incorporated in December of 1970. The 1970s were boom times for Faro. The mine was profitable, wages were high, there were the benefits of heavily subsidized housing, and the town grew. In 1980 Faro had the highest average incomes in Canada according to the 1981 Census. Although there were strikes, social problems (alcohol and drug abuse were not uncommon) and a seemingly constant shortage of housing, most residents recall the early years fondly.

Cyprus Anvil became a subsidiary of Dome Petroleum in 1981. Dome had neither the expertise nor the interest to run the mine, metal prices dropped, and Cyprus Anvil began losing money and building up debt. A temporary shutdown was announced in June of 1982, and Dome put the operation up for sale. The shutdown continued as metal prices remained very low and the mine remained unsold. A stripping operation, heavily subsidized by government, provided work for approximately one third of the mine's workforce from mid-1983 to October 1984 when the company locked out its remaining workers. In May 1985 the company announced it was permanently closing the mine.

With the announcement of permanent closure came severance pay for the locked-out workers, and by July 1985, Faro was a virtual ghost town. There was no apparent reason for anyone to remain, but a stubborn few hung on, believing that, contrary to all the evidence, Faro had a future. These few (totalling less than 100 according to long-time local residents) were proven correct. During the summer of 1985 Curragh Resources Inc. began negotiations to buy the mine, mill and the housing in the town. In November 1985 Curragh took over the mine, mill and housing. The effective purchase price was zero; Dome received nothing but a possible share of future profits despite paying $340 million in cash for the mine in 1981. Curragh provided $20 million in capital towards the $40 million required to restart the mine. Most of the rest was provided, either directly or through loan guarantees, by the federal and territorial governments. In addition, most of Cyprus Anvil's debt was written off, power was supplied to Curragh at below cost, and $25 million was spent upgrading the highway to Skagway to allow concentrate to be shipped to tidewater. In the spring of 1986 the Faro mine and mill were back in operation and the town of Faro emerged from a near-death experience.

Curragh carried on mining the Faro ore body and then moved on to the Vangorda deposit in 1990 when the Faro pit was exhausted. Everything appeared to be running smoothly and the mine was profitable. By 1992 however, the company was mired in difficulties largely created by its investments in other assets (including the Westray Coal mine in Nova Scotia that suffered a major disaster) and these drove the company to

bankruptcy. In April 1993 the Faro mine was shut down for the second time. This time there was no major stripping program to allow some people to continue working, and again the town's population dropped precipitously (though it never fell below approximately 500).

The mine had been profitable, and there was still ore in the ground. A new company, Anvil Range Mining Corporation, bought the property in 1994 — with no direct government assistance — and after a $75 million stripping program and work at the mill, production began again in August of 1995. Work resumed at the Vangorda deposit and the company began to mine the Grum deposit. Full commercial production was achieved by November 1995. Again, the community got back on its feet, and many hoped for stability as the new company had little debt and owned no other properties.

In November of 1996, 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. The shutdown occurred as announced. Anvil Range declared bankruptcy in April 1998, leaving the property in the hands of a receiver.

5.4.2 Faro: Demographics and Community Economy

Since 2000, the town's population has remained relatively stable at just under 400 residents. In December 2010, Faro's population was 390 according to Yukon Bureau of Statistics data (YBS 2010b). From the 2006 Census, Faro's proportion of children appears to match with the Yukon as a whole, but the community has significantly fewer people in their 20s and 30s. The community's median age is 44.8, significantly higher than the Yukon's median of 38.4. Faro has relatively few aboriginal residents, with 16% of the population identifying themselves as aboriginal in the 2006 Census.

The 2006 Census found that Faro had proportionately far fewer single parent families than the Yukon as a whole (9% of families versus 21%). Faro matches the overall education levels of the Yukon quite closely, except that the town has a significantly lower proportion of university graduates (10.7% versus 17.7% for the Yukon).

Statistics on the GDP of individual Yukon communities are not kept, but a reasonably good indicator of the size of the local money economy is aggregate personal income. In the 2008 tax year, residents of Faro reported a total of $10.3 million in income from all sources. It is important to note that this represents only the formal, dollar economy; the value of subsistence activities and any other unpaid work are not captured by dollar measures of economy size.

The Yukon Bureau of Statistics spatial price index for October 2010 found that the average price of a selected basket of goods was 9.5% higher in Faro than in Whitehorse. At the time of the price survey, there was no gasoline for sale in the community. However, in May 2011, gasoline prices were 9.6% higher in Faro than in Whitehorse while Arctic stove oil was less than 1% more expensive in the community.

The 2006 Census found that Faro had an experienced labour force of 180 people. The most common industry employing Faro workers was public administration (25% of the labour force) but the community had 14% of the workforce working in mining and oil and gas extraction, far higher than the Yukon average of 3.6%. The Census shows the most common occupations in Faro to be in the trades, transport and

equipment operators category, in sales and service occupations, and in business, finance and administration occupations.

Average incomes in Faro are lower than those in the Yukon as a whole. The 2006 Census showed an average income of $34,200 in the community, with an average family income of $68,600. The Yukon's average family income in the 2006 Census was $86,000.

For 2010 the Yukon Bureau of Statistics (2011f) reported that Faro has 25 businesses employing a total of 43 people based in the community.

5.4.3 Faro: Social Infrastructure and Social 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 bylaws in the municipality. YG provides other community infrastructure and services including the school and the health centre.

Policing in Faro is the responsibility of the Royal Canadian Mounted Police who maintain a local detachment. Fire protection, ambulance and search and rescue services are provided by volunteer organizations.

Statistics Canada data indicates that Faro has low crime rates. In 2009 the overall rate of reported incidents was 7.5 per 100 inhabitants. Reported violent crime in 2009 was 1.8 reported incidents per 100 inhabitants.

YG maintains the Faro Community Health Centre staffed by nurse practitioners. The territorial government also provides schooling in Faro through the Del van Gorder School which offers classes from Kindergarten through to Grade 12. In April 2011 total enrolment was 39 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 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. It also has a golf course that winds its way through the center of the community.

5.5 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 (Figure 2.2-1). Watson Lake, along with neighbouring Upper Liard, Two Mile and Two and One-Half Mile Villages, is the home community of the LFN. Because the KRP is located on Kaska traditional territory, the LFN has an identified interest in the KRP.

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 LFN acts as the only form of local government in Upper Liard, Two Mile and Two and One-Half Mile Villages.

Watson Lake had a population of 1,525 in December 2010 according to the Yukon Bureau of Statistics (2010b).

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, and trades, transport, equipment operators, utilities and manufacturing.

Overall levels of education in Upper Liard, Two Mile and Two and One-Half Mile Villages 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%.

For 2010 the Yukon Bureau of Statistics (2011f) reported that Watson Lake has 105 businesses employing a total of 320 people based in the community.

5.6 Teslin and Teslin Tlingit Council

Teslin is located on Teslin Lake at the mouth of the Nisutlin River (Figure 2.2-1). It is the home community of the TTC. The broader community includes the original Teslin Post 13 (a First Nation reserve), the Village of Teslin and outlying areas such as the Teslin Cottage Lots. Because the KRP is located within the First Nation's traditional territory, the TTC has an identified interest in the KRP.

The Village of Teslin is an incorporated municipality and the Village collects property taxes, delivers a variety of municipal services, and has the authority to pass bylaws in the municipality. The municipal government works closely with and delivers municipal services to the TTC lots and housing within the municipal boundary where a large proportion of the First Nation citizens reside.

Teslin had a population of 463 in December 2010 according to the Yukon Bureau of Statistics (2010b).

The 2006 Census found that Teslin had a labour force participation rate of 70%, lower than that of the Yukon as a whole, and an unemployment rate of 17.1%, much higher than the Yukon's. The most common occupations in the community are in the sales and service cluster (22% of those employed), the business, finance and administration cluster (17%), and the trades and transportation cluster (14%). Approximately 8.5% of the workforce works in occupations unique to primary industry.

For 2010 the Yukon Bureau of Statistics (2011f) reported that Teslin has 27 businesses employing a total of 43 people based in the community.

6.0 PROJECT DESCRIPTION

6.1 Project Identification

This section contains detailed information on the construction, operation, and decommissioning phases of the KRP, as well as alternatives to the Project.

6.1.1 Principal Project

The KRP includes the design, construction, maintenance, and decommissioning and reclamation for a 1,500 tonnes per day (tpd) gold mine and process plant in south-central Yukon. Principal activities of the Project are to:

- Extract gold-bearing ore from nine open-pits and two potential underground mines
- Process ore on-site to remove gold
- Produce gold doré bars
- Transport tailings to the TSF
- Provide employment and business opportunities to local communities
- Decommission the Site using best practices.

6.2 Accessory Activities

In support of this Project, KRH is proposing to maintain the following existing infrastructure components (which will then be decommissioned and reclaimed as required during the closure and reclamation phase of the Project):

- Water well and water treatment system (installed in 2011)
- Solid waste incinerator and solid waste storage area
- Cache creek diversion.

KRH is also proposing to upgrade the following existing infrastructure components (which will then be decommissioned and reclaimed as required during the closure and reclamation phase of the Project):

- Potable water storage tanks (installing additional tanks)
- Waste management system (installed contact rotator to connect with existing siphon tanks and septic field in 2011)
- Mill building
- Site haul roads
- Fire suppression system (expanding to support 200 person camp and other infrastructure)
- Powerhouse and power distribution system (expanding to additional infrastructure)

- Camp (expanding to 200 person capacity).

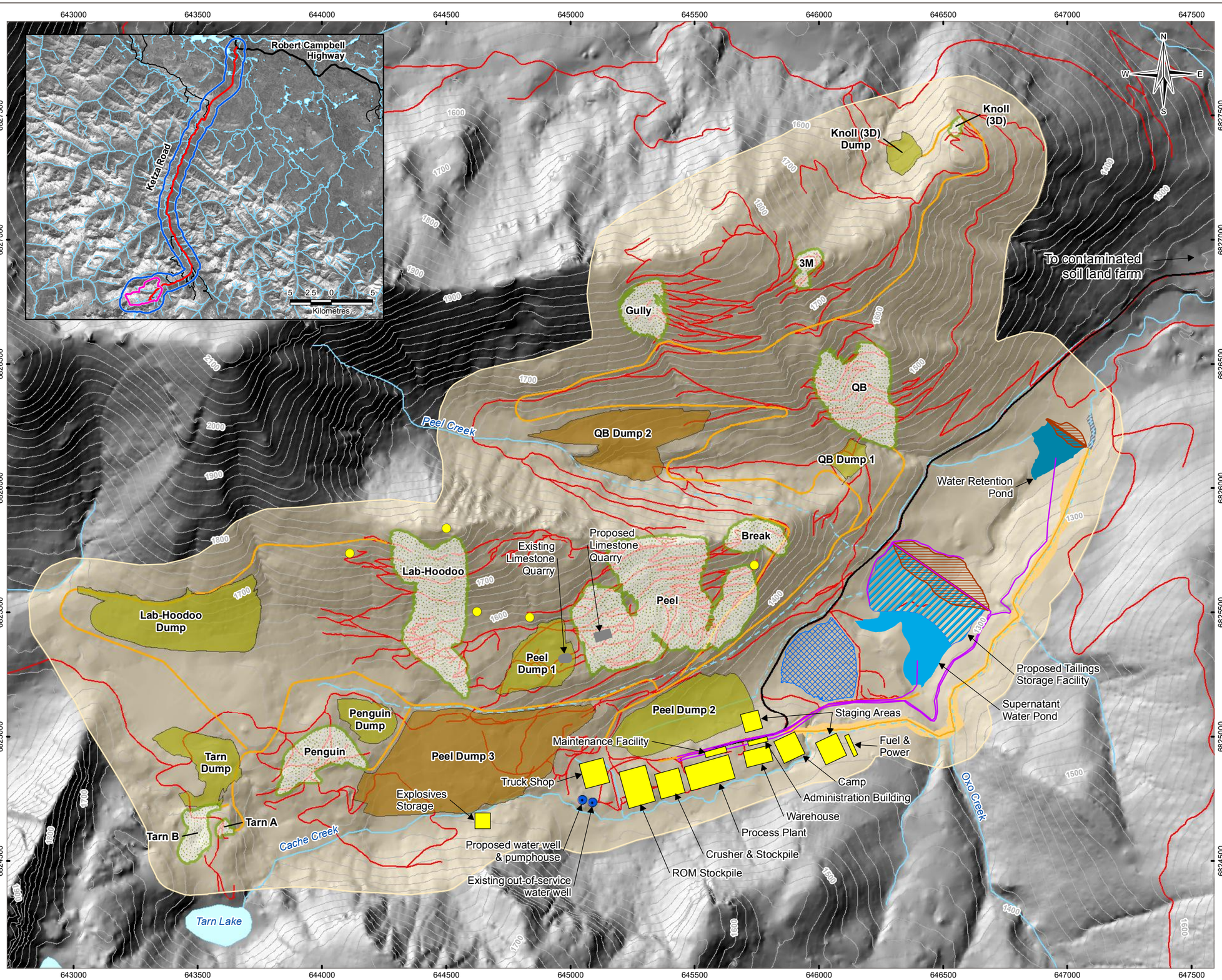
The following components will be designed, constructed, operated, maintained, decommissioned, and reclaimed, as required, by KRH in support of the Project:

- Ore process plant
- Maintenance facility
- Warehouse
- Administration building
- Contaminated soil land treatment facility
- Diesel fuel storage facility (fuel and power)
- Tailings storage facility
- Pumphouse
- Site haul roads
- Water diversion structures
- Water retention pond
- Open pit mining excavations
- Crusher and grizzly feeder
- Explosives storage
- Run of Mine (ROM) stockpile
- Low-grade stockpile
- Overburden stockpile
- Staging area.

Other accessory activities of the KRP include:

- Hauling fuel and other materials on the Ketza Road to the Site
- Transporting employees via bus on the Ketza Road to the Site
- Using haul trucks (e.g., CAT 740 and CAT 77) to transport material to the stockpiles and waste dumps.

A site plan showing the layout and general location of infrastructure and mining components is presented in Figure 6.2-1.



LEGEND

- Underground Access Points
- Project Footprint
- Infrastructure
- Pit Shells
- Mixed PAG/NAG Waste Rock Pile
- Non-Acid Generating Waste Rock Pile
- Canamax Tailings Storage Facility
- Dam Structure
- Proposed Tailings Storage Facility
- Supernatant Water Pond
- Water Retention Pond
- Limestone Quarry
- Diversion and Access Road
- Rip-Rap Channel
- Pipelines
- Ketza Road
- Proposed Haul Roads
- 2006 Existing Roads
- Contour (20 m)
- Proposed Diversion
- Watercourse
- Waterbody

NOTES

Base data source: 1:50,000 NTS
Contours provided by Aero Geometrics, Ltd

STATUS

ISSUED FOR USE

KETZA RIVER PROJECT

Proposed Project Layout

PROJECTION	DATUM	CLIENT
UTM Zone 8	NAD27	Ketza River Holdings

Scale: 1:15,000
250 125 0 250
Metres

FILE NO.				
W23101052_ProjectLayout.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
W23101052.114	SL	TP	TP	0
OFFICE	**DATE**			
EBA-VANC	July 26, 2011			

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Figure 6.2-1

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6.3 Alternatives and Chosen Approach

This Project Proposal outlines a feasible method of extracting, processing, marketing, and closing the KRP. Methods for extracting, concentrating, and shipping gold doré from the KRP to a refinery are also outlined. The mine plan and ancillary activities have been developed to a pre-feasibility level of engineering had have taken into consideration the potential effects to the surrounding environment, potential social effects, First Nation's cultures, and the existing economic and regulatory climate in Yukon.

Alternatives to the mine plan as presented in this Project Proposal have also been considered and are discussed in the following subsections.

6.3.1 Access Alternatives

The Site is currently accessed year-round by all-weather roads which connect the property to Yukon's highway system. A helipad near the Site allows access during brief periods when the road is impassable or as required for emergency use.

Alternate access to the Site was evaluated including the option of a fully operational airstrip. The airstrip would require sufficient capacity to allow for landing of de Havilland Dash 8-type aircraft or larger. This size of aircraft would be sufficient to move employees, small equipment and materials to and from the Site; however, shipment of larger equipment would still require road access. The airstrip was not chosen as the primary method of access to the Site due to of the existence of the Ketza Road. Due to the relatively close proximity of the Site to Whitehorse and surrounding communities, a road was determined to be the best alternative for the transport of people, equipment, and materials to and from the KRP.

6.3.2 Tailings Containment Alternatives

An engineering desktop study considered three tailings disposal options for the KRP from a technical and economic perspective. The study was based on conceptual mine development criteria and limited preliminary site testing information (EBA 2011f). The three options that were assessed included conventional, thickened, and dry stack tailings. Preliminary design criteria used in the study included:

- Base case impoundment to accommodate current reserves of 2.4 million tonnes
- Potential impoundment expansion to accommodate reserves of 4.5 million tonnes
- Mill throughput of 1,500 tpd (550,000 tonnes/year)
- Assumption that some or all of the tailings may be potentially acid generating.

Each tailings disposal option comprised individual components including the tailings transport, reclaim water, seepage collection, containment, power consumption, and operating costs. The options were evaluated based upon technical merit, environmental considerations, and economic feasibility.

The comparative economic assessment was developed using unit costs and consistent assumptions between the three options. Initial capital costs, ongoing capital costs and annual operating costs were estimated for each option.

The assessment indicated that the dry stack tailings option had the lowest capital costs, but highest operating costs, while conventional tailings had higher capital costs with lower operations costs due to the significant embankment and tailings storage facility lining during initial construction. The thickened tailings presents the moderate option for both capital and operating costs, and resulted in the lowest overall costs of the three options. Given the preliminary environmental and operational inputs, it was recommended that further design and environmental studies focus on the thickened tailings concept.

6.3.3 Power Alternatives

Power for the site will be supplied by on-site generators. A power house with two (2) diesel generators (3 MW each) will provide adequate power for the camp, plant, and ancillary infrastructure. A power line from the nearby town of Faro was considered as an alternative power source but is not considered to be an economically viable option.

6.3.4 Processing Alternatives

Several methods are commonly used to process ore. Three of the most appropriate for the KRP were evaluated more formally and include carbon-in-leach (CIL), carbon-in-pulp (CIP), and heap leach. Processing adjustments as they relate to throughput may also be explored if they prove beneficial.

Carbon-in-Leach (CIL) is the chosen processing method for all ore mined at the Ketza site. CIL is a standard method for processing gold as it leads to high recoveries at reasonable costs when gold is the sole element for recovery. Alternate means of gold recovery could be implemented as part of the CIL process as technologies are refined. For example the Anglo American Research Laboratory (AARL) elution method could be substituted for the currently proposed pressurized Zadra stripping approach. Similarly, cyanide destruction, which will currently use the copper catalyzed SO_2/Air removal method, could be replaced by Caro's Acid cyanide destruction method if it offers distinct advantages, such as better operational efficiency or worker or environmental safety.

Carbon-in-Pulp (CIP) is another common processing method used to recover gold. In many cases, CIP and CIL are similar in terms of operating costs and recovery. CIL may provide more protection against 'preg-robbing' and can have lower capital costs.

Heap Leach processing provides a third alternative to CIP and CIL however is less effective for processing sulphide-enriched ore material. Both capital and operating costs are reduced in a heap leach operation. Drawbacks to heap leaching are primarily associated with poor metal recovery in comparison to CIL or CIP and the requirement for a large footprint for leach operations.

With respect to planned processing rates, the current ore throughput has been set at a rate of 1,500 tpd, which is the optimum rate for the size of the deposit. A higher throughput rate would require more capital expenditure and result in a shorter mine life, which could negatively affect overall KRP economics. A lower throughput would result in lower yearly revenues, consequently lowering the value of the KRP.

6.3.5 Mining Trade-offs

Open pit mining was chosen as the primary mining method based upon the location and geometry of the ore bodies. There are also cost advantages to open pit mining which include lower operating cutoff grades and higher resource recovery. As an alternative, underground mining could selectively recover higher grade resources at a higher cost per tonne than open pit mining. Underground mining often requires a more specialized skill set than open pit mining, and may not be readily available in the local workforce without specific training. Underground mining methods may be employed selectively to recover high grade resources beyond the limits of the open pits.

Blasting, excavation and transportation of ore and waste in the open pits will be owner-operated. The alternative would be contractor-operated, where contractors provide staff and equipment. Contract operated mining incurs lower capital costs; however there are also slightly higher operating costs. Owner-operated mining requires the owner to purchase all necessary equipment, hire sufficient staff and train staff to the level necessary to perform their function efficiently.

The increase in operating costs from contractor-operated mining would offset any potential benefit from lower capital costs and improved logistics, therefore owner-operated mining has been selected as the preferred option for open pit mining. For the underground operations, KRH have selected contractor-operated mining due to the small scale of the underground mine and the need for specialized training and equipment.

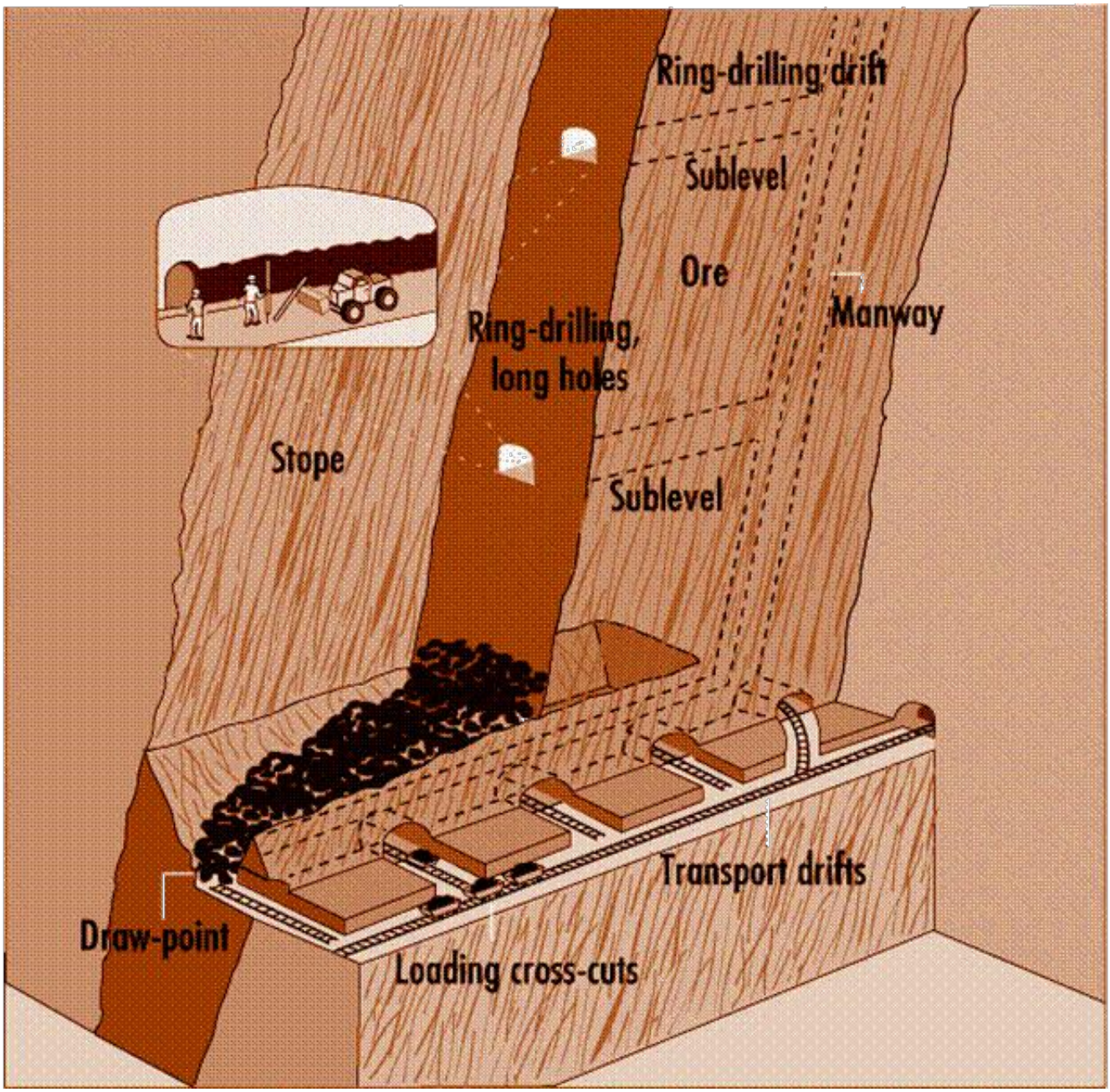
6.3.6 Underground Mining Method Alternatives

KRH is proposing underground mining methods for the resources below the Peel open pit, with the potential for underground mining below the Lab-Hoodoo open pit as well. Additional underground resources have been delineated below some of the other pits, however, these resources are not currently being considered for development in this Project Proposal.

The underground resources are shallow to steeply dipping and require a mining method that will recover high grade resources with reasonable cost recovery. Options for underground mining methods suitable for this deposit type include caving methods, cut and fill, room and pillar, shrinkage stoping, sub-level stoping, long hole and short hole stoping. The underground mining methods are short sub-level stoping for steeply dipping areas of the ore body, and drift and fill for the shallow dipping areas of the ore body.

Short sub-level stoping is a variation on longhole stoping that has low operating costs relative to many other mining methods and is more flexible and selective than traditional longhole open stoping (Figure 6.3-1). Longhole stoping is one of the most common underground mining methods worldwide, useful for steeply dipping orebodies. The short sub-level stoping variation will allow for more selective mining than longhole mining but will incur slightly higher operating costs.

Drift and fill is a variation on the cut and fill mining method, allowing for consecutive cut and fill operations (Figure 6.3-2). Cut and fill is a highly selective mining method that is not capital intensive, however it incurs high operating costs. Drift and fill is ideal for high grade, shallow dipping orebodies. While there are some areas that would be acceptable to mining room and pillar, preliminary analysis finds that drift and fill provides improved economics to the overall operation.



NOTES

Source: Hamrin, Hans (1998). "Techniques in Underground Mining." *Encyclopedia of Occupational Health and Safety 4th ed.* (74.14) Ed. Jeanne Stellman. Geneva, International Labour Office, 1998. Google Books, May 11, 2011.

STATUS
ISSUED FOR USE

CLIENT
Ketza River Holdings

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KETZA RIVER PROJECT

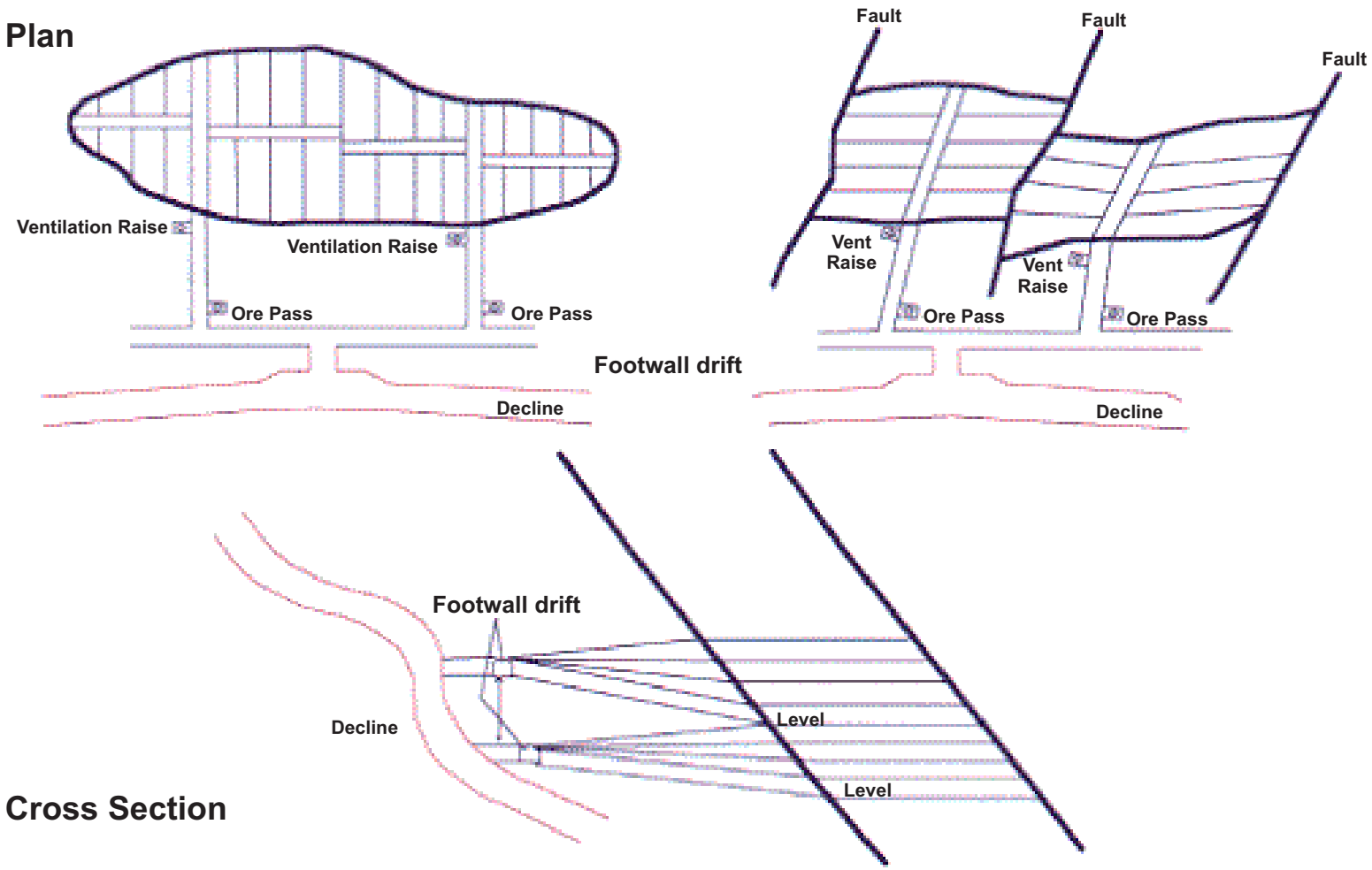
Schematic of Sublevel Stoping Mining Method

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 20, 2011

Figure 6.3-1

Q:\Vancouver\Graphics\ENVIRONMENTAL\W231\W23101052_Ketza\W23101052_SublevelStoping.cdr



NOTES

Fernando Real (1999). *A Perspective on Neves - Corvo Mining Project Development: A Success Against an EU Trend.* Mining Development Strategies With a Focus on the Case of the Iberian Pyrite Belt. Technical Journey 25th September 1998 Lisbon, Portugal. (http://e-geo.ineti.pt/edicoes_online/diversos/mining_develop/capitulo4.htm)

STATUS
ISSUED FOR USE

CLIENT
Ketza River Holdings

A TETRA TECH COMPANY

KETZA RIVER PROJECT

Schematic of Drift and Fill Mining Method

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 6.3-2

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Caving mining methods require very high capital investment and create heavy dilution of the ore body. A benefit to caving is the extremely low operating costs. Caving methods are generally used for large, steeply dipping underground ore bodies unlike those found at the KRP. This method is not suitable, as it would incur development costs unjustified by the size of the potential underground orebody.

Shrinkage stoping mining method is a highly selective mining method used for steeply dipping orebodies. Throughput is very low and operating costs are higher than that of longhole stoping. For the Ketza mine, underground longhole stoping provides improved economics over shrinkage stoping.

Room and pillar is a mining method often employed on shallow dipping orebodies. Room and pillar involves excavating of rooms while leaving pillars behind to provide support. At the end of the process, these pillars would either be left behind, or remotely mined.

6.3.7 Water Source Alternatives

Potable water for the camp will be pumped from a well to a treatment facility and stored in tanks in an adjacent pumphouse. There is currently a non-functioning water well located west of the process plant on the north side of Cache Creek, and a new water well site is located on the north side of Cache Creek in the same general area (see Figure 6.2-1).

An alternate source of potable water is direct extraction from Cache Creek. This method has not been selected as surface water quality varies during the year, would likely require more comprehensive treatment, and may not supply enough water for a full camp during the winter.

Water used for mill processes will be reclaimed from the TSF and the water retention pond downstream of the TSF. Water from precipitation and localized runoff will initially be stored within the footprint of the TSF to provide a start-up water source. Throughout operations, fresh water will be recycled from the water retention pond to provide fresh water make-up and supplement water being reclaimed from the process plant and the TSF.

6.3.8 Alternative Infrastructure and Facilities

Portions of the existing camp and mill will be upgraded for use during the construction and operation phases. The current facilities are too small to support the mine during full operation. Alternate locations for major buildings were considered and final locations were selected to best accommodate mining logistics.

The remoteness of the Site warrant the construction of both on-site accommodation and administrative facilities. KRH maintain offices in Whitehorse and Vancouver BC, however, most day-to-day administrative activities will likely occur at the mine-site office.

Similarly, staff accommodation will be constructed on-site as daily transport of staff to site would be inefficient and costly. Modular accommodation units on a compacted gravel pad will be utilized. Constructing the modules off-site includes electrical and plumbing, which makes for faster and more efficient installation. The modular nature of the units will also facilitate demobilization of the structures at the end of mine life, as well as decommissioning and reclamation of the site.

6.3.9 Closure Alternatives

Several options exist for closure of the various facilities and infrastructure associated with the KRP once operations are complete. The main components are described in more detail below.

6.3.9.1 Tailings Storage Facility

The primary options for the final closure of the TSF include leaving the existing facility as a water retaining structure and locally relocating and capping any exposed tailings or draining the TSF and capping the tailings. The second option is likely the most favourable for achieving long term stability and minimizing overall risk.

6.3.9.2 Open Pits

The current plan for closure of the earliest mined pits includes the option to partially backfill them with mine waste from the other operating pits, where practical. Flooding of the pits at closure could also act as a potential option. Flooding would facilitate the removal of suspended solids and could provide natural attenuation of acid rock drainage (ARD) and metal leaching (ML) into the receiving environment. Appropriate drainage structures would be designed to address overflow conditions, where applicable, and discharge would only be allowed if water quality criteria were achieved. Pit water requiring discharge that does not meet appropriate water quality criteria would be directed to a water treatment facility on-site. The potential for early backfilling as well as in-pit treatment of site water requires more detailed investigation that will be conducted as part of the detailed design stage.

6.4 Geological Setting

6.4.1 Proposed Mine Site Area

Two predominant lithological zones have been identified within the Ketza River mine property. The Manto Zone comprises the Peel, Penguin, Lab-Hoodoo, Tarn, and Break deposits and the Shamrock zone comprises the Gully, 3M, and Knoll deposits.

Waste rock mining unit volumes were reported on a per pit and lithology basis, including argillite, limestone, and other waste rock lithologies which were subdivided into hisulphide, oxide, sulphide, transulphide and unaltered categories, which are defined as follows:

- **Unaltered (unalt):** <30% Oxide and <2% total sulphide minerals
- **Oxide (ox):** ≥50% Oxide and <2% total sulphide minerals
- **Transulphide (transulf):** contains 3 different domains:
  - 50% total sulfide minerals and ≤2% Fe-Oxide minerals
  - 30-50% oxides and <2% total sulphide minerals
  - >50% oxide minerals and 2-15% sulfide minerals
- **Sulphide (sulf):** ≤50% oxide minerals and ≥50% total sulphide minerals (excludes hisulf material defined below)
- **Hisulphide (hisulf):** ≥85% to 100% total sulphide minerals and <5% total oxide minerals.

NOTE: Oxide minerals consist mostly of limonite, goethite, hissingerite, and lesser scorodite (As-oxide).

Bedrock geology associated with Manto Zone deposits is dominantly composed of limestone, mineralized limestone (containing various amounts of sulphide minerals or oxide or iron-oxide minerals with various amounts of limestone rock), oxide-altered limestone, argillite, mudstone, siltstone, and lesser quartz veining and intrusive rock with varying amounts of oxide and / or sulphide mineralization. Shamrock Zone deposits are predominantly comprised of argillite-rich rocks. For the purposes of this application and future tailings studies, unaltered and oxide materials are generally considered "oxides", while the sulphide, transulphide, and hisulphide types are generally considered "sulphides".

The KRP is located in the Pelly Mountains of central Yukon. The mountains are made up of a shallow marine miogeoclinal sequence of rocks forming a carbonate platform bounded by the Omenica Tectonic Belt to the southwest and a faulted lobe of the Yukon Tanana Terrain to the northeast across the Tintina Fault. This carbonate platform is known as the Cassiar Terrain or Pelly-Cassiar Platform (Pelly-Cassiar). The Property is underlain by Lower Cambrian carbonate and clastic sedimentary rock units. The Lower Cambrian units form a conformable series which is unconformably overlain by Late Cambrian black shale (Fonseca 1998).

There are two general types of gold deposits on the property: manto-type replacement sulfide deposits and shamrock-type quartz-sulfide fissure vein and stockwork (including quartz-breccia and disseminated) deposits. Both styles of sulfide-bearing mineralization are locally oxidized throughout the property which has partially to totally converted the sulfide minerals to oxide minerals (Fe-oxides and/or As-oxides). Mantos are defined as sub-horizontal, tabular massive sulfide (or oxide) bodies and chimneys are sub-vertical, massive sulfide (or oxide) bodies and at the Site are hosted within the Lower Cambrian limestones. Sub-vertical, and some sub-horizontal, bodies are structurally controlled while the remainder of the sub-horizontal bodies occur along permissive horizons within limestone.

The quartz-sulfide fissure vein and quartz-breccia systems occur in a sequence of interbedded Lower Cambrian phyllite, argillite, siltite, quartzite and lesser carbonate rocks on the eastern side of the Ketza Uplift. Mineralization consists of pyrrhotite, pyrite and arsenopyrite in massive quartz-sulfide fissure veins and lesser quartz-breccia veins with some stockwork and disseminated styles of mineralization. The veins are controlled by moderate to high-angle faults or fracture systems.

6.4.2 Results of Waste Rock Geochemical Characterization Program

Waste rock volumes were estimated in the mine plan and used during this evaluation. Guidelines for minimum sample requirements for static testing presented in *The Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (Price 2009) were used to estimate the number of samples required for preliminary static testing. Additionally, SRK et al. (1992) developed a curve based on sites in British Columbia that may be used as a guideline to judge appropriate representative sample quantities. The minimum recommended sample requirements are based on the volume of each distinct material type. A summary of samples by waste rock type is presented in Table 6.4-1. Further details of the waste rock geochemical characterization program are presented in Appendix K1.

Table 6.4-1: Summary of Samples from the Geochemical Characterization Program

Waste Rock Mining Units	Total Tonnage (millions)	Samples Required	Samples Collected to Date		
			2008	2010/2011	Total
Manto-ARG-Unaltered*	10.5	80	-	78	78
Manto-Shale-Transulf*	0.5	20	6	13	19
Manto-Limestone-Oxide*	2.1	36	4	32	36
Manto-LST-Sulph*	1.4	30	15	7	22
Manto-LST-Trans*			8	9	17
Manto-LST-Unaltered*	20.4	110	34	52	86
Manto-Other-Unaltered*	2.1	38	23	14	37
QB-ARG-Oxide*	1.7	32	29	3	32
QB-ARG-Sulf	0.27	12	5	6	11
QB-ARG-Trans			-	5	5
QB-ARG-Unaltered*	6.4	65	12	73	85

*Indicates rock types submitted for humidity testing.

Waste Rock Acid-base Accounting Results

Acid base accounting (ABA) analysis for the waste rock samples includes whole rock paste pH, total sulphur and sulphate sulphur by LECO furnace, net neutralization potential by standard Sobek method, and fizz rating. Total inorganic carbon and total sulphur were calculated from analytical results, and used to determine the sample neutralization potential (NP) and maximum potential acidity (MPA), respectively. The neutralization potential ratio (NPR) is calculated by dividing the NP by the MPA. Samples were collected from drill core by a YNG geologist and submitted to ALS Laboratories for analysis. A total of 428 samples were analyzed including 136 samples from 2008 and 292 samples from 2010/2011.

A summary of the ABA results is presented in Table 6.4-2 and additional information is found in Appendix K1.

Table 6.4-2: ARD Classification for Ketza Material Types

Material Type	# Samples (n)	ARD Classification # Samples			Minimum NPR	Maximum NPR	Classification
		PAG	Uncertain	NAG			
Manto-ARG-Unaltered	79	5	13	61	0.27	60.71	NAG
Manto-Limestone-Oxide	36	0	0	36	15.68	6400	NAG
Manto-LST-Sulph	22	16	1	5	0.02	159.25	PAG
Manto-LST-Trans	17	0	1	16	1.58	6349	NAG
Manto-LST-Unaltered	86	1	0	85	0.05	6387	NAG
Manto-Other-Unaltered	37	10	4	23	0	224	Uncertain
Manto-Shale-Transulf	19	15	4	0	0.05	1.59	PAG
QB-ARG-Oxide	32	11	1	20	0.13	6330	NAG
QB-ARG-Sulf	11	10	0	1	0.01	0.88	PAG
QB-ARG-Trans	5	5	0	0	0.01	0.07	PAG
QB-ARG-Unaltered	75	35	28	22	0.08	30.93	Uncertain

Based on the above classification of materials and the estimated waste rock volumes provided in Appendix K1, approximately 33 Mt of waste rock is expected to be NAG (all 33 Mt are from the Manto Zone), 10.2 Mt Uncertain classification (2.1 Mt Manto Zone, 8.1 Mt Shamrock Zone), and 0.8 Mt PAG (0.5 Mt Manto Zone, 0.3 Mt Shamrock Zone).

The results show that the unaltered argillite, oxide limestone, transuphide limestone and unaltered limestone rock types encountered in the Manto Zone are dominantly classified as non-acid generating.

Samples collected from the Shamrock Zone exhibited variable ABA characteristics. The argillite oxide waste rocks are classified as NAG. The argillite sulphides and transulphide are classified as PAG and the unaltered argillite is classified as uncertain.

Waste Rock Metal Leaching Summary Results

Whole rock metals and shake flask ML testing was completed on each waste rock unit to evaluate potential for metal leaching. Details of this testwork and results are included in Appendix K1, and summarized below. Each of the waste rock mining units have concentrations of multiple metals which are greater than the CCME ALG, indicating the strong potential for metal leaching to surface waters. The results of the shake flask ML tests are summarized in Table 6.4-3.

Table 6.4-3 presents the average concentration of metals by waste rock mining unit with comparison to the CCME ALG. All waste rock units contain samples with arsenic, cadmium and uranium above CCME ALG.

Aluminum concentrations are greater than CCME AGL for argillite, sulphidic limestone, other unaltered and shale transulphide units within the Manto Zone and in all waste rock units in the Shamrock zone.

Copper concentrations are greater than CCME AGL for argillite, unaltered limestone, other unaltered and shale transulphide units within the Manto Zone and in all waste rock units in the Shamrock zone.

Lead concentrations are greater than CCME AGL for argillite, other unaltered and shale transulphide units within the Manto Zone and in all waste rock units in the Shamrock Zone.

Nickel concentrations are greater than CCME AGL for argillite, transulphide limestone, other unaltered and shale transulphide units within the Manto Zone and in all waste rock units in the Shamrock Zone.

Selenium concentrations are greater than CCME AGL in all the Manto Zone units except the sulphidic limestone and within the argillite oxide and unaltered argillite in the Shamrock Zone.

Silver concentrations are greater than CCME AGL in the unaltered argillite, limestone oxide, limestone transulphide, other unaltered and shale transulphides within the Manto Zone and in all waste rock units in the Shamrock Zone with the exception of the sulphidic argillite.

Thallium concentrations are greater than CCME AGL for unaltered argillite, limestone transulphides and shale transulphide units within the Manto Zone and in all waste rock units in the Shamrock Zone.

Zinc concentrations are greater than CCME AGL for unaltered argillite, sulphidic limestone, unaltered limestone, other unaltered and shale transulphide units within the Manto Zone and in all waste rock units in the Shamrock Zone.

Table 6.4-3: Average Concentration and Standard Deviation of Leachable Metals per Waste Rock Type

Waste Rock Mining Unit	Total # Samples	CCME ALG (mg/L)	Leachable Metals (mg/L)											
			Aluminum (Al)-Leachable	Arsenic (As)-Leachable	Cadmium (Cd)-Leachable	Copper (Cu)-Leachable	Iron (Fe)-Leachable	Lead (Pb)-Leachable	Nickel (Ni)-Leachable	Selenium (Se)-Leachable	Silver (Ag)-Leachable	Thallium (Tl)-Leachable	Uranium (U)-Leachable	Zinc (Zn)-Leachable
			0.1	**0.005**	**0.000017**	**0.004**	**0.3**	**0.007**	**0.15**	**0.001**	**0.0001**	**0.0008**	**0.015**	**0.03**
Manto-ARG-Unaltered	78	Average	**74.91**	**0.0096**	**0.0066902**	**0.0428**	**61.43**	0.0052	**0.304**	**0.0008**	**0.00110**	0.00054	0.0133	**0.263**
		Standard Deviation	**132.99**	**0.0134**	**0.0278675**	**0.1116**	**88.98**	**0.0105**	**0.219**	**0.0009**	**0.00646**	0.00069	0.0120	**0.776**
Manto-Limestone-Oxide	32	Average	0.02	**0.3716**	**0.0003844**	0.0015	0.13	0.0006	0.012	0.0005	**0.00045**	0.00006	0.0088	0.006
		Standard Deviation	0.01	**0.5258**	**0.0009348**	0.0006	0.04	0.0002	0.013	0.0003	**0.00094**	0.00002	0.0086	0.002
Manto-LST-Sulph	15	Average	**0.49**	**1.1746**	-0.0000833	-0.0095	**555.43**	0.0004	0.000	0.0004	**0.00017**	0.00009	0.0109	0.008
		Standard Deviation	**1.23**	**2.8888**	**0.0001342**	**0.0148**	**794.48**	0.0006	0.002	0.0001	0.00005	0.00002	0.0099	**0.034**
Manto-LST-Trans	9	Average	0.02	**0.2110**	**0.0001333**	0.0016	**58.29**	0.0008	0.037	**0.0006**	**0.00018**	0.00020	0.0098	0.008
		Standard Deviation	0.01	**0.3505**	**0.0002878**	0.0005	**44.21**	0.0003	0.062	0.0005	0.00006	0.00038	0.0071	0.003
Manto-LST-Unaltered	52	Average	0.02	**0.1253**	**0.0000502**	0.0038	**0.85**	0.0007	0.031	**0.0009**	**0.00013**	0.00007	0.0084	0.008
		Standard Deviation	0.01	**0.4028**	**0.0000568**	**0.0169**	**4.15**	0.0003	0.025	**0.0014**	0.00005	0.00003	0.0071	0.006
Manto-Other-Unaltered	22	Average	**16.80**	**0.0246**	**0.0026714**	**0.0413**	**68.33**	0.0025	**0.283**	**0.0007**	**0.00022**	0.00013	0.0137	**0.146**
		Standard Deviation	**50.36**	**0.0412**	**0.0033628**	**0.1203**	**138.67**	0.0065	**0.250**	**0.0007**	**0.00022**	0.00011	**0.0155**	**0.311**
Manto-Shale-Transulphide	16	Average	**75.62**	**0.09371**	**0.01955**	**0.21143**	**241.55813**	**0.52286**	**1.67259**	**0.00394**	**0.0002**	**0.00156**	**0.16974**	**2.82331**
		Standard Deviation	**77.79**	**0.18167**	0.02959	0.40523	202.26267	0.84781	1.28155	0.00386	0.00011	0.00145	0.15343	4.02976
QB-ARG-Oxide	6	Average	**52.59**	**45.6010**	**0.0293267**	**3.5372**	**299.08**	**0.0481**	**0.397**	**0.0011**	**0.05177**	**0.00132**	**0.0736**	**0.336**
		Standard Deviation	**76.11**	**84.9014**	**0.0603117**	**8.2644**	**343.55**	**0.0889**	**0.525**	0.0002	**0.06439**	**0.00106**	**0.0462**	**0.466**
QB-ARG-Sulf	11	Average	**72.30**	**0.5518**	**0.0001768**	**0.0111**	**3169.09**	**0.0269**	**0.221**	**0.0007**	**0.00034**	0.00034	**0.0293**	**0.424**
		Standard Deviation	**85.00**	**0.8497**	**0.0001607**	**0.0161**	**4865.75**	**0.0469**	**0.245**	**0.0009**	**0.00034**	0.00028	**0.0399**	**0.555**
QB-ARG-Trans	5	Average	**175.10**	**29.4160**	**0.1717170**	**2.5710**	**1100.00**	**0.6624**	**1.446**	0.0005	**0.00197**	**0.00102**	**0.0936**	**9.348**
		Standard Deviation	**159.85**	**20.2204**	**0.3161355**	**4.3117**	**1090.43**	**1.3705**	**1.395**	0.0001	**0.00401**	**0.00169**	**0.0938**	**13.680**
QB-ARG-Unaltered	75	Average	**132.45**	**6.3946**	**0.0239158**	**1.4155**	**231.35**	**0.0624**	**0.862**	**0.0005**	**0.00368**	**0.00093**	**0.0581**	**0.809**
		Standard Deviation	**89.82**	**11.4580**	**0.0494074**	**3.2978**	**174.16**	**0.0913**	**0.883**	0.0003	**0.01062**	**0.00107**	**0.0328**	**1.080**

Average metal concentrations exceeding the CCME ALG are highlighted in **bold**

Waste Rock Humidity Cell Test Results

Nine samples of waste rock were submitted for humidity cell testing (HCT). In accordance with methods outlined in *The Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (Price 2009) complete analysis results and methodology is presented in Appendix K2 and summarized here below.

Humidity cell samples and rational as to why the humidity cells were selected are provided in Table 6.4-4. Samples are comprised of composite material collected from drill core from areas within the pit boundaries of the current proposed mine plan.

Table 6.4-4: Humidity Cell Sample Description

Humidity Cell ID	Waste Rock Unit	Comments	Date Started
HC1	QB-ARG-UNALT	Dominant source of waste from QB zone.	January 2011
HC2	QB-ARG-OX	Lesser amounts of waste, largest anticipated arsenic source.	January 2011
HC3	MANTO-ARG-UNALT	Major waste rock contributor (30%), ABA results indicate PAG	January 2011
HC4	MANTO-LIMEST-TRANSULF	Minor waste rock contributor, but with potential PAG and ML concerns.	January 2011
HC5	MANTO-LIMEST-OX	Minor waste rock contributor, but with ML concerns.	January 2011
HC6	MANTO-LIMEST-UNALT	Dominant source of waste from Mantos zones (55%), likely NAG, results will aid in predictive modelling.	January 2011
HC7	MANTO-OTHER-UNALT	2008 ABA results included mudstone, siltstone and vein materials.	January 2011
HC8	MANTO-SHALE UNIT 2-TRANSULF	Anticipated PAG Material	January 2011
HC9	MANTO-LIMEST-SULF	Anticipated PAG Materials	January 2011

Within the Shamrock Zone, argillite sulphide and transulphide were not selected for HCT analysis due to low predicted excavation quantities. Only unaltered argillite and argillite oxide were selected for HCT analysis. The cells were initiated in January 2011, and the first leachate samples were collected on January 8, 2011. The cells have been sampled weekly for pH, conductivity, acidity, alkalinity, chloride, sulphate, and dissolved metals. Complete analysis and discussion is presented within Appendix K2.

HCT analytical results show Manto and Shamrock Zone waste rock have strong potential for metal leaching, even at near neutral or slightly alkaline pH ranges. Since the first week of testing, the arsenic concentrations in the Manto Limestone oxide have exceeded the CCME ALG. They have since continued to rise over the last 21 weeks of analyses. As the pH decreases in some of the HCTs, the ratio and relative concentration of the metals exceeding the CCME ALG are expected to increase.

6.4.3 Results of Tailings and Ore Geochemical Characterization Program

ABA/ML testing was completed to provide initial characterization of the ore and tailings material. Humidity cell tests were initiated in 2008 to establish long term leachate composition for unprocessed sulphide ore and sulphide and oxide tailings samples.

Laboratory testing was conducted by ALS Minerals and ALS Environmental in Vancouver, BC according to methods defined in *The Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (Price 2009). Table 6.4-5 provides a summary of samples for humidity cell testing.

Table 6.4-5: Summary of Samples Submitted for Humidity Cell Testing

Humidity Cell ID	Material Type	Material Description	Date Started	Number of Weeks of Analysis
Ketza – Sulphide Ore	Sulphide Ore (Composite)	Composite sample unprocessed sulphide ore	May 8, 2011	160
Ketza – Sulphide Tailings	Sulphide Tailings	Processed sample	June 6, 2011	156
Ketza – Oxide Tailings	Oxide Tailings	Processed sample	June 6, 2011	156

Tailings and Ore Acid Base Accounting Results

ABA analysis for the tailing and sulphide ore samples includes whole rock paste pH, total sulphur and sulphate sulphur by LECO furnace, net neutralization potential by standard Sobek method, and fizz rating. Total inorganic carbon and total sulphur were calculated from analytical results, and used to determine the sample NP and MPA, respectively. The NPR is calculated by dividing the NP by the MPA. A summary of the ABA results is presented in Table 6.4-6.

The results indicate a clear distinction between the sulphide bearing samples and the oxide sample. The sulphide tailing sample, three sulphide mine ore rock samples and the sulphide mine ore composite sample are classified as PAG. The oxide tailings sample is classified as NAG.

Tailings and Ore Metal Leaching Summary Results

The sulphide and oxide tailings samples were submitted for shake flask analysis. Testing was conducted to evaluate ML potential. Test work was completed in accordance with MEND 2009 Guidelines. The results of the shake flask evaluation for ML potential are contained in the attached Table 6.4-7. The results of the shake flask testing are compared to the CCME ALG.

Leachable metal concentrations of arsenic and silver from oxide and sulphide tailings samples exceed the CCME ALG. The concentration of arsenic from the oxide sample exceeds the CCME ALG by 3 orders of magnitude or 3,300 times. The concentration of arsenic from the sulphide tailings sample exceeds the CCME ALG by 2 orders of magnitude or 180 times. Silver concentrations from the oxide and sulphidetailings samples are slightly above an order of magnitude in the oxide sample and less than an order of magnitude in the sulphide sample. The concentration of leachable copper in the oxide sample exceeds the CCME ALG by slightly more than an order of magnitude.

Table 6.4-6: Acid Base Accounting Analyses of Tailings and Ore Composite Samples

Sample Identification	Maximum Potential Acidity	Fizz Rating	Net Neutralization Potential	Neutralization Potential	Paste pH	NPR (NP:MPA)	Total Sulphur	Sulphate Sulphur (Carbonate Leach)	Sulphate Sulphur (HCl Leach)	Sulphide Sulphur	Inorganic Carbon, C	Inorganic Carbon, CO_2	Classification
	$tCaCO_3$/1,000t material		$tCaCO_3$/1,000t material	$tCaCO_3$/1,000t material			%	%	%	%	%	%	
Ketza-Sulphide tailings	731.3	3 (moderate)	-570	161	8.3	0.22	23.4	0.12	0.02	23.3	2.22	8.1	PAG
Ketza-Oxide tailings	41.3	3 (moderate)	210	251	8	6.08	1.32	1.1	1.08	0.22	3.12	11.4	NAG
Sulphide Ore E915633	909.4	2 (slight)	-860	49	6.8	0.05	29.1	0.12	0.05	29.0	-	-	PAG
Sulphide Ore E915637	887.5	2 (slight)	-838	50	7.1	0.06	28.4	0.09	0.04	28.3	-	-	PAG
Sulphide Ore E915813	1015.5	2 (slight)	-948	68	8.4	0.07	32.5	0.03	0.02	32.5	-	-	PAG
Sulphide Ore Composite	937.5		-882	55.7	7.4	0.06	30.0	0.08	0.04	29.9	-	-	PAG

Table 6.4-7: Metal Leaching Analyses of Tailings and Ore Composite Samples

Sample ID	Units	Oxide Tailings	Sulphide Tailings	CCME Guideline (mg/L)
Matrix		Solid	Solid	
Physical Tests				
Hardness (as mg $CaCO_3$/L)	mg $CaCO_3$/L	1,680	263	
% Moisture	%	<0.10	<0.10	
Leachable Anions and Nutrients				
Acidity (as mg $CaCO_3$/L)	mg $CaCO_3$/L	5.8	2.1	
Alkalinity, Total (as mg $CaCO_3$/L)	mg $CaCO_3$/L	99.8	62.2	
Bromide - Br (mg/L)	mg/L	<0.50	<0.050	
Chloride - Cl (mg/L)	mg/L	<5.0	<0.50	
Conductivity (µS/cm)	µS/cm	2450	576	
Fluoride - F	mg/L	0.30	0.069	
Nitrate (as N) (mg/L)	mg/L	0.542	0.0116	2.9
Nitrite (as N) (mg/L)	mg/L	0.017	<0.0010	0.197
pH	pH	7.82	7.99	9
Sulfate (SO_4) (mg/L)	mg/L	1510	174	
Anion	Sum	33.5	4.9	
Cation	Sum	35.2	5.5	
Cation - Anion Balance		2.6	6.1	
Leachable Metals				
Aluminum (Al)-Leachable	mg/L	<0.050	0.0323	0.1
Antimony (Sb)-Leachable	mg/L	0.0056	0.0316	
Arsenic (As)-Leachable	mg/L	**16.6**	**0.904**	0.005
Barium (Ba)-Leachable	mg/L	<0.010	0.0085	
Beryllium (Be)-Leachable	mg/L	<0.0050	<0.00050	
Bismuth (Bi)-Leachable	mg/L	<0.0050	<0.00050	
Boron (B)-Leachable	mg/L	<0.10	<0.010	
Cadmium (Cd)-Leachable	mg/L	<0.00050	<0.000050	0.000017
Calcium (Ca)-Leachable	mg/L	651	88.7	
Chromium (Cr)-Leachable	mg/L	**0.0194**	<0.00050	0.0089
Cobalt (Co)-Leachable	mg/L	0.0091	0.00447	
Copper (Cu)-Leachable	mg/L	**0.069**	0.0036	0.004
Iron (Fe)-Leachable	mg/L	**0.560**	0.247	0.3
Lead (Pb)-Leachable	mg/L	<0.0010	0.00025	0.007
Lithium (Li)-Leachable	mg/L	<0.050	<0.0050	
Magnesium (Mg)-Leachable	mg/L	13.5	10.1	
Manganese (Mn)-Leachable	mg/L	<0.0050	0.0179	
Mercury (Hg)-Leachable	mg/L	0.000360	<0.000050	

Table 6.4-7: Metal Leaching Analyses of Tailings and Ore Composite Samples

Sample ID	Units	Oxide Tailings	Sulphide Tailings	CCME Guideline (mg/L)
Molybdenum (Mo)-Leachable	mg/L	<0.0010	0.00145	
Nickel (Ni)-Leachable	mg/L	<0.0050	<0.00050	0.15
Phosphorus (P)-Leachable	mg/L	<0.30	<0.30	
Potassium (K)-Leachable	mg/L	3.12	1.32	
Selenium (Se)-Leachable	mg/L	<0.0050	<0.00050	0.001
Silicon (Si)-Leachable	mg/L	4.62	1.39	
Silver (Ag)-Leachable	mg/L	**0.00225**	**0.000605**	0.0001
Sodium (Na)-Leachable	mg/L	36.1	4.66	
Strontium (Sr)-Leachable	mg/L	0.297	0.220	
Thallium (Tl)-Leachable	mg/L	<0.0010	<0.00010	0.0008
Tin (Sn)-Leachable	mg/L	<0.0050	<0.00050	
Titanium (Ti)-Leachable	mg/L	<0.010	<0.010	
Uranium (U)-Leachable	mg/L	0.00854	0.00123	0.015
Vanadium (V)-Leachable	mg/L	<0.010	<0.0010	
Zinc (Zn)-Leachable	mg/L	<0.10	<0.010	0.03

Metal concentrations exceeding the CCME ALG are highlighted in **bold**

Tailings and Ore Humidity Cell Results

HCT was conducted for tailings from the two ore rock types, oxide and sulphide. A third Humidity Cell is a composite sample made from unprocessed sulphidic ore materials composited from three massive pyrrhotite core samples (E913813, E915637, and E915633).

The following parameters have been measured on a weekly basis and results graphed in excel to track rates over time:

- Conductivity
- pH
- Acidity (as $CaCO_3$)
- Alkalinity Total (as $CaCO_3$)
- Sulfate (SO_4).

In addition to the parameters listed above, dissolved metals were also tested weekly until week 19 of testing for the composite ore cell, and week 16 of the oxide and sulphide tailings cells. Following the initial weekly testing, dissolved metals were tested every fourth week. Concentration of selected dissolved metals were graphed to identify trends in leaching behaviour, including arsenic, copper, iron, nickel, lead and zinc.

Leachable metal concentrations were compared to the CCME ALG. A comparison of the ABA, ML, and HCT results confirms that stockpiled ore material will likely pose an acid-leaching hazard within a minimum of three years of placement in situ, and also pose a metal leaching hazard for copper and iron which may exceed the respective CCME ALG.

HCT results indicate that the sulphide tailings will not produce acid leachate within the first three years; however ABA testing confirms that the sulphide tailings will likely generate acid at a future date if exposed to air and water. Once acid generating conditions are established, the metal leaching behaviour of the sulphide tailings will be altered, likely generating higher concentrations of dissolved metals.

Oxide tailings are generally acid neutralizing, as indicated by ABA testing and verified with the HCT results.

Oxide tailings may be expected to leach high concentrations of arsenic soon after placement in situ, as soluble arsenic species are washed from the tailings during precipitation events. Over time, the concentration of dissolved arsenic can be expected to decrease.

6.4.4 Mitigation Measures

Waste rocks will be sorted and stored appropriately during operations. Where possible PAG waste rock will be encapsulated within NAG waste rock to limit exposure to oxygen and water. Waste rock dumps with potential to generate ARD or ML will be engineered such that drainage from these dumps will be monitored and/or will report to the TSF.

Liners, diversions and waste rock pads will be used to reduce the amount of potentially contaminated water infiltrating the surrounding environment.

At closure, waste rock dumps will be covered using impermeable dry cover, if necessary runoff will be collected and treated before being discharged. This includes the runoff from the open pit high-walls in the Shamrock zone.

6.5 Technologies

The mining, processing and waste containment methods for the KRP are considered to be conventional and have been proven worldwide as successful. The methods will be adapted to suit the climate and geological setting of the KRP.

Several technologies are proposed for use as part of the overall KRP:

- Mining:
  - Open pit mining
  - Short sub-level open stoping underground mining method
  - Drift and fill underground mining method
- Processing and Refining:
  - Semi-Autogenous Grinding (SAG) milling
  - Cyanide leaching

  - Carbon-in-Leach (CIL) processing
  - Carbon elution
  - Electrowinning
  - Cyanide destruction
- Tailings Storage and Treatment:
  - Filter presses and thickeners for dewatering tailings to become thickened
  - Geosynthetics for use in the water retention dam and tailings embankments
- Water Distribution and Treatment:
  - Heat traced water supply lines
  - Sewage treatment plant
  - Potable water treatment plant
- Other:
  - Enclosed utilidor structures for service lines
  - Solid waste incinerator.

6.5.1 Mining

Open pit mining is the most common type of mining employed worldwide for near surface deposits and was selected by KRH as the primary method for mining the near surface ore bodies, based largely on overall KRP economics. Open pit mining comprises a large excavation with a series of benches and an access ramp allowing ore and waste material to be transported from the excavation to surface. The KRP will use owner-operated trucks and equipment for this type of mining.

Underground mining methods will be used to access resources below some of the open pits, and will be carried out by contractor-operated trucks and equipment. The underground methods proposed include short sub-level stoping and drift and fill mining. These methods were chosen in order to mine more selectively and produce less waste rock.

Short sub-level stoping is an underground mining technique employed on steeply dipping ore bodies. It is similar to regular sub-level stoping only with smaller stope heights. Drifts are driven parallel to the ore body. Drilling into the ore body is upward from the drift with small cross cuts at the base of the blasted stope acting as drawpoints. The open stopes are generally backfilled once all the material has been removed. Operating and capital costs are relatively low compared to other underground mining methods. Long-hole stoping is considered to be a less expensive method, however, unlike sub-level mining it does not allow for as selective of mining of the ore body. Due to the more specialized labour force required for underground mining, this phase will be conducted by contract mining. Figure 6.3-1 presents a typical schematic showing sub-level stoping, a larger version of short sub-level stoping.

Drift and fill is an underground mining technique employed on shallow dipping ore bodies. This method has multiple cut and fill operations adjacent to one another, used for extraction of wide, shallow ore bodies. See Figure 6.3-2 for a typical schematic showing the drift and fill method.

6.5.2 Processing and Refining

The processing method selected for gold recovery from ore is CIL. This processing technology is widely used and is considered to be cost-effective and safe.

6.5.2.1 Primary Crushing

Ore hauled from the open pits and underground mining operations will be broken into smaller size fractions by an outdoor primary vibrating grizzly and jaw crusher. This primary crushing facilitates more effective grinding at later stages in the processing and allows for easier transport of the ore material into the processing facilities on conveyor systems.

6.5.2.2 Semi-Autogenous Grinding Mill

SAG milling is a grinding technique used following crushing as primary grinding to further reduce the size fraction of material that will be sent through the process plant. A SAG mill is a large spinning drum that allows material to break upon itself through autogenous impact and abrasion. Some grinding media, usually steel balls, are used to assist in reducing the particle size of the material.

6.5.2.3 Secondary Grinding

Secondary grinding will be achieved by ball milling. The ball mill is similar to the SAG mill with smaller feeder and output apertures. Material within the ball mill is also finer, and the rock no longer contributes towards breaking itself. The ball mill reduces the rock material to a predetermined optimum grain size for the leaching process.

6.5.2.4 Cyanide Leaching

The leaching process involves the application of chemical solutions to the ore in order to extract the minerals of interest. With respect to gold, the solution is usually a cyanide-based solvent that is added to a tank with finely ground gold bearing ore. The gold dissolves into the solution (termed a “pregnant solution”) and is then extracted from the pregnant solution by additional processing.

6.5.2.5 Carbon-in-Leach Processing

CIL is a method that removes gold from the pregnant solution by introducing carbon particles into the cyanide system. The gold within solution adsorbs onto the carbon, away from the cyanide. The carbon is subjected to elution (described below), whereas the cyanide solvent is removed and subsequently destroyed.

6.5.2.6 Carbon Elution

Carbon elution is the process by which the gold is removed from the carbon into a solution that can be used in electrowinning. The carbon elution process uses a method known as pressurized Zadra stripping. Loaded carbon from the CIL circuit enters the carbon elution circuit where carbon is batched into a loaded

carbon wash column. Trash and slime are removed from the carbon by elutriation with water and the cleaned carbon is acid washed to remove scale buildup (as required). Carbon is then transferred to the pressure elution column where the gold is stripped from the carbon by hot caustic eluate, and transferred to the electrowinning circuit.

6.5.2.7 Electrowinning

Electrowinning is a process that removes highly concentrated gold from solution. A cathode and anode are placed in the gold bearing solution and a low voltage direct current is applied through the solution. Due to their ionic charge, gold ions are reduced and deposited onto the cathode, while water is oxidized at the anode.

6.5.2.8 Cyanide Destruction

The copper catalyzed SO_2/Air removal method will be used to destroy cyanide, with arsenic removal by ferric arsenate precipitation. This method was used during Canamax's operation at the site in 1988. It is anticipated that the cyanide destruction circuit would remove more than 99.5% of the cyanide, with the remaining discharge being deposited into the TSF.

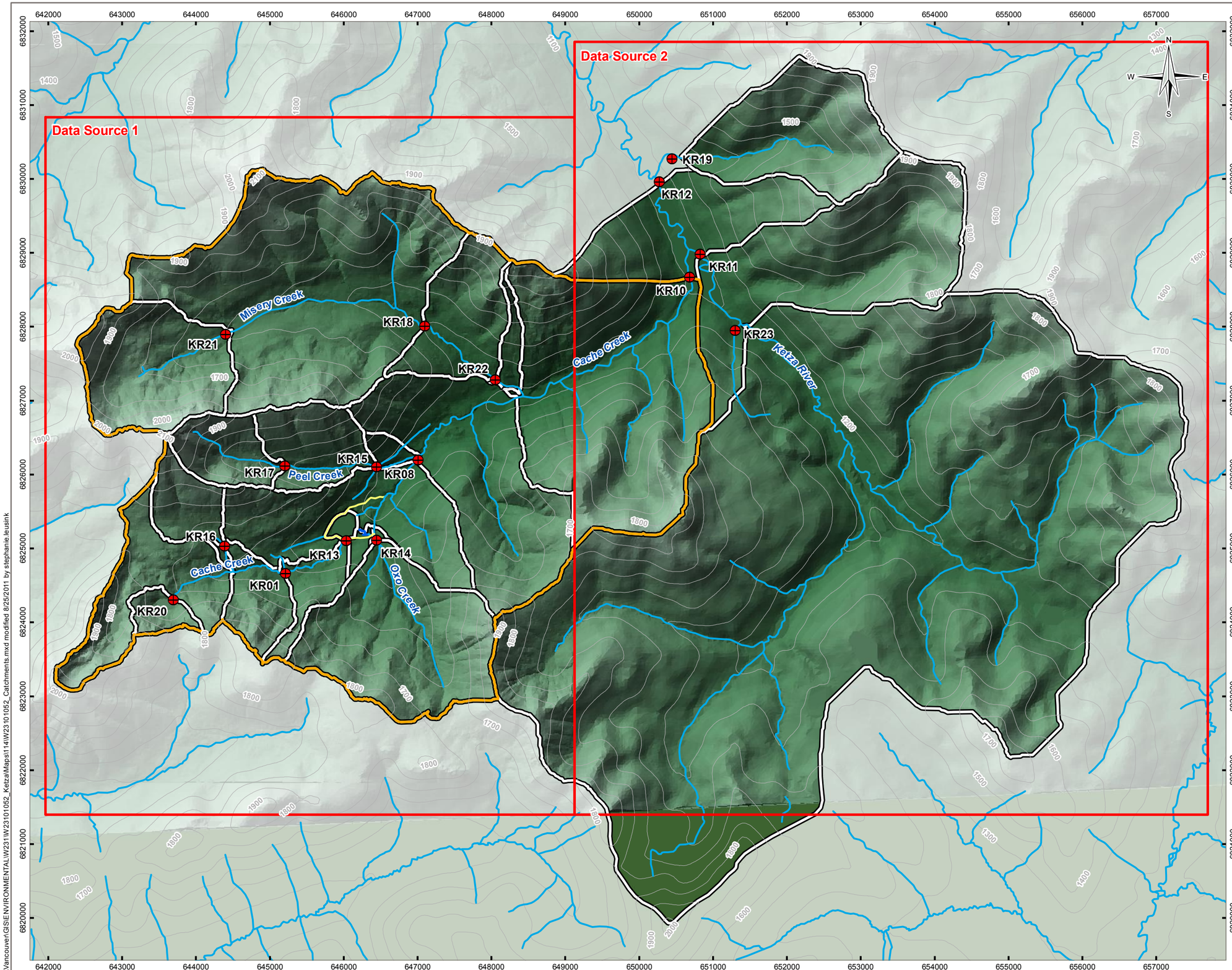
6.5.3 Water Balance

A site water balance was prepared to:

- Optimize water use strategies for various mining activities
- Provide input to the design of engineered structures (e.g., the TSF and water retention dam)
- Establish procedures to limit site discharge and facilitate compliance when discharge is required
- Allow for better site water management, particularly with respect to erosion and flow over exposed surfaces, in ditches, channels, and creeks.

The KRP catchment area is defined by the boundary of the catchment area of Cache Creek to its confluence with the Ketza River. Within this catchment there are three other notable tributaries: Peel Creek; Oxo Creek; and Misery Creek. Several locations within the Cache Creek watershed were used for the collection of water quality samples and occasional instantaneous flow gauging. The creeks, catchments and local gauging stations are shown in Figure 6.5-1.

Mean annual precipitation and monthly precipitation values and distributions were derived from the precipitation data gathered at the KRP climate stations (1986-1995; 2006-2010). There is no continuous, long-term, streamflow data available within the study watershed. Instantaneous field measurements of flows have been gauged by field staff since 1985. In total, 95 flow measurements from 10 locations have been collected across the Site. Average monthly runoff depths were calculated from these field measurements and combined to approximate the average yearly runoff unit hydrograph.



LEGEND

- Monitoring Stations
- Contour (100 m interval)
- Diversion
- Drainage
- Emergency Spillway
- Catchments

NOTES

1. Data Source 1: Surface was derived from 1 m contours.
2. Data Source 2: Surface was derived from NTS 1:50,000 contours.

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Regional Water Catchments Division Plan Map

PROJECTION UTM Zone 8		**DATUM** NAD27		**CLIENT** Ketza River Holdings
Scale: 1:50,000 (500 250 0 500 1,000 Metres)				
FILE NO. W23101052_Catchments.mxd				eba A TETRA TECH COMPANY
PROJECT NO. W23101052.114	**DWN** SL	**CKD** WW	**APVD** WW	**REV** 0
OFFICE EBA-VANC	**DATE** July 26, 2011			**Figure 6.5-1**

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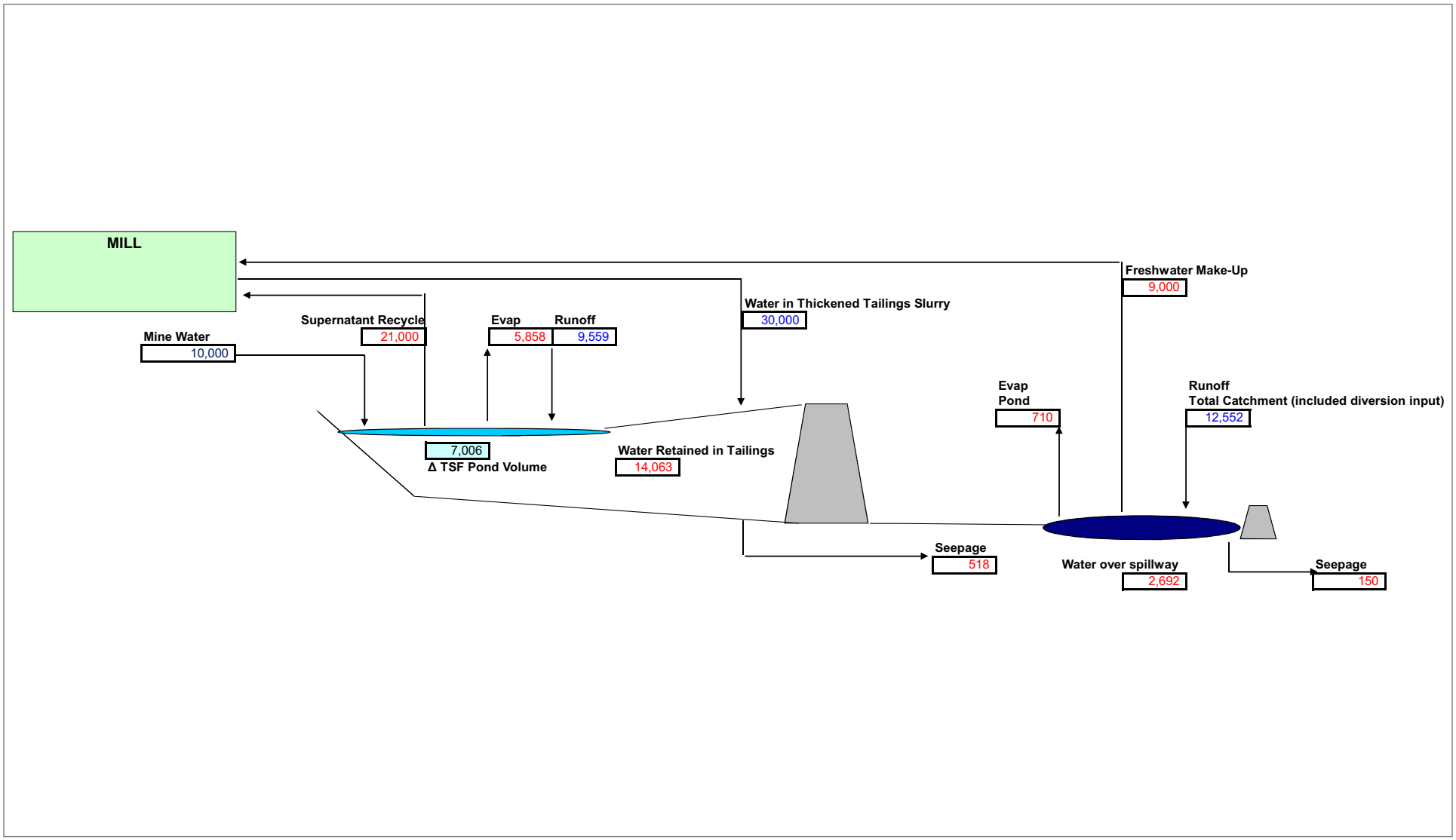
Runoff volumes for the 10 year wet and 10 year dry years were calculated based on the projected precipitation for these events and the average runoff coefficient for the Site. The proportion of runoff was calculated to be 65%, based upon the average runoff depth and the average precipitation depth. This information was used to calculate a hydrologic baseline for the proposed tailings pond catchment listed in Table 6.5-1.

Table 6.5-1: Updated Hydrological Baseline Data for Tailings Pond Catchment

Month	Precipitation (mm)			Runoff (mm)			Lake Evaporation (mm)
	Average	10-Year Wet	10-Year Dry	Average	10-Year Wet	10-Year Dry	Average
Jan	64	73	54	2	3	2	-
Feb	49	57	42	3	3	2	-
Mar	49	57	42	3	3	2	-
Apr	28	32	24	3	3	2	-
May	28	32	24	89	101	76	82
Jun	49	57	42	173	199	148	92
Jul	56	65	48	87	99	74	64
Aug	78	89	66	32	37	27	32
Sep	85	97	72	29	34	25	14
Oct	71	81	60	30	35	26	-
Nov	92	105	78	5	5	4	-
Dec	64	73	54	3	4	3	-
Total	**706**	**808**	**602**	**459**	**525**	**391**	**284**

Water balance calculations for the KRP operations include monthly averaged precipitation, loss to evaporation, as well as seepage loss, requirements for the processing facility, and other operation related uses. The projected annual water balances completed for average precipitation conditions at Ketza indicate that the overall Project area will be operated in a surplus condition (i.e., inflows > outflows). Discharge of pore water from the tailings mass due to consolidation and inefficiencies of the diversion system result in a final supernatant pond volume of approximately 130,000 m^3. This surplus water will need to be discharged either during operations or at closure. Figure 6.5-2 displays the inputs, outputs, and average monthly volume estimates for the site water balance.

The Project infrastructure designs described are preliminary. They are based upon initial water balance calculations and a pre-feasibility level of engineering design. The water balance will need to be updated as more information becomes available and more rigorous analysis and/or modeling performed.



NOTES

1. All flows are in m^3/month
2. All results are for average precipitation conditions.
3. Based on monthly average.
4. Excess storage in the water retention pond will be discharged via the spillway to Cache Creek.
5. Water retention pond maximum volume is 90,000 m^3; excess is spilled.
6. A minimum of 9,000 m^3/month of freshwater is required for mill operations.
7. Red numbers are outputs and blue numbers are inputs.

STATUS
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Ketza River Holdings

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KETZA RIVER PROJECT

Average Monthly Water Balance

PROJECT NO.	DWN	CKD	APVD	REV
V15101019.002	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 6.5-2

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6.5.4 Tailings Storage and Treatment

KRH will use compression thickeners to dewater the mine tailings to a solid to water ratio of 50 to 65% by weight. The thickened tailings will be discharged at the crest of the dam and topographical highpoints along the margins of the facility. By depositing from the dam, the supernatant pond will be pushed away from the embankment towards the western portion of the facility. This will have two positive effects:

1. It will increase the seepage path for any water, thus reducing seepage
2. The recycle system will be located closer to the mill, reducing operating costs and improving efficiency.

The TSF will use a combination of a geosynthetic clay liner on the face of the embankment and along the entire facility base, extensive tailings beaches, and groundwater recovery measures to minimize seepage loss.

Beach development will be managed to maximize storage volume in the TSF and to control the location of the supernatant pond. Consolidation of the tailings will occur continuously during deposition, and will continue after mining, until all excess pore pressures have dissipated. Expulsion of the initial pore fluids during consolidation will result in settlement of the tailings surface and a corresponding increase in the average density.

This design will facilitate long term stable ground conditions for the installation of an impermeable cover material during mine closure. A top cover of material over the low permeability layer will be of sufficient thickness with appropriate drainage control to minimize long-term erosion and materials movement due to weathering and frost action.

6.5.5 Water Distribution and Treatment

Heat tracing of water lines is used throughout northern Canada to prevent freezing. The system is designed in accordance to the type, size, and required insulation of a pipe as well as the anticipated environmental conditions. This technology will be used for the KRP water distribution system.

The sewage treatment plant for the KRP is a containerized rotating biological contactor attached to the existing (installed in 2011) siphon tanks and septic field. This sewage treatment system is successfully employed at many remote sites in Canada. The system is completely insulated and containerized. As well, manufacturer specifications allow for operation to sustained outdoor temperatures as low as -40°C. Similar types of sewage treatment systems are in place and operating successfully at the EKATI and Diavik Diamond Mines in NWT, and at the Minto Copper Mine in Yukon.

Potable water will be withdrawn from a well that was installed in 2011. The potable water treatment plant has been designed to provide potable water which meets Canadian health standards. Water quality testing of the well has been completed following drilling and prior to the installation of the treatment plant. The treatment plant will be located in a building located near the water well. The well building will also contain water storage for firefighting and water storage tanks.

6.5.6 Other

Enclosed insulated utility corridors (utilidors) will be used at the KRP. The process plant and accommodations complex are separated, and utility services are needed 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, NWT, and the EKATI Diamond Mine, NWT.

Solid waste incinerators are common in remote areas of human habitation. Combustible solid wastes will be incinerated on site using the existing incinerator to reduce the need to haul garbage back to a landfill or local community for treatment. Incineration also destroys food waste, which often attracts animals to the site, increasing human to animal interaction. The use of incinerators is common at remote mine sites; for example, they are currently being used successfully at the Minto Copper Mine, EKATI Diamond Mine, and the Diavik Diamond Mine, as well as at the current Ketza exploration camp.

Additionally, waste oil burners may be sourced for use at the KRP to produce heat and reduce the amount of waste oil hauled off-site.

6.6 Project Scheduling and Phases

6.6.1 Project Schedule

The KRP has been divided into six main phases as shown in Figure 6.6-1. The phases include:

1. Permitting and design phase
2. Procurement phase
3. Construction phase
4. Operations phase
5. Decommissioning phase
6. Post-closure monitoring phase.

Each phase is divided into separate components which are individually discussed. A detailed schedule of the KRP and individual components is included in Appendix L1.

The schedule includes the permitting and design phase which is estimated to be completed in approximately two years. This includes the preparation, submission and approval of all related documentation to permit the construction and operation of the mine. The authorizations that KRH understands are required for the KRP are listed in Table 1.5-1.

The estimated completion of the permitting and design phase is the end of the first quarter of 2013 (not considering the time required to complete information requests, if any).

The procurement phase will begin during the permitting and design phase. Procurement of crushing and grinding mills will be initiated first and processing and mining equipment procurement afterward.

The construction phase is scheduled to begin following contract tendering and once appropriate professional contractors have been hired. A pre-construction phase could begin shortly after obtaining

Part 1 of the Quartz Mining License, which could be as early as March 2013. The remaining construction activities would occur following the completion of the permitting and design phase, including obtaining Part 2 of the Quartz Mining License. The full construction phase is estimated to be complete by fall 2014. Construction of the TSF should be completed at least six months prior to production in order for it to charge with sufficient operating water.

Commencement of the operations phase (mining) is contingent upon the successful completion of the permitting, procurement, and construction phases. Based on the estimated timeline to complete these phases, mining and general operations of the KRP are scheduled to commence during fall 2014.

The current mine life is proposed to be 5 years. Progressive reclamation will begin in early 2015 and will continue until the end of the mine life. Full decommissioning will begin in 2019 and is scheduled to be completed by 2022. Post-closure monitoring activities will follow the decommissioning of the mine. The duration of the monitoring activities will be determined upon assessment of the mine closure. It is anticipated that they will continue for a minimum of 3 years.

6.6.2 Construction Phase

The construction phase of the KRP could commence in the second quarter of 2013 (pre-construction) and will be completed by fall 2014. Proposed timelines of construction activities are shown in the preliminary KRP schedule (Figure 6.6-1).

6.6.2.1 Road Infrastructure

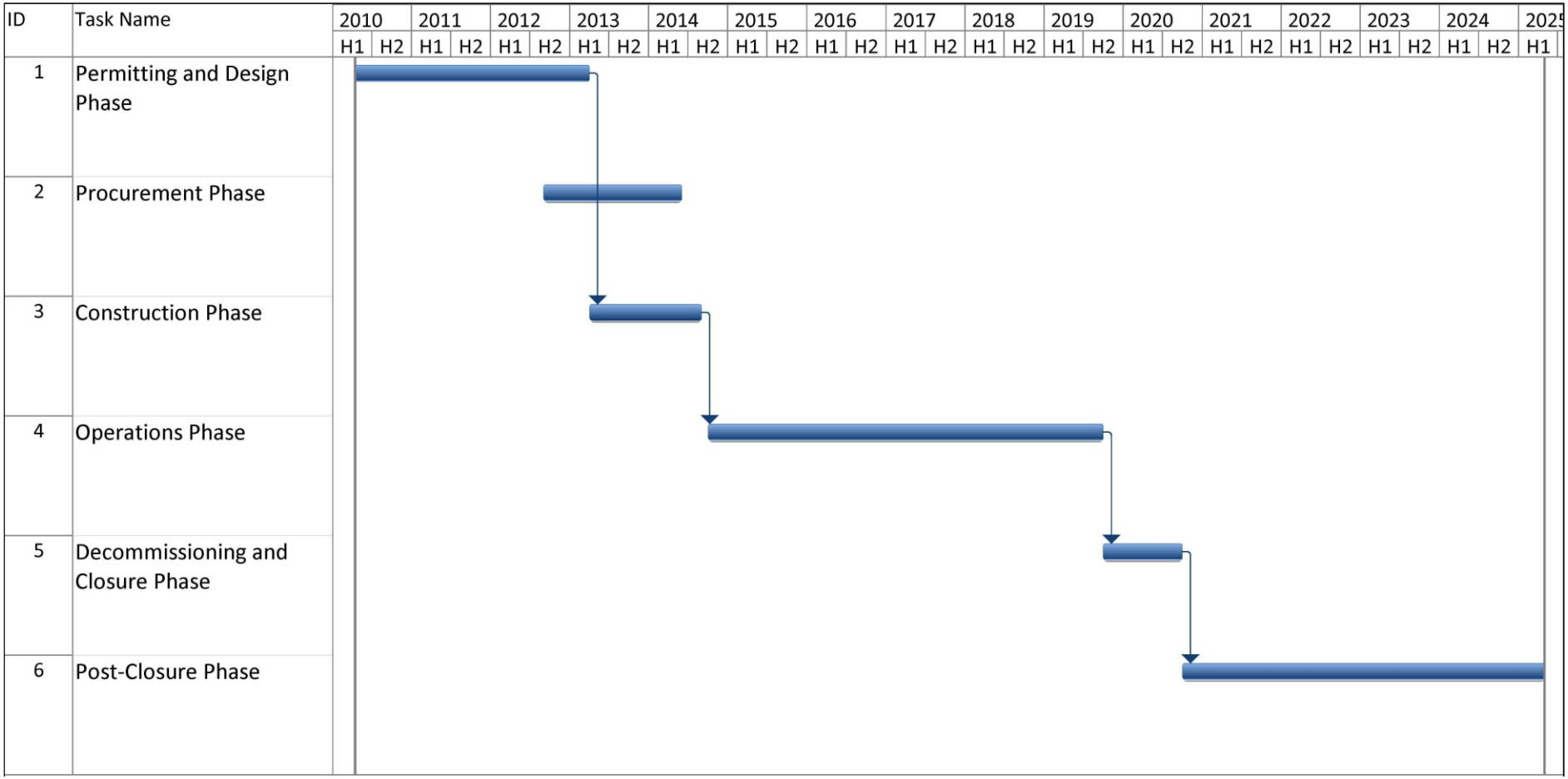
Ketza Road

The KRP is currently accessed along the Ketza Road, a 40 km gravel road from the Robert Campbell Highway at approximately Km 323. This road was originally developed to service the Canamax Mine between 1988 and 1990. The road is currently owned by the Yukon government but is unmaintained. A Land Use Permit (YA5F233) was issued to KRH from 2005 to 2008 to allow for road maintenance activities. Another application is currently being assessed by YESAB that will allow KRH to undertake care and maintenance of the Ketza Road.

Service and Haul Roads

A network of service and haul roads currently exists at the Site. These roads facilitated the mining activities conducted by Canamax between 1988 and 1990. Currently, exploration roads service many of the pit areas and the process plant. Future development of the mine will require the upgrade of these roads to allow for the movement of haul trucks around the site. Most roads will be upgraded to be approximately 27 m wide (ditch to cut) to accommodate two-way traffic. Some roads in steeper topography will be 15 m wide and single lane. Construction of additional haul roads will also be required. Figure 6.6-2 shows the existing and likely future road development at the site.

Service roads to the administration buildings, storage facilities, historic tailings impoundment, and accommodations already exist on site. Additional roads will be constructed to service the proposed TSF. Resurfacing of these roads will be required and will make use of locally sourced NAG material where possible.



NOTES

This schedule is approximate, projected from the date of this report, and is subject to change.

STATUS

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CLIENT

Ketza River Holdings

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KETZA RIVER PROJECT

Preliminary Project Schedule

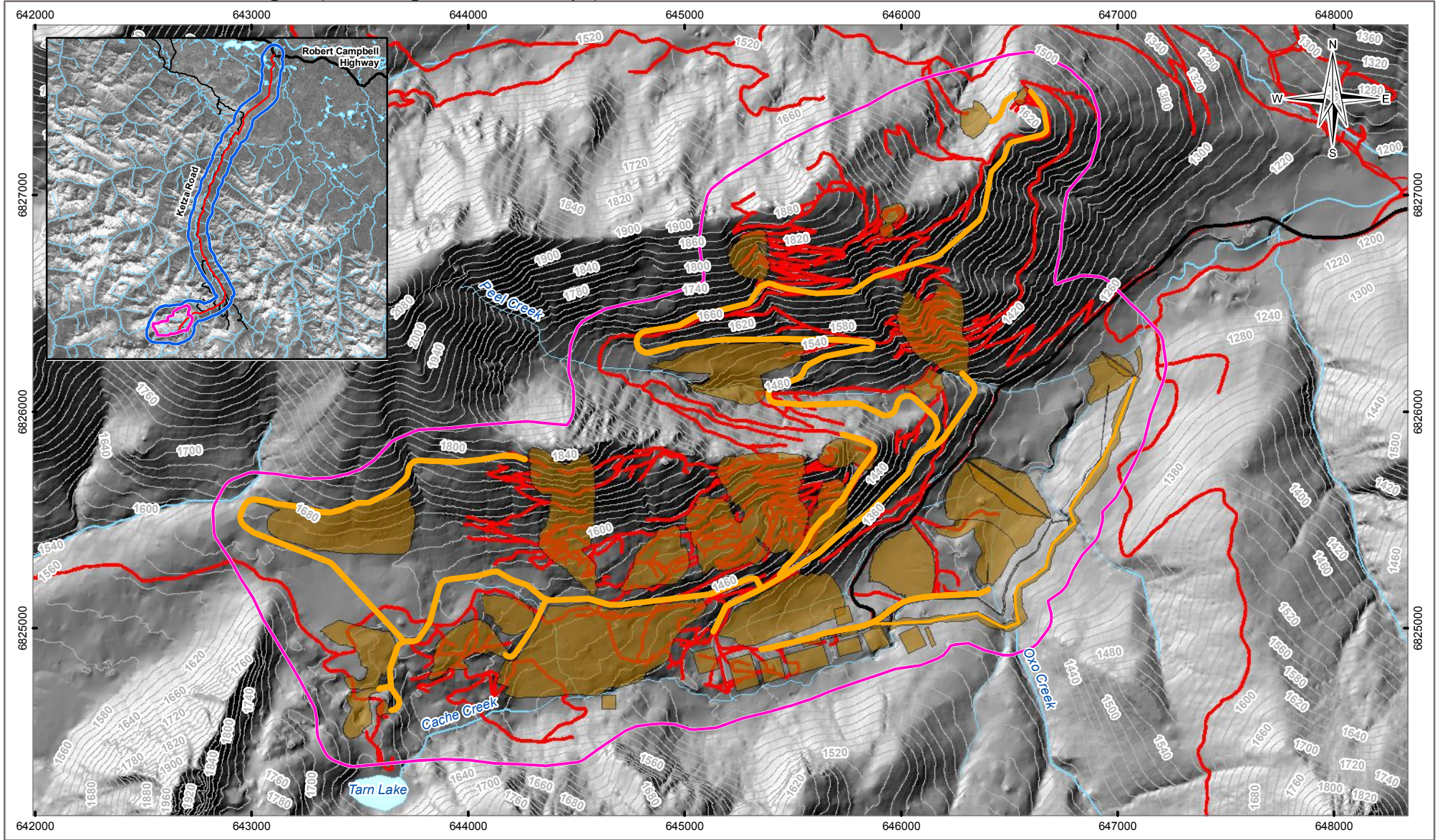
PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 6.6-1

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LEGEND

- Project Footprint
- Infrastructure Footprint[3]
- Ketza Road
- Proposed Haul Roads
- 2006 Existing Roads
- Contour (20 m)
- Watercourse
- Waterbody

Scale: 1:25,000

500 250 0 500

Meters

PROJECTION UTM Zone 8

DATUM NAD27

FILE NO. W23101052_Roads.mxd

CLIENT Ketza River Holdings

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KETZA RIVER PROJECT

Existing and Future Road Development

PROJECT NO.	DWN	CKD	APVD	REV
V15101019.002	SL	JN	TP	0

OFFICE EBA-VANC

DATE July 26, 2011

Figure 6.6-2

NOTES
1. Base data source: 1:50,000 NTS
2. Imagery and contours provided by Aero Geometrics, Ltd
3. For detailed infrastructure footprint, see Figure 6.2-1

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The construction of haul roads in steeper topography will use a typical cut and fill method, a cross-section of which is shown in Figure 6.6-3. Haul roads from the Peel, Break, Lab-Hoodoo, Penguin, and Tarn open pits to the process plant will be wide enough to allow for one-way traffic of Cat 777 haul trucks. Haul roads from the 3m, QB and Gully open pits will be wide enough to allow for one-way traffic of Cat 740 haul trucks. Pullout areas will be constructed to allow for oncoming traffic to pass. Berms will be sized according to applicable industry standards.

6.6.2.2 Site Buildings

Water Intake Infrastructure

A new potable water supply well was installed in 2011 and is located west of the process plant on the north side of Cache Creek to supply potable water to the camp. An estimated maximum of 60,000 litres of water per day is required. Water will be pumped from the well to an existing water treatment facility and existing fresh water storage tanks within a well building. A small amount of fresh water (approximately 5 m^3/day) will also be pumped to the process plant and workshop. Raised benches alongside the service road for the water retention pond will support the insulated pipes. A water retention dam will be constructed along Cache Creek, downstream from the TSF, to store fresh water for processing.

Pumphouse

The pumphouse will allow for water to be pumped from the water retention pond and the TSF to the process plant. The pumphouse will be constructed on a small pad. A second pumphouse will be built adjacent to the potable water well. The structures will be approximately 10 m by 10 m in size.

Fire Suppression and Compression House

Fire suppression and compression equipment are currently located in the well building, which will be upgraded to service the KRP. Water will be pressurized and will be piped to the accommodations complex, the process plant, the maintenance facility, the warehouse, the met / assay lab, the crusher, and the powerhouse in case of fire.

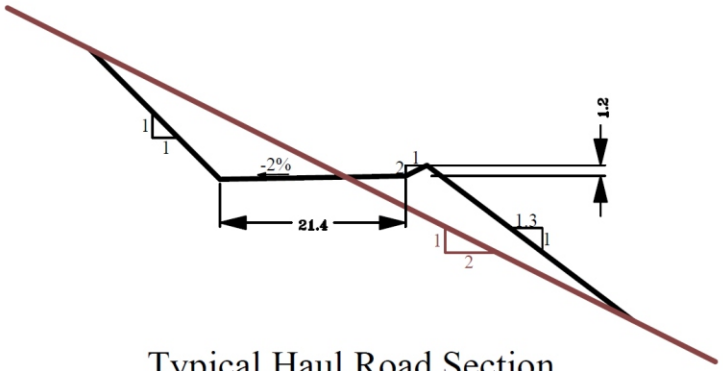
Water Treatment Facility

The water treatment facility is housed within the current well building. It is not expected that there will be additional construction considerations for the water treatment facility.

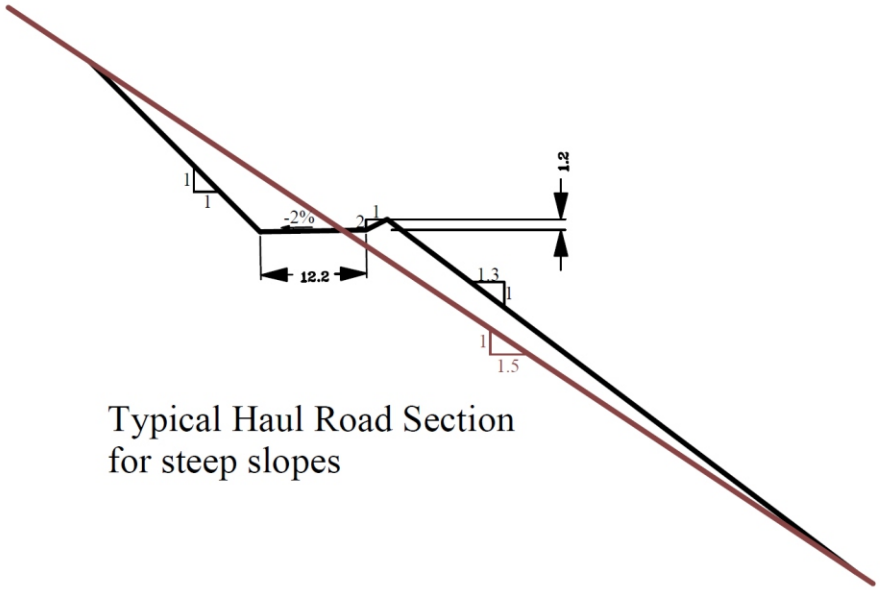
Infrastructure Pads

KRH will construct a series of infrastructure pads in the southern portion of the site footprint where infrastructure currently exists (as shown in Figure 6.2-1). The infrastructure pads will provide level areas for new infrastructure construction.

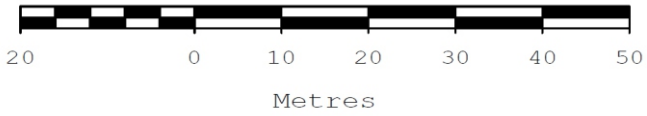
Construction of the infrastructure pads will involve clearing the overburden soil and blasting the bedrock to below the desired pad elevation where required. Infrastructure foundations will be cast directly onto the bedrock surface prior to the placement of the levelling fill. Broken blast rock fill will be placed, levelled and compacted to the design elevation.



Typical Haul Road Section
for medium slopes



Typical Haul Road Section
for steep slopes



NOTES
Produced by Practical Mining LLC.

STATUS
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KETZA RIVER PROJECT

Typical Haul Road Cross Section

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 6.6-3

Q:\Vancouver\Graphics\ENVIRONMENTAL\W2311\W23101052_Ketza\W23101052_HaulRdSection.cdr

Mine Site Accommodations Complex

The current accommodation complex was upgraded in the summer of 2011 and involved the installation of a 49-person modular complex, including a bunkhouse and kitchen. The 49-person accommodation complex will be expandable for use during the construction, operations, and decommissioning phases of the mine. The complex will be expanded to accommodate up to 200 people during peak construction. During the operations 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 first aid / nursing station, a potable water treatment facility and distribution system, and a recreation complex (complete with recreation and gym facilities).

The current diesel generator will power the camp until the main generators and power distribution systems are online. Fresh water will be supplied from the water supply well. Heat for the accommodations complex will be generated using propane furnaces and will be augmented by heat recovered from the power generation and waste incineration facilities.

The accommodations complex modules will be installed on the existing infrastructure pads as described above. The modules will be connected together in accordance with the manufacturer's recommendations and specifications. The sewage treatment plant for the KRP is a containerized rotating biological contactor attached to the existing (installed in 2011) siphon tanks and septic field. The potable water, sewage treatment, and power systems will be upgraded to accommodate the 200-person camp. Solid waste will be incinerated in a propane fired solid waste incinerator. The first aid and nursing station will be located within the accommodations complex.

The majority of the proposed camp footprint area is already cleared of trees and brush, and does not require levelling. The current plant area promotes drainage off the infrastructure pad into the surrounding areas.

Equipment Maintenance Facility

A steel building will house a workshop which will consist of two 15 m x 20 m bays capable of servicing a CAT 777 dump truck. The workshop will require power, potable, and non-potable water, the latter of which will likely be sourced from the water retention pond.

Warehouse

The warehouse will be located east of the process plant. The warehouse will maintain an inventory of most supplies required for the operations at the Site including spare parts, consumables and truck tires and will be used for mobile equipment maintenance. A staging area will be located across the road from the warehouse and will also provide storage.

Administration Building

The administration building will house the technical offices, excluding metallurgy, and on-site administrative offices. The building will be one level and will be located north of the warehouse. This building will be constructed on the existing infrastructure pad that currently supports the camp.

The building will be sufficient to house 30 staff members during operations, including geologists, mine engineers, controllers, surveyors, and administrative staff.

Crusher

The primary crusher on-site will be a jaw crusher. This crusher will be located to the west of the process plant and to the east of the ROM stockpile. No secondary or tertiary crushing will be required as there will be a SAG mill within the process plant.

Process Plant

The process plant will consist of the secondary crushing and CIL processing facilities in addition to housing storage and office space for metallurgy and plant personnel. The existing processing building on-site will retain its current dimensions of 75 m x 25 m and will house most of the CIL processing equipment. An addition to the west side of the building will increase the overall operational footprint. The addition will house the secondary grinding infrastructure. Cyanide leach tanks and thickeners will be located just outside of the primary building. The mill and will be designed to process 1,500 tpd run of mine ore.

The foundations for heavy or vibratory (major) grinding equipment will be cast 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 placed on the existing foundation. The current infrastructure pad will be sufficient to provide the foundation for the additional SAG mill and secondary grinding infrastructure.

Once the new process building is in place, the floor slab will be poured and the mill components will be installed on this poured foundation. Once the floor slab is complete, installation of mechanical and electrical connections for the major and minor equipment will commence. Installation of the ancillary equipment (stairs, catwalks, walkways, railings, etc.) will occur throughout the construction of the process plant. The layout of the process plant including fuel tanks is shown in Figure 6.6-4.

Explosives Storage

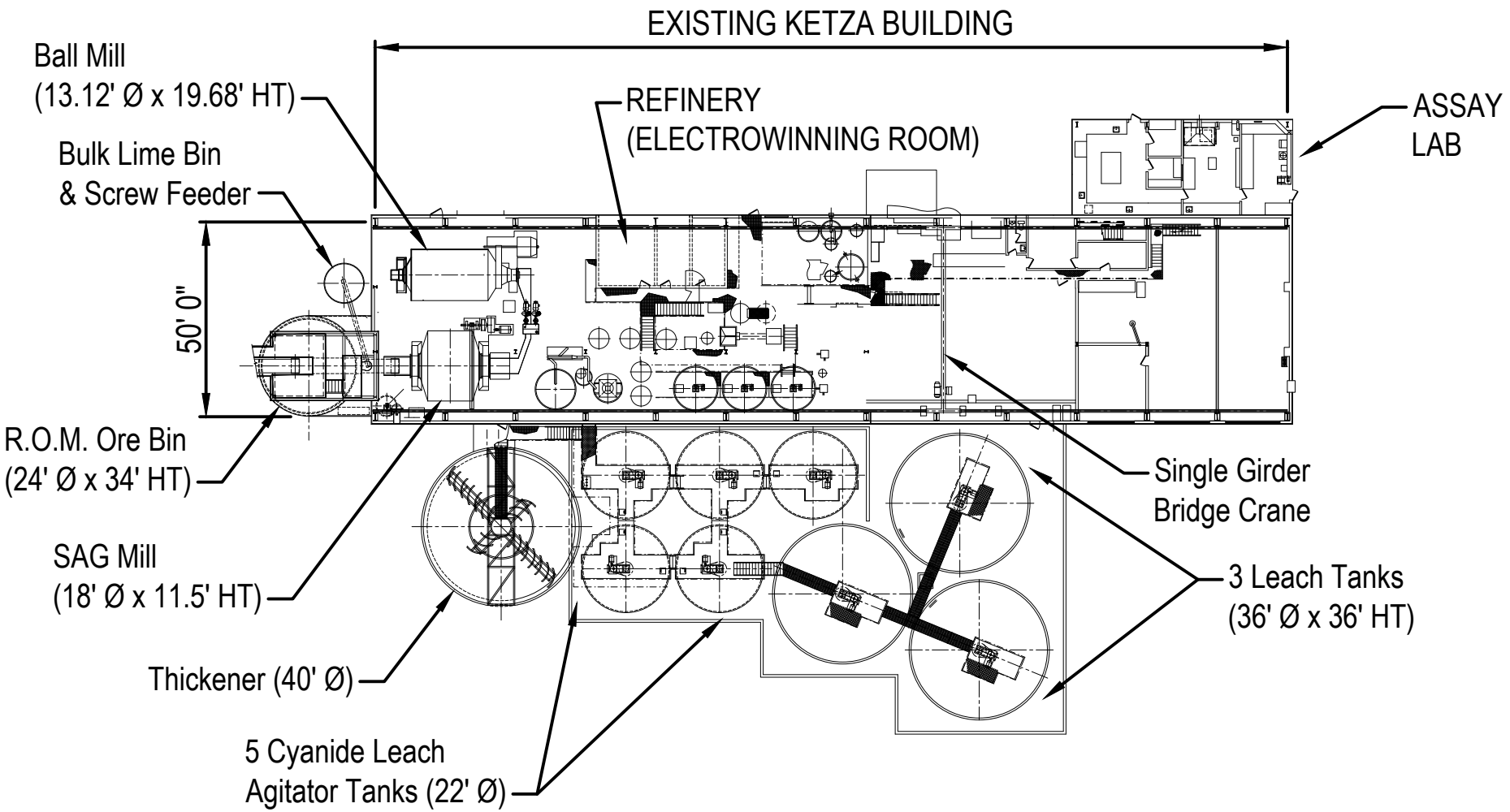
The explosives and caps magazine will be located in an area approximately 500 m west of, and away from, infrastructure to meet Land Use Permit, Quartz Mining Licence, and *Explosives Act* requirements. Explosives and caps will be stored in separate buildings, with only one access to the facility. The area will be surrounded by a chain link fence and will be kept locked.

Metallurgical Lab and Assay Lab

The metallurgical lab and assay lab will be included in the process plant building. The lab will have appropriate ventilation and fire suppressant systems installed. All Material Safety Data Sheets (MSDS) for chemicals used around the site will be stored within the assay lab.

Chemical Storage

A secure chemical storage area will be located adjacent to the assay lab, within the process plant. This facility will be locked and only authorized personnel will have access. Appropriate procedures will be in place for moving and storing hazardous chemicals.



NOTES
Source: Laurion Consulting Inc.
Ketza River Plant Layout: 1,500 tonne/day
Drawing No. KET-GA6B-R14_(3).dwg

SCALE 1" = 40'
10' 0' 10' 25' 50'

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KETZA RIVER PROJECT

Typical Process Plant Layout

PROJECT NO.	DWN	CKD	REV
W23101052.114	JAB	TP	1

OFFICE	DATE
VANC	September 6, 2011

Figure 6.6-4

Powerhouse

Foundations for the diesel generators needed during construction and operations will be cast directly onto bedrock with fill placed around them to level the pad to the design elevation. The building and its heat recovery systems will be founded on compacted fill as described in the infrastructure pads and site roads section. The powerhouse location is shown in Figure 6.2-1.

Following construction of the building shell, the floor slabs will be poured and equipment will be installed in the powerhouse and then completion of the insulation of interior walls, electrical and mechanical systems, and interior finishing will be completed.

6.6.2.3 Staging Area

A staging area will be constructed east of the camp (Figure 6.2-1). An alternative staging area will be located across the road from the administration building. Construction of the staging area will be limited to the removal of vegetation cover in the area, levelling the ground surface by balanced cut and fill methods (i.e., the amount of material cut will be equal to the amount of fill required to create a level pad), and placing gravel surfacing to allow access by equipment and promote drainage.

The staging area will be used to accommodate construction material storage that is transported from the various vendors to the mine site. This will facilitate a single transfer point to supply materials to the mine site.

6.6.2.4 Borrow Sites

NAG material for use in construction of infrastructure pads, cut and fill, road maintenance, and rock armouring will be sourced locally. Pre-production materials removed from the open pits and early NAG waste rock generated from the Peel, Tarn, and Penguin pits will provide some materials during construction. Additional materials will be extracted from a limestone quarry that exists at the Site within the footprint of the Peel pit (Figure 6.2-1).

Organics have already been stripped from the area. Quarry sideslopes will be designed to maintain geotechnical stability prior to mining of the Peel pit. Any necessary tree removal will be conducted in accordance with the Quartz Mining Licence. Additional NAG limestone will need to be sourced throughout mine operations for construction and closure activities.

6.6.2.5 Open Pit Mining Pre-Production

Pre-stripping of overburden and waste material will be required for all open pits. Material which is classified as NAG will be crushed and used in construction of the foundations of various infrastructure pads and as fill for some of the pit access roads. The Peel, Tarn, and Penguin open pits will be the first to be mined. These pits lie within the Manto Zone, which is partially composed of unmineralized limestone that has been characterized as NAG rock material. It is anticipated that NAG rock from pre-stripping of these pits will be used in early site construction. Unused NAG and organic pre-strip material will be extracted and stockpiled to the west of the main infrastructure area for future application. PAG pre-strip material will be transported to the Peel Dump 3 waste dump for disposal (Figure 6.2-1).

6.6.2.6 Underground Mining Pre-Production

Ramp Access

The underground mine design for Peel and Lab-Hoodoo has ramp access from near the bottom of each respective pit. The declines will be driven at a grade of -12.5%. The cross-sectional area will be 4 m high by 3.5 m wide to provide sufficient width and height for equipment and for fresh air intake. Development will be mechanized using a single-boom jumbo. Walls and backs will be drilled with typical 0.8 m spacing and loaded with light Amonium Nitrate Fuel Oil (ANFO) to reduce blast damage and increase geotechnical performance. Material will be removed using load-haul-dump vehicles (LHD). Temporary electric pumps will be used to dewater the development face.

Ventilation

A temporary ventilation system will be installed at the commencement of development for underground operations. Ventilation will be provided by fans conveying fresh air to development headings through flexible ducting, forcing the return air to flow up the decline and out the adit opening. The permanent ventilation systems will be constructed during development of the declines and ramps and will include ventilation raises.

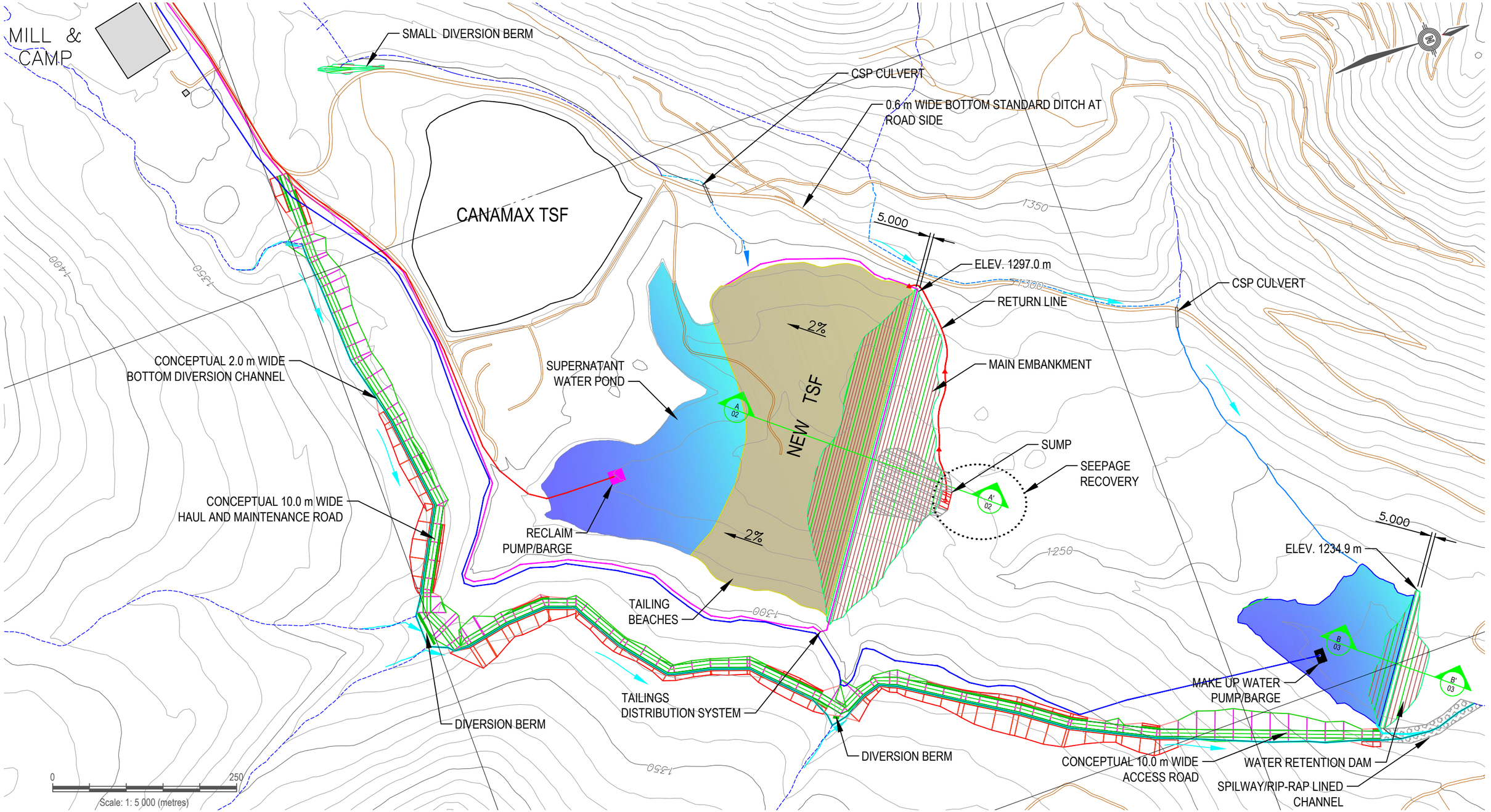
The ventilation plan during mining will include the installation of a stand-alone mine axial fan with a secondary backup fan at the portal of each ventilation raise. The stand-alone mine axial fan will be installed on concrete foundations near the ventilation raise portals. The foundation area will be stripped and a concrete foundation will be poured on bedrock. The fan and ducting will connect to the ventilation raise. If necessary, a refrigeration unit will also be installed to cool the air during summer before forcing it into the decline, to preserve any permafrost.

6.6.2.7 Tailings Storage Facility

The Ketza TSF is to store approximately 3 million tonnes of thickened tailings and associated process water from the mining operations under the current mine plan. The Ketza mill is scheduled to process 1,500 tonnes of ore daily for 5 years. The TSF will be located in the Cache Creek catchment area east (down-gradient) of the mill site (Figure 6.2-1). The site is suitable for a 3 Mt facility with the potential to expand to 4.5 Mt if required. The TSF plan and layout is presented in Figure 6.6-5. A longitudinal section through the proposed TSF is shown in Figure 6.6-6. Features of the TSF include:

- One main embankment
- A full geosynthetic clay liner (GCL) along the base of the facility and up the face of the embankment
- Seepage collection ditches, ponds, pump-stations and pipelines
- Tailings distribution systems for thickened tailings
- Reclaim water floating pump-station and return pipeline system
- Surface water diversion channels
- Tailings beaches
- Supernatant water pond
- Seepage recovery and monitoring wells, including recovery pumps and pipelines.

Q:\Kelowna\Drafting\W231\W23101052\114\W23101052.114_FIGURE 6.6-5.dwg [FIGURE 6.6-5] September 06, 2011 - 2:10:10 pm (BY: BOKIC, JON)



LEGEND

- FRESH WATER DIVERSION CHANNEL/DITCH
- RECLAIMED WATER RETURN LINE
- TAILINGS LINE
- MAKE UP WATER LINE
- APPROXIMATE FLOW DIRECTION
- ANTICIPATED CUT
- ANTICIPATED FILL
- SECTION LINES
- WATERCOURSE/DIVERSION
- EXISTING ROADS

LOCATION	STRUCTURE VOLUME	IMPOUNDMENT VOLUME
DYKE 1	649,292 m^3	2,054,324 m^3
WATER DAM	33,636 m^3	85,021 m^3

NOTES
-HORIZONTAL DATUM IS UTM NAD27 ZONE 8, ALL DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
-DYKE UPSTREAM SLOPE 2:1, DOWN STREAM SLOPE 2.5:1. DYKE IMPOUNDMENT IS AT 2° SLOPE.
-DAM SLOPES ARE 3:1. DAM IMPOUNDMENT IS FLAT.

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KETZA RIVER PROJECT

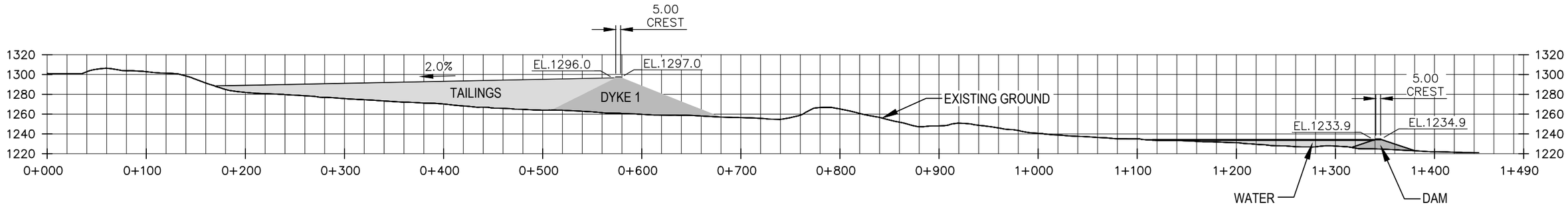
Tailings Storage Facility Plan

eba A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
W2310105.114	RH	SL	0

OFFICE: EBA-Kelowna
DATE: September 6, 2011

Figure 6.6-5



LEGEND

0 200

Scale: 1: 4 000 (metres)

NOTES

-HORIZONTAL DATUM IS UTM NAD27 ZONE 8, ALL DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
-DYKE UPSTREAM SLOPE 2:1, DOWN STREAM SLOPE 2.5:1. DYKE IMPOUNDMENT IS AT 2° SLOPE.
-DAM SLOPES ARE 3:1. DAM IMPOUNDMENT IS FLAT.
-VOLUMES BASED ON AVERAGE 1.6 t/m³ DENSITY

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KETZA RIVER PROJECT

Tailings Storage Facility Section A-A', B-B'

PROJECT NO.	DWN	CKD	REV
W23101052.114	RH	SL	0

OFFICE	DATE
EBA-Kelowna	July 26, 2011

Figure 6.6-6

The objectives of the TSF are to manage the tailings produced by the KRP in a safe, stable, and economic manner that complies with regulatory requirements and commitments to stakeholders. The preliminary design of the TSF has taken into account the following considerations:

- Permanent and secure confinement of solid waste materials within an engineered disposal facility
- Control, collection, and removal of free draining liquids from the tailings during operations, for recycling as process water
- Partial diversion around the TSF, of surface runoff from up-stream
- The placement of a GCL throughout the TSF to minimize seepage from the facility
- The inclusion of a monitoring program to achieve set performance goals and to meet design criteria.

Even though the TSF will be constructed in an area underlain by relatively impervious glacial deposits, fully lining the TSF provides a level of redundancy to the seepage control measures, which will minimize the potential for seepage and any potential related effects on the environment. The proposed geosynthetic clay liner (GCL) is a composite liner that combines geotextile outer layers with a core of low-permeability sodium bentonite clay. Bentonite is a natural sealant which hydrates on contact with water. When used as part of a GCL, bentonite can provide approximately the same hydraulic protection as one metre of compacted clay. GCLs are very effective hydraulic barriers even under high gradient conditions. GCLs are used extensively in higher risk facilities, such as landfills, and have been utilized in other northern mining applications.

Initial construction of the TSF will begin with the starter embankment using materials from stripping and borrow sources. The main dam will be raised using the downstream method, in an on-going manner throughout the mine life. This offers a number of advantages including:

- The ability to continue placement of the GCL up the face of the embankment in a seamless manner
- The ability to reduce capital costs and defer some capital expenditures until after the mine is operating
- Better co-ordination with the mine plan for use of the NAG waste rock for embankment construction
- The ability to refine design and construction methods as required
- The ability to remain flexible with design and incorporate new and emerging technologies and environmental practices
- To allow for an Observational approach to be utilized in the ongoing design, construction and operation of the impoundments.

The Observational approach is a continuous, managed, integrated, process of design, construction control, monitoring, and review that enables previously defined modifications to be incorporated during or after construction, as appropriate. All of these aspects have to be demonstrably robust. The objective is to achieve greater overall economy without compromising safety. Use of the Observational approach enhances knowledge and understanding of site-specific conditions. For the method to be applicable, the character of the project must be such that it can be altered during construction.

The phased construction of the TSF will be scheduled to allow for sufficient storage volume and to avoid overtopping and the need for interim spillways on the embankment crest. The embankment design provides sufficient freeboard to accommodate the probable maximum flood (PMF), combined with wave

run-up. A typical section of the tailings embankment is shown in Figure 6.6-7. The construction of the TSF will be staged over four years with successive raises as shown in Figure 6.6-8.

The glacial till and soils in the TSF area will form a competent, non-liquefiable foundation for the embankment. The starter embankment foundation will require clearing, stripping, contouring, and compaction in preparation for fill and GCL placement. An average topsoil stripping depth of 0.5 m has been assumed within the embankment footprint.

Construction of the starter embankment will begin approximately 6 months before mill start-up and will take approximately 3 months to construct. The base of the TSF will require grading to facilitate the placement of the GCL and to allow it to tie in with the GCL on the embankment face. GCL placement can only occur during late spring, summer and early fall, so the construction schedule will require some optimization during future design phases to cooridnate base preparation with GCL installation (base preparation needs to be complete prior to GCL installation).

Approximately 16,000 m^3 of water will be impounded, likely from diverted drainage, prior to mill start-up, and will be available for mill commissioning and early operations. Mill process water for ongoing operations will be reclaimed from the TSF and supplemented with water from the water retention pond.

6.6.2.8 Water Storage

Water will be stored within an engineered water retention pond downstream of the TSF as part of the overall site water management plan and as a means of reducing potential effects to the downstream environment. Water from this facility will provide fresh water to the mill as well as for fire protection.

Construction of the water retention dam will be in much the same manner as the TSF starter embankment, however, a permanent spillway will be incorporated to allow excess, clean water to flow into the Cache Creek channel, as required. The dam will have a low-permeability internal core and associated filter zones to provide long-term stability. Construction will occur concurrently with the TSF starter embankment so sufficient water is available at start-up.

Glacial till, glacial drift, and residual soils will make up the primary foundation for the water retention dam. Alluvial deposits that may present geotechnical constraints to development will be addressed accordingly (as required) during detailed design.

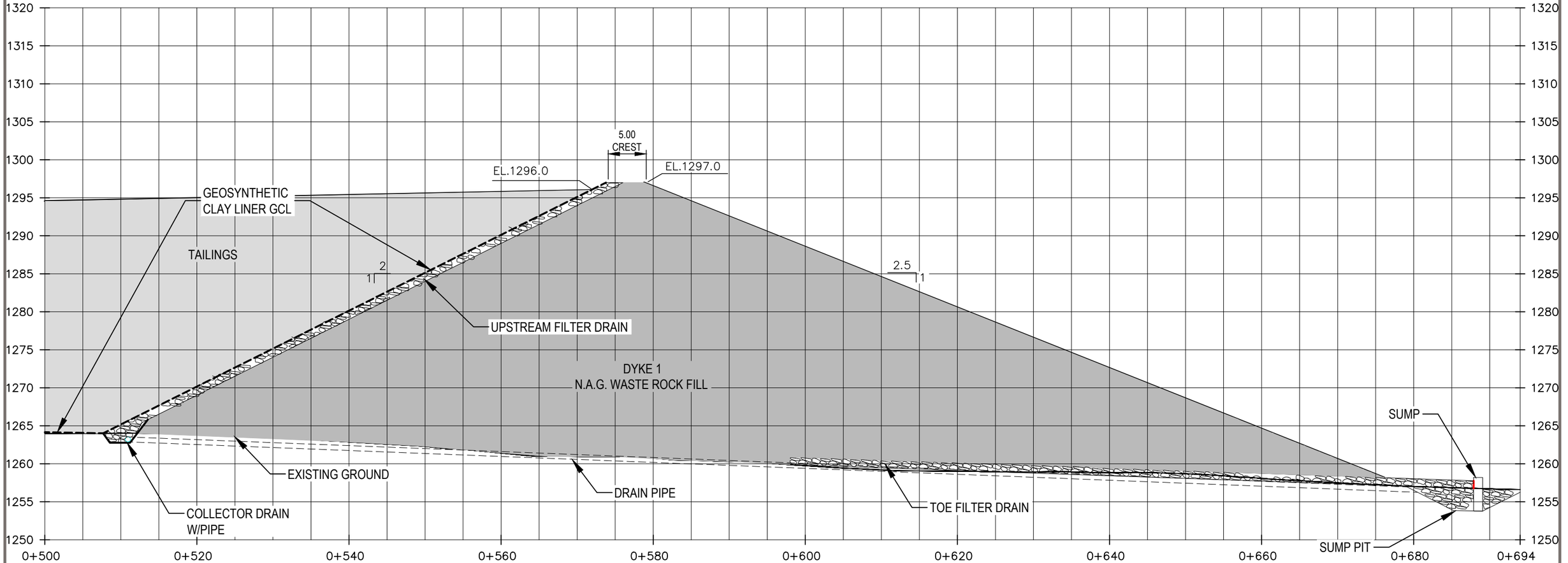
The water retention dam will be constructed to its final height at start-up and is not anticipated to require expansion during operations. The water dam will use approximately 30,000 m^3 of mine waste and/or local borrow material in its construction. A cross-section of the water retention dam is shown in Figure 6.6-9.

6.6.2.9 Water Diversion Structures

Water diversion structures will divert fresh water from Cache Creek, its tributaries (primarily Oxo Creek) and general surface runoff around the TSF into the water retention pond. This has four main benefits:

- Minimizes the potential volume of impacted water impounded behind the tailings dyke
- Maximizes the potential supply of clean water which is required for mill use
- Allows greater flexibility for tailings and water management
- Reduces the risk of overtopping, piping or instability related to high water levels within the TSF.

Q:\Kelowna\Drafting\W231\W23101052\114\W23101052.114_FIG 6.6-6,7,9_R0.dwg [FIGURE 6.6-7] September 08, 2011 - 10:43:26 am (BY: BOKIC, JON)



SECTION A-A'

LEGEND

- GEOSYNTHETIC CLAY LINER
- UPSTREAM FILTER DRAIN

0 10

Scale: 1: 250 (metres)

NOTES
-HORIZONTAL DATUM IS UTM NAD27 ZONE 8, ALL DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
-DYKE 1 SLOPES UPSTREAM 2:1 DOWN STREAM SLOPES ARE 3:1, DYKE IMPOUNDMENT IS2%.
-VOLUMES BASED ON AVERAGE 1.6 t/m³ DENSITY.

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Ketza River Holdings

KETZA RIVER PROJECT

TAILINGS EMBANKMENT CROSS-SECTION A-A'

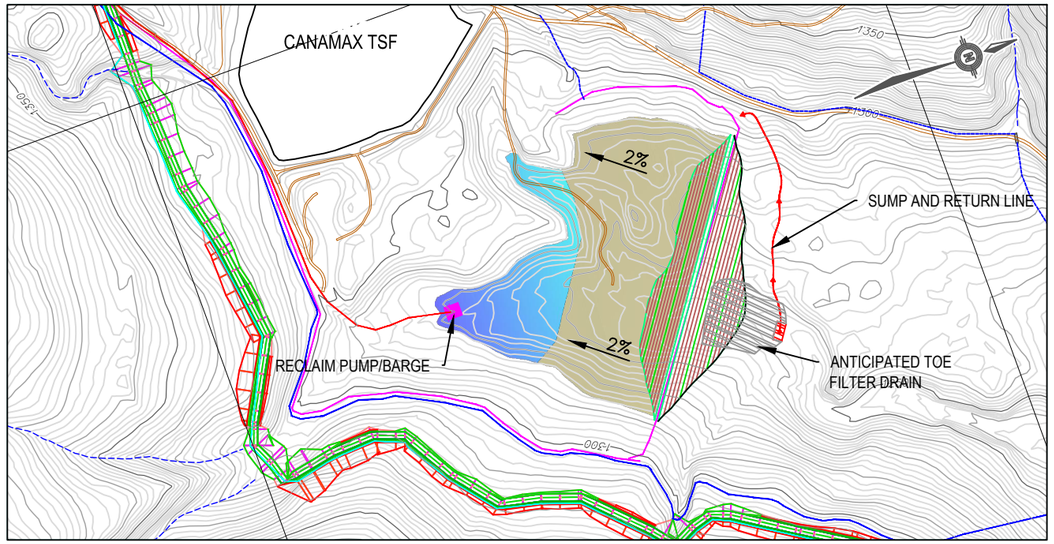
PROJECT NO.	DWN	CKD	REV
W23101052.114	RH	LS	0

OFFICE: EBA-Vancouver
DATE: September 8, 2011

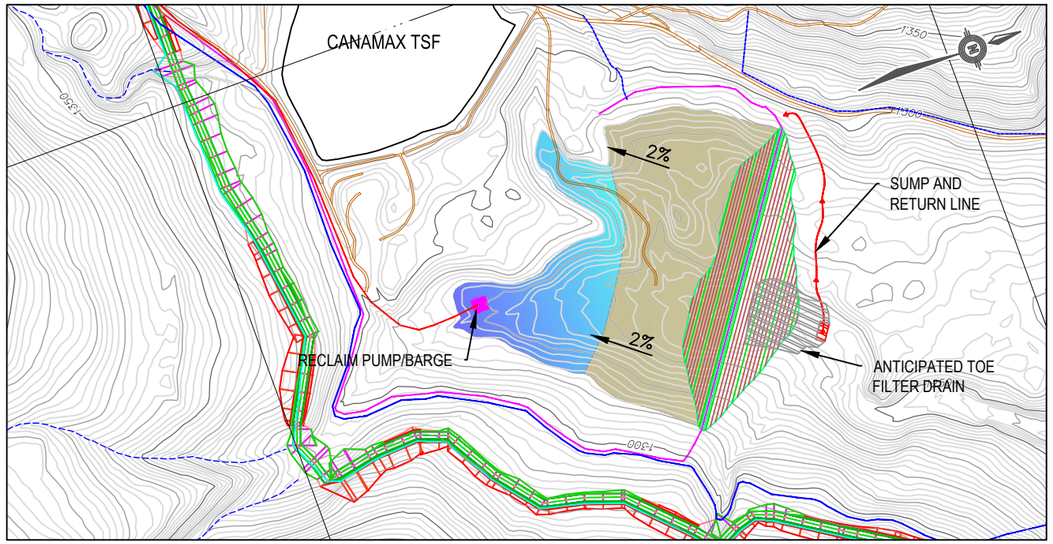
A TETRA TECH COMPANY

Figure 6.6-7

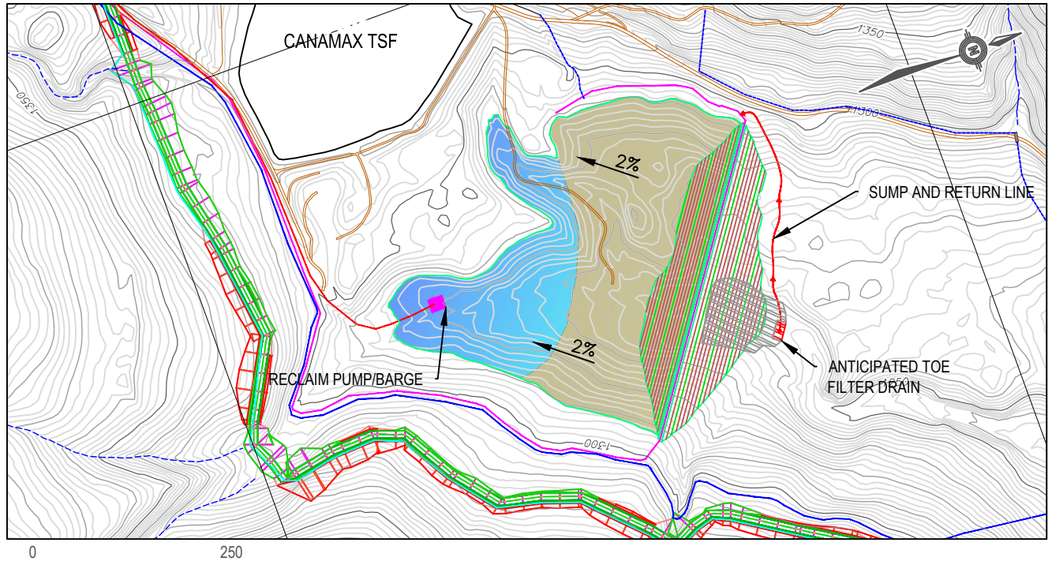
STAGE 1 START-UP
(JUST DAM & 20,000 m³ OF WATER)



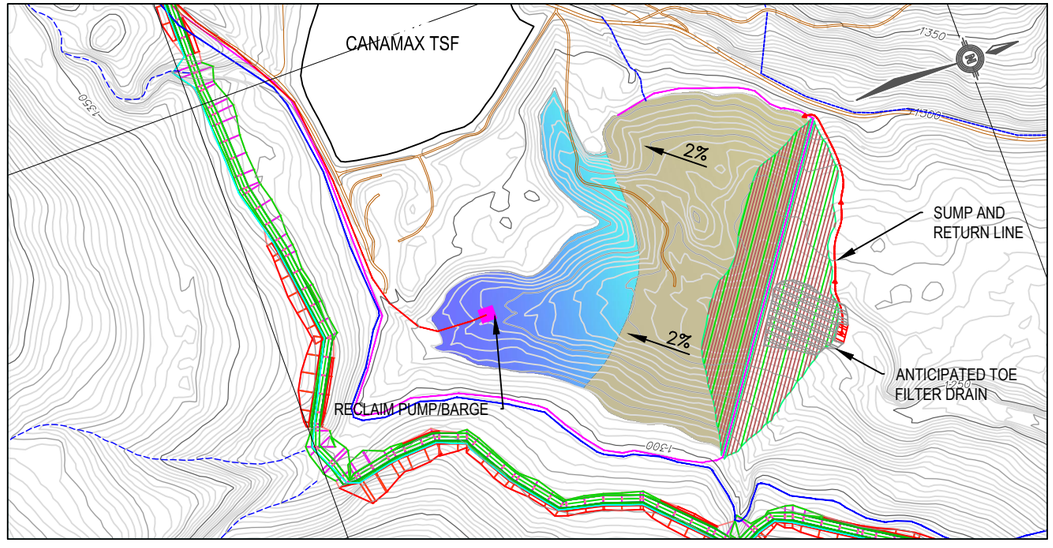
STAGE 2 - CONSTRUCTION IN YEAR 3



STAGE 3- CONSTRUCTION IN YEAR 4



STAGE 4 - FINAL CONFIGURATION



0 250

Scale: 1: 7 500 (metres)

LEGEND

- FRESH WATER DIVERSION CHANNEL/DITCH
- RECLAIMED WATER RETURN LINE
- TAILINGS LINE
- MAKE UP WATER LINE
- APPROXIMATE FLOW DIRECTION

STAGE	STORAGE YEAR	IMPOUNDED VOLUME
1	START-UP THRU YR. 3	1,032,096 m^3
2	YR. 4	1,381,899 m^3
3	YR. 5	1,766,853 m^3
4	YR. 6	2,054,324 m^3

NOTES
-HORIZONTAL DATUM IS UTM NAD27 ZONE 8, ALL DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
-DYKE UPSTREAM SLOPE 2:1, DOWN STREAM SLOPE 2.5:1. DYKE IMPOUNDMENT IS AT 2° SLOPE.
-VOLUMES BASED ON AVERAGE 1.6 t/m³ DENSITY.

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Ketza River Holdings

KETZA RIVER PROJECT

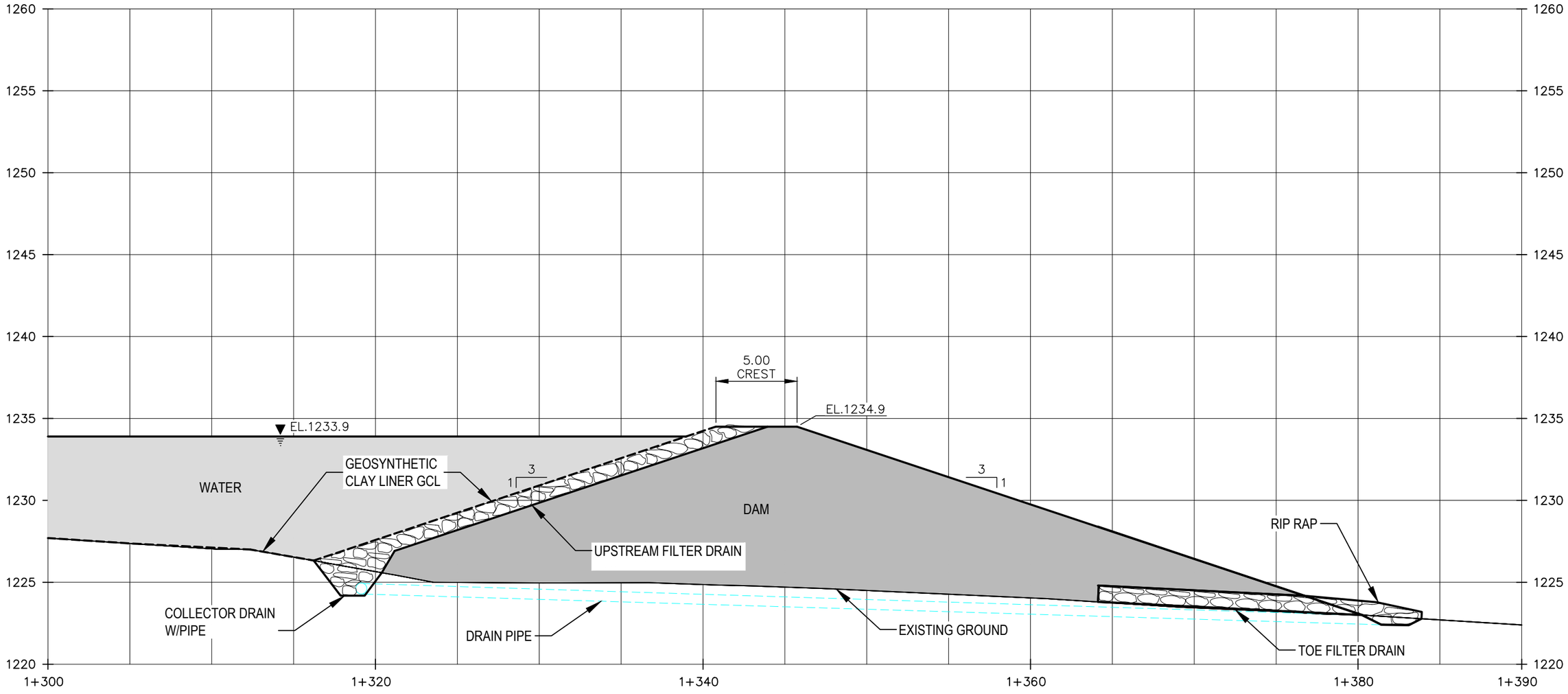
Tailings Storage Facility Staged Dyke Site Plan

eba A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
W23101052.114	RH	SL	0

OFFICE: EBA-Kelowna
DATE: July 20, 2011

Figure 6.6-8



LEGEND

- GEOSYNTHETIC CLAY LINER
- UPSTREAM FILTER DRAIN

0 10
Scale: 1: 250 (metres)

	STRUCTURE VOLUME	IMPOUNDED VOLUME
WATER DAM	300,220 m^3	1,032,096 m^3

NOTES
-HORIZONTAL DATUM IS UTM NAD27 ZONE 8, ALL DIMENSIONS AND ELEVATIONS ARE IN METERS, UNLESS NOTED OTHERWISE.
-WATER DAM SLOPES ARE 3:1, WATER IMPOUNDMENT IS FLAT.

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Ketza River Holdings

KETZA RIVER PROJECT

WATER RETENTION DAM CROSS-SECTION B-B'

eba A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
W23101052.114	RH	SL	0

OFFICE: EBA-Kelowna
DATE: September 8, 2011

Figure 6.6-9

The diversion of Cache Creek will include a diversion berm within the existing Cache Creek channel, located southeast of the Canamax TSF at an elevation of approximately 1,335 m, and a new open ditch along the uphill side of the new Site access road that is to be constructed around the eastern perimeter of the TSF. The ditch will collect flow from Oxo Creek and any of the unnamed tributaries of Cache Creek to the southwest of the proposed TSF and will discharge into the unnamed tributary of Cache Creek downstream of the TSF and the water retention pond (Figure 6.2-1).

Several unnamed tributaries of Cache Creek also contribute surface runoff from the northwest and northeast of the TSF. These tributaries, including Peel Creek, will collect seepage and runoff from numerous waste piles associated with the Shamrock Zone open pit mining. The discharge from these tributaries will be collected in a second, open drainage ditch and will be diverted into the TSF as shown in Figure 6.6-5.

It is anticipated that the diversion berms will be constructed of homogenous clay till sourced within the area of the TSF. A geosynthetic clay liner may be required on the upstream face to decrease permeability.

The geometry and armouring of the open ditches as well as culvert sizing will be finalized during detailed design. An allowance will be incorporated into the design for possible ice formation throughout the diversion system.

Although no site specific investigation has taken place along the diversion alignment, it is anticipated that sporadic permafrost will be encountered, especially on the northern aspect of the southeast slope. If permafrost is encountered, special provisions, such as buttressing or soil insulation will be incorporated into the final design.

6.6.2.10 Water Usage

Water usage during the construction phase will be limited to the camp facilities and small volumes of water required for construction, and will use the existing (2011) well. Water will be pumped to a treatment facility and a fresh water storage tank located in the well house. It is expected that the water usage for the camp will be approximately 300 litres per person per day or a total of 60,000 litres per day at peak capacity.

6.6.2.11 Waste Generation and Handling

There will be several types of waste generated during the construction phase of the KRP. Potential waste types, volumes, and handling and disposal methods are summarized in Table 6.6-1. Currently, combustible waste generated in camp is burned in an incinerator or hauled to the Ross River landfill. Trash awaiting incineration is stored in bear-proof metal storage containers. Two siphon tanks and a septic field were installed in 2011 to manage sewage. A land treatment facility is proposed for the containment and treatment of non-hazardous organic wastes. An on-site landfill may also be considered in future.

Overburden material, including organics, will be stockpiled during pre-development stripping for use in progressive reclamation. Provided sufficient materials are present, organics may be stripped and stored separately. The pile will either be planted with a short term vegetative cover or protected by other measures to prevent water and wind erosion. Inorganic material recovered from pre-development will be used as aggregate material or rock armour material.

Table 6.6-1: Potential Wastes Generated During Construction Phase

Waste Type	Description	Amount	Handling Method	Disposal Method
Solid Waste	General waste produced in camp, including food scraps.	1.3 kg/person/day to 260 kg/day (maximum).	Bagged garbage hauled in a truck.	Propane fired incinerator or new on-site landfill.
Construction Waste	Wood, drywall, metal, etc. from building construction.	20 kg/m^2 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 stored for later disposal, hazardous waste accounted for below.
Lubricants	Oils used in machinery, glycol, etc.	Estimated at 5% of fuel consumption – 480,000 litres/year.	Stored in bulk waste oil containers, specific to waste type.	Waste oil will be hauled off site to an approved disposal area. If possible, waste oil burners will be sourced as an option to burn waste oil for heating
Sewage	Human waste, grey water.	Estimated to be the same as water consumption at 300 litres/person/day (maximum of 60,000 litres/day).	Sewage will be treated in an on-site facility.	A state of the art system for recovering clean water during sewage treatment is being investigated, however in the eventuality it is not determined to be feasible or if it is periodically inoperable, then treated sewage effluent will be comingled into the TSF along with process water
Hazardous 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.	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 at a maximum of 130 ha of clearing.	Trees will be handled in accordance with the plan established under the Quartz Mining Licence	Depending on the plan developed under the Quartz Mining Licence, either stockpiled for use by the local communities, or burned.
Vegetation and overburden	Stripping of topsoil and unused soil from borrow pits and road construction.	Estimated to be 80 m^3.	These materials will be stockpiled near the areas from which they were stripped.	These materials will be used in the final reclamation of the site.

6.6.2.12 Land Treatment Facility

A land treatment facility (LTF) is planned to naturally treat contaminated soils from operations and closure activities at the Site. The proposed site is located near the 4 km mark along the Ketza Road (starting from the Robert Campbell Highway). The LTF will have a treatment capacity of less than 2,500 m^3 within a footprint of approximately 40 m by 70 m. The design capacity is sufficient to treat soils contaminated by a spilled fuel truck (<1,000 m^3). The impermeable base of the facility will be comprised of four 30 cm lifts totalling 1 m of compacted silty soil and would be surrounded by 1-2 m tall berms to prevent exchange of material with the outside environment. Construction of the facility is estimated to take 1 month.

6.6.2.13 Bulk Fuel Storage

An 800,000 L fuel farm consisting of four double walled 200,000 L containers will be located inside a lined, bermed containment area and will supply the generators and mobile equipment. The tanks are estimated to store sufficient fuel for approximately one month of operation. Secondary containment areas will be sized to hold 110% of the largest tank (220,000 L) in accordance with CCME environmental codes of practice for petroleum product storage (CCME 2003b). The fuel farm will be located away from any waterbodies, as appropriate. Table 6.6-2 shows typical fuel consumption estimated for an operation of this size.

Table 6.6-2: Estimated Fuel Consumption

Use	Manufacturer	Equipment Model	Number Required	Max Fuel Burn per Unit (L/hr)	Total Expected Fuel Burn Monthly
Primary Haul Truck	Caterpillar	Cat777	5	98	282,240
Secondary Haul Truck	Caterpillar	Cat740	2	47	47,376
Loader	Caterpillar	992	1	93	53,568
Loader	Caterpillar	972H	1	33	19,008
Dozer	Caterpillar	844H	1	80	46,080
Dozer	Caterpillar	834H	1	58	33,408
Grader	Caterpillar	140H	1	20	8,640
Production Drill	Sandvik	DR540	1	63	18,144
Production Drill	Sandvik	DI500	1	45	12,960
Generators (3,000 kW)			1	465	267,840
Total					**789,264**

6.6.2.14 Power Generation Requirements

Approximately 600 kW of power will be required during the construction phase. Power will be supplied by diesel generators on site. The camp, mill and other surface facilities will be primarily serviced by one 500 kW diesel generator unit. A maximum of ten portable generators, all rated at 10 kW or less will be for use at various construction sites. Power requirements will be assessed in more detail at the time of construction.

6.6.2.15 Fuel, Hazardous Materials and Explosives Management

Fuel

Fuel will be stored adjacent to the proposed staging area (Figure 6.2-1) and will be available during the construction phase for equipment, power generation, and heating requirements. During construction and mine operations, a fuel truck will be used for mobile refuelling. When not in use, the fuel truck will be stored on-site.

Fuel will be temporarily stored during the early stages of the construction phase in two existing double-walled enviro-tanks each with a capacity of 7,500 L (under current storage tank permit 0211-41). The area surrounding the bulk fuel storage will be bermed and will employ corrosion and leak detection systems.

Secondary containment in conformance with the CCME environmental code of practice for fuel storage tanks (CCME 2003b) will also be implemented. These temporary tanks will be demobilized from site once one of the four permanent 200,000 L bulk fuel storage tanks are constructed and commissioned.

Explosives

Both ANFO and emulsion will be used throughout the pre-production development and operations stagesat the mine site. Explosives will be used during construction of the infrastructure pads.

The explosives will be stored within an explosives magazine in accordance with the federal *Explosives Act* and regulations administered by NRCAN. Access to the explosives magazine will be limited to approved personnel and regular inventories of supplies will be conducted. The location of the explosives magazine is to the west of the primary infrastructure (Figure 6.2-1).

6.6.2.16 Access and Transportation

The KRP is accessible by the Ketza Road at Km 323 of the Robert Campbell Highway. The Site is approximately 80 km by road from Ross River and approximately 500 km from Whitehorse.

The road from Whitehorse to Ross River is suitable for the transport of equipment to site during construction. Heavy equipment will not be transported to site during spring break-up and freshet.

Bridges and culverts along the Ketza Road will be inspected and upgraded as required. An application is currently being assessed by YESAB to undertake care and maintenance of the Ketza Road.

6.6.2.17 Work Force Requirements

KRH will complete all pre-production mining with their personnel and equipment. Personnel requirements at startup are summarized in Table 6.6-3. These numbers are approximate, as actual staff numbers will be finalized at the start of the Project.

The remainder of the work force required for the construction phase will be a combination of skilled and non-skilled labour. The peak personnel required on site during construction is estimated to be 200.

Table 6.6-3: Estimated Pre-production Mining Work Force for Construction Phase

Skillset	Number
Engineers, geologists, technical staff	12
Mine Foremen and Superintendents	9
Drillers and Blasters	8
Operators	20
Non-skilled labourers	15
Mechanics and skilled trades	10
Total	**74**

6.6.2.18 Quality Assurance / Quality Control

All design work will be carried out by qualified Professional Engineers and, where necessary, independent third party review of detailed plans will be conducted. All designs will conform to Yukon Territory and applicable Federal building and design codes. Contractors hired for construction will be required to conduct quality control on their work as part of their contract terms. KRH will use a combination of external consultants and their internal project management team to conduct quality assurance on all aspects of the construction. KRH quality assurance will include, but not be limited to:

- Daily inspections of all construction projects, and
- Timely completion of all required testing as detailed in design reports, construction specifications, permits, and licenses.

6.6.2.19 Commissioning

For the mine to be commissioned, KRH anticipates that the following will have to be obtained, approved, or completed:

- A Decision Document for the *YESAA* Project Proposal submission for the KRP
- Land use permit
- Quartz mining license
- All other required environmental, health, and federal permits
- Water licence
- Construction, inspection, and approval of mine-site infrastructure
- Hiring of staff
- Mine pre-development activities.

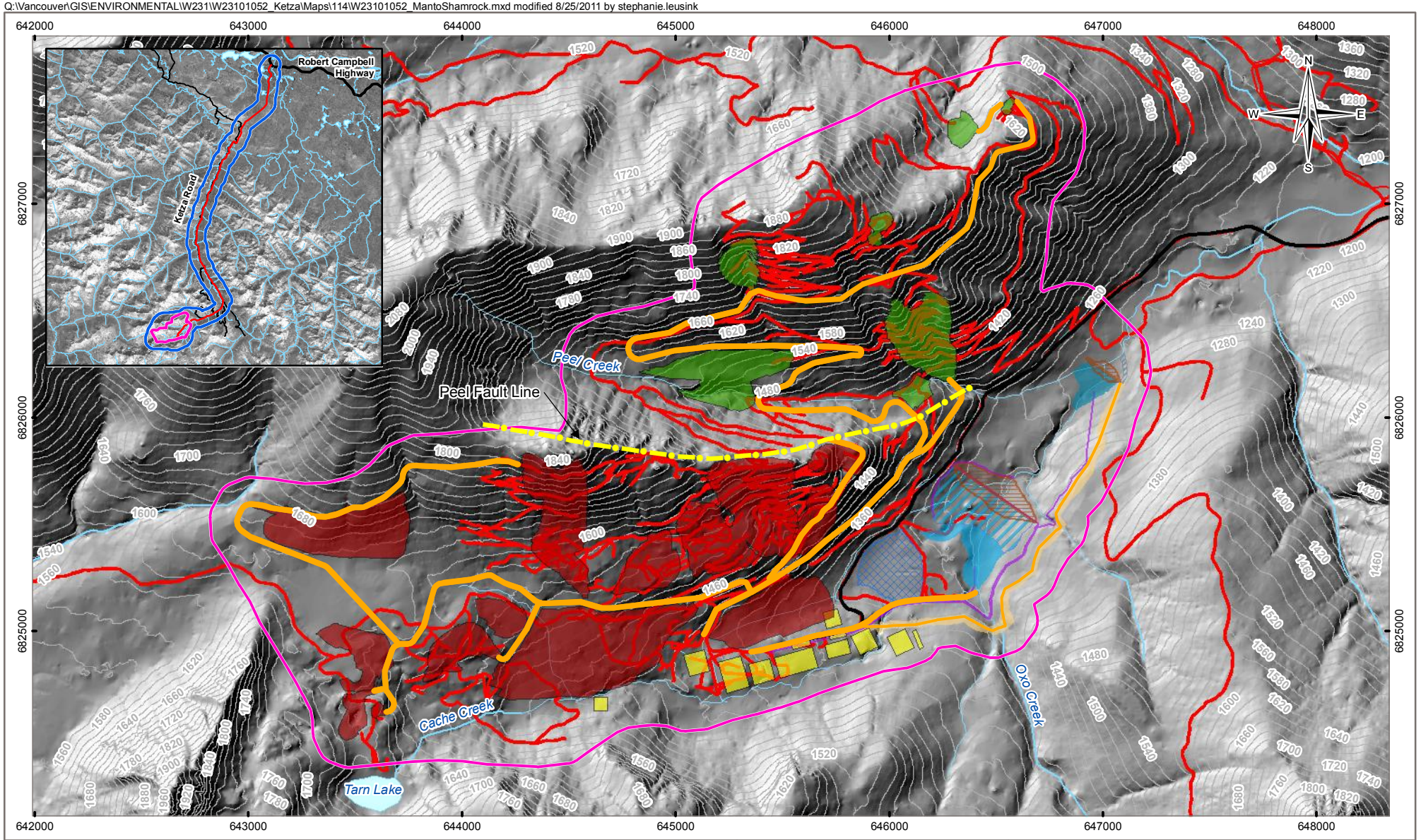
6.6.3 Operations Phase

Under the current mine plan and Project schedule (Figure 6.6-1) the KRP will have a 5 year mine life, with an estimated completion date in the fall of 2019. The operations phase and general mine production from the open pits is scheduled to begin on October 1, 2014.

6.6.3.1 Open Pit Mining

Open pit mining will occur at several sites to mine near surface mineral resources (Figure 6.2-1). The pits are located in two broadly classified stratigraphic domains separated by the steeply south-dipping Peel Fault (Figure 6.6-10). The Manto Zone to the southwest hosts the proposed Peel, Break, Lab-Hoodoo, Penguin, and Tarn pits within a predominantly limestone stratigraphy. The Shamrock Zone to the northeast, hosts the proposed QB, Gully, 3M, and Knoll pits within a predominantly meta-pelite stratigraphy. Figures 6.6-11 and 6.6-12 show cross sections of the Lab-Hoodoo and Penguin pits, respectively. Figure 6.6-13 outlines the proposed mining schedule for each pit.

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LEGEND

- Peel Fault Line
- Pit/Waste Dump Zone
- Manto Zone
- Shamrock Zone
- Project Footprint
- Ketza Road
- Proposed Haul Roads
- Existing Road
- Contour (20 m)
- Watercourse
- Waterbody

NOTES
1. Base data source: 1:50,000 NTS
2. Imagery and contours provided by Aero Geometrics, Ltd
3. For detailed infrastructure footprint, see Figure 6.2-1

STATUS
ISSUED FOR USE

Scale: 1:25,000

500 250 0 500

Meters

PROJECTION	DATUM
UTM Zone 8	NAD27

FILE NO.
W23101052_MantoShamrock.mxd

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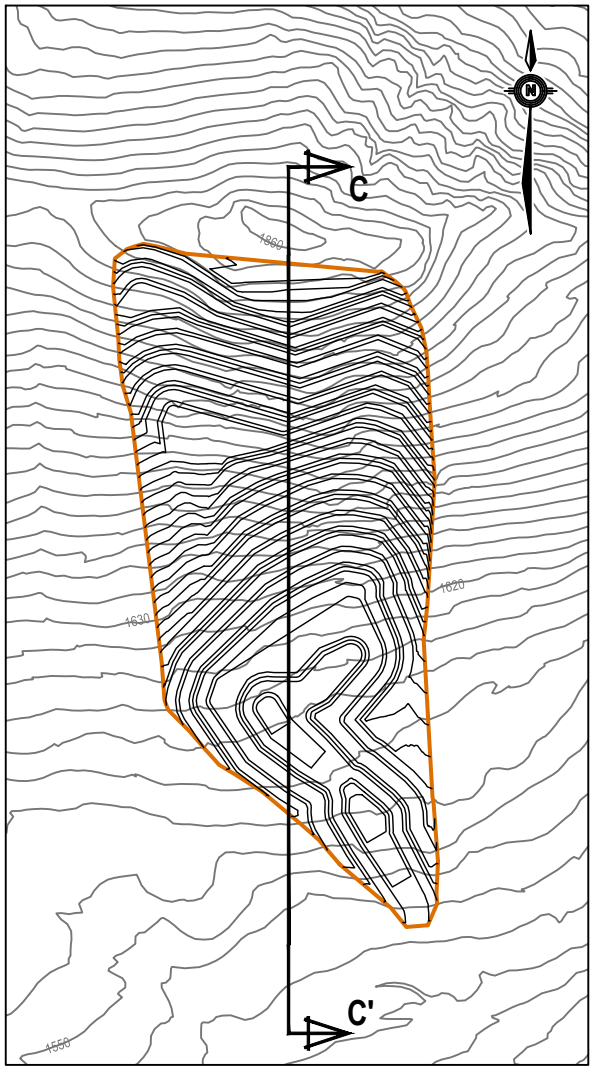
KETZA RIVER PROJECT

Plan Map Showing Open Pits, Waste Dumps and Peel Fault

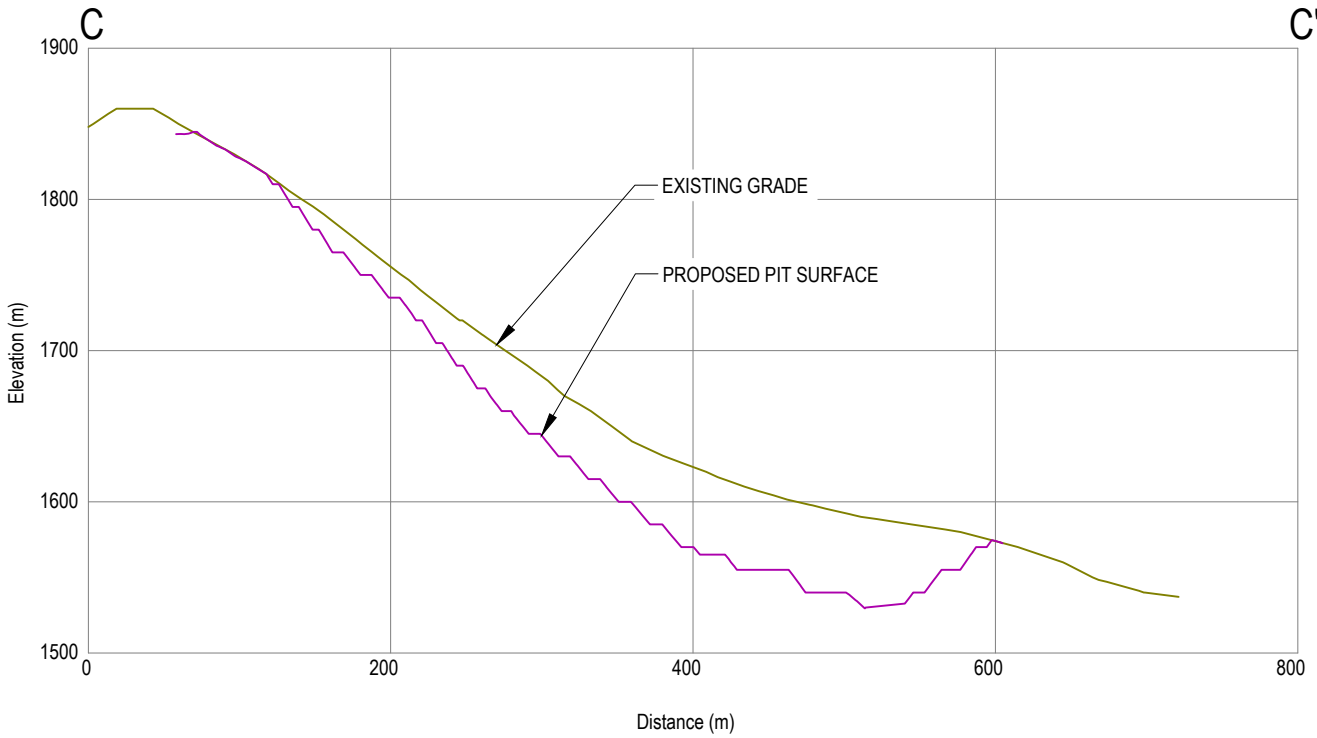
PROJECT NO.	DWN	CKD	APVD	REV
V15101019.002	SL	JN	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 6.6-10



PLAN
SCALE 1:7500



SECTION C-C'
SCALE 1:5000

NOTE
- Drawing provided by Practical Mining LLC
- Contours shown are at 10 m intervals

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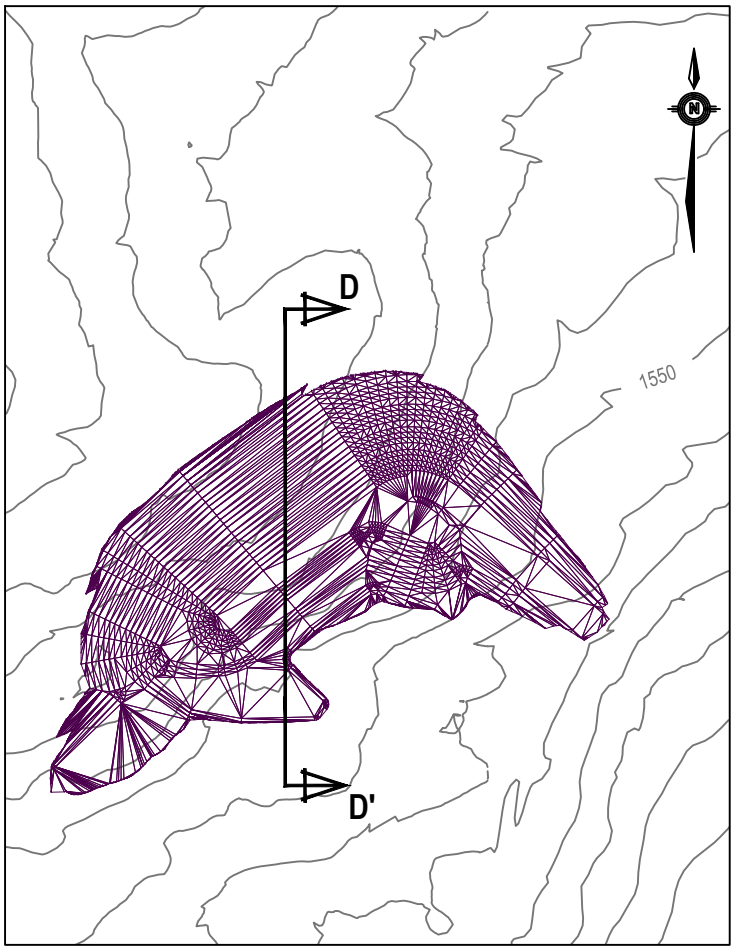
KETZA RIVER PROJECT

LAB-HOODOO PIT
PLAN AND CROSS SECTION

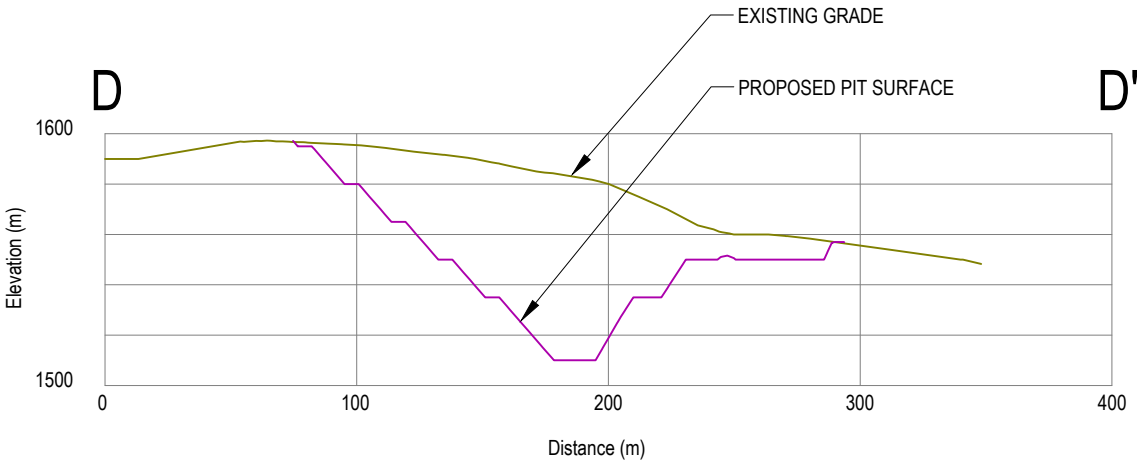
PROJECT NO.	DWN	CKD	REV
W23101052.114	TF	TP	0

OFFICE	DATE
VANC	July 26, 2011

Figure 6.6-11



PLAN
SCALE 1:5000



SECTION D-D'
SCALE 1:3000

NOTE
- Drawing provided by Practical Mining LLC
- Contours shown are at 10 m intervals

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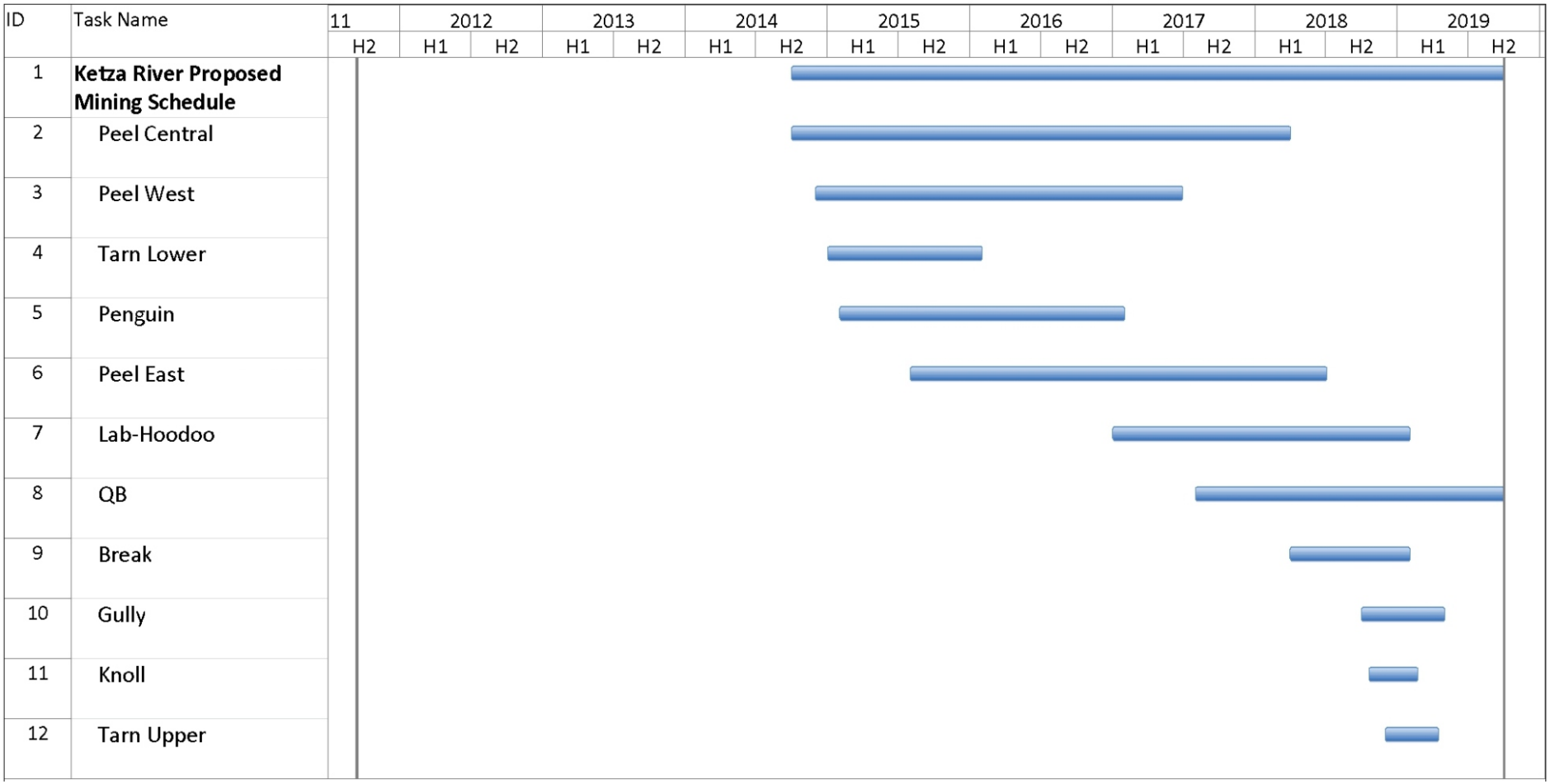
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KETZA RIVER PROJECT

PENGUIN PIT
PLAN AND CROSS SECTION

PROJECT NO.	DWN	CKD	REV
W23101052.114	TF	TP	0
OFFICE: VANC	DATE: July 26, 2011		

Figure 6.6-12



NOTES

This schedule is based on the schedule provided by Practical Mining LLC.

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KETZA RIVER PROJECT

Proposed Open Pit Mining Schedule

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	September 13, 2011

Figure 6.6-13

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Rock material will be excavated from the pits using conventional mining methods. Primary hauling of ore and waste material from the pits will use five 90 tonne Cat 777's with a Cat 992 loader with 12 m^3 buckets, or equivalent, at the Peel, Lab-Hoodoo, Penguin, and Tarn pits. One Cat 973D loader using a 4 m^3 bucket, or equivalent, will be used as a secondary loading unit, primarily for undertaking work including sumps, pulling batters, drop cuts, and support mining.

Open Pit Design

The Peel pit is the largest pit for the KRP. A total of 23 Mt of material, including 1.3 Mt of ore will be mined from this pit with an average grade of 5.9 grams per tonne (g/t) gold. Bench face angles vary but are approximately 60° in most areas of the pit. Overall slope angles vary but are approximately 45° in most areas of the pit. Bench heights are 15 m and bench widths vary between 5 and 10 m.

The Lab-Hoodoo pit is also a large pit, located west of the Peel pit. A total of 10.2 Mt of material, including 290 kt of ore will be mined from this pit at an average grade of 5 g/t gold. Bench face angles vary but are approximately 54° in most areas of the pit. Overall slope angles vary but are approximately 42° in most areas of the pit. Bench heights are 15 m and bench widths are 7 m.

The Penguin pit is located to the southwest of the Lab-Hoodoo pit. A total of 4.1 Mt of material including 310 kt of ore will be mined from this pit at an average grade of 2.7 g/t gold. Bench face angles vary but are approximately 55° in most areas of the pit. Overall slope angles vary but are approximately 47° in most areas of the pit. Bench heights are 15 m and bench widths are 4.5 m.

The Tarn pit is located in the very southwestern corner of the mine site area. A total of 780 kt of material including 100 kt of ore will be mined from this pit at an average grade of 3.8 g/t gold. Bench face angles vary but are approximately 45° in most areas of the pit. Overall slope angles vary but are approximately 38° in most areas of the pit. Bench heights are either 10 or 15 m and bench widths are 4 m.

The QB pit is located in the northeast area of the mine site. A total of 7.7 Mt of material including 440 kt of ore will be mined from this pit at an average grade of 3.4 g/t gold. Bench face angles vary but are approximately 55° in most areas of the pit. Overall slope angles vary but are approximately 40° in most areas of the pit. Bench heights are 15 m and bench widths are 7 m.

The Gully pit is located in the northeast area of the mine site. A total of 1.6 Mt of material including 70 kt of ore will be mined from this pit at an average grade of 3.7 g/t gold. Bench face angles vary but are approximately 65° in most areas of the pit. Overall slope angles vary but are approximately 47° in most areas of the pit. Bench heights are 15 m and bench widths are 8 m.

The Break pit is located in the northeast area of the mine site. A total of 1.5 Mt of material including 23 kt will be mined from this pit at an average grade of 9.9 g/t gold. Overall slope angles are approximately 45° in most areas of the pit.

The 3M pit is located between the Gully and Knoll (3D) pits. A total of 390 kt will be mined including 12 kt of ore at an average grade of 2 g/t gold. Overall slope angles for the 3M pit is approximately 45° in most areas of the pit.

The Knoll (3D) pit is a small pit located in the northeast area of the mine site. A total of 270 kt will be mined from the pit including 14 kt of ore at an average grade of 6.2 g/t gold. Overall slope angles are approximately 45° in most areas of the pit.

6.6.3.2 Underground Mining

Contractor-operated underground mining will occur below the Peel pit with potential for underground mining below the Lab-Hoodoo open pit as well. The Peel underground will use short sublevel stoping in the steeply dipping areas of the deposit, and drift and fill in shallow dipping areas. Due to the steeply dipping nature of the Lab-Hoodoo ore body, short sublevel stoping only has been proposed for mining. It is anticipated that a mining contractor will produce up to 500 tpd of ore from the various underground mines. Underground mining will occur concurrently with the open pit operations.

Underground resources are external to the pit designs which meet or exceed the respective cutoff grades for oxide and sulphide ores following a 30% grade dilution. Mining recovery of these resources is estimated at 60%. Figures 6.3-1 and 6.3-2 show typical schematics of the sublevel stoping (larger version of small sublevel stoping) and drift and fill underground mining methods, respectively.

Ventilation

Ventilation systems for underground mining will include installation of a stand-alone mine axial fan, with a secondary backup fan, at the portal of each ventilation raise. The fan will exhaust stale air from the underground allowing for fresh air to be supplied through the main ramp access. One 2.1 m diameter raise at each underground mine will be sufficient. The system will also incorporate ventilation doors, stoppings, bulk heads, auxiliary fans, and regulators, as required. Ventilation will be designed in accordance with Yukon Occupational Health and Safety Regulations.

Detailed design for the underground mines has not been completed and will likely be subject to change. The information specified above represents a typical scenario for this type of operation.

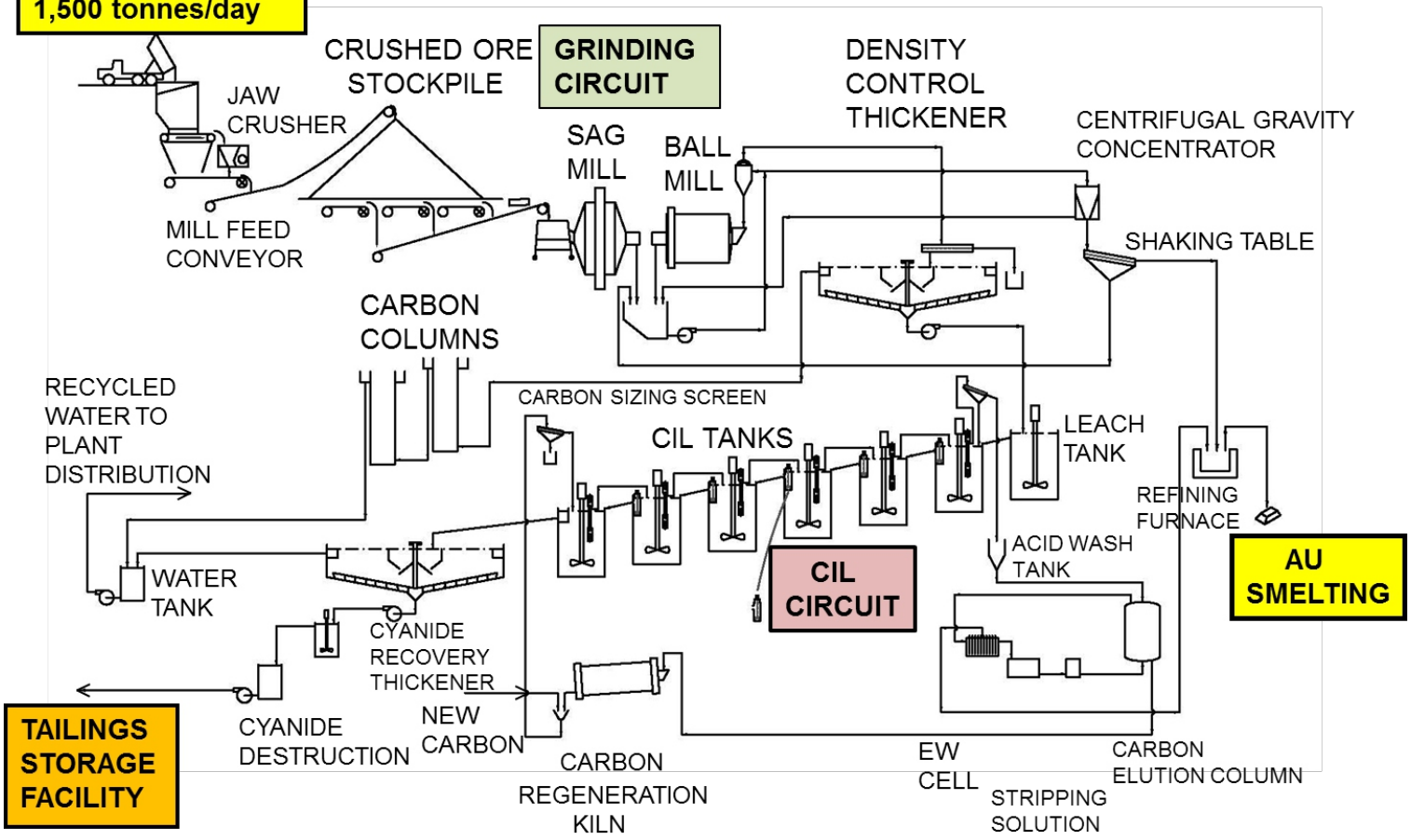
6.6.3.3 Processing

The proposed process plant for the KRP will treat a nominal 1,500 tpd of mixed sulphide and oxide ore using a conventional CIL process. The mill flow sheet is presented in Figure 6.6-14. Processing will consist of ore crushing followed by SAG-Ball mill grinding, with CIL to leach and recover the gold. Gold will then be removed from the carbon by pressure Zadra elution and recovery by electrowinning. Plant effluents will be detoxified using the copper catalyzed SO_2/Air oxidation method for cyanide and ferric arsenate precipitation for arsenic removal. During detailed engineering, competing technologies may be reviewed and substituted.

ROM ore will be delivered to the process plant by trucks, and will either be deposited directly into the ore feed hopper or placed onto the ore storage pad. The ore storage pad will contain several weeks of plant feed (approximately 25,000 t) to allow for optimal processing. It will also be used to blend ore as required. Ore will be reclaimed from the pile and fed into the hopper by front end loader.

KETZA RIVER FLOWSHEET

November 16, 2010



NOTES

1. Figure created on November 16, 2010.
2. Figure shows a typical CIL process flowsheet and actual design is subject to change.

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KETZA RIVER PROJECT

Typical Carbon-In-Leach Process Flowsheet

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.114	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 6.6-14

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6.6.3.4 Water Usage

Water usage during operations will include pumping freshwater from a water well west of the process plant on the north side of Cache Creek. The fresh water from the water well will be treated and used as potable water for the camp facilities. It is expected that the water usage for the camp will be approximately 300 litres per person per day or 60,000 litres per day at peak capacity.

Water used for processing will be supplied primarily from the TSF supernatant pond and from the water retention pond. It is estimated that the process plant will use approximately 2.5 million litres of water per day.

6.6.3.5 Pumping Water to Site

Water for processing will be pumped to the mill from recovered supernatant water in the TSF. There is likely to be a surplus of water from the TSF; however, if required make up water will come from the water retention pond. Water will be pumped via a 100 mm to 250 mm diameter insulated and heat-traced pipeline. The pumps at the intake station will operate year-round during mining. However, provisional storage on site will be required when the system is down for maintenance or repair. The system may intermittently be turned off while the process plant is not operational and water is not required. The pumps will be powered from the main power generation system. The power line will run adjacent to the pipeline bench along the shoulder of the access road.

6.6.3.6 Water Storage

During operations, efforts will be made to limit potential downstream effects that could result from proposed development activities. Various options for seepage control and surface runoff have been built into the design, construction, and operation of the water retention dam at the Site. A water storage plan will be developed to manage and control water sources that originate within the Project area. The plan would include measures such as optimizing the use of available water sources to satisfy milling requirements and related mining activities. Water storage activities will include:

- Providing adequate storage and freeboard within the TSF for full containment of process water and storm events, including the PMF
- Diverting runoff from the undisturbed catchment area around the TSF
- Collecting and recycling seepage from the TSF
- Optimizing the volume of water stored in the tailings supernatant pond to meet operational requirements and post-closure objectives.

Seepage from the embankment will be monitored and collected (if required) in seepage collection sumps, to be located at the downstream toe of the embankment. Collected water will be returned to the TSF. Design provisions to minimize seepage losses include:

- A geosynthetic clay liner at the base of the impoundment and up the face of the embankment
- The development of extensive tailings beaches (which isolate the supernatant pond from the embankments)
- Contingency measures for groundwater recovery and recycle.

6.6.3.7 Water Diversion Structures

Water will be diverted around the QB Dump 2 and Peel Dump 3, as well as around the TSF and water retention pond (Figure 6.2-1). Additional structures will be constructed as necessary to collect water flowing off of the waste piles for diversion into the TSF. Operation of the water diversion structures will be limited to ongoing maintenance and snow clearing.

6.6.3.8 Potable and Waste Water Treatment

The mine will have both a potable water treatment facility and a mechanical wastewater treatment facility. Potable water will be serviced from an existing well drilled into the nearby underground aquifer, and treated waste water will be discharged through a contact rotator to the septic system.

The potable water treatment system is in place and will bring the water to Canadian Drinking Water Standards. The well will be monitored regularly. The potable water will be chlorinated before it is distributed in the site potable water distribution system. The potable water will be used exclusively to service the camp, with the exception of a small volume of treated water required for the CIL carbon elution cycle in the processing facility.

The water distribution system will consist of steel pipes installed within utilidors to pump treated water throughout the site. The potable water treatment facility will be located in the well house.

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 is a rotating biological contact unit designed to produce effluent in accordance with Yukon Water Board requirements for treated sewage effluent. Treated effluent will be discharged from the plant into the septic field. The wastewater treatment plant will be located near the accommodations complex.

6.6.3.9 Tailings Disposal

The tailings will be produced from conventional milling of ore. The CIL process will result in a single thickened tailings stream for disposal in the TSF. The assumed characteristics of these tailings streams are summarized as follows:

- Total solids throughput: 1,500 tpd (nominal at 100% availability)
- 60% solids
- Specific gravity of approximately 3.2
- 1.6 t/m^3 for settled dry tailings (assumed).

The tailings are expected to be relatively homogenous, with little segregation between the coarse and fine fractions in the tailings stream. Tailings beaches are expected to form a relatively gentle slope of about 2% to 2.5%.

A single HDPE tailings delivery pipeline will run at a continuous downgrade from the mill tailings station at elevation 1,360 m to the main embankment. The line will continue downgrade onto and along the TSF embankment crest. Off-takes in this line will allow direct discharge of bulk tailings into the facility.

The discharge of thickened tailings from the delivery pipeline into the TSF will be from one of a series of large-diameter valved off-takes, located at intervals along the embankment crest. The tailings discharge points, initially established along the starter embankment will be lifted onto the crest of the on-going embankment raises. A schematic of the staged dyke development through operations, with anticipated tailings volumes, is presented in Figure 6.6-8.

It is anticipated that pumping of tails will not be required, as there is sufficient elevation head available for the life of the Project. Tailings deposition will be by a single co-mingled tailings stream, which will be submerged in the TSF.

On-going consolidation of the tailings deposit is an important consideration for the design and construction of the TSF during operations and after closure. Consolidation occurs continuously within the tailings deposit during deposition, and will continue after completion of operations, until all excess pore pressures have dissipated. Expulsion of pore fluids during consolidation results in settlement of the tailings surface and a corresponding increase in the average density of the deposit.

6.6.3.10 Camp Operations

Single room accommodations will be provided for workers in the accommodations complex. The operating camp will be located in the same area as the current exploration camp (Figure 6.2-1). Personnel will work 12 hour days on a 2 week in, 2 week out rotation.

Meals will be provided at the camp through the kitchen / canteen in the accommodations complex. A recreation facility will be available for employees in their off-time. Equipment Maintenance Facility Operation

Equipment maintenance will be conducted in the equipment maintenance facility, located south of the Peel dump and west of the process plant (Figure 6.2-1). 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. The facility will be insulated for all weather operation.

6.6.3.11 Warehouse

The warehouse will be located directly adjacent to the equipment maintenance facility (Figure 6.2-1). Materials sent to and from site will go through the warehouse. The warehouse will store excess inventory of all materials used in the mine, process plant, offices and assay lab.

6.6.3.12 Fuel, Hazardous Material, and Explosives Management

Fuel

Fuel will be transported by tandem axle fuel tanker trucks from Whitehorse to the main fuel storage facility (Figure 6.2-1). It will consist of four double-walled 200,000 L capacity tanks within a bermed area. All mobile equipment at the Site, including personnel vehicles, will be diesel fuelled. The fuel storage facility will employ corrosion and leak detection systems and will have secondary containment in conformance with the CCME environmental code of practice for fuel storage tanks (CCME 2003b). Access to fuel resources will be limited to authorized personnel.

Explosives

Both ANFO and emulsion will be used as explosives. Materials will be trucked to site and transported on site by a truck specially equipped to handle explosives. Transportation, storage, and use of explosives will be carried out in accordance with the federal *Explosives Act* and regulations. Figure 6.2-1 shows the location of the proposed explosives storage magazine, which will be a secured facility with restricted access.

Hazardous Materials

Hazardous chemicals or materials will be transported and stored strictly in accordance with applicable laws and regulations. Material Safety Data Sheets (MSDS) will be readily available to all staff responsible for handling hazardous materials.

Cyanide in briquette form will be trucked to site in factory packed, sealed shipping containers. On-site, cyanide will be stored in both a solid and liquid form. Solid cyanide briquettes would be stored in the shipping container they were transported in until needed. Solid cyanide will be transformed into a liquid in a contained mixing area. The liquid cyanide will be stored in special containers prior to being used during processing.

In the unlikely event of a spill either during transportation or on-site, the solid form of cyanide provides for easier containment and subsequent clean up. Safeguards will also be in place for both the solid and liquid cyanide storage facilities, such as containment within sealed containers and behind berms. Access to the cyanide storage facilities will be restricted to authorized personnel.

6.6.3.13 Access and Transportation

All equipment, supplies, and personnel, will be transported to site via all-weather roads from Whitehorse or nearby communities. These roads are not seasonally dependent and will be good for use all year around, the possible exception being spring breakup and freshet. The all-weather road route from Whitehorse is approximately 500 km long and will take approximately 8 hours to drive. The Site is equipped with a helipad that allows for access and transportation during brief periods of time when the road may become impassable.

Personnel will be transported to site via bus that will run from Whitehorse, through Ross River and Faro to Site. Most supplies and equipment will be shipped from Whitehorse to Site. Some materials that require rush delivery can be taken to Site by helicopter.

Transportation around site will be conducted by company designated light vehicles and a shuttle system that will take staff from camp to various infrastructure and back to camp around shift change.

6.6.3.14 Work Force Requirements

KRH will conduct all operations of the mine excluding underground mining, which will be contractor-operated. With scheduled rotations, there will be approximately 150 people (maximum) on site at any one time. Table 6.6-4 summarizes the anticipated operating personnel requirements; a more detailed breakdown is provided in Appendix L2.

Table 6.6-4: Operations Employment Estimates

Position	Per Crew	Total
Open Pit Mine Operations	15	56
Underground Mine Operations - Contractor	14	40
Mine Maintenance	7	28
Mine Staff	15	28
Mill Staff	10	20
Mill Operations	9	30
Mill Maintenance	10	32
Camp and Administration	18	36
Ketza River Operations Requirement	**98**	**270**
Weekdays	9	9
2x2 shifts	35	140
2x2 dayshift only	41	82
Contractor 2x1	13	39
Maximum On-site at Anytime	**146**	
Total Maximum Employed		**270**

6.6.3.15 Power Generation and Requirements

During operations, electricity requirements for the mine site are estimated to be 3 MW, 80% of which is estimated to be used by the process plant. To meet the electricity demand for the mine site, a powerhouse with 2 diesel generators (3 MW each) and a heat recovery system is planned. The powerhouse will be a single-story pre-engineered building.

6.6.3.16 Quality Assurance / Quality Control

KRH will use a combination of external consultants, an internal project management team, and internal mine staff to conduct quality assurance and quality control on all aspects of the tailings placement, backfill placement where required, mine planning, mine operation, ventilation operation, and all other tasks as necessary. Quality assurance and quality control will include, but not be limited to:

- Daily inspections of ground conditions and ventilation systems
- Regular review of the mine plan
- Annual inspections of all dams and water diversion structures.

All required testing and instrumentation monitoring as detailed in design reports, construction specifications, permits, and licenses will be conducted.

6.6.4 Closure and Reclamation Phase

Closure and reclamation of Project components will be carried out as progressive (during production) and post-closure reclamation activities. A conceptual Closure and Reclamation Plan has been developed and is presented in Appendix L3. The Plan is based upon the current pre-feasibility level of engineering design and is expected to evolve as the Project progresses. The Plan addresses the long-term physical and chemical stability of the Site following the cessation of mining operations and includes a preliminary monitoring framework.

KRH has successfully conducted reclamation at the Site already, and received the Robert E. Leckie Award for Outstanding Environmental Reclamation in 2007. Reclamation efforts to date have included removing chemicals and waste petroleum from the site, disposing of 600 barrels of miscellaneous substances, and removing over 100 truck loads of garbage, including scrap metal. Various areas have also been resloped and seeded, several buildings have been removed, and a new incinerator was installed to replace the existing landfill.

7.0 ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS ASSESSMENT METHODS

7.1 Environmental Assessment Methods

The environmental assessment methods for the KRP were developed in accordance with YESAB's *Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions* (2005). The effects assessment identifies and examines the potential effects of the KRP on the biophysical and socio-economic environments in the proposed development area and the surrounding region.

The environmental effects assessment includes the following components:

- Identifying valued components
- Identifying temporal and spatial boundaries
- Summarizing baseline information
- Effects characterization and mitigation
- Evaluating consequence
- Determining significance.

Each component is briefly described in the following subsections.

7.1.1 Identifying Valued Environmental and Socio-economic Components

VESECs are elements of environmental or socio-economic systems valued by the public, First Nations, scientists and government for environmental, scientific, social, aesthetic, or cultural reasons (YESAB 2005). VESECs for the KRP were identified through community and stakeholder meetings, baseline studies analysis, review of academic literature, government publications, other published documents, and professional experience. Traditional knowledge and community information have been incorporated when available. Identified VESECs for the KRP are presented in Table 7.1-1 and are discussed in the effects assessment sections that follow.

7.1.2 Identifying Temporal and Spatial Boundaries

Each VESEC has a defined temporal and spatial boundary (Figure 7.1-1). The boundaries identify how Project-related activities and VESECs overlap in time (seasonal and annual) and geographic area. The temporal and spatial boundaries provide the basis for the effects characterization and significance determination.

7.1.3 Summarizing Baseline Information

The baseline conditions summarize key components of the existing conditions for each VESEC, considering past, current, and anticipated future conditions (including external pressures from the KRP, but not including the potential effects from the KRP) for each VESEC. The summary of baseline conditions highlights information necessary for the effects assessment, including scientifically established criteria or indicators.

7.1.4 Effects Characterization and Mitigation

Potential environmental effects associated with the KRP are evaluated using baseline conditions, an understanding of the KRP components and activities, available mitigation measures, standard assessment tools, and professional judgement to analyze the anticipated interaction between KRP activities and VESECs. KRP-related effects are typically described according to a set of criteria, and considered for all phases of the KRP: construction, operation, decommissioning, closure and abandonment.

The following criteria were used to assess the effects of the KRP on VESECs:

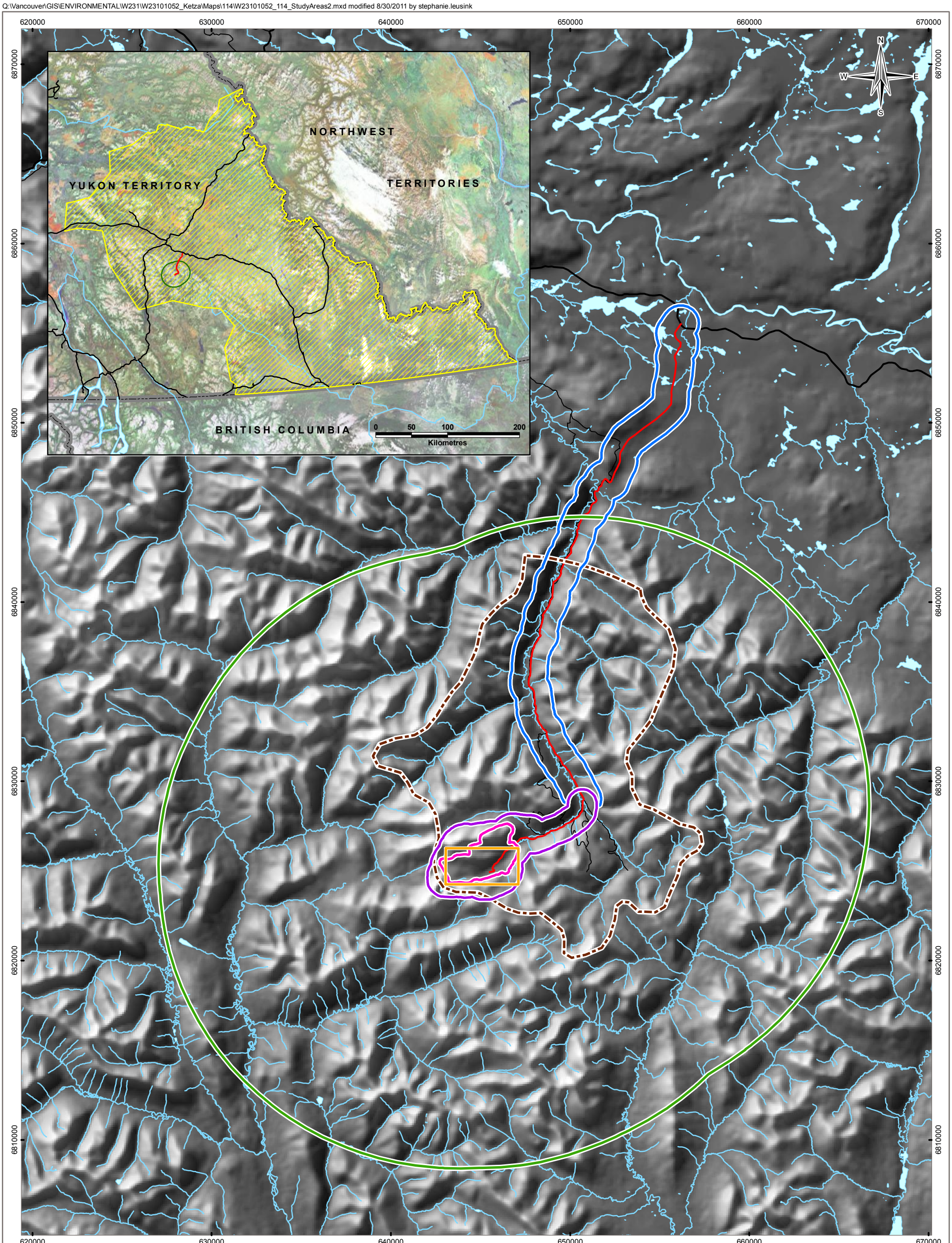
- The nature of the effect
- The geographic range of the effect
- The timing of the effect (including duration and frequency)
- The magnitude of the effect (i.e., what degree of change is expected)
- The reversibility of the effect
- The likelihood and certainty that the effect will occur.

Corresponding mitigation measures have been identified for the elimination, reduction or control of adverse environmental and socio-economic effects on the VESECs (YESAB 2005). Appropriate management and mitigation measures to avoid or minimize anticipated KRP effects have been implemented throughout the design of the KRP. The current Project Proposal represents a balance between effective and efficient operations of the Project throughout its life cycle, and environmental and socio-economic responsibility. Design alternatives that were considered, rejected and/or implemented are discussed in more detail in Section 6.3.

Table 7.1-1: Ketza River Project Valued Environmental and Socio-economic Components

Environmental Component	Valued Environmental and Socio-economic Component (VESEC)
Natural Landscape, Soil Stability, and Terrain Hazards	Natural landscape Stability of soils Human safety
Climate	Climate
Air Quality	Air quality
Noise Levels	Noise levels
Ecosystems and Vegetation	Sensitive ecosystems Rare plant habitat potential
Wildlife	Woodland Caribou Moose Thinhorn Sheep Grizzly Bear Wolverine Raptor nesting (cliff habitat) Upland breeding birds
Surface Water Quality	Surface water quality
Hydrology	Water flow quantity Water flow timing
Hydrogeology	Groundwater quality Groundwater quantity
Aquatic Ecosystems and Fisheries Resources	Benthic invertebrates and periphyton Riparian vegetation (in relation to fish habitat) Stream substrate (in relation to fish habitat) Fish presence and abundance
Heritage Resources	Historic sites Archaeological or paleontological remains
Aesthetics	Aesthetics
Effects of the Environment on the Project	Rockfalls, landslides and avalanches Earthquakes Permafrost High winds Flooding Fire

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LEGEND

- Cumulative Effects Study Area
- 2007 Terrain Study Area
- Project Footprint
- Local Study Area
- Ketza Road Study Area
- Surface Water Quality Regional Study Area
- Wildlife Regional Study Area
- Ketza Road
- Robert Campbell Highway
- Minor Road
- Watercourse
- Waterbody

NOTES
Base data source: NTS 1:50,000

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Study Areas

PROJECTION: UTM Zone 8	DATUM: NAD27			CLIENT: Ketza River Holdings
Scale: 1:200,000 (4 2 0 4 Kilometres)				eba A TETRA TECH COMPANY
FILE NO.: W23101052_114_StudyAreas2.mxd				
PROJECT NO.: W23101052.114	DWN: SL	CKD: TP	APVD: TP	REV: 0
OFFICE: EBA-VANC	DATE: July 26, 2011			Figure 7.1-1

7.1.5 Evaluating Consequence

Residual effects are those effects anticipated to remain after mitigation measures are applied. Consequence has been defined as the result of an activity that may slightly or substantially change the environment in a negative or positive way. Determining the consequence of a residual effect has been used in this Project Proposal as a step that precedes but influences significance determination. Residual effects are categorized in Table 7.1-2.

Table 7.1-2: Residual Effects Assessment and Consequence Criteria

Criterion	Descriptor	Definition
Geographic Extent	Local	Effect will be confined to the LSA (i.e., the KRP footprint)
	Regional	Effect will be confined to the RSA (i.e., the larger region surrounding the KRP)
	Beyond Regional	Effect will extend beyond the RSA
Duration	Short Term	Effect will occur or last for short periods of time – hours to months, up to one year
	Medium Term	Effect will occur or last for the life of the KRP (e.g., 10 years to abandonment)
	Long Term	Effect will extend or last beyond the life of the KRP
Frequency	Isolated	Effect will be confined to a discrete or specific period of time
	Sporadic	Effect will occur on occasion and at irregular intervals
	Periodic	Effect will occur intermittently but repeatedly during the life of the KRP
	Continuous	Effect will occur continually during the life of the KRP
Magnitude	Very Low	Effect will produce no detectable change from baseline conditions (e.g., the portion of the VESEC affected will be <1%)
	Low	Effect will be within the range of baseline conditions or natural variation (e.g., the portion of the VESEC potentially affected will be <5%)
	Moderate	Effect will slightly exceed baseline conditions or the limits of natural variation (e.g., the portion of the VESEC potentially affected will be 5 – 10%)
	High	Effect will produce a notable change beyond baseline conditions or the upper or lower limit of natural variation (e.g., the portion of the VESEC potentially affected will be >10%)
Reversibility	Reversible Short Term	Effect is reversible during the life of the KRP
	Reversible Long Term	Effect is reversible within 100 years
	Irreversible	Effect is irreversible
Likelihood	Low	Effect is unlikely but could occur
	Moderate	Effect is likely but may not occur
	High	Effect is likely to occur
Consequence		
	Very Low	Effect may result in a slight change in condition of the VESEC in the LSA or RSA for a very short duration but the VESEC will likely return to baseline conditions within 1 year
	Low	Effect may result in a slight change in condition of the VESEC in the LSA or RSA during the life of the KRP but the VESEC will likely return to baseline conditions within 1 year

Table 7.1-2: Residual Effects Assessment and Consequence Criteria

Criterion	Descriptor	Definition
	Moderate	Effect may result in a noticeable but stable change in the condition of the VESEC compared to baseline conditions, and which may persist in the LSA or RSA after KRP closure and into the foreseeable future OR The effect could result in a noticeable change in the condition of the VESEC exceeding established guidelines or thresholds but the VESEC should return to baseline conditions within 1 – 10 years
	High	Effect will result in notable changes in the condition of the VESEC, and which may or may not return to baseline conditions in >10 years

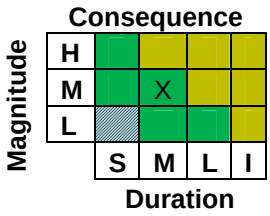
To determine the level of consequence associated with each residual effect, the magnitude, duration and location of the effect were used as primary considerations. Consequence was determined considering residual effects in the LSA and RSA, and ranked Very Low to High, as outlined in Table 7.1-3. Examples of residual effects evaluation and consequence determination for the LSA and RSA are shown in Table 7.1-4. Residual effects are also considered in consideration of cumulative effects in Section 12.0.

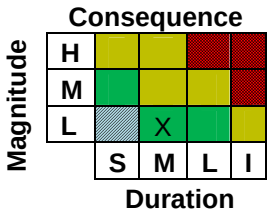
Table 7.1-3: Consequence Evaluation Criteria

Location	Magnitude	Duration	Consequence
Local Study Area (LSA)	Low	Short Term	Very Low
	Moderate – High	Medium – Long Term	Low
	Low – High	Long Term – Irreversible	Moderate
Regional Study Area (RSA)	Low	Short Term	Very Low
	Moderate	Medium Term – Irreversible	Low
	High	Short – Long term	Moderate
	Moderate – High	Long Term – Irreversible	High
Beyond RSA	Low – High	Short – Medium Term	Moderate
	Low – High	Long Term – Irreversible	High

Table 7.1-4: Sample Residual Effects Assessment Table

Evaluation of Residual Effect Within the Local Study Area						
Description of Residual Effect (after Mitigation)	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Likelihood**
Example residual effect	Moderate	Local	Medium-term	Isolated	Reversible Short-term	Low
Evaluation of Residual Effect Within the Regional Study Area						
Description of Residual Effect (after Mitigation)	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Likelihood**
Example residual effect	Low	Regional	Medium -term	Periodic	Reversible Short-term	High





7.1.6 Determining Significance

Residual effects are evaluated for their environmental consequence using biological and physical criteria including environmental and socio-economic context, thresholds, environmental consequences, ecological context, likelihood of the residual effect occurring, standard guidelines criteria or objectives, and best professional judgement.

Each residual effect was evaluated according to the expected change in overall condition of the VESEC being assessed and was assigned a rank of either Low, Medium or High significance. If no residual effects were predicted to occur, no further evaluation of the effect was carried out, and a significance rating was not assigned.

When evaluating significance, precautionary principles were also used, so that where there was uncertainty about significance, the final evaluation was based on the greater of the possible effects. Each significance assessment is accompanied by the level of confidence associated with that assessment.

7.2 Socio-economic Assessment Methods

The advent of YESAA has changed the nature and scope of socio-economic impact assessments of projects in the Yukon. These are now required to be much more comprehensive and detailed than what was done under previous legislation.

In YESAB's *Guide to Socio-economic Effects Assessments* (2006), seven principles are laid out to provide broad and general direction on how a proponent is to conduct a socio-economic effects assessment:

- Achieve a broad understanding of the local and regional settings potentially affected by the proposed action
- Focus assessment on key aspects of the human environment
- Provide valid and relevant information for use in decision-making
- Identify methods and assumptions and define significance
- Ensure that effect equity issues are described and analyzed
- Consider and recommend suitable mitigation and include in the assessment mechanisms to improve the likelihood of mitigation success
- Determine the best development alternative(s) rather than merely serving as an arbiter between socio-economic benefit and social cost.

We have been fully aware of these principles from the beginning of the effects assessment process for the Project that began in 2007, and have followed them throughout.

YESAB suggests a six-step process for conducting socio-economic effects assessments:

1. Determine scope of project
2. Determine scope of assessment
3. Compile the socio-economic baseline
4. Characterize potential effects
5. Determine required mitigation/enhancements
6. Determine significance.

All of the steps outlined are included in the socio-economic effects assessment for the KRP.

Both the Act and the YESAB's published guides emphasize the importance of engagement with potentially affected communities to establish and validate valued socio-economic components (VESECs), to characterize potential effects, to evaluate potential mitigation and enhancement strategies, and finally, to determine the significance of the potential effects on the VESECs. The last three tasks are an iterative process, which involves substantial contact and consultation with potentially affected communities, First Nations, and other identified interests. From the very beginnings of the assessment process, KRH and its consulting teams has been very much engaged with the Yukon communities most likely to be affected by the KRP, with First Nation governments, with YG, and with others who have an interest in the KRP.

7.2.1 Determine Scope of the Project

Determining the socio-economic scope of a project requires that we:

1. Identify and describe the principal project
2. Identify and describe any accessory project or projects

3. Summarize the broad project components and activities that will be included in the assessment
4. Describe and document the rationale used to determine the socio-economic scope of the project.

The KRP Project description can be found in Section 6 of this Project Proposal.

In Section 9 of the Project Proposal we summarize the broad project components that are included in the socio-economic effects assessment and describe and document the rationale used to determine the socio-economic scope of the Project.

7.2.2 Determine Scope of the Assessment

Determining the scope of the socio-economic effects assessment includes:

1. Developing a basic understanding of the socio-economic setting
2. Identifying which communities, governments, organizations, and individuals have an interest in a given project
3. Identifying what those interested parties value in the socio-economic context (their valued socio-economic components or VESECs)
4. Determining whether the project is likely to have a significant effect on those valued socio-economic components
5. Establishing the spatial and temporal boundaries for the assessment and documenting the rationale for choosing those boundaries.

In Section 5.0 of the Project Proposal, the socio-economic setting in which the Project will operate is described. In Section 9.0, the remaining steps for determining the scope of the socio-economic assessment are identified.

7.2.3 Compile Socio-economic Baseline

In an effects assessment, the baseline provides the necessary indicators for answering the question; what effects will the proposed project have on the community or other interest? 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 VESECs and point to measurable change in human population, communities and social and economic relationships resulting from a 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."*

Thus, the socio-economic baseline data presented in Section 9.0 of the Project Proposal have not been put together simply to provide a backdrop for the effects assessment or as a background primer for those not familiar with the affected communities. Rather, all of the data on the communities, and for the Yukon that make up the baseline has been selected to provide useful indicators for measuring the anticipated effects

on each of the identified valued socio-economic components (VESECs) for the proposed development, operation and closure of the KRP. The baseline indicators will also provide the means for longer term socio-economic effects monitoring as the KRP proceeds. It is also important to note that the anticipated effects of the Project on the baseline indicators assist in devising effective mitigation and enhancement measures during the effects assessment itself.

However, there is not always a clear and direct indicator for each of the VESECs. Where this is the case, we have either selected indicators that, singly or together, can provide indirect or proxy means of measurement or we have not provided a quantifiable indicator at all where there is no value in doing so. In these cases we acknowledge the VESEC (it is often the case in the social sciences that the things we have no means of measuring are given insufficient weight in an assessment), and describe any indirect or anecdotal evidence for our assumptions of how the KRP will affect it. Providing an indicator that has only a tenuous or tangential relationship to the VESEC at best will not assist in the assessment and may distract from what is actually valued. We are trying to avoid including data simply because it is available.

7.2.4 Socio-economic Effects Assessment with Mitigation and Enhancement Measures

In Section 9.0 of the Project Proposal we:

- Characterize and assess the effects the KRP may have on the VESECs identified
- Propose mitigation measures when those effects are negative or enhancement measures when they are positive
- Document the rationale and methods used.

In Section 9.0 we have grouped sets of potential socio-economic issues or effects of the Project into the following five VESECs:

- Economy and Sustainable Livelihood
- Human Health and Well-being
- Community Vitality
- Infrastructure and Services
- Culture, History and Heritage.

Each VESEC has a number of sub-components. Where VESECs overlap among the identified interests we characterize how each of those interests will be affected. Included under each of the VESECs are the mitigation or enhancement measures planned by KRH to maximize the social and economic benefit of the KRP and minimize social and economic costs. Where applicable we have distinguished between the three broad phases of the KRP: construction, operation, and closure/reclamation.

7.2.5 Significance Analysis and Cumulative Effects

The final step in the socio-economic effects assessment of the Project presented in Section 9.0 of the Project Proposal is an analysis of the significance of the anticipated residual social and economic effects of the KRP once mitigation and enhancement measures have been applied. In addition we include a discussion of the possible cumulative effects of the KRP in addition to other known activities and KRPs in the region.

8.0 ENVIRONMENTAL EFFECTS ASSESSMENT

8.1 Natural Landscape, Soil Stability, and Terrain Hazards

8.1.1 Identification of Valued Environmental and Socio-economic Components

Based on the surficial geology and terrain hazard baseline studies, the following VESECs have been identified:

- Natural landscape
- Stability of soils
- Human safety.

The natural landscape component was identified due to its importance to both ecological processes as well as social values. Soil stability was selected as it can reflect the overall health of an ecosystem. Human safety was selected as a valued component due to the potential effects of terrain hazards such as rockfalls, snow avalanches, debris flows, and landslides on the safety of on-Site employees.

The temporal boundary for the natural landscape, soil stability and terrain hazards assessment is beyond the mine life. The spatial boundary is the Site and Ketza Road.

Mass movement mechanisms are uncommon in the LSA. One relic debris flow is interpreted south of the mill but it is inactive. The frequency of this debris flow is low. The time period for unstable soils to accumulate on gully side slopes, combined with extremely high precipitation and/or meltwater runoff, is very long-term and it is unlikely that a debris flow event will occur again within the life of the mine. Rockfalls typically occur on steep (greater than 70% gradient slopes) and are generally very small and frequent rather than large and infrequent. Rockfall is more common in the spring with night time freezing and daytime thawing. The mill area and most other work sites are not affected by rockfall.

8.1.2 Effects Characterization

For natural landscape, soil stability, and terrain hazards, the effects characterization is summarized below for each of the VESECs.

Natural Landscape

The removal of vegetation and the stripping of soil for infrastructure development may result in negative effects to the natural landscape leading to a reduced aesthetic value, and the ability of soils to support natural vegetation and existing habitat.

New road construction and areas of road widening along existing access roads could result in potential effects to permafrost, if present. The potential effects include the melting of exposed or disturbed permafrost, which could lead to sloughing of slopes. It is not anticipated that upgrades and maintenance of the roads, including repair or replacement of bridges or culverts, will affect permafrost, if present, in the existing roadway.

Soil Stability

Effects to soil stability may occur through the alteration of natural landscapes during road construction and development of mine infrastructure, borrow sites, quarries, stockpiles, and staging areas. Typical practices that may affect the physical environment include the removal of surficial material to form potentially unstable cutslopes; placement of fill on unstable natural slopes; stripping to expose underlying soils and permafrost, if present, as well as alteration of the landform resulting in redirection and/or concentration of natural drainage channels.

Without proper mitigation, foundations (of waste dumps, dams, TSFs, buildings, etc.) cutslopes and fillslopes (along roads, within pits, etc.) can become unstable in some areas and may be subject to failure and erosion due to site specific soil conditions, terrain attributes, or the melting of permafrost, if present. These potential effects can be mitigated with proper investigation, design, construction, and maintenance practices.

Exposed soils on slopes above streams or connected to streams by ditches can cause increased sedimentation in streams. In the absence of proper drainage management, alteration of natural drainage patterns can result in unnatural runoff 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 KRP is currently accessed by the Ketza Road. Access within the property will use a combination of existing roads and haul roads. The haul roads represent about 10 km of new road construction that will lead to the edge of the Site footprint. Most of the new roads will be located on mid-valley slopes with some sections along lower valley slopes. The new roads will be located mostly through irregular terrain on valley sideslopes ascending from lower valley slopes to mid- and upper- valley slopes through a series of switchbacks. About 2.3 km of the northern-most section of the haul road is located across terrain that has not been characterized in detail. Terrain in this area is similar to the area that has been mapped, with the dominant geomorphological processes being rockfall and snow avalanche. Standard cut and fill methods are expected to 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 VESEC is a specific consideration in relation to terrain hazards and soil stability, mainly due to potential landslides, debris flows, rockfalls and snow avalanches along the road alignments. There were no active or recent landslides or debris flows reported to have affected the Ketza Road, but there is potential for debris flow activity in gullied stream channels on the steep valley side slopes that could potentially affect sections of the haul roads. Rockfall is an ongoing erosion process forming talus slopes at the base of upper valley slopes. Upper sections of the haul roads cross the initiation zones of active rockfall

areas such that ongoing rockfall is expected to occur especially in connection with freeze/thaw or wet/dry events. Snow avalanche hazard has been identified in the study area, primarily along road alignments. There is a high probability of snow avalanches in some parts of the KRP area, based on avalanche potential studies previously undertaken at the Site.

8.1.3 Mitigation Measures

Natural Landscape

KRH will employ the following mitigative strategies to reduce potential negative effects on the natural landscape from aesthetic and soil function standpoints:

- 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. Selection of borrow sites will consider aesthetics, i.e., visual effects of development. Where possible, borrow sites will be developed in areas where visual effects will be minimized. Minimizing the effect to the natural landscape will be considered when designing and clearing for mine infrastructure development.
- Where there is a potential for soil erosion, 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 that new drainage patterns are directed to areas with stable soil and terrain. Erosion can be mitigated by seeding, armouring or other techniques recommended by a qualified professional.
- Slope stability studies 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

KRH 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 8.1-1 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 8.1-1: Typical Cutslope Ratios

Material	Horizontal:Vertical Cutslope
Till	0.25:1
Soft rock	0.5:1 (benched)
Sandy or gravel alluvium	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)

Source: Chatwin et al. 1994

- Fillslopes will generally be prepared by removing vegetation and organic soils prior to placement of fill material. If fillslopes are constructed in terrain with naturally steep slopes, (e.g., greater than approximately 30%), a qualified professional will determine the appropriate design, including road construction, using full bench and end haul methods, or using an engineered fill or other designed structure. Terrain at potential fillslopes will be assessed during predesign 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.
- Surficial materials at the KRP are expected to be mostly well-drained to moderately well-drained. There were no drainage-related mass movement processes observed in the study area. Culverts or bridges, as appropriate, will be placed at all natural watercourses. The diameter of the culverts will be sized according to anticipated flow conditions, using appropriate methods of analysis. Appropriate structures to pass potential debris flows will be designed where required. Recommendations for culvert-spacing in areas with infrequent natural watercourses will be developed during assessment for final detailed design. Micro-watersheds will be defined to avoid the over-concentration of natural drainage runoff to culverts. Inlets and outlets of culverts will be armoured where required, to protect against erosion and disperse the flow energy on to natural slopes and streams. 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 maximize design function during periods of peak volume runoff.
- It is anticipated that permafrost encountered in road widening, if any, will be localized and small in areas. 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. In order to mitigate the effects on permafrost in areas of road widening, these areas will be constructed to minimum widths acceptable for safe vehicle use in the mining operations, where possible. Slope stabilization will be employed in areas of sloughing.
- Standard mitigation measures will be used to reduce the potential to introduce sediment to streams during construction. Sediment fences will be placed in ditches and other appropriate locations if intercepted runoff contains unacceptable levels of suspended sediment, as defined by the Water Licence 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. Where fine-textured soils on cleared slopes are identified as having erosion potential from precipitation and runoff, revegetation of the slopes, or another appropriate cover method, will be implemented as a mitigative technique as required through prescriptive measures provided by a qualified professional.

- Upon completion of road construction, KRH 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 the road surface, 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 will be implemented such as adding sediment fences in key locations and the temporary diversion of runoff away from streams.

Human Safety

KRH 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 magnitude and probability of occurrence of rockfalls will be evaluated during predesign geotechnical evaluation, and an appropriate mitigation strategy will be implemented, as required (e.g., installation of rockfall fences, monitoring, road shutdown criteria). 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, and undertake appropriate mitigative actions, as required.
- KRH will continue to control avalanche conditions proactively, whenever a hazard is observed or anticipated. Development activity in areas of high avalanche hazard will be monitored, and if required, limited during perios of high avalanche probability.

Key environmental effects and mitigation measures are summarized in Table 8.1-2.

Table 8.1-2: Natural Landscape, Soil Stability and Terrain Hazards – Key Environmental Effects and Mitigation

Key Environmental Effects	Mitigation Measures
Reduced Aesthetic Value	▪ Minimum road widths and infrastructure footprint to be used ▪ Cleared slopes to be revegetated or covered by other suitable means ▪ Aesthetics will be considered for borrow pit site selection
Soil Stability	▪ Cover or revegetate disturbed areas with native species ▪ Seed, armour, or apply other mitigation measures as required ▪ Appropriate cut slope ratios will be applied ▪ Conscientious drainage management ▪ Engineered cut and fill slopes ▪ Regular slope stability assessments will be conducted ▪ A geotechnical evaluation will be conducted as part of detailed road design ▪ Specific design parameters will be applied to sections identified with permafrost ▪ Adequately sized culverts will be used and additional culverts installed where necessary ▪ Sections of existing roads with inadequate culvert frequency will be identified and additional ditches and culverts will be added as required ▪ Culvert inlets and outlets will be armoured as required
Human Safety	▪ A reporting system will be in place for potential rockfalls and actual fallen rocks ▪ Snow avalanche management and safety training program will continue

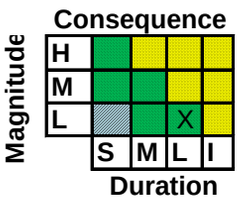
8.1.4 Residual Effects, Consequence, and Significance Determination

The effects of KRP activities on the VESECs soil stability and human safety from a geology and terrain hazards standpoint can be adequately mitigated, therefore, further assessment has not been completed for these effects.

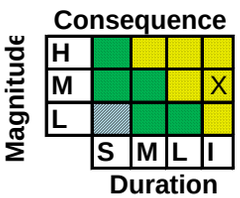
The removal of soil following implementation of mitigation measures, will not be completely mitigated. The overall consequence of the effects has been assessed by considering the magnitude, extent and duration of the Project-related activities. The results of this assessment are summarized in Table 8.1-3.

Table 8.1-3: Natural Landscape, Soil Stability and Terrain Residual Effects Assessment

Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Stripped Soils	Low	Local	Long-term	Isolated	Reversible Long-term	High



Permafrost degradation	Moderate	Local	Long-term	Isolated	Irreversible	High



8.2 Climate

8.2.1 Identification of Valued Environmental and Socio-economic Components

Climate is recognized as a VESEC for the Project. Climate, particularly in northern regions, is of concern in relation to global warming, due to a global increase in greenhouse gas (GHG) emissions which threaten the ecosystems which northern communities depend on. With global emphasis being placed on climate and its rate of change, this VESEC is of high importance to society, at a community, territorial and national level.

8.2.2 Summary of Baseline Information

Detailed baseline climatic conditions at the Site, regional climate trends and future climate scenarios are summarized in Section 4.5. In summary, air temperatures at the KRP typically range from 20°C during the summer to -20°C during the winter. The presence of strong winter inversions results in warmer temperatures at elevation (typically to 1,600 m) than those observed in the valleys. The Site receives an average of 715 mm of water-equivalent precipitation annually: 275 mm as rainfall, 440 mm as water-equivalent snowfall. Based on observed regional rates of precipitation increase with height, precipitation is likely greater (between 840 and 1,200 mm) at higher elevations on the Site. Lake evaporation is estimated at 285 to 300 mm/year. The prevailing wind direction (at the camp) is from the south-southwest and wind speeds are typically light (75% of all winds recorded as less than 3 m/s).

Long-term regional data show a slightly increasing trend in both winter and summer temperatures and a near-neutral trend in precipitation. Climate models generally predict an increase in annual air temperatures between 2°C and 5°C and an increase in annual precipitation up to 10% for the region over the next half century.

8.2.3 Effects Characterization

KRP activities will result in the emission of GHGs, most significantly carbon dioxide (CO_2) but also including methane (CH_4) and nitrous oxide (N_2O). GHGs have been linked to climate change and a general warming of arctic regions and a resulting increasing destabilization of permafrost. GHG emissions management is a territorial and national responsibility. Under the Copenhagen Accord, Canada has committed to reducing its GHG emissions to a level 17% below 2005 levels by 2020 (EC 2011).

GHG emissions are calculated in terms of tonnes of CO_2 equivalency (tCO_2e) defined as the concentration of CO_2 that will produce the same level of radiative forcing (warming) as a given type and concentration of greenhouse gas. Table 8.2-1 summarizes the trends in GHG emissions in the Yukon and Canada. Based on its national inventory, EC (2011) estimates Yukon's total GHG emissions in 2009 to be 0.317 megatonnes of carbon dioxide equivalent ($MtCO_2e$), a decrease of 12% from 2008 levels and 22% from 2005 levels. Canada's total GHG emissions in 2009 were estimated to be 690 $MtCO_2e$, a decrease of 6% from 2005 levels (Table 8.2-1).

Table 8.2-1: Trends in GHG Emissions – Yukon and Canada

	1990	*1995	*2000	2005	2008	2009
Yukon GHG Emissions ($MtCO_2e/yr$)	0.540	0.570	0.470	0.409	0.362	0.317
Canada GHG Emissions ($MtCO_2e/yr$)	590	640	716	731	732	690

Source: *Environment Canada 2005 – Table A10-12.
Environment Canada 2011 – Table 5-1, Table A14-13.

The energy requirement for mining operations at the KRP is expected to be 3 MW, supplied by diesel generators at an estimated fuel consumption rate of 800,000 L per month. To estimate GHG due to diesel consumption, the Intergovernmental Panel on Climate Change (IPCC) provides a guideline of 2.6 kg CO_2/L (22 lbs/gallon, US EPA 2005). At the projected fuel consumption rate, approximately 25 kt CO_2 will be produced by operations at Ketza in one year. The estimate is comparable to Tamerlane Ventures Inc. estimate of 56 $ktCO_2e$ produced annually from 6 MW of diesel power production (28 $ktCO_2e$/yr for 3 MW, EBA 2008f).

Average GHG emissions generated in gold production have been estimated at 11.5 tCO_2e/kg Au (Mudd 2008). Production emission sources include fuel consumption of haul trucks, gold mine methane, blasting agents and liquefied petroleum gas. At an estimated gold production rate of 1,700 kg Au annually at Ketza, an additional 17 $ktCO_2e$ will be expected to be produced per year. Another estimate is provided using Barrick Gold Corp.'s 2010 estimate of 29 $kgCO_2e$ emitted per tonne of ore production from direct and indirect sources (fuel consumption, explosives use, purchased energy). At an expected ore production of 1,500 tonnes/day, KRP will produce 16 $ktCO_2e$ of GHG in one year.

These calculations provide an estimate of the potential GHG emissions produced from mining operations at KRP. The overall estimate of 42 $ktCO_2e$/yr represents 13% of all GHGs produced in the Yukon in 2009, but is insignificant (less than 0.001%) compared to the national inventory.

8.2.4 Mitigation Measures

KRH will consider connecting to the regional electrical power grid to potentially reduce its diesel consumption at Site, and subsequently, its GHG emissions. The use of grid power is estimated to result in a reduction in diesel consumption of 3,000,000 L/yr and a subsequent reduction in GHG emissions of 8 $ktCO_2e$ annually.

The following mitigation measures will be adopted and followed throughout operations in order to minimize the Project's GHG emissions:

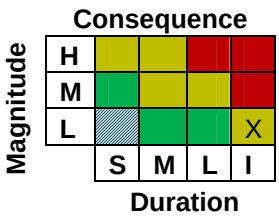
- KRH will investigate and consider the feasibility of using commercially-available alternate energy sources.
- Generators, vehicles, and other machinery used on-site will be operated in an efficient manner.
- KRH will conduct regular maintenance of all equipment.

8.2.5 Residual Effects, Consequence, and Significance Determination

The consequence attributed to GHG emissions at the KRP following mitigation measures is moderate with respect to the LSA and the RSA (Table 8.2-2), although such consequence is difficult to assess given the nature of the issue. Climate change is a global issue. Due to atmospheric circulation, emission of GHGs is not confined to the region, but rather contributes to the overall global concentration of atmospheric CO_2. While GHG emissions due to the KRP's mining operations constitute 13% of the territorial inventory, contributions from the mine are of low significance on a national or global scale. Furthermore, although scientific opinion suggests that increasing atmospheric CO_2 is directly related to global warming and climate change, the certainty and degree of such effects as well as the reversibility of atmospheric GHG is uncertain.

Table 8.2-2: Climate Residual Effects Assessment

Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
GHG Emissions	Low	Beyond Regional	Medium-term	Continuous	Irreversible	High



8.3 Air Quality

8.3.1 Identification of Valued Environmental and Socio-economic Components

Air quality is identified as a VESEC, as KRP activities will produce emissions that have the potential to affect health and safety, particularly in the vicinity of the mine, and potentially hundreds of kilometres down valley as airborne constituents are transported by wind. Of particular concern with the operations are total suspended particulates (TSP), specifically particulates less than10 µm in diameter (PM_{10}), or thoracic particles, in fugitive dust which can penetrate the human respiratory tract and lead to acute and chronic health problems (CEPA 1999). Particulates less than 2.5 µm ($PM_{2.5}$)are generally more toxic in nature, are respirable into the gas-exchange regions of the lung, and carry twice the risk of mortality (CEPA 1999). Airborne particulates also affect the health of wildlife (Section 8.7) and negatively impacts vegetation growth (Section 8.6).

8.3.2 Summary of Baseline Information

Baseline air quality is not monitored at the Site, however ambient background particulate concentrations for remote sites typically ranges between 4 and 12 µg/m^3 for PM_{10} and less than 6 µg/m^3 for $PM_{2.5}$ (CEPA 1999). The Canada Wide Standards national standard for $PM_{2.5}$ is 30 µg/m^3 averaged over a 24-hour

period. The maximum acceptable level for TSP is 120 µg/m^3 over a 24-hour period and 70 µg/m^3 averaged annually.

Fugitive road dust due to vehicular traffic during exploration activities may temporarily elevate dust levels in the vicinity of the road, but is of minor significance since such activity is low and confined to the road corridor. Elevated levels of particulates may occur during the summer months due to migration of forest fire smoke in the region, although such occurrences are rare.

Low wind speeds at the Site and prevalent inversion conditions during the winter greatly hinder the ability of the atmosphere to disperse pollutants from their source, potentially resulting in poorer air quality within the LSA during such meteorological conditions.

8.3.3 Identification of Temporal and Spatial Boundaries

Consideration of air quality effects from KRP activities is mainly confined to the upper Cache Creek Valley airshed, the corridors of the Ketza Road and the Robert Campbell Highway. Fine particulates can be transported hundreds of kilometres by the wind, however due to atmospheric dispersion, concentrations are likely insignificant with respect to human health.

Pre-construction will begin as early as March 2013. The full construction phase is estimated to be complete by fall 2014. The operational phase is scheduled to commence during fall 2014 and last for five years. Full decommissioning is scheduled to be completed by 2022. Fugitive dust emissions will be of concern during the construction phase, peaking during the operational phase and declining throughout the decommissioning phase.

8.3.4 Effects Characterization

Particulate air pollution is linked to cardio-respiratory health issues with both acute and chronic exposure. Health issues associated with short-term exposure to elevated levels include increased respiratory problems, such as coughing or wheezing, and/or small reductions in lung function, especially in asthmatic adults. Long term exposure is associated with lung function decrements, respiratory disease symptoms, and lung cancer (CEPA 1999).

Particulates greater than 2.5 µm, consisting of materials typical of the earth's crust (oxides of iron, calcium, silicon and aluminum) are efficiently removed by gravitational settling and remain in the atmosphere for periods of a few hours to a few days. Particulates less than 2.5 µm, consisting of ammonium, sulphate, nitrate, lead, elemental carbon and organic compounds, may persist in the atmosphere from a few days to a few weeks (CEPA 1999).

Sources of particulates during the life of the KRP include:

- Constructing Site roads and surface structures through blasting and clearing
- Quarrying and borrowing for construction / foundation materials
- Operations at the Site, such as crushing, blasting and hauling
- Transporting equipment and supplies along Site roads, the mine access road and the Robert Campbell Highway
- Wind erosion
- Burning waste using a solid waste incinerator.

A cursory estimate of ground level concentrations near the source (pits) has been conducted based on inventories calculated from similar projects. PAE Holmes (2009), in its Air Quality Assessment for Barrick Gold Corp.'s Cowel Gold Mine estimated total dust emissions from open pit mining with an annual ore production rate of approximately 5.5Mt to be just over 5,000 tonnes per year. With a projected annual ore extraction rate at Ketza of 0.5 Mt (1,500 tonnes/day), fugitive dust, or TSP, proportionate to the PAEHolmes inventory, will be in the range of 500 tonnes per year.

HC's estimate of TSP composition for PM_{10} and $PM_{2.5}$ is approximately 50% and 25%, respectively. Using these guidelines, total annual PM_{10} emissions will be approximately 250 tonnes per year or 685 kg per 24-hour period. If we assume 50% of all dust is emitted from Peel Pit, the largest pit on the Site with an approximate surface area of 400,000 m^2, and that the height of the inversion layer is 100 m above the elevation of the pit, concentrations without any atmospheric dispersion will be on the order of 8 mg/m^3. This is a crude estimate, but its significance is important to note when compared to the Canada-wide Standards air quality objective of 25 $\mu g/m^3$ (JAICC 2005).

8.3.5 Mitigation Measures

To reduce the health and safety risk to workers, PM levels will be maintained at or below national air quality standards. The ability of the atmosphere to disperse pollutants will be diminished under inversion conditions which are prevalent during the winter (see Section 4.4.3). Mixing heights under such conditions (i.e., the top of the inversion layer), are typically around 1,600 m asl. throughout the Yukon (Pinard et al. 2009). The majority of the pits are near or slightly below this elevation, resulting in a very shallow stable layer of atmosphere which will trap airborne pollutants and suppress vertical and horizontal mixing, particularly under calm wind conditions which are also observed to be prevalent at Site (see Section 4.4.2*)*.

Mitigation measures that will be undertaken by KRH are:

- Particulate monitoring will be carried out at locations where personnel will be working.
- Employees will wear appropriate Personal Protective Equipment (PPE) in higher dust areas, to reduce the potential for particulate matter inhalation.
- Dust suppressants will be applied in areas of high activity under dry conditions, (such as water or calcium chloride) will be applied as required, to minimize airborne dust.

8.3.6 Residual Effects, Consequence, and Significance Determination

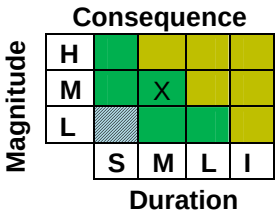
The potential consequence associated with prolonged exposure to particulate matter is high, however epidemiological evidence shows that the magnitude of risk for non-accidental mortality for each 10 µg/m^3 increase in concentration of PM_{10} increases approximately 0.8% at concentrations ranging between 25 and 115 µg/m^3. For $PM_{2.5}$, a 1.5% increase in mortality per 10 µg/m^3 increase is observed at concentrations ranging between 11-30 µg/m^3 (CEPA 1999).

Effects of dust emissions are mostly limited to the airshed of the LSA. As a result, air quality issues are considered to be of very low significance outside of the LSA. Dust emissions within the LSA are considered to be of moderate significance because meteorological conditions which will lead to high levels of particulate matter near the surface will likely be periodic in nature and air quality will return to baseline after completion of the KRP.

The residual effects from dust are summarized in Table 8.3-1.

Table 8.3-1: Air Quality Residual Effects Assessment

Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Exposure to particulate matter / dust emission	Moderate	Local	Medium-term	Periodic	Reversible Short-term	High



8.4 Noise Levels

8.4.1 Identification of Valued Environmental and Socio-economic Components

Noise level has been designated as a VESEC as it is anticipated that the Project will elevate noise levels above baseline within the LSA. A low noise environment is also considered a VESEC with respect to wildlife, as noise may affect an animal's physiology and behaviour (Radle 2007; Section 8.7).

8.4.2 Summary of Baseline Information

Noise levels at the Site are currently not monitored, however ambient noise will be expected to be typical of a remote forested mountainous setting. Environmental noise is a combination of distant sounds consisting of birds, animals, wind in trees and passing aircraft (AMEC 2008). This background noise is interrupted by short duration noisy events such as passing vehicle traffic, snowmobiles, helicopters or other noises related to exploration activities and baseline studies on the Site.

Based on other baseline studies in remote areas of British Columbia with effective noise absorbers such as trees and hills, ambient non-anthropogenic noise levels at the Site will be expected to be in the range of 15 to 25 A-weighted decibels (dBA) averaged over a 24-hour period.

8.4.3 Identification of Temporal and Spatial Boundaries

Noise will be generated in areas where Project activities occur, most notably blast areas, and will propagate with attenuation of approximately 6 decibels per doubling of distance from the source, although this will depend on meteorological and ground conditions. Noise will also be generated along the Ketza Road and along the Robert Campbell Highway.

For the evaluation of noise, the boundaries of the LSA are defined at a distance 1.5 km from noise sources. Noise must achieve attenuation to 40 dBA to satisfy regulatory compliance according to the Alberta Energy and Utilities Board noise guide for remote facilities (EUB 1999). The boundaries of the RSA are defined at a distance 8 km from high level blasting noise, the distance required to achieve attenuation to background levels (AMEC 2008).

Noise is expected to be generated throughout the lifespan of the KRP (2013 to 2022). Maximum noise levels are expected to occur during the construction phase where blasting is required. Noise levels will be lowest during the decommissioning phase when drills and blasting are absent. There will be little distinction between daytime and night time noise periods as activities will occur continuously.

8.4.4 Effects Characterization

Sources of noise during the life of the KRP will include but are not limited to the following (typical noise level at 7 m; AMEC 2008):

- Production blasting (110 dBA)
- Primary crusher (104 dBA)
- Rock breaker (100 dBA)

- Blast hole drill (100 dBA)
- Loaders and haul trucks (85-98 dBA)
- Hydraulic excavator (90 dBA)
- Diesel generators (78 dBA).

Buses and supply trucks (approximately nine per week during operation) will increase vehicle noise, in particular tire noise, along Robert Campbell Highway.

8.4.5 Mitigation Measures

Due to the remote location of the Site mitigation measures are not required for human interest outside of the RSA. To maintain employee health and safety, PPE will be required around activities of high noise. Exposure at the camp will be reduced by:

- Insulating the camp walls.
- Designing the layout of the camp and on-site accommodation away from more active mining areas.
- Noise related to blasing activities will be controlled and minimized to the extent possible, for example through the use of constructed berms, dampening mats, or other methods.

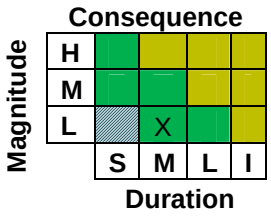
Blasting operations will be conducted in accordance with a Blasting Management Plan, which will include provisions for clearing both personnel and wildlife within a defined radius of a blast location. When blasting near surface waters, blasting will be conducted in accordance with DFO's *Guideline for Use of Explosives In or Near Canadian Fisheries Waters* (Section 8.12).

8.4.6 Residual Effects, Consequence, and Significance Determination

Noise disturbance is determined to be of moderate consequence in the LSA (Table 8.4-1), however noise-related effects to humans can be minimized through the use of PPE.

Table 8.4-1: Noise Residual Effects Assessment

Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Noise	Low	Local	Medium-term	Periodic	Reversible Short-term	High



8.5 Ecosystems and Vegetation

8.5.1 Identification of Valued Environmental and Socio-economic Components

VESECs considered in the effects assessment include ecosystems and plant species in general, as well as ecosystems that may be particularly sensitive to disturbance and those with a higher potential to support rare plant habitat (Table 8.5-1). Sensitive ecosystems include wetlands and those with a high lichen or *Sphagnum* component.

Table 8.5-1: Valued Environmental and Socio-economic Components Related to Ecosystems and Vegetation Considered in the Assessment of Project Effects

Valued Environmental and Socio-economic Component	VESEC Description	Mapped Ecosystem Unit
Sensitive ecosystems	High lichen cover	Heather-Lichen Fescue-Lichen Shrub Birch-Lichen Crowberry-Lichen Fir-Lichen
	High *Sphagnum* cover, Wetland	*Carex*-Moss
	Wetlands	Willow Riparian Willow-Forb
Rare plant habitat potential	Very high potential	Fir-Willow Willow-Shrub Birch Willow-Forb
	High potential	Shrub Birch-Lichen *Carex*-Moss

8.5.2 Summary of Baseline Information

The KRP is located in south-central Yukon, within the Boreal Cordillera Ecozone, Pelly Mountains Ecoregion, and Saint Cyr Range Ecodistrict. The ecosystems and vegetation present are characteristic of Boreal, Subalpine, and Alpine Bioclimate Zones, which are all present in the LSA. Non-vegetated talus slopes, Spruce-Moss forest, and Fir-Moss forest are relatively common, particularly along the Ketza Road. Anthropogenic features, such as roads and previous mine workings are also evident within the proposed mine site area. Surveys for rare plants and sensitive ecosystems were included as part of the baseline study program. No rare plants were identified in the field.

8.5.3 Effects Characterization

The primary effects of the KRP on ecosystems and plant species will be their removal and/or burial as a result of infrastructure development. Other effects include changes to soil conditions, an increase in air emissions largely in the form of fugitive dust, and the potential to introduce non-native and invasive plant species into previously undisturbed areas. These effects are likely to directly and indirectly influence the overall health, productivity, and function of the ecosystems and plant species present. With reclamation, the majority of the anticipated effects will be reversible over the long-term.

The Project footprint (the Site) footprint and mapped distribution of Ecosystem Units within the LSA were used to assess KRP effects on ecosystems and plants. Some KRP-related disturbances such as fugitive dust deposition and invasive species introductions are anticipated to be more localized in their extent, occurring closer to KRP infrastructure. Because the Ketza Road between the Robert Campbell Highway and the Site has been in place and active for years, effects relating to the disturbance or removal of ecosystems and vegetation have not been quantified. Effects associated with the potential to deposit fugitive dust and introduce invasive plant species are discussed.

8.5.3.1 Removal and/or Burial of Ecosystems and Vegetation

The footprint of Project-related infrastructure footprint is approximately 331 ha in size, of which 45% (148 ha) is composed of waste dumps and pits (Table 8.5-2). An additional 24% (80 ha) of the total infrastructure footprint is attributable to existing disturbance in the form of roads. Wherever possible, the placement of infrastructure has incorporated previously disturbed areas, such as existing roads and areas with exposed soil.

Table 8.5-2: Distribution of Ketza River Project Infrastructure Footprint Components

Infrastructure Footprint Component	Infrastructure Footprint Area (ha)	Proportion of Infrastructure Footprint (%)
Waste Dump	83.0	25.0
Existing Roads	79.8	24.1
Pit Extents	65.6	19.8
Haul Road	32.4	9.8
TSF	24.2	7.3
Ketza Road	21.7	6.5
Canamax TSF	11.8	3.6
Infrastructure	9.5	2.9
Dam Structure	2.8	0.8
Pipeline	0.6	0.2
Total	**331.4**	**100.0**

The KRP infrastructure footprint covers approximately 12% of the LSA and is dominated by anthropogenic and treed Ecosystem Units (Table 8.5-3). Combined, these Ecosystem Units cover approximately 235 ha (71%) of the Project infrastructure footprint. Approximately 39% (111 ha) of the area associated with existing roads in the LSA has been incorporated into the KRP infrastructure footprint and will either stay as roads or will be integrated into other infrastructure.

Natural ecosystems that will be affected most by KRP development include Fir-Moss and Willow-Riparian units, which cover approximately 75 ha (23%) and 26 ha (8%) of the infrastructure footprint, respectively (Table 8.5-3). Both of these Ecosystem Units occur outside of the infrastructure footprint area; it is unlikely that the level of disturbance proposed will threaten their sustainability within the larger landscape.

Development of the pits and waste dumps in particular is expected to result in irreversible disturbance due to the nature of the development (e.g., excavation of the pits and deep burial of areas for waste dumps). Ecosystem Units predominant in waste dump areas include Fir-Moss, which covers approximately half of

the proposed area identified for development (44 ha of the 83 ha proposed), and Fescue-Lichen, which covers another 10 ha. The pit extents are dominated by existing roads, which cover 51 ha of the 66 ha proposed.

Both the Fir-Moss and Fescue-Lichen units occur beyond the infrastructure footprint area. When compared to the total amounts of these Ecosystem Units present within the larger mine site LSA, KRP development will result in the irreversible disturbance of 11% of Fir-Moss (44 ha of the 402 ha present) and 11% of Fescue-Lichen (10 ha of the 88 ha present).

Table 8.5-3: Ecosystem Unit Distribution within the Infrastructure Footprint and Mine Site Local Study Area

General Ecosystem	Ecosystem Unit	Infrastructure Footprint Area (ha)	Ecosystem Proportion of Infrastructure Footprint (%)	Ecosystem Distribution within the Mine Site LSA (ha)	Footprint Proportion of the Mine Site LSA (%)
Anthropogenic	Road	110.9	33.5	286.2	38.7
	Tailings	11.8	3.6	11.8	100.0
	Rural	6.6	2.0	8.8	75.2
Dwarf Shrub	Heather-Lichen	14.5	4.4	112.5	12.9
	Crowberry-Lichen	6.7	2.0	47.2	14.3
	Dwarf Willow-*Carex*	0.6	0.2	70.6	0.9
	Mountain Avens-*Carex*	0.0	0.0	9.5	0.0
Herbaceous	Fescue-Lichen	15.1	4.6	87.7	17.2
	Carex-Moss	1.6	0.5	16.2	9.7
	Willow-Forb	0.0	0.0	42.0	0.0
Shrub	Willow Riparian	26.3	7.9	174.4	15.1
	Willow-Shrub Birch	7.5	2.3	148.6	5.0
	Willow-Slope	7.3	2.2	34.2	21.3
	Shrub Birch-Lichen	6.4	1.9	63.1	10.2
Sparsely Vegetated	Talus	9.4	2.8	674.6	1.4
	Rock Outcrop	0.0	0.0	8.6	0.0
Treed	Fir-Moss	75.4	22.8	402.1	18.8
	Fir-Willow	12.3	3.7	162.7	7.6
	Spruce-Moss	12.2	3.7	408.3	3.0
	Fir-Lichen	4.8	1.5	18.6	26.0
	Black Spruce-Moss	0.6	0.2	8.8	7.3
	Aspen-*Viburnum*	0.1	0.02	16.4	0.5
Water	River	1.1	0.3	22.4	4.7
	Lake	0.0	0.0	6.0	0.0
Total		**331.4**	**100.0**	**2,841.4**	**11.7**

8.5.3.2 Sensitive Ecosystems

Seven of the eight sensitive Ecosystem Units identified within the LSA occur within the KRP infrastructure footprint, and cover a total of 75 ha or 23% of the infrastructure footprint overall (Table 8.5-4). They are largely represented by Ecosystem Units with a high lichen cover. Disturbances to individual Ecosystem Units compared to their distribution in the mine site LSA range between 0% (will not be disturbed, as is the case with the Willow-Forb unit) and 26% (Fir-Lichen).

Table 8.5-4: Sensitive Ecosystem Unit Distribution within the Infrastructure Footprint and Mine Site Local Study Area

Sensitivity	Ecosystem Unit	Infrastructure Footprint Area (ha)	Ecosystem Proportion of Infrastructure Footprint (%)	Ecosystem Distribution within the Mine Site LSA (ha)	Footprint Proportion of the Mine Site LSA (%)
High lichen cover	Fescue-Lichen	15.1	4.6	87.7	17.2
	Heather-Lichen	14.5	4.4	112.5	12.9
	Crowberry-Lichen	6.7	2.0	47.2	14.3
	Shrub Birch-Lichen	6.4	1.9	63.1	10.2
	Fir-Lichen	4.8	1.5	18.6	26.0
Wetland	Willow-Riparian	26.3	7.9	174.4	15.1
	Willow-Forb	0.0	0.0	42.0	0.0
High *Sphagnum* cover, Wetland	*Carex*-Moss	1.6	0.5	16.2	9.7
Sensitive Ecosystem Total		**75.5**	**22.8**	**561.6**	**13.4**
Not Sensitive		255.9	77.2	2,279.8	11.2
Total		**331.4**	**100.0**	**2,841.4**	**11.7**

8.5.3.3 Rare Plant Potential

The vast majority (92%) of the KRP infrastructure footprint is characterized by Ecosystem Units with a very low to moderate potential of supporting rare plant habitat (Table 8.5-5). KRP development will result in the disturbance of approximately 28 ha of area with a high to very high rare plant habitat potential, which represents 6% of the total characterized (432 ha) within the larger mine site LSA. Fir-Willow, Willow-Shrub Birch, and Shrub Birch - Lichen units will be disturbed most. However, all of these units occur within the larger mine site LSA, and none are expected to have greater than 10% of their total area affected.

Table 8.5-5: Rare Plant Habitat Potential Distribution within the Infrastructure Footprint and Mine Site Local Study Area

Rare Plant Habitat Potential	Ecosystem Unit	Infrastructure Footprint Area (ha)	Ecosystem Proportion of Infrastructure Footprint (%)	Ecosystem Distribution within the Mine Site LSA (ha)	Footprint Proportion of the Mine Site LSA (%)
Very High	Fir-Willow	12.3	3.7	162.7	7.6
	Willow-Shrub Birch	7.5	2.3	148.6	5.0
	Willow-Forb	0.0	0.0	42.0	0.0
High	Shrub Birch-Lichen	6.4	1.9	63.1	10.2
	Carex-Moss	1.6	0.5	16.2	9.7
High – Very High Rare Plant Habitat Potential Total		**27.8**	**8.4**	**432.4**	**6.4**
Very Low – Moderate Rare Plant Habitat Potential		303.6	91.6	2,409.0	12.6
Total		**331.4**	**100.0**	**2,841.4**	**11.7**

8.5.3.4 Potential Introduction of Invasive Plant Species

Invasive plants can negatively affect the economy, environment, and health of those living within affected regions. Although currently there are relatively few invasive plant species in Yukon, control and management of invasive plants becomes increasingly expensive if initiatives are not implemented early (YISC 2011).

Invasive plants are able to aggressively establish themselves and quickly spread within a new environment. This ability enables them to out-compete native species which can affect species richness, diversity, and the overall functionality of natural ecosystems (Haber 1997). The successful propagation of invasive plants relies, in part, on the presence of suitable habitat, a source of invasive plant material, and a means of dispersal.

Development projects by their nature result in disturbances to the environment, and can inadvertently create growing conditions that are favourable for the establishment of invasive species. Soils exposed by the removal of vegetation are particularly vulnerable to colonization. The transport of dirty equipment from sites with invasive species to other sites provides a dispersal mechanism for invasive plant propagules potentially lodged in machinery, tires, and mud.

The most effective management of invasive plants is to prevent their establishment (YISC 2010; Carlson and Shephard 2007; USDA 2011; Polster 2005). Removal once established is very costly and can be particularly challenging in more remote areas. Yukon currently reports the presence of 20 invasive plant species that can potentially negatively affect rangelands, forestry operations, water quality, and recreational opportunities (YISC 2011). Certain species, such as sweetclover (*Melilotus* spp.) have become so abundant along roadsides, it is obstructing sightlines and attracting wildlife, which can result in serious accidents (Photo 8.6-1).

The increase in vehicular traffic associated with the development of the KRP poses the greatest potential to disperse invasive species and introduce them into the KRP area specifically, particularly if equipment is sourced from areas with known infestations and arrive on-site dirty.



Photo 8.6-1: Sweetclover obstructing signage along the Alaska Highway. Source: Line et al. (2008).

8.5.3.5 Changes to Soil Conditions

Land clearing as part of infrastructure development is likely to result in complete soil disturbance such that the entire soil profile will be altered. Areas requiring large cut and fills (e.g., during road construction), could change local drainage patterns and promote increased soil erosion, both of which can affect upstream and downstream ecosystems (Pomeroy 1985; Spellerberg and Morrison 1998; Trombulak and Frissell 2000). Infrastructure placement can result in soil compaction and the interruption of surface and shallow subsurface flows, leading to localized ponding and drying. Ecosystems that will be most affected by altered soil conditions, particularly those affecting drainage, are those that are defined by their relative moisture regimes (e.g., are wetter or drier); changes to local hydrology could result in shifts in species composition away from characteristic assemblages.

8.5.3.6 Effects of Dust Deposition

Dust is a likely product of certain Project-related activities such as general construction and road use during the summer months. Dust deposition may affect both the surrounding substrate and vegetation; the level of effect is typically dependent on the following:

- Deposition frequency
- Load
- Duration
- Physical and chemical properties of the dust.

Other influences on dust deposition patterns include:

- Particle size
- Wind direction and velocity
- Terrain
- Vegetation density and structure
- Vehicle size and speed
- Traffic volumes.

Several studies of the effects of road dust on vegetation have noted the variability in particle transport, with effects being detected 100m away (Auerbach et al. 1997), 200m away (Santelmann and Gorham 1988; Angold 1997), and up to 400m away (Lamprecht and Graber 1996). Walker and Everett (1987) identified that up to 75% of the total dust load can be deposited within the first 10 m of the road irrespective of site conditions.

Studies by the United States Environmental Protection Agency (US EPA 1995) have also highlighted the influence of particle size on dust deposition patterns. Large particles (e.g., those with an aerodynamic diameter >100 µm), tend to settle within 10 m of the source, while particles with moderate sizes (e.g., with diameters between 30 – 100 µm) settle within 100 m. Very small particles (e.g., with aerodynamic diameters <15 µm) tend to be transported over much greater distances as they are less influenced by gravitational settling. Road dust generally contains particles ranging in size from >3 to <10 µm and is the result of road surface aggregate being thrown into suspension by traffic (Walker and Everett 1987).

Plants can be both physically and physiologically affected by dust particles. Dust settling onto plant surfaces can reduce photosynthetic efficiency by blocking stomata, smothering leaf surfaces, and increasing leaf surface temperatures (Thompson et al. 1984; Pyatt and Haywood 1989; Farmer 1993).

Dust deposition can also modify the surrounding environment by changing substrate properties such as soil pH, soil nutrient regime, and surface albedo (which can result in earlier snowmelt) (Walker and Everett 1991; Auerbach et al. 1997). Longer-term studies have shown that these substrate changes can further influence changes in plant community composition, most notably as a decline in vigour and abundance of *Sphagnum* and lichen species as well as an increase in graminoids (e.g., grasses and sedges) closer to the dust source (Myers-Smith et al. 2006; Auerbach et al. 1997).

Lichen and *Sphagnum* moss species are often used as indicators of environmental conditions as they tend to have higher sensitivities to disturbances (Myers-Smith et al. 2006; Markert 1993; Tyler 1989; Spatt and Miller 1981). Declines in lichen abundance in studies of road dust deposition have been attributed largely to the sensitivity of lichen to the physical effect of dust deposition, the chemical composition of the dust itself, and the inability of the lichen to compete with other species that are responding more favourably to the changes in local growing conditions (Myers-Smith et al. 2006; Auerbach et al. 1997). A change in soil pH, from acidic to more neutral conditions, was identified as the likely cause of the decline in *Sphagnum* species (Myers-Smith et al. 2006; Auerbach et al. 1997).

Ecosystem Units of the KRP that could be most affected by dust deposition are those that support *Sphagnum* and lichen species and are characterized by more acidic or nutrient poor soil conditions. Specific Ecosystem Units include:

- Fescue-Lichen
- Heather-Lichen
- Crowberry-Lichen
- Shrub Birch-Lichen
- Fir-Lichen
- *Carex*-Moss.

8.5.4 Mitigation Measures

Mitigation to reduce the potential effects to Ecosystem Units and plant species are outlined in Table 8.5-6 and generally involve limiting the overall size of the footprint, incorporating previously disturbed areas into development plans, and avoiding sensitive Ecosystem Units and ecosystems with a higher potential to support rare plant habitat, where possible. Reclamation trials will be developed throughout the life of the KRP to identify the most effective treatment options for rehabilitating disturbed areas. Treatments will be applied progressively wherever possible, and will be implemented fully after KRP closure.

8.5.4.1 Invasive Plant Species

Efforts will be made to control the establishment and spread of invasive plant species. Managing exposed soils, either through re-vegetation or some other means of cover, is the primary mitigation for invasive plant species. It is also important that equipment being brought to site is clean as spores and seeds of invasive plant species are often transported via dirty equipment. Establishing a regular monitoring program for invasive plant detection on-site with a follow-up control and removal program, if required, will be in accordance with the early detection and rapid response approach to invasive plant control suggested by the Yukon Invasive Species Council (YISC 2011).

8.5.4.2 Changes to Soil Conditions

Efforts will be made where possible to clear the minimum area of land necessary for development and to maximize the use of previously disturbed lands. Rapidly covering exposed soils will not only help prevent the possible colonization by weedy or invasive species, it will also minimize the potential for soil loss from erosion. Limiting the ponding and pooling of water on surfaces will also minimize changes to existing soil moisture regimes.

8.5.4.3 Dust Deposition

Dust management will generally involve watering dust-prone areas as and when required, as well as adhering to speed limits which helps restrict the re-suspension of particulates. Alternative dust suppressants may be considered, and will be in accordance with the Yukon Environmental Programs Branch guidelines for the use of dust suppressants (YG Environment 2002).

Table 8.5-6: Summary of Ecosystem and Vegetation-Related Mitigation for the Ketza River Project

Potential Effect	Potential Consequence	Mitigation Measures
Removal and/or burial of ecosystems and plant species (including sensitive ecosystems and those that potentially provide high to very high rare plant habitat)	Long-term removal/disturbance of soil, ecosystems, and plant species	Minimize footprint size Maximize use of previously disturbed areas Stabilize exposed soils early to limit soil loss through erosion Where possible, avoid Ecosystem Units that are sensitive or have higher rare plant habitat potential Restrict on-site activities (e.g., ATV use) to footprint/disturbed areas Conduct reclamation trials over the life of the mine to determine effective treatment options Reclaim disturbed areas to ecosystems that are viable and self-sustaining
Potential introduction and spread of invasive plant species	Potential alteration of plant species composition in affected ecosystems; displacement of native plant species	Minimize footprint size Limit extent of exposed soil and re-vegetate/cover exposed areas as soon as possible Implement program to verify equipment transported to and used on site is clean; Conduct periodic monitoring of disturbed sites, particularly roadsides, for invasive species presence Implement strategy for removal if present
Changes to soil conditions	Alteration of local soil moisture regime, potential increase in soil loss through erosion, changes to plant community composition due to altered substrate	Minimize footprint size Stabilize exposed soils early to limit soil loss through erosion Minimize ponding and pooling of water on disturbed surfaces
Dust deposition	Alteration of local soil conditions and plant species composition, reduction in plant health and productivity	Apply appropriate dust suppressant as required Adhere to YG Department of Environment's guidelines for the use of dust suppressants (YG Environment 2002) Reduce vehicle traffic volumes Reduce speed limits

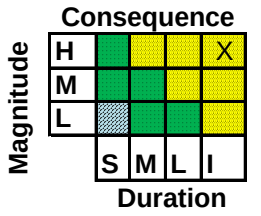
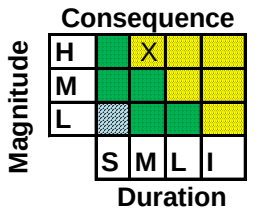
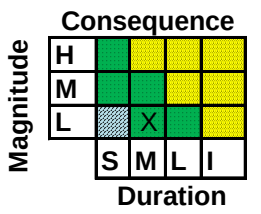
8.5.5 Residual Effects, Consequence, and Significance Determination

Within the infrastructure footprint, the removal or burial of ecosystem types and plant species will occur during construction and the effects will remain until the closure and decommissioning phase (Table 8.5-7). The effects are considered to be of high magnitude and of moderate consequence overall. Activities resulting in the irreversible disturbance of Ecosystem Units (e.g., through pit excavation and deep burial by waste rock) have also been assigned a moderate consequence due to the localized nature of the disturbance and the presence of affected ecosystems elsewhere in the LSA.

Effects to Ecosystem Units and plants from dust deposition and the potential introduction of invasive plant species have been assessed as being of low magnitude, persisting over the life of the KRP (e.g., medium-term). The effects will occur periodically and will be reversible over the long-term.

The residual effects described for ecosystems and vegetation have been determined to be of low significance overall due primarily to their localized and largely reversible nature.

Table 8.5-7: Ecosystem and Vegetation Residual Effects Assessment

Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Removal/burial of Ecosystem Units and Plant Species (Pits, Waste Rock Storage Areas)	High	Local	Long-term	Isolated	Irreversible	High	
Removal/burial of Ecosystem Units and Plant Species (Other Infrastructure)	High	Local	Medium-term	Isolated	Reversible Long-term	High	
Dust Deposition and Potential Introduction of Invasive Plant Species	Low	Local	Medium-term	Periodic	Reversible Long-term	High	

8.6 Wildlife

The Project has the potential to directly or indirectly affect wildlife species within the LSA or WRSA throughout the life-cycle of the KRP. KRP components that may potentially affect wildlife and wildlife habitat include the construction, operation, decommissioning and reclamation phases.

8.6.1 Identification of Valued Environmental and Socio-economic Components

VESECs were used to evaluate potential effects of the KRP on wildlife and wildlife habitat in the development area, and regional area where appropriate. The selection of wildlife-related VESECs for this Project Proposal is based on:

- Information provided in YESAB's *Integration and Implementation of Wildlife Baseline and Monitoring Programs in the Yukon: A Proponents Guide* (YESAB 2007)
- The biophysical components, species and species groups, which have been identified as being important by residents, resource managers, or by KRH.

Potential wildlife-related VESECs were screened using the following considerations:

- Species listed by SARA and/or assessed by COSEWIC as endangered, threatened, or special concern
- Species considered culturally important (i.e., important harvest species such as Moose, caribou and Thinhorn Sheep)
- Species considered sensitive to anthropogenic disturbance
- Species which are dependent upon dominant vegetation community types or habitats in the LSA.

Species and/or habitats that were selected as potential VESECs may not meet all of the criteria listed above; some were selected on the basis of only one category. For example, all species that have been identified by COSEWIC as endangered, threatened or special concern were considered as potential VESECs. The wildlife species, species groups, or wildlife habitat selected as VESECs are:

- Woodland Caribou
- Moose
- Thinhorn Sheep
- Grizzly Bear
- Wolverine
- Raptor Nesting (cliff habitat)
- Upland Breeding Birds.

All species or species groupings that were considered as potential VESECs are listed in Table 8.6-1.

Table 8.6-1: Valued Environmental and Socio-economic Components Evaluated for Ketza River Project's Wildlife Effects Assessment

Species/Group	Conservation Status	Culturally Significant	Sensitive to Disturbance	Representative of Southern Yukon	Selected for Assessment
Woodland Caribou	Special Concern (SARA; COSEWIC)	Yes	Yes	Yes	Yes
Moose	None	Yes	Yes	Yes	Yes
Thinhorn Sheep	None	Yes	Yes	Yes	Yes
Mule Deer	Specially Protected (*Wildlife Act*, Yukon)	Yes	No	Yes	No
Grizzly Bear	Special Concern (COSEWIC)	Yes	Yes	Yes	Yes
Black Bear	None	Yes	No	Yes	No
Grey Wolf	None	Yes	No	Yes	No
Wolverine	Special Concern (COSEWIC)	Yes	Yes	Yes	Yes
Small Mammals	N/A	Yes (some)	Some Species	Yes	No
Horned Grebe	Special Concern (COSEWIC)	No	Yes	Yes	No
Harlequin Duck	Special Concern (SARA; COSEWIC)	No	Yes	Yes	No
Barrow's Goldeneye	Special Concern (SARA; COSEWIC)	No	Yes	Yes	No
Raptor Nesting Habitat (Cliff)	N/A	N/A	Yes	Yes	Yes
Peregrine Falcon (*anatum*)	Threatened (SARA) Special Concern (COSEWIC) Specially Protected (*Wildlife Act,* Yukon)	Yes	Yes	Yes	Yes (The assessment for Raptor Nesting Habitat will encompass any potential effects to this species.)
Gyrfalcon	Specially Protected (*Wildlife Act,* Yukon)	Yes	Yes	Yes	Yes (The assessment for Raptor Nesting Habitat will encompass any potential effects to this species.)
Golden Eagle	None	Yes	Yes	Yes	Yes (The assessment for Raptor Nesting Habitat will encompass any potential effects to this species.)
Short-eared Owl	Special Concern	No	Yes	Yes	Yes (The assessment for Upland Breeding

Table 8.6-1: Valued Environmental and Socio-economic Components Evaluated for Ketza River Project's Wildlife Effects Assessment

Species/Group	Conservation Status	Culturally Significant	Sensitive to Disturbance	Representative of Southern Yukon	Selected for Assessment
	(SARA) Special Concern (COSEWIC) Specially Protected (*Wildlife Act*, Yukon)				Birds will encompass any potential effects to this species)
Horned Lark	None	No	Yes	Yes	No
Olive-sided Flycatcher	Schedule 1 (SARA) Threatened (COSEWIC)	No	Yes	Yes	Yes (The assessment for Upland Breeding Birds will encompass any potential effects to this species)
Common Nighthawk	Schedule 1 (SARA) Threatened (COSEWIC)	No	Yes	Yes	No
Rusty Blackbird	Schedule 1 (SARA) Special Concern (COSEWIC)	No	Yes	Yes	No
Savannah Sparrow	Special Concern (COSEWIC)	No	Yes	Yes	Yes

The assessment of potential effects begins with a review of the activities associated with the three primary phases of the KRP (construction, operation, and closure/reclamation, Table 8.6-2). Several activities associated with the Project are predicted to result in either direct or indirect loss of wildlife habitat. Direct habitat loss occurs if vegetation communities are removed or altered. Indirect habitat loss, for example, can occur through the effects of dust accumulating on vegetation making it no longer available as a food source.

8.6.2 Potential Wildlife Effects and Mitigation Measures

The following sections present the potential effects to wildlife species and wildlife habitat, along with associated mitigation measures. A summary is also provided in Table 8.6-2.

8.6.3 Woodland Caribou

Woodland Caribou are included as a VESEC because they are a Species of Special Concern under the *Species at Risk Act* (SARA) and are a culturally important species. The potential exists for Woodland Caribou to be affected by activities associated with the Project.

8.6.3.1 Summary of Baseline Information

The ranges of the Finlayson Herd and the Wolf Lake Herd lie generally outside the WRSA (Figure 4.8-1); however, caribou use within the WRSA has been documented. A total of 36 caribou in 17 groups have been observed during the Ketza Wildlife Baseline Program (2007 to 2011).

Key habitat for Woodland Caribou includes calving areas, rutting areas, winter range, migration corridors and mineral licks.

Ketza River Holdings

Table 8.6-2: Summary of Potential Residual Wildlife Effects and Proposed Mitigation Measures

Wildlife VEC	Description of Potential Effect	Project Phase (Timing)	Mitigation and Enhancement Measures	Description of Residual Effect (after Mitigation)	Evaluation of Residual Effect					
					Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Woodland Caribou Moose Thinhorn Sheep Grizzly Bear Wolverine Raptor Nesting (Cliff Habitat) Short-eared Owl Upland Breeding Birds	Habitat Loss	Site Preparation and Construction	The habitat to be disturbed is neither unique to the Project area nor limited within the WRSA. Minimize development footprint to maximum extent possible. Salvage of organic or mineral top soils for future re-application during reclamation. Re-contouring, scarification, and reseeding of disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat.	Negligible: Effect may result in slight decline in VEC within the Project footprint area for the duration of the Project; however, VEC is anticipated to return to baseline conditions following mine closure/reclamation.	Very Low	Local	Medium-term	Isolated	Reversible Short-term	Low
Woodland Caribou Moose Thinhorn Sheep Grizzly Bear Wolverine Raptor Nesting (Cliff Habitat) Short-eared Owl Upland Breeding Birds	Habitat Degradation	Construction and Operation	The habitat to be disturbed is neither unique to the Project area nor limited within the WRSA. Minimize development footprint to maximum extent possible. Salvage of organic or mineral top soils for future re-application during reclamation. Re-contouring, scarification, and reseeding of disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat.	Negligible: Effect may result in slight decline in VEC within the Project footprint area for the duration of the Project; however, VEC is anticipated to return to baseline conditions following mine closure/reclamation.	Very Low	Local	Medium-term	Isolated	Reversible Long-term	Low
Woodland Caribou Moose Thinhorn Sheep Grizzly Bear Wolverine Raptor Nesting (Cliff Habitat) Short-eared Owl Upland Breeding Birds	Physical Disturbance: Displacement Dust Noise	Construction; Operation; and Reclamation	Application of dust suppressants. Storage and disposal of all hazardous waste in an approved manner. Wildlife harassment is prohibited	Negligible: Effect may result in slight decline in VEC within the Project footprint area for the duration of the Project; however, VEC is anticipated to return to baseline conditions following mine closure/reclamation.	Very Low	Local	Medium-term	Continuous	Reversible Short-term	Low
Woodland Caribou Moose Thinhorn Sheep Grizzly Bear Wolverine	Behavioural Disturbance: Migration Disruption Habituation (e.g, attraction to food waste)	Construction; Operation; and Reclamation	All food wastes and human garbage incinerated daily or stored in wildlife-proof containers for off-site disposal or will be disposed of in an approved landfill; staff training.	Negligible: Effect may result in slight decline in VEC within the Project footprint area for the duration of the Project; however, VEC is anticipated to return to baseline conditions following mine closure/reclamation.	Very Low	Local	Medium-term	Sporadic	Reversible Long-term	Low
Woodland Caribou Moose Thinhorn Sheep Grizzly Bear Wolverine	Vehicle Traffic	Construction; Operation; and Reclamation	Speed limits will be posted and enforced Transportation activities give right-of-way to wildlife	Negligible: Effect may result in slight decline in VEC within the Project footprint area for the duration of the Project; however, VEC is anticipated to return to baseline conditions following mine closure/reclamation.	Very Low	Local	Medium-term	Periodic	Reversible Long-term	Low
Woodland Caribou Moose Thinhorn Sheep Grizzly Bear Wolverine	Hunting and Trapping	Construction; Operation; and Reclamation	No hunting policy will be implemented for all project employees and contractors.	Negligible	Very Low	Local	Medium-term	Sporadic	Reversible Long-term	Low

Caribou cows, with calves, have been observed in the WRSA in late July, indicating that the high alpine and subalpine plateaus within the WRSA are likely used for calving.

During the rut, Woodland Caribou tend to congregate on alpine / subalpine plateaus. One rut survey was conducted on October 4, 2007, resulting in no caribou being observed. A rut survey was attempted again in fall 2010, but was cancelled due to poor weather conditions. A WKA for caribou rut has been identified in the southwest corner of the WRSA (Figure 4.8-2). Although no caribou have been observed in the WRSA during the rut period, rutting may still occur.

No caribou have been observed in the WRSA during the winter (October to April). Caribou tend to use older forests, open lakes and wetlands during the winter. This habitat type is limited within the WRSA. Mineral licks have been identified within the WRSA; however none occur within the KRP area.

8.6.3.2 Identification of Temporal and Spatial Boundaries

Caribou have been observed in the WRSA in July. It can be assumed that any project activities occurring during the summer have the potential to directly and/or indirectly affect caribou throughout the construction, operation, closure / reclamation phases. Particularly, activities that occur along migration routes or in the alpine / subalpine, where caribou spend most of the summer and early fall, may overlap with caribou use in the WRSA.

Activities that may overlap with caribou use include road building and use, pit construction, and operations in the alpine and subalpine habitats.

Both the Finlayson and Wolf Lake Herds overwinter outside of the WRSA, as described in Section 4.11.2.1.

8.6.3.3 Effects Characterization

During the construction phase, the Project and its associated activities may affect Woodland Caribou through habitat loss or degradation, and physical or behavioral disturbance, including displacement. Caribou will also be exposed to low levels of vehicle traffic and other related activities, such as hunting. As previously mentioned, there is an existing road to the Site and vehicle traffic, although minimal, does already occur. It should be noted that large areas of vegetation within the Site footprint have already been cleared during previous mining and exploration activities in the LSA.

Potential effects on caribou during the operations phase may include physical or behavioral disturbance from localized development related noise, dust or activities. Caribou will also be exposed to low levels of vehicle traffic and other indirect activities, such as hunting.

Potential effects on caribou during the closure and reclamation phase may include physical or behavioral disturbance from localized reclamation activities. Caribou will also be exposed to low levels of vehicle traffic and other indirect activities, such as hunting.

Caribou encountering such activities may show minor displacement behavior and avoid the immediate Project development area and/or roads. The duration of such exposures are expected to be brief, perhaps lasting a few minutes to a few hours, and are reversible upon cessation of the activity or by moving away from the activity. The number and frequency of such exposures to disturbance are expected to be limited and sporadic.

8.6.3.4 Mitigation Measures

Woodland Caribou habitat is not unique to the Project LSA or WRSA, nor is it limited. To minimize habitat loss and/or degradation for all wildlife species, the development footprint will be minimized to the maximum extent possible. Organic and/or mineral soils will be salvaged for future re-application during reclamation. Disturbed areas will be re-contoured, scarified, and seeded with appropriate and approved native seed mixes to restore productive habitat.

KRH will implement mitigation measures that will eliminate or minimize potential direct and indirect negative effects on caribou during all phases of the KRP. Table 8.6-2 lists the potential effects and associated mitigation measures to eliminate or reduce potential negative effects on caribou. The proposed mitigation measures are summarized below:

- A no hunting policy for all KRH employees and contractors will be implemented.
- Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas (i.e., mineral licks).
- A wildlife right-of-way policy will be implemented for all mine-related traffic.
- Dust suppressants will be applied, where and as required.
- An employee training program will be conducted to inform employees of the importance of abiding by all wildlife mitigation measures.
- Following mine closure, all infrastructure will be removed from the site and the footprint will be reclaimed.
- The harassment of wildlife, including Woodland Caribou, is prohibited, as defined under the *Wildlife Act* (Yukon).
- All helicopter traffic will avoid Woodland Caribou and other large mammals.
- Caribou observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log.
- A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Woodland Caribou.

8.6.3.5 Residual Effects and Consequence Determination

With implementation of the mitigation measures, the potential for residual effects on Woodland Caribou foraging and use in the KRP area is low. Loss of habitat, although minimal, is anticipated until completion of the reclamation phase. If re-vegetation is unsuccessful, minor residual effects may exist, however this is not anticipated. Any unsuccessful re-vegetation will be limited in spatial extent and is not anticipated to significantly affect the Finlayson or Wolf Lake Woodland Caribou Herds.

A wildlife monitoring program will provide a real-time evaluation of the adopted mitigation measures and information for adapting measures to increase effectiveness where appropriate.

8.6.3.6 Significance Determination

Based on current use patterns within the WRSA, potential effects from the Project on local Woodland Caribou populations are anticipated to be low in magnitude and local in geographical extent. With the implementation of the mitigation measures described above, the KRP will not result in any significant adverse residual effects on caribou; therefore, no consequence is anticipated.

8.6.4 Moose

Moose were selected as a VESEC because of their importance in large mammal predator-prey relationships; and their importance as a food source to northern communities. Project activities have the potential to affect local Moose populations.

8.6.4.1 Summary of Baseline Information

Moose populations in the Yukon are estimated at 65,000 to 70,000 animals (YG Environment 2007a). The average Moose density throughout the Yukon is estimated at 185 Moose per 1,000 km^2. Moose populations in the south-central Yukon, which includes the KRP area, are estimated at 150 to 249 Moose per 1,000 km^2 (Moose Management Team 1996).

The KRP WRSA provides important year-round habitat for Moose. Boreal valleys and subalpine draws and saddles provide important Moose forage throughout the year. Areas with adequate browse, protective cover and mineral licks are important for Moose. All three of these habitat features occur in the WRSA.

During the Wildlife Baseline Program, conducted between 2007 and 2011, a total of 287 Moose were observed using the WRSA, indicating this area provides habitat for Moose. The Cache Creek Valley, where the majority of the KRP will take place, consists of riparian, high boreal habitat along the lower reaches of Cache Creek, rising to a subalpine saddle. This habitat type is important for Moose, but is not limiting in the WRSA. Very few Moose have been observed in the Cache Creek valley, but the riparian corridor along the Ketza River, which is adjacent to the access road where the road leaves the Pelly Mountains, has been identified as important Moose habitat, particularly during the winter.

No Moose or Moose sign was observed near any of the identified mineral licks that were assessed within the WRSA in July 2010.

8.6.4.2 Identification of Temporal and Spatial Boundaries

Moose have the potential to occur in the WRSA year-round. KRP activities during the construction, operation, and closure / reclamation phases have the potential to affect Moose wherever they occur within the KRP area throughout the year. The spatial distribution of Moose observations throughout the WRSA is shown on Figures 4.8-3 to 4.8-5.

Clearing for KRP components, such as pits, TSF, camp, and mill area, has the potential to affect Moose populations during the summer and early fall (May to late September). During the operations phase, traffic along the Ketza River valley will pass through important Moose habitat.

The temporal scope of the effects assessment assumes the local Moose population and KRP activities have the potential to overlap year-round.

8.6.4.3 Effects Characterization

During the construction phase, the KRP and its associated activities may affect Moose through habitat loss or degradation, and physical or behavioral disturbance, including displacement. Moose will also be exposed to low levels of vehicle traffic and other indirect activities, such as hunting. As previously mentioned, there is an existing road to the Site and vehicle traffic, although minimal, does already occur. It should be noted that large areas of vegetation within the Site footprint have already been cleared during previous mining and exploration activities in the LSA.

Potential effects on Moose during the operations phase may include physical or behavioral disturbance from localized development related noise, dust or activities. Moose will also be exposed to low levels of vehicle traffic and other indirect activities, such as hunting. The Ketza Road parallels the Ketza River from the confluence of Cache Creek and Ketza River to where the road leaves the Pelly Mountains. The riparian habitat along the Ketza River provides important habitat to Moose year-round, particularly during the winter. Vehicle-Moose collisions have the potential to occur.

Potential effects on Moose during the closure and reclamation phase may include physical or behavioral disturbance from localized reclamation activities. Moose will also be exposed to low levels of vehicle traffic and other indirect activities, such as hunting.

Moose may avoid the immediate KRP development area and/or the access roads. The duration of such exposures are expected to be brief, perhaps lasting a few minutes to a few hours, and are reversible upon cessation of the activity or by moving away from the activity. The number and frequency of such exposures to disturbance are expected to be limited and sporadic.

8.6.4.4 Mitigation Measures

Moose habitat is not unique to the KRP LSA or WRSA, nor is it limited. To minimize habitat loss and / or degradation for all wildlife species, the development footprint will be minimized to the maximum extent possible. Organic and/or mineral soils will be salvaged for future re-application during reclamation. Disturbed areas will be re-contoured, scarified, and seeded with appropriate and approved native seed mixes to restore productive habitat.

KRH will implement mitigation measures to eliminate or minimize potential direct and indirect negative effects on Moose during all phases of the KRP. Table 8.6-2 lists the potential effects and associated mitigation measures to eliminate or reduce potential negative effects on Moose and other species. The proposed mitigation measures are summarized below:

- A no hunting policy for all KRH employees and contractors will be implemented
- Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas such as along the section of the access road that parallels the Ketza River
- A wildlife right-of-way policy will be implemented for all mine-related traffic
- Dust suppressants will be applied, where and as required
- An employee training program will be conducted to inform employees of the importance of abiding by all wildlife mitigation measures

- Following mine closure, all infrastructure will be removed from the site and the footprint will be reclaimed
- The harassment of wildlife, including Moose, is prohibited, as defined under the *Wildlife Act* (Yukon)
- All helicopter traffic will avoid Moose and other large mammals
- Moose observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
- A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Moose.

8.6.4.5 Residual Effects and Consequence Determination

With implementation of the mitigation measures, the potential for residual effects on Moose foraging and use in the KRP area is low. Loss of habitat, although minimal, is anticipated until completion of the reclamation phase. If re-vegetation is unsuccessful, minor residual effects may exist, however this is not anticipated. Any unsuccessful re-vegetation will be limited in spatial extent and is not anticipated to affect the local Moose population.

A wildlife monitoring program will provide a real-time evaluation of the adopted mitigation measures and information for adapting measures to increase effectiveness where appropriate.

8.6.4.6 Significance Determination

With the implementation of the mitigation measures described above, KRP development-related activities are not anticipated to affect the overall health or well-being of the local Moose population, specifically the adult population, adult survivorship or potential recovery effects. Potential Project effects are expected to be low in magnitude and local in geographical extent. With the implementation of the mitigation measures, the KRP will not result in any significant adverse residual effects on Moose; therefore, no consequence is anticipated.

8.6.5 Thinhorn Sheep

Thinhorn Sheep were selected as a VESEC based on their importance in large mammal predator-prey relationships and their social and economic importance. KRP activities have the potential to affect local Thinhorn Sheep populations.

8.6.5.1 Summary of Baseline Information

Approximately 22,000 Thinhorn Sheep occur in the Yukon, of which approximately 18,000 are Dall's Sheep, 1,500 are Stone Sheep, and 2,500 are Fannin Sheep. Dall's Sheep and Stone Sheep are subspecies of Thinhorn Sheep, and Fannin Sheep are an intermediate colour phase between the two. Thinhorn Sheep populations are considered to be stable in the Yukon and densities range from 2 sheep to more than 30 sheep per 100 km^2.

Life requisites that are critical to sheep survival and success of sheep populations are winter range, movement corridors, summer range, lambing areas, and mineral licks.

The area surrounding the KRP contains high quality year-round habitat for Thinhorn Sheep, and habitat use in this area is well documented. The WRSA contains numerous WKAs for sheep, including 15 winter range polygons, three polygons for spring lambing areas, and six early winter rutting polygons. These WKAs are shown on Figure 4.8-6.

Numerous sheep surveys have been conducted in the WRSA; the survey information is summarized in Section 4.11.2.3. During the Wildlife Baseline Program, conducted between 2007 and 2011, more than 218 sheep have been observed. The distribution of sheep is shown by season on Figures 4.8-7 to 4.8-9. Surveys conducted within the WRSA have documented use during the winter and summer (including lambing); and seasonal migration between mountain blocks. Sheep have been documented crossing the Ketza Road near the confluence of Cache Creek and the Ketza River.

8.6.5.2 Identification of Temporal and Spatial Boundaries

As mentioned above, Thinhorn Sheep use areas within the WRSA year-round. All KRP activities that occur in the alpine and subalpine habitats, or overlap with movement corridors, at any time during the year have the potential to affect Thinhorn Sheep.

8.6.5.3 Effects Characterization

During the construction phase, construction of high elevation access roads and pits may affect Thinhorn Sheep through displacement and indirectly through habitat loss and or degradation. Sheep do not appear to regularly use the mountain blocks that surround the Cache Creek Valley, the primary area for these activities. Sheep have been observed one mountain block away from the Project site during most surveys. It should be noted that mining activity in the WRSA has been taking place since the 1980s and sheep use is still considered to be quite high, despite the ongoing activity.

Potential effects on sheep during the operations phase may include physical or behavioral disturbance from localized development-related noise, dust or activities. Blasting or helicopter use may cause short-to medium-term avoidance.

Potential effects on sheep during the closure and reclamation phase may include physical or behavioral disturbance from localized reclamation activities.

Throughout the Project life, it is anticipated that sheep will continue to use the migration corridor that crosses the access road near the confluence of Cache Creek and the Ketza River. Vehicle collisions or avoidance / disruption to sheep movement may occur as a result of vehicle use on the Ketza Road. The existing Ketza Road provides access to local hunters.

8.6.5.4 Mitigation Measures

KRH will implement mitigation measures to eliminate or minimize potential direct and indirect negative effects on Thinhorn Sheep during all phases of the KRP. Table 8.6-2 lists the potential effects and associated mitigation measures to eliminate or reduce potential negative effects on Thinhorn Sheep and other species. The proposed mitigation measures are summarized below:

- A no hunting policy for all KRH employees and contractors will be implemented.
- Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas, such as along the section of the Ketza Road that parallels the Ketza River.
- A wildlife right–of-way policy will be implemented for all mine-related traffic.
- Dust suppressants will be applied, where and as required.
- An employee training program will be conducted to inform employees of the importance of abiding by all wildlife mitigation measures.
- Following mine closure, all of the infrastructure will be removed from site and the footprint will be reclaimed.
- The harassment of wildlife, including Thinhorn Sheep, is prohibited, as defined under the *Wildlife Act* (Yukon).
- All helicopter traffic will avoid sheep and other large mammals.
- Thinhorn Sheep observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log.
- A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Thinhorn Sheep.

8.6.5.5 Residual Effects and Consequence Determination

With implementation of mitigation measures, disturbance and habitat-related effects on Thinhorn Sheep will be of a negligible and insignificant nature with no residual effects expected to occur.

8.6.5.6 Significance Determination

Potential effects of the KRP on Thinhorn Sheep are expected to be low in magnitude and local in geographical extent. With the implementation of the mitigation measures described above, the KRP will not result in any significant adverse residual effects on Thinhorn Sheep; therefore, no consequence is anticipated.

8.6.6 Grizzly Bear

Grizzly Bears occur throughout the WRSA, from the boreal valleys to the high alpine areas. The Grizzly Bear has been selected as a VESEC as it is a Species of Special Concern (COSEWIC 2010) and it is considered to be a species of social and economic significance in the Yukon. Grizzly Bears are not listed under the *Species at Risk Act* and are not Specially Protected under the *Wildlife Act* (Yukon). KRP activities have the potential to affect local Grizzly Bears.

8.6.6.1 Summary of Baseline Information

Grizzly Bears occupy the entire Yukon Territory but are believed to occur at relatively low densities. Approximately 6,000 to 7,000 Grizzly Bears are present within the Yukon, of which, approximately 473 (7 to 8% of the population) are believed to occur within the Pelly Mountain Ecoregion (YG Environment 2007a; Bear Management Team 1997). Grizzly Bear population densities vary throughout their range in relation to topography, cover, food abundance and behaviour (Pasitschniak-Art 1993). Grizzly Bear densities within the Pelly Mountain Ecoregion are estimated at 15 bears per 1,000 km^2 (Bear Management Team 1997). The size of the KRP WRSA is approximately 1094 km^2.

Grizzly Bears are known to favour alpine areas in June and July, as well as river flood plains in late July, in response to availability of food sources such as grasses, horsetails and soapberries (YG Environment 2007a; Miller et al. 1982). In addition, Grizzly Bears use subalpine areas in August, both alpine and subalpine areas equally in September, and higher elevation habitat types until October prior to denning (Miller et al. 1982). With the onset of winter, Grizzly Bears begin to gain weight during the fall (bear weight either remains stable or is lost during all other seasons) (YG Environment 2007a). Fall feeding periods are therefore critical for the survival and reproductive success of Grizzly Bears in the Yukon.

Dens are commonly located on south and southeast facing slopes at treeline and above, but may occur on any aspect (YG Environment 2007a; Miller et al. 1982; EBA 2011b). Seven dens were identified within a six km radius of the existing KRP camp during the Den Emergence Surveys, conducted in spring 2011 (EBA 2011b).

Twelve Grizzly Bears have been observed in the WRSA between 2007 and 2011 during the Wildlife Baseline Program. Based on these observations and the den surveys, it can be assumed that the WRSA supports Grizzly Bears throughout the denning and non-denning periods.

8.6.6.2 Identification of Temporal and Spatial Boundaries

In the Yukon, Grizzly Bears typically den between October and April/May. All KRP activities occurring during the spring, summer and early fall (April to October) have the potential to have direct or indirect effects on local Grizzly Bears.

8.6.6.3 Effects Characterization

Activities associated with construction, operation, and closure/reclamation are likely to have both direct and indirect effects on Grizzly Bears. Potential direct effects include loss of foraging habitat; loss of denning habitat; vehicle collisions; and restricted movement. Indirect effects may include avoidance of areas with disturbance, habituation and/or human conflict, and hunting which could lead to increased risk of mortality.

Based on EBA's observations of bear and bear sign within the WRSA, both Grizzly and Black Bears are expected to be present in the vicinity of the KRP footprint area quite regularly, and may directly encounter, or be disturbed by, localized development-related noise or activities. Similarly, bears will be exposed to low levels of vehicle traffic at the local mine site.

8.6.6.4 Mitigation Measures

Grizzly Bear habitat is not unique to the KRP LSA or WRSA, nor is it limited. To minimize habitat loss and/or degradation for all wildlife species, the development footprint will be minimized to the maximum extent possible. Organic and/or mineral soils will be salvaged for future re-application during reclamation. Disturbed areas will be re-contoured, scarified, and seeded with appropriate and approved native seed mixes to restore productive habitat.

KRH will implement mitigation measures to eliminate or minimize potential direct and indirect negative effects on Grizzly Bears during all phases of the KRP. Table 8.6-2 lists the potential effects and associated mitigation measures to eliminate or reduce potential negative effects on Grizzly Bears and other species. The proposed mitigation measures are summarized below:

- A no hunting policy for all KRH employees and contractors will be implemented.
- Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas, such as along the section of the Ketza Road that parallels the Ketza River.
- A wildlife right-of-way policy will be implemented for all mine-related traffic.
- As is the current practice at the Site, to minimize potential attraction / habituation of bears to the KRP, the worksites will be kept clean and free of garbage. All food waste, human garbage, and non - hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed of in an approved manner.
- All hazardous waste will be stored and disposed of in an approved manner.
- An employee training program will be conducted to inform employees of the importance of abiding by all wildlife mitigation measures.
- Following mine closure, all of the infrastructure will be removed from site and the footprint will be reclaimed.
- The harassment of wildlife, including Grizzly Bears, is prohibited, as defined under the *Wildlife Act* (Yukon).
- All helicopter traffic will avoid Grizzly Bears and other large mammals.
- Grizzly Bears observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log.
- A wildlife monitoring program will be implemented during the construction, operation, and closure / reclamation phases which will assess and address any other effects on Grizzly Bears.

8.6.6.5 Residual Effects and Consequence Determination

Loss of habitat is anticipated until reclamation and closure have been completed. There is a potential for minor residual effects if re-vegetation is only partially successful. However, any unsuccessful re-vegetation will be limited in spatial extent and is not expected to affect local Grizzly Bear populations. Residual effects may also result from the loss of denning habitat in the saddle near Tarn and Penguin Pits. An active den was found in this location during the den emergence surveys conducted in spring 2011. However, because

denning habitat is not limiting in the WRSA, the effect is local in spatial extent, has a medium term duration, is isolated, and the magnitude is considered to be very low (i.e., the effect will not produce detectable changes from baseline conditions), the consequence is considered to be low.

8.6.6.6 Significance Determination

Potential effects of the KRP on Grizzly Bears are expected to be low in magnitude and local in geographical extent. With the implementation of the mitigation measures described above, the KRP will not result in any significant adverse residual effects on Grizzly Bears; therefore, no consequence is anticipated.

8.6.7 Wolverine

The Wolverine was selected as a VESEC because it is often used as a biological indicator of ecosystem integrity due to its dependence on large, intact and connected ecosystems. The Wolverine may be negatively affected by habitat fragmentation, overharvesting, decline in prey species and by disturbance (COSEWIC 2003). Wolverines have been observed in the study area and are assumed to use the WRSA year-round. The Wolverine is a species of Special Concern (COSEWIC 2010) in Canada but is not listed under the *Species at Risk Act* or *Wildlife Act* (Yukon). The Wolverine also has cultural and economic significance as it is a species that is harvested for its fur. KRP activities have the potential to affect local Wolverine populations.

8.6.7.1 Summary of Baseline Information

Wolverines have been assessed by COSEWIC (2010) as Special Concern. Reproductive rates are low, and sexual maturity is delayed compared to other mammalian carnivores. Wolverines are not protected under SARA.

Wolverines live at low densities even under optimal conditions (Banci 1994). Wolverines are expected to occur across the KRP study area year-round, wherever abundant prey occurs. Based on known information and observations made during aerial baseline surveys, Wolverines occur, and natal dens have been observed, within the WRSA year-round. Nine Wolverines have been observed in the WRSA during the Wildlife Baseline Program between 2007 and 2011, and one Wolverine was observed by KRH employees (Table 4.8-19). The distribution of Wolverine observations is shown on Figure 4.8-11.

Although active year-round, Wolverines will construct snow dens to escape predators, cache food, and raise their young. Kits (young) are born in February or March in a shallow pit dug in the ground within a constructed snow den (Banci 1994). In addition, natal dens have been documented in abandoned beaver lodges and bear dens, in upturned roots and fallen logs, or rocks crevices (Banci 1994).

8.6.7.2 Identification of Temporal and Spatial Boundaries

It should be assumed that Wolverine use the WRSA year-round. All KRP activities that occur in any habitat type, at any time during the year have the potential to affect Wolverine, mainly through disturbance.

8.6.7.3 Effects Characterization

The primary ways the KRP associated infrastructure and activities can affect Wolverines is through physical or behavioral disturbance, including displacement and habituation (e.g., attraction). Potential effects on Wolverines could also result from the loss or degradation of denning habitat.

Based on EBA's observations between 2007 and 2001 within the WRSA, Wolverines may potentially be present in the vicinity of the KRP footprint area year-round, and may potentially directly encounter or be disturbed by localized development-related noise or activities. Similarly, Wolverines will be exposed to low levels of vehicle traffic and potentially exposed to associated activities such as hunting and trapping.

8.6.7.4 Mitigation Measures

Wolverine habitat is not unique to the KRP LSA or WRSA, nor is it limited. To minimize habitat loss and / or degradation for all wildlife species, the development footprint will be minimized to the maximum extent possible. Organic and/or mineral soils will be salvaged for future re-application during reclamation. Disturbed areas will be re-contoured, scarified, and seeded with appropriate and approved native seed mixes to restore productive habitat.

KRH will implement mitigation measures that will eliminate or minimize potential direct and indirect negative effects on Wolverine during all phases of the KRP. Table 8.6-2 lists the potential effects and associated mitigation measures to eliminate or minimize potential negative effects on Wolverine and other species. The mitigation measures are summarized below:

- To minimize potential attraction/habituation of Wolverines to the KRP, the worksites will be kept clean and free of garbage. All food waste, human garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed of in an approved manner.
- A no hunting policy for all KRH employees and contractors will be implemented.
- Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas, such as along the section of the Ketza Road that parallels the Ketza River.
- A wildlife right-of-way policy will be implemented for all mine-related traffic.
- All hazardous waste will be stored and disposed of in an approved manner.
- An employee training program will be conducted to inform employees of the importance of abiding by all wildlife mitigation measures, including the appropriate protocol for addressing nuisance Wolverines.
- Following mine closure, all of the infrastructure will be removed from site and the footprint will be reclaimed.
- The harassment of wildlife, including Wolverines, is prohibited, as defined under the *Wildlife Act* (Yukon).
- All helicopter traffic will avoid Wolverines and large mammals.
- Wolverine observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log.
- A wildlife monitoring program will be implemented during the construction, operation, and closure / reclamation phases which will assess and address any other effects on Wolverines.

8.6.7.5 Residual Effects and Consequence Determination

With the implementation of the mitigation measures as described, KRP development-related activities are not expected to affect the overall health or well-being of the Wolverine population in the WRSA. No residual effects are anticipated.

8.6.7.6 Significance Determination

Potential effects of the KRP on Wolverine are expected to be low in magnitude and local in geographical extent. With the implementation of the mitigation measures described above, the KRP will not result in any significant adverse residual effects on Wolverine; therefore, no consequence is anticipated.

8.6.8 Raptor Nesting (Cliff Habitat)

Peregrine Falcon and Gyrfalcon are both species with special conservation status. The Golden Eagle is a culturally important species and WKAs for Golden Eagle nesting have been identified in the WRSA (Figure 4.8-12). All three of these raptors occur in the WRSA and nest on high cliffs. KRP activities have the potential to directly and indirectly affect local raptor nesting habitat.

8.6.8.1 Summary of Baseline Information

Peregrine Falcon

Peregrine Falcons commonly arrive in the Yukon in April; by mid - October most of the Peregrine Falcons have left for their wintering grounds (Alexander et al. 2003). Peregrines have two main habitat requirements: nesting sites, which are commonly located along cliff ledges typically near water; and access to prey species. Peregrines mainly hunt other birds in the air, so open landscapes such as grasslands, alpine tundra and waterways are important hunting areas.

Known Peregrine Falcon nesting sites have been documented within the Peel Ecoregion, and historically Peregrine Falcons were known to nest within the Southern Lakes Ecoregion, south of the study area (CPAWS 2002). Rand (1946) reported Peregrine Falcons were observed along the Pelly and Macmillan Rivers in the Yukon. In addition, Peregrine Falcon WKAs have been identified along the Pelly River, approximately 10 km northeast of the WRSA. Peregrine Falcons may use areas designated as WKAs for Golden Eagle as nesting habitat for both species is similar (Figure 4.8-12).

Although no known Peregrine Falcons have been observed and no nest sites have been documented within the WRSA, nesting may occur as suitable nesting and feeding habitat exists throughout the WRSA.

Gyrfalcon

Gyrfalcons are considered Secure by COSEWIC, but are Specially Protected under the *Wildlife Act* (Yukon).

Gyrfalcons are year-round residents in the Yukon; however, southern migrations may occur if prey populations (particularly ptarmigan) are low. Primary prey of Gyrfalcons includes ptarmigan, waterfowl, other birds (including passerines), and some small mammals (Clum and Cade 1994).

Gyrfalcons are associated with arctic and alpine tundra (Alpine Bioclimate Zone), and commonly occupy territories that are close to rivers (Clum and Cade 1994). Known breeding habitat in mountainous terrain in the Richardson and Mackenzie Mountains commonly includes alpine habitat above timberline (Clum and Cade 1994). Breeding habitat may occur in the Alpine Bioclimate Zone throughout the entire study area, particularly in areas designated as Golden Eagle WKAs by the YG Department of Environment (Figure 4.8-12).

Breeding and wintering territories are centered on nest sites or scrapes. Favoured scrape sites include cliff ledges with overhangs. Gyrfalcons will use abandoned stick nests of Golden Eagles, Rough-legged Hawk or Common Raven (Alexander et al. 2003). Winter ranges for resident Gyrfalcons are the same as the breeding ranges (Clum and Cade 1994; Alexander et al. 2003).

Gyrfalcon may use WKAs for Golden Eagle and Peregrine Falcon, and have similar nesting habitat requirements (Figure 4.8-12). A Gyrfalcon has been observed in the WRSA, but no nesting sites have been documented (EBA 2011b).

Golden Eagle

Golden Eagles arrive in southern Yukon anywhere between early to late March (if not over - wintered) and depart to wintering grounds by late September or October (Alexander et al. 2003). It is assumed some Golden Eagles may remain throughout the winter during high Snowshoe Hare densities (Alexander et al. 2003).

Primary habitats for nesting and foraging include alpine and subalpine zones (Kochert et al. 2002). Golden Eagles typically nest on south facing cliff ledges, which are commonly re-used for many decades; however, a tree nest has been reported near Ross River (Alexander et al. 2003).

Golden Eagles are sensitive to human disturbances during the nesting and breeding season (approximately April to late August). The Ketza Road travels approximately 1 km from the nearest known Golden Eagle WKA (YG Environment 2010b). Golden Eagles may use the road for hunting. Golden Eagles have been observed (n=28) and nests have been identified within the WRSA. These observations are described in further detail in EBA (2008d), EBA (2011a) and EBA (2011b) which are included in Appendices F1, F2, and F3, respectively.

8.6.8.2 Identification of Temporal and Spatial Boundaries

Peregrine Falcons and Golden Eagles begin their migration to the Yukon in March and April, and depart in September / October. Gyrfalcons are year-round residents. The KRP has the potential to affect these cliff nesting raptors mostly during the summer months. Although Gyrfalcons are present year-round, mining activities conducted during the winter are not anticipated to adversely affect Gyrfalcons.

8.6.8.3 Effects Characterization

Cliff nesting raptors within the LSA may potentially be affected, directly and indirectly, by all phases of the KRP. The majority of disturbance to these species will occur during the construction and operation phases. These species are most sensitive to disturbance during the breeding season, particularly when they are sitting on eggs or have chicks in the nest. Although direct habitat loss is not anticipated, indirect habitat

loss may potentially result from blasting of the pits and construction of access roads, or from helicopter disturbance. Noise disturbance may make habitats adjacent to the mine footprint less favourable. Cliff nesting habitat does exist around the mine footprint. However, no nests have been observed in the LSA and of these species, only Golden Eagles have been observed.

8.6.8.4 Mitigation Measures

KRH will implement mitigation measures to eliminate or minimize potential direct and indirect negative effects on cliff nesting raptors during all phases of the Project. Table 8.6-2 lists the potential effects and associated mitigation measures to eliminate or minimize potential negative effects on cliff nesting raptors and other species. The proposed mitigation measures are summarized below:

- A nest survey will be conducted at the Site at the start of the breeding season each year, to locate any active raptor nests. If active raptor nests are found near work sites, appropriate measures will be taken to avoid disturbance of these nests during the breeding season (May 1 to August 1).
- Helicopter traffic will avoid raptors and active raptor nests
- An employee training program will be conducted to inform employees of the importance of abiding by all wildlife mitigation measures
- Raptors observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
- A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases to assess and address any other possible effects on raptors.

8.6.8.5 Residual Effects and Consequence Determination

With the implementation of the mitigation measures as described, disturbance and habitat-related effects on cliff nesting raptors, will be of a negligible and insignificant nature with no residual effects anticipated to occur.

8.6.8.6 Significance Determination

Potential effects of the Project on cliff nesting raptors are expected to be low in magnitude and local in geographical extent. With the implementation of the mitigation measures described above, the KRP will not result in any significant adverse residual effects on cliff nesting raptors; therefore, no consequence is anticipated.

8.6.9 Upland Breeding Birds (Passerines)

Upland Breeding Birds (passerines) represent a large and diverse group of species. Many of these species have a broad range of life requisites. Upland Breeding Birds were chosen as a VESEC because they represent a large group of birds and nesting habitat. Within this category, the Olive-sided Flycatcher, Savannah Sparrow, and Short-eared Owl have Conservation Status. Although the Short-eared Owl is a raptor, it was included in this VESEC as its life requisites are the same as passerines; and therefore, the effects characterization, recommended mitigations and significance determination are essentially the same.

8.6.9.1 Summary of Baseline Information

Upland Breeding Birds are widely distributed throughout the KRP study area and occupy all terrestrial habitat types. A total of 74 upland breeding bird species may potentially occur in the KRP study area as summer or year-round residents (Table 4.8-21). Additional upland bird species may occupy the WRSA during spring and/or fall migration.

Upland Breeding Birds are common in the WRSA during spring, summer and fall. Within the WRSA, the density of upland breeding birds is dependent upon food abundance, nesting habitat, and predation. Appropriate nesting habitat is not considered a limiting resource for birds occurring in the WRSA.

8.6.9.2 Identification of Temporal and Spatial Boundaries

Some species are year-round residents while the majority are migratory and are present only during their breeding season. Those species nesting within the WRSA 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, passerines, shorebirds and waterfowl begin nesting between May and the end of June.

All KRP activities occurring from February until the end of June will overlap with bird nesting times. This includes the clearing, construction, and operation phases for the roads, infrastructure, and TSF. Clearing operations for the majority of the KRP components will be completed during the summer months and will therefore overlap with nesting birds in the LSA.

8.6.9.3 Effects Characterization

Local Upland Breeding Birds will be directly and indirectly affected by all phases of the KRP, including construction, operation, closure and reclamation; however, the greatest effects may occur during clearing activities (direct habitat loss).

In addition to direct habitat loss, clearing activities occurring during bird nesting times may result in direct mortality. The majority of Upland Breeding Birds and their active nests are protected under the federal *Migratory Birds Convention Act*. In addition, upland nesting birds may encounter low levels of vehicle traffic, which may lead to an increase in mortality, including hunting (e.g., ptarmigan and grouse species).

Indirect Project effects on Upland Breeding Birds may include habitat avoidance, habitat alteration and fragmentation. Increased dust, noise and edge effects may make adjacent habitats less favorable to some species. KRP activities will create habitat edges which may benefit edge-dwelling species and habitat generalists, but negatively affect interior forest species and those more sensitive to human disturbances.

A few bird species, such as the flycatchers and swallows, may use KRP buildings and infrastructure during foraging and as nesting substrates.

8.6.9.4 Mitigation Measures

Upland Breeding Bird habitat is not unique to the KRP LSA or WRSA, nor is it limited. To minimize habitat loss and/or degradation for all wildlife species, the development footprint will be minimized to the maximum extent possible. Organic and/or mineral soils will be salvaged for future re-application during reclamation. Disturbed areas will be re-contoured, scarified, and seeded with appropriate and approved native seed mixes to restore productive habitat.

KRH will implement mitigation measures that will eliminate or minimize potential direct and indirect negative effects on Upland Breeding Birds during all phases of the KRP. Table 8.6-2 lists the potential effects and associated mitigation measures to eliminate or minimize negative effects on Upland Breeding Birds and other species. The proposed mitigation measures are summarized below:

- To reduce the effects of localized direct habitat loss, the Project footprint will be minimized as much as possible (including use of existing cleared lands). During the final abandonment phase, infrastructure pads, roads and development sites will be re-contoured and scarified as required to maximize surface stability and to encourage the re-establishment of native vegetation.
- If upland breeding bird nests are encountered in close proximity to active work sites, appropriate measures will be taken, as possible, to minimize clearing activities that would disturb actively-used nests during the breeding season.
- Dust suppressants will be applied, where and as required.
- A no hunting policy for all KRH employees and contractors while working on-site will be enforced.
- An employee training program will be conducted to inform employees of the importance of abiding by all wildlife mitigation measures.
- A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases to assess and address any other possible effects on Upland Breeding Birds.

8.6.9.5 Residual Effects and Consequence Determination

With the implementation of the mitigation measures as described, disturbance and habitat-related effects on Upland Breeding Birds, as well as other wildlife species, will be of a negligible and insignificant nature with no residual effects anticipated to occur.

8.6.9.6 Significance Determination

Potential effects that the KRP may have on Upland Breeding Birds are expected to be low in magnitude and local in geographical extent. With the implementation of the mitigation measures described above, the KRP will not result in any significant adverse residual effects on Upland Breeding Birds; therefore, no consequence is anticipated.

8.7 Surface Water Quality

8.7.1 Identification of Valued Environmental and Socio-economic Component

Surface water quality is a VESEC in itself. High water quality contributes to ecological productivity and subsequently socio-economic benefits. The surface water in the Surface Water RSA is not used directly by people (i.e., drinking); but it is used by aquatic and terrestrial plants and animals which people may use in turn. Potential effects of the KRP on surface water quality are assessed both spatially and temporally.

Surface water quality effects are assessed in relation to the Project Footprint and the Surface Water RSA established in Section 4.9. The Project Footprint is defined Figure 4.9-1; the Surface Water RSA is defined as the surface water within the same drainage as the Project Footprint to a maximum of 15 km downstream (Figure 4.9-2); and the Beyond-Surface Water RSA is the area outside of the Surface Water RSA.

Surface water quality effects are assessed in relation to short-term, medium-term and long-term. Short term effects are those that last up to months. Medium term effects last between months to years (typically the life of the project from Construction to Closure). Long term effects are those that will last beyond the life of the Project.

8.7.2 Summary of Baseline Information

The KRP is located within the Ketza River drainage basin. There are several tributaries (some unnamed) within the Project's lease boundaries that eventually flow into Ketza River, which flows into the Pelly River. As part of the previous Water Licence for the Canamax mine, water quality monitoring has been conducted at the Site since 1988 (no monitoring was done from 1997 to 2004). Water sampling stations are located in the Canamax TSF, Ketza River and five of its tributaries (Tarn Lake, Cache Creek, Oxo Creek, Peel Creek and Misery Creek). The Canamax TSF was established during mining activity on the Site by the previous owners, Canamax and is situated within the Cache Creek watershed. A detailed review of the surface water monitoring program is presented in Section 4.11 and a summary is provided in this section.

The surface water in the Project Footprint and Surface Water RSA currently has eight observed chemical parameters that are never or rarely found in concentrations that exceed the CCME ALG (mercury, molybdenum, nitrate (as N), nitrate (as NO_3), nitrite (as N), nitrite (as NO_2-), phosphorus and thallium). Fifteen chemical / physical parameters have been observed to occasionally, frequently or always exceed the CCME ALG (aluminum, ammonia, ammonia (as N), arsenic, cadmium, copper, cyanide total, iron, lead, pH, nickel, selenium, silver, TSS and zinc). The historical data for these chemical / physical parameters indicate the following:

- Aluminum, ammonia, ammonia (as N), arsenic, cadmium, copper, total cyanide, iron, lead, pH, nickel, selenium, silver, TSS and zinc
  - Lead concentrations, nickel concentrations and pH levels at Background Stations were unique. At these stations alone, they exceed the CCME ALG (lead occasionally exceeds at KR23, nickel frequently exceeds at KR18 and pH is always below the CCME ALG at KR18)
  - The remaining parameter concentrations did not vary significantly between areas. Only minor differences were identified
  - The Background area has slightly higher concentrations of aluminum, cadmium, copper, nickel, selenium and zinc
  - The On Site: TSF area had slightly higher concentrations of ammonia (as N), arsenic and total cyanide
  - The On Site: Non TSF area had slightly higher concentrations of iron
  - There is not a significant water quality impact from the Canamax TSF Area on other waterbodies within the Project Footprint and Surface Water RSA.
- The parameters which exceeded the CCME ALG do not have significant seasonal concentration changes (except potentially arsenic and cadmium down gradient of the Project Footprint)
- The parameters which exceeded the CCME ALG do not have significant concentration changes since 2005
- Discharge from the Canamax TSF (similar to previous Water Licence requirements) has not significantly affected downstream water quality.

8.7.3 Summary of Baseline Acid Rock Drainage and Metal Leaching Information

EBA was retained by KRH in 2008 to conduct the preliminary characterization of mine waste rock, ore and tailings for mining operations at the Ketza River mine property. The following is a summary of baseline information that is discussed in greater detail in Section 4.4.

8.7.3.1 Waste Rock

Preliminary waste rock descriptions and screening for ARD associated with the Mantos and Shamrock zone ore has been carried out. A total of 428 samples were submitted for ABA over three years, including 136 samples from 2008 and 292 samples from 2010/2011. In 2011, a total of 321 samples from the 2011 characterization program were submitted for shake flask ML analysis. Nine waste rock samples were submitted for HCT in 2011.

Acid Rock Drainage

Within the Manto Zone, four of the seven waste rock types are expected to be NAG. Transulfide shale materials (representing an uncertain tonnage of waste) are expected to be PAG. In addition, the sulfidic limestone, representing less than 1.4 million tonnes of the over 36 million tonnes of waste rock, has uncertain acid generating properties, but is likely also PAG. Preliminary HCT results from the first 15 weeks of sampling confirm that the sulfate concentrations in the sulphidic limestone are increasing, while the alkalinity is decreasing. These trends generally confirm that this material will likely be acid generating over time. However, the large quantity of NAG materials available from the remaining five waste rock types provides ample neutralizing capacity, capable of preventing net acidic discharge from the waste rock impoundment.

Shamrock zone waste rocks are mixed acid generating classes, indicating that the unaltered argillite is Uncertain PAG and the oxide argillite is likely NAG. However, HCT results indicate that the unaltered argillite sample is already generating acidic leachate, beginning from the first week of sampling. These results strongly indicate that the unaltered argillite is actually PAG and should be handled as such. The oxide argillite is also decreasing in acidity over the first 15 weeks of HCT analyses, and is currently at a pH of 6.52, although the ABA analyses suggested this material is NAG. The HCT samples should be monitored closely over the next several months in order to determine the most appropriate classification and handling of this material.

Metal Leaching

ML analytical results show Mantos and Shamrock zone waste rock have strong potential for metal leaching, even at near neutral or slightly alkaline pH ranges. Since the first week of testing, the arsenic concentrations in the Mantos Limestone oxide have exceeded the CCME ALG. They have since continued to rise over the last 21 weeks of analyses. As the pH decreases in some of the HCTs, the ratio and relative concentration of the metals exceeding the CCME ALG are expected to increase.

8.7.3.2 Tailings and Ore

Acid Rock Drainage

Results of ABA testing on the ore and tailings material indicates that stockpiled ore material will likely pose an acid-leaching hazard within a minimum of three years of placement in situ.

Humidity cell tests were initiated in 2008 to establish long term leachate composition for unprocessed sulphide ore and sulphide and oxides tailings samples. The results indicate that the sulphide tailings will not produce acid leachate within the first three years; however the sulphide tailings will likely generate acid at a future date if exposed to air and water. Oxide tailings are generally acid neutralizing, as indicated by ABA testing and verified with the HCT results.

Metal Leaching

Shake flask testing was completed on the oxide and sulphide tailings samples, to evaluate metal leaching. Results indicated that stockpiled ore material will likely pose a metal leaching hazard for copper and iron which may exceed the respective CCME ALG. Once acid generating conditions are established, the metal leaching behaviour of the sulphide tailings will be altered, likely generating higher concentrations of dissolved metals. Oxide tailings may be expected to leach high concentrations of arsenic soon after placement in situ, as soluble arsenic species are washed from the tailings during precipitation events. Over time, the concentration of dissolved arsenic can be expected to decrease.

8.7.4 Effects Characterization

Each activity listed in the PDR (Section 6.0) has been assessed for its potential effect on surface water quality. Emergency response measures for spills to surface water are addressed in the ERP. Each listed activity was evaluated according to the criteria presented in Section 7 (Table 7.1-2).

Activities unlikely to affect surface water quality are summarized below. These activities are expected to have very low potential effects (local, short in duration, isolated, produce non-detectable changes in surface water quality, reversible during the life of the Project, unlikely to occur, and are of low consequences):

- Buildings (construction and reclamation)
- Enclosed utilidor for service lines (construction, operation and maintenance and reclamation)
- Heat trace water supply lines (construction, operation and maintenance and reclamation)
- Infrastructure pad (construction and reclamation)
- Pouring of dore bars at processing plant (construction, operation and maintenance and reclamation)
- Power distribution (construction, operation and maintenance and reclamation)
- Powerhouse and generators (construction, operation and maintenance and reclamation)
- Processing plant (construction, operation/ maintenance and reclamation)
- Removal of seepage collection system (reclamation)
- Reclamations of underground access and ventilation (reclamation).

Due to the limited potential effect(s) of these activities, they are not examined further. However, mitigations applied to other activities will likely further lower any potential negative effect(s) that may occur.

8.7.5 Mitigation Measures

The assessment of activities with potential effects to surface water quality is summarized in Tables 8.7-1, 8.7-2 and 8.7-3. Mitigative measures can reduce the potential effects of the activities considered. Mitigation is intended to prevent process water and runoff from the mine site from entering downstream waterbodies. A description of the mitigation measures are presented in Tables 8.7-1, 8.7-2 and 8.7-3. Mitigations include:

- In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust, in accordance with Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002)
- A minimum 30 m riparian buffer will be maintained along streams, wherever possible
- KRH will limit vegetation removal, wherever possible. KRH will re-establish vegetation in cleared areas, where the Project plan allows.
- KRH will stabilize exposed erodible materials
- KRH will follow and maintain natural drainage patterns wherever possible
- KRH will use geochemical characterization to minimize PAG volumes and to understand long term ARD/ML behavior
- KRH will monitor drainage water quality to determine if ARD or ML is occurring
- Hazardous materials will not be stored within 30 m of any watercourse
- KRH will maintain and monitor equipment so it is in good condition and leak free
- All motorized vehicles will be equipped with a spill response kit
- KRH staff will be familiar with the Emergency Response Plan which will be applied as soon as a spill or leak has been detected
- KRH will place fuel storage tanks in secondary containment
- Dust will be suppressed on the stockpiled ore when necessary through measures which could include wetting down with water, tarp coverings or constructing a shed structure over the stockpile to retain dust on the pad
- KRH will visually inspect and record conditions at the waste rock dumps during mine operations, to look for signs of oxidation of sulphide minerals
- All waste rock stockpiles will be constructed with a low-permeability basal layer (pad) with drainage collection to an outlet pipe or structure

- There will be segregation of waste rock to place only NAG rock, or blended NAG and PAG rock (net NAG) into the NAG waste rock dumps. PAG waste rock will be placed in the two designated PAG waste rock dumps (Peel Dump 3 and QB Dump 2)
- KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of pads or liners
- Surface runoff from affected Site areas, including pits, waste rock dumps, and stockpiles will be directed to the TSF or treated to site specific water quality criteria as identified in the approved Water License for the KRP.
- A passive water treatment system may be included near waste rock dumps and/or open pit outfalls
- KRH will use geochemical characterization to minimize PAG volumes and to understand long term ARD/ML behavior
- Where possible, waste rock dumps will be placed on existing ground surface (above the existing groundwater table)
- Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific water quality criteria as identified in the KRP's approved Water License.
- KRH will follow best practices for explosives handling and blasting
- All waste rock stockpiles will be constructed with a low-permeability basal layer (liner) with drainage collection to an outlet pipe or structure
- KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of liners
- KRH will adhere to the Waste Management Permit for incinerating
- All food wastes and garbage will be incinerated regularly
- KRH will implement preventative design measures for TSF (e.g., full liner, drains, sump, recirculating system back to TSF); on closure, low-permeability cover and full reclamation of TSF; monitoring groundwater and surface water quality downstream of TSF
  Groundwater and surface water around the TSF will be monitored during operations and after closure. The groundwater monitoring wells will be retained for use as long term monitoring devices
- Dewatering water will be diverted to the TSF during operation
- KRH will design the dewatering system to minimize dewatering volumes
- Surface runoff water that meets water quality discharge criteria will be released to the surface water drainage system. Drainage that does not meet those criteria will be conveyed and discharged to the TSF

- Water discharged from the TSF, Water Retention Pond, and Waste Rock Piles will meet site specific water quality criteria as identified in the approved Water License for the KRP prior to discharge to the receiving environment
- Worksites will be kept clean and free of garbage
- Non-combustible waste will be handled appropriately and either transferred to an off-site approved landfill or managed within an approved on-site landfill contained on an impermeable foundation and covered
- Leaks or spills will be contained and treated according to the Emergency Response Plan
- KRH will store hazardous materials as instructed by the manufacturer
- KRH will direct surface runoff away from/off the TSF at closure
- Selective discharge of tailings around the TSF will be conducted during the final years of operations to establish a final tailings beach that will facilitate surface water storage and reclamation

8.7.6 Consequence and Significance Determination

After applying the mitigations presented above, four residual effects remained and were subsequently assessed further (Table 8.7-4). The results from this assessment indicate that consequences are either very low or low:

- Very low consequence potential effects are related to the release of water from the Water Retention Pond and TSF. The application of the mitigations presented in Tables 8.7-1 to 8.7-3 render this effect unlikely to occur to an extent that will affect surface water quality downstream.
- Low consequence potential effects are related to ARD and ML concerns associated with exposed rock. This is unlikely to affect surface water quality in the Surface Water RSA, particularly following the aplication of the mitigations presented in Tables 8.7-1 to 8.7-3. Potential effects from this will not occur in a short time period. Monitoring of groundwater and surface water will help identify if this potential effect is occurring as metals concentrations will likely increase and pH levels will likely decrease. If an effect is observed, further approved mitigations will applied as soon as possible. These may include groundwater treatment, surface water treatment, and re-engineering the underground and/or open pit workings. Considering the consequence and the mitigations, the significance of these effects are low.

Table 8.7-1: Construction Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Ketza Road	Dust from excavation work and increased vehicle and foot traffic during the Construction Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Sporadic Magnitude: Moderate Reversibility: Short-term Likelihood: High Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Borrow Sites	Dust from excavation work and increased vehicle and foot traffic during the Construction Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Borrow Sites	Erosion from excavation work and increased vehicle and foot traffic could come into contact with surface water New, loose granular materials that intercept natural drainage paths could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Borrow Sites	Newly exposed material from excavation work could cause metal leaching (ML) and/or acid rock drainage (ARD) in later phases; This could increase metal concentrations and/or decrease pH in the surface water	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None
Camp	Dust from increased vehicle and foot traffic during the Construction Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: High Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Diesel Fuel Storage Facility	A spill may occur from fuel storage tanks or during the transfer of fuel from/to the tanks The spill may reach surface water and introduce petroleum hydrocarbon chemicals	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: High Reversibility: Short-term Likelihood: Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None

Table 8.7-1: Construction Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Explosive Storage	Explosives storage may leach nitrates into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Fuel Transport	A spill may occur during the transport and transfer of fuel from/to the tanks which may reach surface water and introduce petroleum hydrocarbon chemicals	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: High Reversibility: Short-term Likelihood: Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None
Haul Roads	Dust from excavation work and increased vehicle and foot traffic during the Construction Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Sporadic Magnitude: Moderate Reversibility: Short-term Likelihood: High Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Haul Roads	Erosion from excavation work and increased vehicle and foot traffic could come into contact with surface water New, loose granular materials that intercept natural drainage paths could come into contact with surface water This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Haul Roads	Newly exposed material from excavation work could cause metal leaching (ML) and/or acid rock drainage (ARD) in later phases; This could increase metal concentrations and/or decrease pH in the surface water	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None
Open Pit and Underground Mines	Dust from excavation work and increased vehicle and foot traffic during the Construction Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Periodic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None

Table 8.7-1: Construction Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Open Pit and Underground Mines	Erosion from excavation work and increased vehicle and foot traffic could come into contact with surface water New, loose granular materials that intercept natural drainage paths could come into contact with surface water This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Open Pit and Underground Mines	Newly exposed material from excavation work could cause metal leaching (ML) and/or acid rock drainage (ARD) in later phases; This could increase metal concentrations and/or decrease pH in the surface water	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: High	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None
Protect Local Watersheds	Positive Effect - Limiting the seepage of pollutants into the ground and near surface water bodies will help to preserve watershed and water supply for wildlife	Extent: Regional Duration: Long-term Frequency: Sporadic Magnitude: Very Low Reversibility: Short-term Likelihood: High Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Pumping Water from Groundwater Wells for Camp	The surface water may decrease in volume from removing water from the well The resulting sediment movement may decrease water quality TSS and metals increase because less water with the same amount of sediments	Extent: Local Duration: Short-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will follow and maintain natural drainage patterns wherever possible	None
Pumping Water from Groundwater Wells for Camp	The surface water may decrease in volume from removing water from the well This will reduce the natural flow of the downstream surface water	Extent: Local Duration: Short-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will follow and maintain natural drainage patterns wherever possible	None
Sewage Effluent Transport	Positive Effect - Effluent will meet water quality criteria which will mix with local, poor quality surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	N/A	None

Table 8.7-1: Construction Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Sewage Treatment Plant	Chemicals or bio-hazardous waste could leak, leach or spill into surface water, introducing new chemicals	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Very Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None
Short Sublevel Open Stoping Underground Method	Dust from excavation work and increased vehicle and foot traffic during the Construction Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Short Sublevel Open Stoping Underground Method	Erosion from excavation work and increased vehicle and foot traffic could come into contact with surface water New, loose materials that intercept natural drainage paths could come into contact with surface water This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Short Sublevel Open Stoping Underground Method	Newly exposed material from excavation work could cause metal leaching (ML) and/or acid rock drainage (ARD) in later phases; This could increase metal concentrations and/or decrease pH in the surface water	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: High	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None
Storage of Non-Combustible Waste Near TSF	Chemicals or bio-hazardous waste could leak, leach or spill into surface water, introducing new chemicals	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: High Reversibility: Long-term Likelihood: High Consequence: Moderate	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Transport of Non-Combustible and Special Waste	Non-combustible waste and/or special waste may leak, leach or spill into surface water, introducing new chemicals	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: High Reversibility: Short-term Likelihood: Low Consequence: Moderate	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None

Table 8.7-1: Construction Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Waste Oil Storage	Waste oil may leak, leach or spill into water from storage container and during transfer This could introduce petroleum hydrocarbons and metals into surface water	Extent: Local Duration: Medium-term Frequency: Continuous Magnitude: High Reversibility: Long-term Likelihood: Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None
Waste Rock Disposal	Precipitation on the stockpiles may wash out the fine material and carry it to downstream water bodies; This may leach metals or generate acid from the stockpile then leach or flow to surface water	Extent: Local Duration: Medium-term Frequency: Periodic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Low	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring Dust will be suppressed on the stockpiled ore when necessary through measures which could include wetting down with water, tarp coverings or constructing a shed structure over the stockpile to retain dust on the pad KRH will visually inspect and record conditions at the waste rock dumps on a quarterly basis during mine operation, to look for signs of oxidation of sulphide minerals All waste rock stockpiles will be constructed with a low-permeability basal layer (pad) with drainage collection to an outlet pipe or structure There will be careful segregation of waste rock to place only NAG rock, or blended NAG and PAG rock (net NAG) into the NAG waste rock dumps. PAG waste rock will be placed in the two designated PAG waste rock dumps (Peel Dump 3 and QB Dump 2) KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of pads Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific criteria prior to discharge to the receiving environment A passive water treatment system may be included near waste rock dumps and/or open pit outfalls KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will locate waste rock stockpiles greater than 30 m from surface water Waste rock dumps will be placed on existing ground surface (above the existing groundwater table)	None
Water Diversion Ditches	Dust from excavation work and increased vehicle and foot traffic during the Construction Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Moderate Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Water Diversion Ditches	Erosion from excavation work and increased vehicle and foot traffic could come into contact with surface water New, loose materials that intercept natural drainage paths could come into contact with surface water This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None

Table 8.7-1: Construction Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Water Diversion Ditches	Newly exposed material from excavation work could cause metal leaching (ML) and/or acid rock drainage (ARD) in later phases; This could increase metal concentrations and/or decrease pH in the surface water	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: High	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None
Water Retention Pond	Dust from excavation work and increased vehicle and foot traffic during the Construction Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Moderate Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Water Retention Pond	Erosion from excavation work and increased vehicle and foot traffic could come into contact with surface water New, loose materials that intercept natural drainage paths could come into contact with surface water This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Water Retention Pond	Newly exposed material from excavation work could cause metal leaching (ML) and/or acid rock drainage (ARD) in later phases; This could increase metal concentrations and/or decrease pH in the surface water	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Ketza Roads	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Moderate Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Borrow Sites	Dust from excavation work and vehicle and foot traffic during the Operations and Maintenance Phase could come into contact with surface water This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Borrow Sites	New, loose geotechnical materials that intercept natural drainage paths could come into contact with surface water This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequences: Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Borrow Sites	Newly exposed material from excavation work during the Operations Phase could cause metal leaching (ML) and/or acid rock drainage (ARD). This could increase metal concentrations and/or decrease pH in the surface water	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Low	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None
Camp	Dust from increased vehicle and foot traffic during the Operations Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Continuous Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Contaminated Soil in the Land Treatment Facility	Dust from the contaminated soil may come into contact surface water. This could introduce petroleum hydrocarbon chemicals and increase TSS and metals in the surface water	Extent: Local Duration: Medium-term Frequency: Sporadic Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Crusher/ Grizzly Feeder	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Periodic Magnitude: Very low Reversibility: Short-term Likelihood: Low Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Diesel Fuel Storage Facility	A spill may occur from fuel storage tanks or during the transfer of fuel from/to the tanks. The spill may reach surface water and introduce petroleum hydrocarbon chemicals	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None
Drift and Fill Method	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Drift and Fill Method	Newly exposed material from excavation work during the Operations Phase could cause metal leaching (ML) and/or acid rock drainage (ARD). This could increase metal concentrations and/or decrease pH in the surface water	Extent: Regional Duration: Long-term Frequency: Continuous Magnitude: Low Reversibility: Long-term Likelihood: Moderate Consequence: Moderate	KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior Surface runoff from affected Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific criteria prior to discharge to the receiving environment KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring	None
Explosive Storage	Explosives storage may leach nitrates into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	KRH will monitor explosives regularly for degradation KRH will follow best practices for explosives handling and blasting to minimize spills and amount of undetonated explosives Hazardous materials will not be stored or transferred within 30 m of any watercourse	None
Fire Suppression System	Water from the water retention pond and other surface water bodies may be used to fight fires. This might increase TSS and metals in downstream water bodies	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Very Low Consequence: Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Fuel Tanks for Processing Plant	A spill may occur from fuel storage tanks or during the transfer of fuel from/to the tanks. The spill may reach surface water and introduce petroleum hydrocarbon chemicals	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Fuel Transport	A spill may occur during the transport and transfer of fuel from/to the tanks which may reach surface water and introduce petroleum hydrocarbon chemicals	Extent: Regional Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None
Haul Roads	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Continuous Magnitude: Low Reversibility: Short-term Likelihood: Moderate Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Hazardous Material Shipping	A spill may occur during the transport and transfer of hazardous materials. The spill may reach surface water and introduce chemicals	Extent: Regional Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None
Hazardous Material Storage	A spill may occur from hazardous materials storage. The spill may reach surface water and introduce chemicals	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None
Low-Grade Stockpile	Precipitation on the stockpiles may wash out the fine material and carry it to downstream water bodies. This may increase TSS and metals in surface water	Extent: Local Duration: Long-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Low	All waste rock stockpiles will be constructed with a low-permeability basal layer (liner) with drainage collection to an outlet pipe or structure KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of liners Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific criteria prior to discharge to the receiving environment A passive water treatment system may be included near waste rock dumps and/or open pit outfalls KRH will locate waste rock stockpiles greater than 30 m from surface water Waste rock dumps will be placed on existing ground surface (above the existing groundwater table)	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Low-Grade Stockpile	Precipitation on the stockpiles may wash out the fine material and carry it to downstream water bodies. This may leach metals or generate acid from the stockpile then leach or flow to surface water	Extent: Regional Duration: Medium-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Moderate Consequence: Low	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring KRH will visually inspect and record conditions at the waste rock dumps on a quarterly basis during mine operation, to look for signs of oxidation of sulphide minerals All waste rock stockpiles will be constructed with a low-permeability basal layer (liner) with drainage collection to an outlet pipe or structure There will be careful segregation of waste rock to place only NAG rock, or blended NAG and PAG rock (net NAG) into the NAG waste rock dumps. PAG waste rock will be placed in the two designated PAG waste rock dumps (Peel Dump 3 and QB Dump 2) KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of liners Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific criteria prior to discharge to the receiving environment A passive water treatment system may be included near waste rock dumps and/or open pit outfalls KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will locate waste rock stockpiles greater than 30 m from surface water Waste rock dumps will be placed on existing ground surface (above the existing groundwater table)	None
Open Pit Mining Method	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Moderate Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Open Pit Mining Method	Newly exposed material from excavation work during the Operations Phase could cause metal leaching (ML) and/or acid rock drainage (ARD). This could increase metal concentrations and/or decrease pH in the surface water	Extent: Regional Duration: Long-term Frequency: Continuous Magnitude: Moderate Reversibility: Long-term Likelihood: Moderate Consequence: High	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific criteria prior to discharge to the receiving environment A passive water treatment system may be included near waste rock dumps and/or open pit outfalls KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior	None
Primary Crushing at Processing Plant	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Moderate Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Processing Plant Carbon Elution	Carbon elution could leak, leach or spill into surface water	Extent: Local Duration: Medium-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Processing Plant Carbon-In-Leach Processing	Carbon elution could leak, leach or spill into surface water	Extent: Local Duration: Medium-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Processing Plant Cyanide Destruction	Positive Effect - Oxidizing the cyanide waste solution on-site reduces the risk of a toxic spill or leak that will be more likely to occur if the cyanide solution were to be stored and/or transported	Extent: Regional Duration: Medium-term Frequency: Periodic Magnitude: Low Reversibility: Short-term Likelihood: High Consequence: Moderate	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None
Processing Plant Cyanide Leaching	Cyanide storage and/or the cyanide leaching solution could leak, leach or spill into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Very Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None
Processing Plant Cyanide Leaching	Cyanide not destroyed during the destruction process could accumulate in the TSF then leak, leach, spill or be pumped into the watershed	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Very Low Consequence: Moderate	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None
Processing Plant Filter Presses and Thickeners	Carbon elution and acid wash may leak, leach or spill into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Very Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None
Protect Local Watersheds	Positive Effect - Limiting the seepage of pollutants into the ground and near surface water bodies will help to preserve watershed and water supply for wildlife	Extent: Regional Duration: Long-term Frequency: Periodic Magnitude: Low Reversibility: Irreversible Likelihood: High Consequence: Low	N/A	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Pumping Water from Groundwater Wells for Camp	The surface water may decrease in volume from removing water from the well The resulting sediment movement may decrease water quality TSS and metals increase because less water with the same amount of sediments	Extent: Local Duration: Short-term Frequency: Periodic Frequency: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will follow and maintain natural drainage patterns wherever possible	None
Run of Mine Stockpile	Precipitation on the stockpiles may wash out the fine material and carry it to downstream water bodies. This may leach metals or generate acid from the stockpile then leach or flow to surface water	Extent: Regional Duration: Medium-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Low	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring KRH will visually inspect and record conditions at the ROM stockpile on a quarterly basis during mine operation, to look for signs of oxidation of sulphide minerals KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will locate the ROM stockpile greater than 30 m from surface water Waste rock dumps will be placed on existing ground surface (above the existing groundwater table)	None
SAG Milling at Processing Plant	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Moderate Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Secondary Crushing at Processing Plant	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Medium-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Moderate Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Sewage Effluent Transport	Positive Effect - Effluent will meet water quality criteria which will mix with local, potentially poor quality surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	N/A	None
Sewage Effluent Transport	Failure in treatment facility and to fully treat harmful biological or chemical contaminates prior to reaching surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Low	KRH will maintain and monitor equipment to ensure it is in good condition and leak free	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Sewage Treatment Plant	Sewage treatment chemicals or bio-hazards onto the ground could leak, leach or spill into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Very Low Consequence: Low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None
Short Sub-Level Open Stopping Underground Method	Dust from excavation work during the Operations and Maintenance Phase could come into contact with surface water. This could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Periodic Magnitude: Very Low Reversibility: Short-term Likelihood: Moderate Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Short Sub-Level Open Stopping Underground Method	Newly exposed material from excavation work during the Operations Phase could cause metal leaching (ML) and/or acid rock drainage (ARD). This could increase metal concentrations and/or decrease pH in the surface water	Extent: Regional Duration: Long-term Frequency: Continuous Magnitude: Moderate Reversibility: Short-term Likelihood: Moderate Consequence: Moderate	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific criteria prior to discharge to the receiving environment KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior	None
Solid Waste Incinerator (In Camp)	Airborne chemicals from incineration could mix with surface water	Extent: Local Duration: Short-term Frequency: Continuous Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will adhere to the Waste Management Permit for incinerating All food wastes and human garbage will be incinerated daily	None
Solid Waste Storage (In Camp)	Chemicals could leak, leach or spill into surface water from the solid wastes into surface water	Extent: Local Duration: Medium-term Frequency: Sporadic Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Moderate	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected An approved sewage treatment system will be employed	None
Staging Area	Petroleum hydrocarbon chemicals could leach, leak or spill into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Moderate	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None
Storage of Non-Combustible Waste Near TSF	Chemicals could leak, leach or spill into surface water from the solid wastes enter groundwater and then surface water	Extent: Regional Duration: Medium-term Frequency: Continuous Magnitude: High Reversibility: Short-term Likelihood: Moderate Consequence: Moderate	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Supernatant Transfer Between the Processing Plant and the TSF	Supernatant could leak, leach or spill into surface water from pipes and attachments transporting the supernatant to/from the TSF	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None
TSF	Tailings and associated chemcials could leak, leach or spill into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	KRH will implement preventative design measures for TSF (full liner, drains, sump, recirculating system back to TSF); on closure, low-permeability cover and full reclamation of TSF; monitoring groundwater and surface water quality downstream of TSF Groundwater and surface water around the TSF will be monitored during operation and after closure. The groundwater monitoring wells will be retained for use as long term monitoring devices KRH will maintain and monitor the embankment dam of the TSF for excess seepage Dewatering water will be diverted to the TSF during operation KRH will design the dewatering system to minimize dewatering volumes Drainage water that meets water quality discharge guidelines will be released to the surface water drainage system. Drainage that does not meet those guidelines will be conveyed and discharged to the TSF Water discharged from the TSF and Water Retention Pond and Waste Rock Pits will meet site specific discharge criteria prior to discharge to the receiving environment	None
TSF Water Removal	Could potentially discharge water containing high concentrations of metals and processing chemicals to surface water	Extent: Regional Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Long-term Likelihood: Low Consequence: Low	Water discharged from the TSF and Water Retention Pond and Waste Rock Pits will meet site specific discharge criteria prior to discharge to the receiving environment	Accumulated processing chemicals, sediments and/or metals could be flushed downstream through pumping
Water Retention Pond	Accumulated sediments and metals could be flushed downstream during a flooding or pumping event	Extent: Local Duration: Medium-term Frequency: Isolated Magnitude: Moderate Reversibility: Long-term Likelihood: Low Consequence: Moderate	Water discharged from the TSF pits, waste rock piles and Water Retention Pond will meet site specific discharge criteria prior to discharge to the receiving environment KRH will limit water retention pond outflow rate to reduce potential downstream erosion	Accumulated sediments and metals could be flushed downstream during a flooding or pumping event
Waste Oil Storage	Petroleum hydrocarbon chemicals could leach, leak or spill into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Very low	Hazardous materials will not be stored or transferred within 30 m of any watercourse KRH will maintain and monitor equipment to ensure it is in good condition and leak free All motor vehicles will be equipped with a spill response kit The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected KRH will place fuel storage tanks in secondary containment	None

Table 8.7-2: Maintenance and Operations Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Waste Rock Disposal	Exposed rock could be a source of ARD and/or ML through run-off and dust These could result in low pH and/or high metals concentrations in groundwater which could permeate to surface water	Extent: Regional Duration: Long-term Frequency: Periodic Magnitude: High Reversibility: Long-term Likelihood: High Consequence: High	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring Dust will be suppressed on the stockpiled ore when necessary through measures which could include wetting down with water, tarp coverings or constructing a shed structure over the stockpile to retain dust on the pad KRH will visually inspect and record conditions at the waste rock dumps on a quarterly basis during mine operation, to look for signs of oxidation of sulphide minerals All waste rock stockpiles will be constructed with a low-permeability basal layer (liner) with drainage collection to an outlet pipe or structure There will be careful segregation of waste rock to place only NAG rock, or blended NAG and PAG rock (net NAG) into the NAG waste rock dumps. PAG waste rock will be placed in the two designated PAG waste rock dumps (Peel Dump 3 and QB Dump 2) KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of liners Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific criteria prior to discharge to the receiving environment A passive water treatment system may be included near waste rock dumps and/or open pit outfalls KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior KRH will locate waste rock stockpiles greater than 30 m from surface water Waste rock dumps will be placed on existing ground surface (above the existing groundwater table)	None

Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Breaching of the Water Retention Pond	Dust from earth works and increased vehicle and foot traffic during the Closure Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Regional Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: Moderate Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Breaching of the Water Retention Pond	Erosion from earth work and increased vehicle and foot traffic could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Breaching of the Water Retention Pond	Short term, immediate increase in TSS and metals concentration when water in the pond is released	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Breaching of the Water Retention Pond	Positive Effect will stop accumulation of sediment in the future	Extent: Regional Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: Moderate Consequence: Low	N/A	None
Camp and Ancillary Infrastructure Reclamation	Dust from earth works and increased vehicle and foot traffic during the Closure Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Camp and Ancillary Infrastructure Reclamation	Erosion from earth work and increased vehicle and foot traffic could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None

Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Camp and Ancillary Infrastructure Reclamation	Infrastructure waste could contaminate surface water	Extent: Local Duration: Medium-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	Worksites will be kept clean and free of garbage Non-combustible waste will be contained on an impermeable foundation and covered Leaks or spills will be contained and treated according to the Emergency Response Plan	None
Cap and Re-vegetate TSF	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: Moderate	N/A	None
Contaminated Soil Land Farm Treatment and Decommissioning	Positive Effect aids in the breakdown of contamination limiting the seepage of pollutants into the ground and near surface water bodies	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Irreversible Likelihood: Low Consequence: Moderate	N/A	None
Contaminated Soil Land Farm Treatment and Decommissioning	Positive Effect ensures remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Irreversible Likelihood: Low Consequence: Low	N/A	None
Contaminated Soil Land Farm Treatment and Decommissioning	Dust from the contaminated soil may enter surface water, this could introduce petroleum hydrocarbon chemicals and increase TSS and metals in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Very low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Contaminated Soils Identification and Treatment	Positive Effect aids in the breakdown of contamination limiting the seepage of pollutants into the ground and near surface water bodies	Extent: Beyond regional Duration: Medium-term Frequency: Periodic Magnitude: Very low Reversibility: Short-term Likelihood: Moderate Consequence: Low	N/A	None

Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Decommissioning to Best Practices	Positive Effect ensures remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Beyond regional Duration: Long-term Frequency: Continuous Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: High	N/A	None
Dismantling and Removal of Tailings and Tailings Related Infrastructure	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: Moderate	N/A	None
Environmental Effects Monitoring	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Beyond regional Duration: Long-term Frequency: Continuous Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: High	N/A	None
Haul Roads Reclamation	Dust from earth works and increased vehicle and foot traffic during the Closure Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Haul Roads Reclamation	Erosion from earth work and increased vehicle and foot traffic could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Haul Roads Reclamation	Positive Effect because the area was not in natural conditions when project began re sloping and re-vegetation will improve stability, decrease erosion and decrease dust generation	Extent: Local Duration: Long-term Frequency: Isolated Magnitude: Low Reversibility: Irreversible Likelihood: High Consequence: Low	N/A	None

Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Inspections, Sampling, Audits and Tours	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Beyond regional Duration: Long-term Frequency: Continuous Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: High	N/A	None
Inspections, Sampling, Audits and Tours	Positive Effect educates stakeholders on project and future projects	Extent: Beyond regional Duration: Long-term Frequency: Continuous Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: High	N/A	None
Ketza Roads Reclamation	Dust from earth works and increased vehicle and foot traffic during the Closure Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Ketza Roads Reclamation	Erosion from earth work and increased vehicle and foot traffic could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Ketza Roads Reclamation	Positive Effect because the area was not in natural conditions when project began re sloping and re-vegetation will improve stability, decrease erosion and decrease dust generation	Extent: Local Duration: Long-term Frequency: Isolated Magnitude: Low Reversibility: Irreversible Likelihood: High Consequence: Low	N/A	None
Long-Term Stabilization of Exposed Erodible Materials	Positive Effect remediation is completed to high standards by stabilizing ARD and/or metal leaching and erosion. Time taken for environmental recovery is decreased	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: Moderate	N/A	None

Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Mitigate Environmental Effects	Positive Effect ensures remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Regional Duration: Long-term Frequency: Sporadic Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Moderate	N/A	None
Open Pits	Newly exposed material from excavation work during the Operation Phase could cause metal leaching (ML) and/or acid rock drainage (ARD) This could increase metal concentrations and/or decrease pH in the surface water	Extent: Local Duration: Long-term Frequency: Continuous Magnitude: Moderate Reversibility: Long-term Likelihood: Moderate Consequence: High	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring A passive water treatment system may be included near waste rock dumps and/or open pit outfalls KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior	None
Open Pits	Water in the pits may be exposed to ARD and/or ML resulting in acidic water with high metals concentrations This could be directed to surface water	Extent: Local Duration: Long-term Frequency: Periodic Magnitude: Moderate Reversibility: Long-term Likelihood: Moderate Consequence: High	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior	Exposed rock in pits could be a source of ARD and/or ML
Other Sites Reclamation	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: Moderate	N/A	None
Post Closure Monitoring and Inspections	Positive Effect ensures remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Regional Duration: Long-term Frequency: Periodic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	N/A	None
Post Closure Monitoring and Inspections	Positive Effect educates stakeholders on project and future projects	Extent: Regional Duration: Long-term Frequency: Periodic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	N/A	None

Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Potential Construction of a Permanent Outlet Channel for Clean Surface Water in Open Pit	Positive Effect will decrease potential of ARD and/or ML in open pit as precipitation will not be stagnant in the pit	Extent: Regional Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: Moderate Consequence: Very Low	N/A	None
Potential Mitigations Resulting from Routine Environmental Monitoring	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Regional Duration: Long-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Low	N/A	None
Processing Plant and Ancillary infrastructure reclamation	Erosion from earth work and increased vehicle and foot traffic could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows. KRH will stabilize exposed erodible materials KRH will follow and maintain natural drainage patterns wherever possible	None
Processing Plant and Ancillary infrastructure reclamation	Dust from earth works and increased vehicle and foot traffic during the Closure Phase could come into contact with surface water, this could increase TSS and metals concentrations in the surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Long-term Likelihood: Low Consequence: Low	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust and will adhere to Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002) A minimum 30 m riparian buffer will be maintained along streams wherever possible KRH will limit vegetation removal wherever possible. KRH will promptly re-establish vegetation in cleared areas where the project plan allows.	None
Processing Plant and Ancillary infrastructure reclamation	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Local Duration: Medium-term Frequency: Isolated Magnitude: Moderate Reversibility: Irreversible Likelihood: Low Consequence: Low	N/A	None
Protect Local Watersheds	Positive Effect - limiting the seepage of pollutants into the ground and near surface water bodies will help to preserve watershed and water supply for wildlife	Extent: Regional Duration: Long-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Low	N/A	None

Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Provide Employment Opportunities to Local People	Positive Effect- Local people will have inherent interest in protecting surface water quality	Extent: Regional Duration: Long-term Frequency: Sporadic Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Low	N/A	None
Reclamation of Canamax Tailings Pond and Historic Waste	Positive Effect removes a pre-existing environmental hazard	Extent: Regional Duration: Long-term Frequency: Isolated Magnitude: Very Low Reversibility: Irreversible Likelihood: High Consequence: Moderate	N/A	None
Re-Establishing Drainage Pattern and Vegetation	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Regional Duration: Long-term Frequency: Isolated Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: Moderate	N/A	None
Regional Erosion Control and Sediment Management	Positive Effect reduces dust and soil access to surface water reducing their effect on increasing TTS /metals	Extent: Regional Duration: Long-term Frequency: Isolated Magnitude: Very Low Reversibility: Irreversible Likelihood: High Consequence: Moderate	N/A	None
Regional Erosion Control and Sediment Management	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Regional Duration: Long-term Frequency: Isolated Magnitude: Very low Reversibility: Irreversible Likelihood: High Consequence: Moderate	N/A	None
Removal of Equipment	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Beyond Regional Duration: Short-term Frequency: Isolated Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	N/A	None

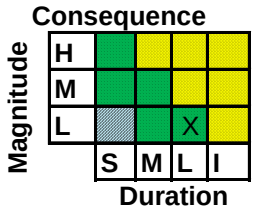
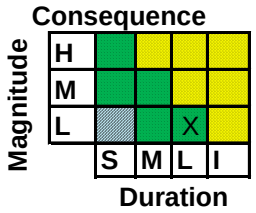
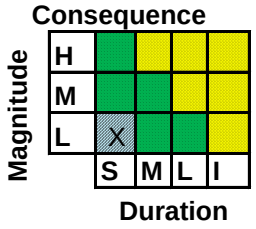
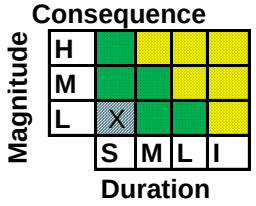
Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
Sediment Removal from Water Retention Dam and Transport to TSF	Positive Effect removes a pre-existing environmental hazard	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Long-term Likelihood: Low Consequence: Low	N/A	None
Sediment Removal from Water Retention Dam and Transport to TSF	Positive Effect removes a potential source of leaching from the water system as the TSF is lined and will be capped	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Irreversible Likelihood: Low Consequence: Moderate	N/A	None
Sediment Removal from Water Retention Dam and Transport to TSF	Positive Effect remediation is completed to high standards, time taken for environmental recovery is decreased and educates workers on practices for future work	Extent: Local Duration: Medium-term Frequency: Isolated Magnitude: Moderate Reversibility: Irreversible Likelihood: Low Consequence: Moderate	N/A	None
Short Sub-Level Open Stopping Underground Method	Newly exposed material from excavation work during the Operation Phase could cause metal leaching (ML) and/or acid rock drainage (ARD) This could increase metal concentrations and/or decrease pH in the surface water	Extent: Regional Duration: Long-term Frequency: Continuous Magnitude: Moderate Reversibility: Short-term Likelihood: Moderate Consequence: Moderate	KRH will monitor drainage water quality quarterly to determine if ARD or ML is occurring KRH will use geochemical characterization to minimize PAG volumes and understand long term ARD/ML behavior	Exposed rock in pits could be a source of ARD and/or ML
Transport of Hazardous Material to Return to Manufacturer	Positive Effect remediation is completed to high standards, and time taken for environmental recovery is decreased Educates workers on practices for future work	Extent: Beyond Regional Duration: Medium-term Frequency: Isolated Magnitude: Moderate Reversibility: Irreversible Likelihood: Low Consequence: High	N/A	None
Transport of Hazardous Material to Return to Manufacturer	Could potentially leak, leach or spill into surface water during transport	Extent: Beyond Regional Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Very Low	KRH will store hazardous materials as instructed by the manufacturer KRH will maintain and monitor equipment to ensure it is in good condition and leak free The Emergency Response Plan will be understood by staff and applied as soon as a spill or leak has been detected	None

Table 8.7-3: Reclamation and Closure Phase Effects Assessment for Surface Water Quality

Activity	Potential Effect	Assessment	Mitigation	Residual Effect
TSF Decommissioning	Could potentially leak or leach metals or processing chemicals from tailings or residual supernatant into surface water	Extent: Local Duration: Short-term Frequency: Isolated Magnitude: Moderate Reversibility: Short-term Likelihood: Low Consequence: Low	KRH will direct surface runoff away from/off the TSF at closure Water discharged from the TSF and Water Retention Pond and Waste Rock Pits will meet site specific discharge criteria prior to discharge to the receiving environment	None
TSF Water Removal	Positive Effect treatment allows remediation to be completed to high standards, and time taken for environmental recovery is decreased	Extent: Local Duration: Medium-term Frequency: Isolated Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	N/A	None
TSF Water Removal	Contaminants could be pumped out of the TSF during decommissioning	Extent: Local Duration: Medium-term Frequency: Isolated Magnitude: Very Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	Water discharged from the TSF pits, waste rock piles and Water Retention Pond will meet site specific discharge criteria prior to discharge to the receiving environment Selective discharge of tailings around the TSF will be conducted during the final years of operations to establish a final tailings beach that will facilitate surface water storage and reclamation	Accumulated processing chemicals, sediments and/or metals could be flushed downstream through pumping
Waste Rock Dump Mitigations for Surface Water	Positive Effect remediation is completed to high standards, and time taken for environmental recovery is decreased. Educates workers on practices for future work	Extent: Regional Duration: Short-term Frequency: Isolated Magnitude: Low Reversibility: Short-term Likelihood: Low Consequence: Very Low	N/A	None

Table 8.7-4: Surface Water Quality Residual Effects Assessment

Residual Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Drift and fill method for underground workings after decommissioning: Exposed rock in drifts could be a source of ARD and/or ML	Low	Local	Long-term	Continuous	Reversible Long-term	Moderate	
Open pit method after decommissioning: Exposed rock in open pits could be a source of ARD and/or ML	Low	Local	Long-term	Continuous	Reversible Long-term	Moderate	
Operation and Decommisioning of the Water Retention Pond: Accumulated sediments and metals could be flushed downstream during a flooding or pumping event	Low	Local	Short-term	Isolated	Reversible Short-term	Low	
TSF Operation and Decomissioning: Accumulated processing chemicals, sediments and/or metals could be flushed downstream through pumping	Low	Local	Short-term	Isolated	Reversible Long-term	Low	

8.8 Hydrology

8.8.1 Identification of Valued Environmental and Socio-economic Components

Flow quantity and timing were identified as hydrology-related VESECs. Project activities during different phases of the KRP could potentially create changes to baseline conditions which, in turn, may potentially impact fisheries and water quality in the Cache Creek and Ketza River systems.

8.8.2 Identification of Temporal and Spatial Boundaries

The spatial boundary for the two hydrology VESECs is limited to the Cache Creek Watershed. In particular, any effects as a result of the Project would be expected to occur along Cache Creek between the Canamax TSF and Ketza River confluence.

Potential changes in hydrology may be of concern during construction and operations of the mine. Following decommissioning, it is anticipated that hydrology will return to baseline conditions.

8.8.3 Summary of Baseline Information

The baseline hydrological conditions associated with Cache Creek are described in Section 4.10. In summary, the Project's Local Study Area (LSA) is located in the headwaters of the Cache Creek watershed. Cache Creek is a tributary of the Ketza River which in turn discharges into the Pelly River. The Cache Creek watershed covers an area of approximately 4,274 ha, including three main tributaries: Oxo Creek (432 ha), Peel Creek (274 ha) and Misery Creek (1,431 ha).

The average monthly flow per unit area hydrograph (Figure 4.10-1) demonstrates that peak flows typically occur during the month of June when temperatures increase and snowmelt begins. It is assumed that the low winter flows in these tributaries are sustained by groundwater recharge.

Presently, ditches divert upper Cache Creek flows around the existing Canamax TSF before merging back with Cache Creek approximately 300 to 400 m downstream. The majority of discharges from the Canamax TSF have occurred during the high flow months and seepage from the Canamax TSF drains into Cache Creek. Table 4.10-2 details the average baseline flows for Peel Creek, Cache Creek (Monitoring Station KR10) and Ketza River (Monitoring Station KR12). In addition, Table 4.10-4 provides an estimate of the natural variability of monthly flows in the LSA. It is observed that the monthly variability of flows ranges from 31% to 44% on a yearly basis. The concept of flow variability is important when evaluating the potential effects to the hydrologic system during mine construction, operations, and decommissioning phases.

8.8.4 Effects Characterization and Mitigation

Potential effects associated with the two hydrology related VESECs during mine activities are identified for the construction, operations, and decommissioning phases. Where effects are predicted, corresponding mitigation measures have been identified that can serve to eliminate or otherwise reduce changes in magnitude and timing of water flows in the LSA.

Residual effects, which are effects that cannot be avoided or fully mitigated, have been evaluated for their significance relative to background conditions. Potential effects on other resources (e.g., fish and fish habitat) are considered in other Sections of this Project Proposal.

8.8.4.1 Construction Phase

The construction phase is proposed to start in the spring of 2013 and will take approximately 1.5 years. The following activities have the potential to affect hydrologic conditions in the LSA during KRP construction:

- Constructing site roads
- Maintaining site roads
- Constructing diversion channels and on-site ditches
- Constructing the TSF
- Constructing the water retention pond.

Construction of Site Roads

As part of construction, a series of exploration roads will be upgraded to haul roads. Water will be required for compaction of earthworks and other upgrading activities. Water withdrawal for the construction of roads will be sourced from local streams (likely Peel Creek) until the water retention pond is constructed and operational.

Potential Effects

The potential hydrological effect during the construction of roads is the minor reduction of downstream flows because of water withdrawals from Peel Creek.

Mitigations

Downstream effects will be mitigated by controlling the rate and location of water withdrawal. If the water retention pond is not built prior to the construction and upgrading of haul roads, it is expected that water will be sourced from Peel Creek. Peel Creek is the only local stream that is non-fish bearing.

The rate of water withdrawals, in total for all mine-related water uses, will be limited to 10% of the total streamflow in Peel Creek, to mitigate downstream withdrawal effects.

Residual Effects

Downstream flow reduction was identified as the only potential residual effect associated with withdrawal of water from Peel Creek. If water is obtained from the water retention pond, no residual effect is expected as the volume required for road construction activities would be minimal in relation to the total volume held in the water retention pond.

Residual Effects Assessment

Flow reductions downstream of the LSA, after withdrawing water from Peel Creek during road construction, are considered to be of low consequence and significance (Table 8.8-1).

The Peel Creek watershed was found to supply approximately 7% of the Cache Creek flows and 3% of the Ketza River flows for an average year. If the water withdrawal from Peel Creek is limited to 10% of the Peel Creek flow, this would represent less than 1% of a change in flow quantity in the downstream environments.

Maintenance of Site Roads during Construction

Road maintenance, primarily dust control and re-surfacing, will be required during the construction phase of the mine. Water withdrawal procedures and limits for road maintenance will be similar to those adopted for the construction of roads, in that it is anticipated that water will be pumped from Peel Creek until the water retention pond is constructed and operational.

Potential Effects

The potential hydrological effect associated with road maintenance is the reduction of downstream flows as a result of water withdrawals from Peel Creek.

Mitigations

Downstream effects will be mitigated by controlling the rate and location of water withdrawals. If the water retention pond is not built when water is required for road maintenance, water will be sourced from Peel Creek, the only local stream that is non-fish bearing. Water withdrawal rates, for all withdrawal activities, will be limited to 10% of the total streamflow in Peel Creek to mitigate downstream withdrawal effects

Residual Effects

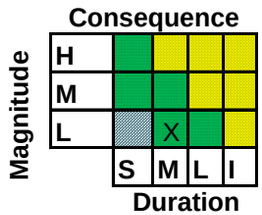
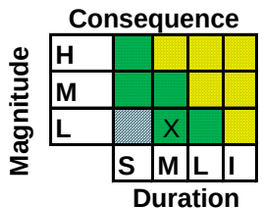
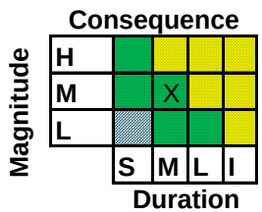
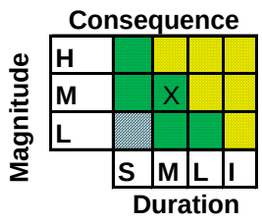
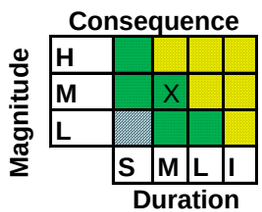
Flow reduction downstream was identified as the only potential residual effect after withdrawing water from Peel Creek. If water is obtained from the water retention pond, no residual effect is expected as the volume required for maintenance would be minimal in relation to the total volume of water held in the water retention pond.

Residual Effects Assessment

Flow reductions downstream of the LSA after withdrawing water from Peel Creek during road maintenance were considered to be of low consequence and significance (Table 8.8-1).

The Peel Creek watershed was found to supply approximately 7% of the Cache Creek flows and 3% of the Ketza River flows for an average year. If the water withdrawal from Peel Creek is limited to 10% of the Peel Creek flow, this would represent less than 1% of a change in flow quantity in the downstream environments.

Table 8.8-1: Hydrology Residual Effects Assessment

Residual Effect	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Reduced flows during construction and maintenance of roads	Low	Local	Medium-term	Isolated	Reversible Short-term	High	
Reduced flows downstream during initial filling of TSF	Low	Local	Medium-term	Isolated	Reversible Short-term	Low	
Reduced flows downstream during initial filling of WRP	Moderate	Local	Medium-term	Isolated	Reversible Short-term	Low	
Reduced flows downstream from surface runoff from Site dumps and pits diverted into TSF	Moderate	Local	Medium-term	Isolated	Reversible Short-term	Low	
Increased flows downstream from decommissioning WRP	Moderate	Local	Medium-term	Isolated	Reversible Short-term	Low	

Diversion and Site Ditch Construction

A water diversion structure will divert water from Cache Creek, Oxo Creek, and general local runoff around the proposed TSF and water retention pond further downstream into Cache Creek. Peel Creek will be diverted around waste dumps and into the water retention pond, ultimately spilling over a fixed spillway into downstream Cache Creek. Seepage and runoff from several waste piles and pits will ultimately be collected by a second set of open drainage ditches for diversion into the TSF.

Potential Effects

The potential hydrological effect resulting from the construction of ditches for local runoff would be changes to downstream flow timing. A change in length and geometry of the surface runoff route would potentially change the timing of flow downstream. The construction of a ditch will create faster and flashier floods downstream because of shortened conveyance length and smaller channel capacity.

Mitigations

- Ditches will follow local topography and drainage patterns
- Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream.

Residual Effects

After applying the above mitigations, no residual effects are anticipated to downstream flows.

Residual Effects Assessment

No residual effects are anticipated.

Tailings Storage Facility Construction

An embankment will be constructed at the initial stage of the TSF to allow for sufficient storage of water. Construction of the initial embankment will begin approximately six months before the mill start-up and will take approximately three months to construct. Approximately 16,000 m^3 of water will be impounded prior to mill start-up, and will be available for mill commissioning and early operations. The source of water will be Cache Creek.

Potential Effects

The potential hydrological effects resulting from the construction of the TSF are:

- Changes to downstream flow timing on Cache Creek because of temporary ditches by-passing the construction site. The construction of temporary ditches around the TSF will create faster and flashier floods downstream because of shortened conveyance length and smaller channel capacity
- Water withdrawal from the upstream Cache Creek watershed to fill the TSF to a volume of 16,000 m^3 for the mill start-up.

Mitigations

- Temporary ditches will follow local topography and drainage patterns. Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream
- The TSF and water retention pond will not be filled concurrently
- To mitigate the effect of withdrawing 16,000 m^3 of water from the watershed, the TSF will be filled during periods of high flow. Depending on the filling schedule, a maximum of 10% of the total natural Cache Creek flows at the Peel Creek confluence will be used.

Residual Effects

After applying the above mitigations related to construction and operation of the temporary ditches, no residual effects are anticipated to downstream flows.

During the filling period of the TSF, small downstream flow reductions in Cache Creek and Ketza River are expected. Table 8.8-2 shows that during the filling period of the TSF, residual effects from removing 10% of Cache Creek flows at the Peel Creek confluence will result in a reduction of approximately 4% of the total Cache Creek flow and approximately 2% of the Ketza River flows at KR12. These reductions are well within the natural variability of the monthly flow regime, as summarized on Table 4.10-4

Table 8.8-2: Effect on the Watershed Flows for Filling the Tailings Storage Facility During an Average Year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pre-Development Flows (m^3/d) at Cache Creek / Peel Creek Confluence (Area = 1,564 ha)	4,910	8,992	3,557	2,922	61,289	145,752	57,394	22,258	21,814	20,890	7,864	6,278
Pre-Development Flows (m^3/d) at Cache Creek Outlet (KR10) (Area = 4,274 ha)	13,417	24,571	9,721	7,986	167,486	398,302	156,843	60,826	59,611	57,087	21,490	17,156
Pre-Development Flows (m^3/d) at KR12 (Area = 9,551 ha)	29,984	54,909	21,722	17,846	374,277	890,076	350,493	135,927	133,210	127,571	48,024	38,338
Maximum 10% of Pre-Development Flows (m^3/d) at Cache Creek / Peel Creek Diverted to fill TSF	491	899	356	292	6,129	14,575	5,739	2,226	2,181	2,089	786	628
% Water Removed from Cache Creek at Peel Creek Confluence	≈10%	≈10%	≈10%	≈10%	≈10%	≈10%	≈10%	≈10%	≈10%	≈10%	≈10%	≈10%
% Water Removed from Cache Creek Flows at KR10	≈4%	≈4%	≈4%	≈4%	≈4%	≈4%	≈4%	≈4%	≈4%	≈4%	≈4%	≈4%
% Water Removed from Ketza River Flows at KR12	≈2%	≈2%	≈2%	≈2%	≈2%	≈2%	≈2%	≈2%	≈2%	≈2%	≈2%	≈2%
Amount of time to fill to 16,000 m^3 (days)	33	18	45	55	3	1	3	7	7	8	20	25

Residual Effects Assessment

The effect of diverting 16,000 m^3 of water from the upper Cache Creek watershed into the TSF was evaluated as having a low consequence and significance for Cache Creek and Ketza River due to the very small reductions in discharges downstream of the diversion and because this diversion will take place during high flow periods (Table 8.8-1).

Water Retention Pond Construction

Downstream of the TSF, an 85,021 m^3 water retention pond will be constructed to provide:

- Supplementary process water to the mill
- Fire protection
- Additional KRP water requirements.

Temporary ditches will be constructed during the development of the water retention pond to permit Peel Creek flows and local runoff to bypass the construction area.

Potential Effects

The potential effects during the construction of the water retention pond are:

- Downstream flow timing modified on Cache Creek because of temporary ditches by-passing the construction site. The construction of temporary ditches around the TSF will create faster and flashier floods downstream because of shortened conveyance length and smaller channel capacity
- Downstream flow reduction due to water withdrawal from Peel Creek to fill the water retention pond to a volume of 85,021 m^3 for the mill start-up.

Mitigations

- Temporary ditches will follow local topography and drainage patterns. Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream
- The TSF and water retention pond will be constructed at the same time but, to maintain continuous flows downstream, they will not be filled concurrently
- A diversion structure will be built to maintain baseflows
- To mitigate the effect of withdrawing 85,021 m^3 of water from Peel Creek, the water retention pond will be filled during periods of high flow. Depending on the filling schedule, a maximum of 10% of the total Peel Creek flows will be used.

Residual Effects

After applying the above mitigations related to construction and operation of the temporary ditches, no residual effects are anticipated to downstream flows.

During the filling period of the water retention pond, small downstream flow reductions in Cache Creek and Ketza River are expected. Table 8.8-3 illustrates downstream effects during the filling period of the water retention pond.

Table 8.8-3: Effect on the Watershed Flows for Filling the Water Retention Pond During an Average Year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pre-Development Flows (m^3/d) at Peel Creek Outlet (Area = 274 ha)	860	1,575	623	512	10,737	25,535	10,055	3,899	3,822	3,660	1,378	1,100
Pre-Development Flows (m^3/d) at Cache Creek / Peel Creek Confluence (Area = 1,564 ha)	4,910	8,992	3,557	2,922	61,289	145,752	57,394	22,258	21,814	20,890	7,864	6,278
Pre-Development Flows (m^3/d) at Cache Creek Outlet (KR10) (Area = 4,274 ha)	13,417	24,571	9,721	7,986	167,486	398,302	156,843	60,826	59,611	57,087	21,490	17,156
Pre-Development Flows (m^3/d) at KR12 (Area = 9,551 ha)	29,984	54,909	21,722	17,846	374,277	890,076	350,493	135,927	133,210	127,571	48,024	38,338
Maximum 10% of Pre-Development Flows (m^3/d) at Cache Creek / Peel Creek Diverted to fill TSF	86	158	62	51	1,074	2,553	1,005	390	382	366	138	110
% Water Removed from Cache Creek at Peel Creek Confluence	≈ 2%	≈ 2%	≈ 2%	≈ 2%	≈ 2%	≈ 2%	≈ 2%	≈ 2%	≈ 2%	≈ 2%	≈ 2%	≈ 2%
% Water Removed from Cache Creek Flows at KR10	≈ 1%	≈ 1%	≈ 1%	≈ 1%	≈ 1%	≈ 1%	≈ 1%	≈ 1%	≈ 1%	≈ 1%	≈ 1%	≈ 1%
% Water Removed from Ketza River Flows at KR12	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Amount of time to fill to 85,021 m^3 (days)	186	102	257	313	15	6	16	41	42	44	116	145

Residual Effects Assessment

The effect of removing 85,021 m^3 of water from Peel Creek to fill the water retention pond was evaluated to be of low consequence and significance (Table 8.8-1) for downstream Cache Creek and Ketza River, since only small flow reductions are anticipated and are within the natural variability of local flows. The natural variability of flows during the high flow season was found to be in the range of 37% to 44% (Table 4.10-4).

8.8.4.2 Operations Phase

The operations phase of the KRP will be five years. Water used for processing will be supplied primarily from the TSF supernatant pond and from the water retention pond. It is estimated that the process plant will use approximately 1,000 m^3/day. Figure 6.5-2 provides the preliminary water balance including water requirements for operations.

Potential direct effects on hydrology during the operations phase are associated with the following activities:

- Water retained in the water retention pond and TSF for mine process use
- Stream diversions
- Water routing
- Road maintenance.

Water Use in Processing

Water used for processing will be primarily from the TSF supernatant pond supplemented by the water retention pond. It is estimated that the process plant will use approximately 1,000 m^3/day. It is estimated that 700 m^3/day can be recovered from the supernatant pond, with the remaining 300 m^3/day coming from the water retention pond.

Potential Effects

The effect of removing 300 m^3/day could reduce downstream flows.

Mitigations

To limit downstream effects related to withdrawal of 300 m^3/day, these volumes will be extracted primarily from the water retention pond. The filling period of the pond will be limited to periods of high flow. Other water needs during the rest of the year will be extracted as well from the pond.

After applying the above mitigations, no residual effects are anticipated to affect downstream flows.

Residual Effects Assessment

No residual effects are anticipated.

Runoff from Waste Dump and Pit Dewatering during Operations Phase

Runoff from numerous waste piles and dewatered pits will be collected by open drainage ditches and directly diverted into the TSF. The total approximate area of these pits and dumps is approximately 173 ha, which represents 11% of the total area upstream of the confluence of Peel Creek and Cache Creek.

Potential Effects

Under existing conditions, surface runoff within the LSA flows toward tributaries of Cache Creek or directly into Cache Creek. Following mine development, runoff from the waste piles and pit areas (approximately 173 ha) at the Site will be directly diverted into the TSF, thereby reducing flow accretion into these systems.

Mitigations

Ditch inspections and maintenance will be conducted on a regular basis to confirm ditches are working properly. There is no mitigation for the loss of runoff from dumps and pits that are diverted into the TSF, until the TSF is decommissioned at the end of the mine life.

Residual Effects

A total of 11% of the runoff will be removed from the Cache Creek flow at the Peel Creek confluence and approximately 2% of the Ketza River flow at KR12 during the filling period due to loss of runoff from pit and dump areas that will be diverted to the TSF.

Residual Effects Assessment

The effect of removing flows from Cache Creek was evaluated as low consequence and significance for Cache Creek and Ketza River since percent of flows removed from local streams are within the limits of natural variability.

Water Routing During Operations Phase

After construction is completed, there will be more impervious surfaces (roads and infrastructure).

Potential Effects

Impervious areas create shorter transit times for runoff to infiltrate into the groundwater, effectively causing larger site runoff. Site runoff will be intercepted by roadside ditches creating faster routing to downstream environments.

Mitigations

Ditch inspections and maintenance will be conducted on a regular basis to confirm ditches are working properly.

Residual Effects

A total of 32 ha of the total catchment area will be covered by new haul roads. Since roads and infrastructure already exist within the Project footprint, the new proposed impervious areas from haul roads are not expected to substantively affect hydrological characteristics since they represent less than 5% of the total LSA. Therefore, no residual hydrological effects are anticipated due to additional impervious area from KRP-related road construction at the Site.

Residual Effects Assessment

No residual effects are anticipated.

Maintenance of Site Roads during Operations Phase

Road maintenance, primarily dust control and re-surfacing, will be required during the operations phase of the mine. Water withdrawal for the maintenance of roads during the operations phase will be sourced from the water retention pond.

Potential Effects

Water usage from the water retention pond for dust control and re-surfacing may result in downstream flow reductions in Cache Creek.

Mitigations

Downstream effects will be mitigated by controlling and monitoring the rate and timing of water withdrawal from the water retention pond.

Residual Effects

The amount of water required from the water retention pond for road maintenance will be less than 1% of the total volume. Therefore, residual effects will be negligible.

Residual Effects Assessment

Since residual effects were evaluated as negligible, no residual effects assessment was performed.

8.8.4.3 Decommissioning and Closure Phase

A goal of the KRP decommissioning phase is to rehabilitate any potential negative effects from the Project's operations. No potential direct or indirect negative effects to water volumes and timing are anticipated during decommissioning as drainage patterns will be re-established to pre-development conditions. The following activities have the potential to affect hydrology within the LSA during the decommissioning phase:

- Decommissioning the water retention pond
- Decommissioning the TSF.

Water Retention Pond Decommissioning

The water retention pond will be pumped down after completion of the operations phase of the Project, and prior to TSF decommissioning. It is expected that there will be sediments accumulated over time in the water retention pond that may require removal and disposal into the decommissioned TSF, after the water retention pond is pumped down. After sediments are removed, if necessary, a channel will be constructed to re-establish natural drainage conditions.

Potential Effects

The potential effects from TSF decommissioning include:

- Flow changes until the water retention pond is fully decommissioned
- Channel erosion from drawdown discharges.

Mitigations

- Discharges will be regulated to mimic natural pre-development flow conditions and prevent downstream channel erosion
- A streambed will be constructed through the water retention pond footprint to mimic and re-establish natural Peel Creek conditions.

Residual Effects

After applying the above mitigations, the residual downstream effects will be limited to a temporary increase in downstream flows until the water retention pond storage is discharged.

Residual Effects Assessment

The total volume of the water retention pond only represents a small volume of the total flow in Cache Creek. During decommissioning, discharges will be regulated to mimic natural flow conditions. As a result, the effect of releasing water from the water retention pond was evaluated as having a Low consequence and significance.

Tailings Storage Facility Decommissioning

At the beginning of the decommissioning phase, the TSF will contain approximately 1.88 million m^3 of consolidated tailings. The objective of TSF decommissioning is to transform the TSF footprint into an integrated component of the surrounding environment. During the final years of the operations phase, selective discharges will be released to facilitate water storage and reclamation. A permanent outlet channel will also be constructed downstream to facilitate the discharge of clean surface waters to downstream reaches.

Potential Effects

The potential effects from TSF decommissioning include flow changes during selective discharges.

Mitigations

Discharges will be regulated to prevent unwanted downstream channel erosion and mimic natural pre-development flow conditions.

Residual Effects

After applying the above mitigations, no residual effects are anticipated to affect downstream flows.

Residual Effects Assessment

No residual effects are anticipated.

8.8.5 Summary of Mitigation Measures

Mitigated measures are identified for different activities associated with the construction, operations and decommissioning phases of the Project, in relation to potential effects related to hydrology. The following mitigations will be applied to reduce Project-related effects downstream, in relation to changes in flow timing and flow magnitude in downstream watercourses (Table 8.8-4):

- Water will be sourced from Peel Creek until the water retention pond is constructed
- The rate of water withdrawal will be limited to 10% of Peel Creek flows to mitigate downstream withdrawal effects during road construction and maintenance
- Ditches will be constructed to follow local topography and drainage patterns
- Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream
- Temporary ditches will follow local topography and drainage patterns. Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream
- To mitigate the effect of withdrawing 16,000 m^3 of water from the watershed, the TSF will be filled during periods of high flow. Depending on the filling schedule, a maximum of 10% of the total natural Cache Creek flows at the Peel Creek confluence will be used
- A diversion structure will be designed and built to maintain baseflows from Peel Creek downstream and limit the filling rate
- To mitigate the effect of withdrawing 85,021 m^3 of water from Peel Creek, the water retention pond will be filled during periods of high flow. Depending on the filling schedule, a maximum of 10% of the total Peel Creek flows will be used
- To limit downstream effects of withdrawing 300 m^3/day, these volumes will be extracted from the retention pond. The filling period of the pond will be limited to periods of high flow. Other water needs during the rest of the year will be extracted as well from the pond
- Ditch inspections and maintenance will be conducted on a regular basis to confirm ditches are operating properly
- Downstream effects will be mitigated by controlling and monitoring the rate and timing of water withdrawal from the water retention pond for water use
- Discharges from the water retention pond and TSF will be regulated to mimic natural pre-development flow conditions and prevent downstream channel erosion
- During Project closure and reclamation, a streambed will be constructed through the water retention pond footprint to re-establish natural Peel Creek conditions.

Table 8.8-4: Summary of Potential Effects, Mitigation Measures and Residual Effects for Hydrology

Project Activity	Potential Effect	Mitigation	Residual Effect	
			None	Assess Consequence
Construction of Site Roads	Flows Reduced	Downstream effects will be mitigated by controlling the rate and location of water withdrawal. If the WRP is not built prior to the construction and upgrading of hauling roads, water will be sourced from Peel Creek. Peel Creek is the only local stream that is non-fish bearing. The rate of water withdrawal will be limited to 10 % of Peel Creek flows to mitigate downstream withdrawal effects.		X
Maintenance of Site Roads	Flows Reduced	Downstream effects will be mitigated by controlling the rate and location of water withdrawal. If the WRP is not built prior to the construction and upgrading of hauling roads, water will be sourced from Peel Creek. Peel Creek is the only local stream that is non-fish bearing. The rate of water withdrawal will be limited to 10 % of Peel Creek flows to mitigate downstream withdrawal effects.		X
Construction of Diversion Chanels and Site Ditches	Flow Timing Increased	Ditches will follow local topography and drainage patterns. Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream	X	
Construction of TSF	Flow Timing Increased	Temporary ditches will follow local topography and drainage patterns. Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstreamdownstream	X	
	Flows Reduced	To mitigate the effect of withdrawing 16,000 m3 of water from the watershed, the TSF will be filled during the freshet (May-July) when flows are high. Depending on the filling schedule, a maximum of 10% of the total natural Cache Creek flows at the Peel Creek confluence will be used for the period of May to June		X
Construction of WRP	Flow Timing Increased	Temporary ditches will follow local topography and drainage patterns. Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstreamdownstream	X	
	Flows Reduced	There will be no mitigations for the filling period of the WRP as all of Peel Creek is diverted into the WRP.		X
Water Use in Processing	Flows Reduced	There will be no mitigations for the filling period of the WRP as all of Peel Creek is diverted into the WRP.		X
Runoff from Waste Dump and Pit Dewatering during Operations Phase	Flows Reduced	Ditch inspections and maintenance will be conducted on a regular basis to ensure ditches are working properly. There is no mitigation for the loss of runoff from dumps and pits that are diverted into the TSF until the TSF is decommissioned at the end of the mine life.		X
Water Routing	Flows Increased	Ditch inspections and maintenance will be conducted on a regular basis to ensure ditches are working properly.	X	
Road Maintenance	Flows Reduced	Downstream effects will be mitigated by controlling the rate and location of water withdrawal. If the WRP is not built prior to the construction and upgrading of hauling roads, water will be sourced from Peel Creek. Peel Creek is the only local stream that is non-fish bearing. The rate of water withdrawal will be limited to 10 % of Peel Creek flows to mitigate downstream withdrawal effects.		X
Decommissioning WRP	Flows Increased	Discharges will be regulated to mimic natural pre-development flow conditions and prevent downstream channel erosion		X
Decommissioning TSF	Flows Increased	Discharges will be regulated to mimic natural pre-development flow conditions and prevent downstream channel erosion	X	

8.8.6 Significance Determination

Flow timing and flow magnitude were identified as two hydrology-related VESECs for the Project. The potential effects on the local hydrology were assessed for a spatial boundary limited to the Cache Creek watershed and Ketza River watershed upstream of the Cache Creek confluence.

The residual effect assessment identified residual effects after mitigations on the magnitude and timing of flows downstream to be of low consequence and significance, and within an identified range of natural variability. Significance was determined with moderate confidence.

With identified mitigations, there are no significant environmental effects expected in relation to hydrology.

8.9 Hydrogeology

8.9.1 Identification of Valued Environmental and Socio-economic Components

Groundwater is an important element of the local ecological system and therefore groundwater quality and quantity are both considered as VESECs 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 Site.

8.9.2 Summary of Baseline Information

Below is a summary of relevant baseline information previously presented in the existing conditions section (Section 4.11) of this Project Proposal:

- The regional groundwater flow divide coincides with surface water divides to the north, south, and west of the KRP area. Groundwater from the Site discharges to the valley of Cache Creek (directly to Cache Creek, or via tributaries Peel Creek and Misery Creek) within or northeast of the Site.
- The groundwater flow direction generally mimics the slope of surface topography. Deep groundwater flows from the highest areas towards Cache Creek and Peel Creek valleys. 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. At lower elevations where overburden covers bedrock, 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 0.08 in the area of the Lab-Hoodoo pit to about 0.4 in the area of the QB pit. 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 tens of metres to several hundred metres per year.
- Shallow and deep groundwater samples obtained from the site had low to high concentrations of total dissolved solids (87 to 3,280 mg/L), and correspondingly low to high electrical conductivities. The pH

values ranged widely (from 3.6 to 8.2) and hardness ranged from 0.7 to 2,980 mg/L. Dissolved oxygen concentrations were generally low suggesting reducing chemical conditions, except for the shallow groundwater samples which had dissolved oxygen concentrations of typically more than 5 mg/L. The groundwater temperature varied between 0.3 and 9.1°C, which appear to vary with seasonal air temperatures.

- Calcium and magnesium are the dominating cations in all groundwater samples from the LSA. Bicarbonate and sulfate were the dominating anions in all samples. Groundwater in the Manto Zone is usually bicarbonate-rich whereas groundwater in the Shamrock Zone is sulphate-dominated.
- Baseline concentrations of many metals exceeded CCME ALG guideline values (aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, mercury, nickel, silver, and zinc) and CSR standards (arsenic, cobalt, cadmium, and copper) in at least one sample.

8.9.3 Identification of Temporal and Spatial Boundaries

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
- Groundwater is extracted from or added to the subsurface
- 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 specific groundwater-related VESECs and the associated temporal overlap are summarized below:

- **Open pits**: groundwater (quantity and quality) within the mine area and draining to the open pits while the ore is extracted. These effects may occur during operation and post-closure.
- **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 operation and post-closure.
- **Tailings Storage Facility**: groundwater quality may be affected by seepage from the TSF.
- **Waste rock dumps**: groundwater quality in the vicinity of waste rock dumps may be affected by recharge from precipitation infiltrating through the waste rock into the underlying aquifer. This temporal overlap occurs during construction, operation, and post-closure.
- **Run of Mine (ROM) Stockpile**: groundwater quality in the vicinity of the ROM Stockpile pad may be affected by recharge from precipitation infiltrating through the stockpile into the underlying aquifer. This temporal overlap occurs during construction and operation.
- **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 Site and at any time during construction, operation, and decommissioning. The risk of chemical spills and releases will be reduced following closure.

8.9.4 Effects Characterization

The effects characterization has been conducted through consideration of the individual KRP 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 mitigative action.

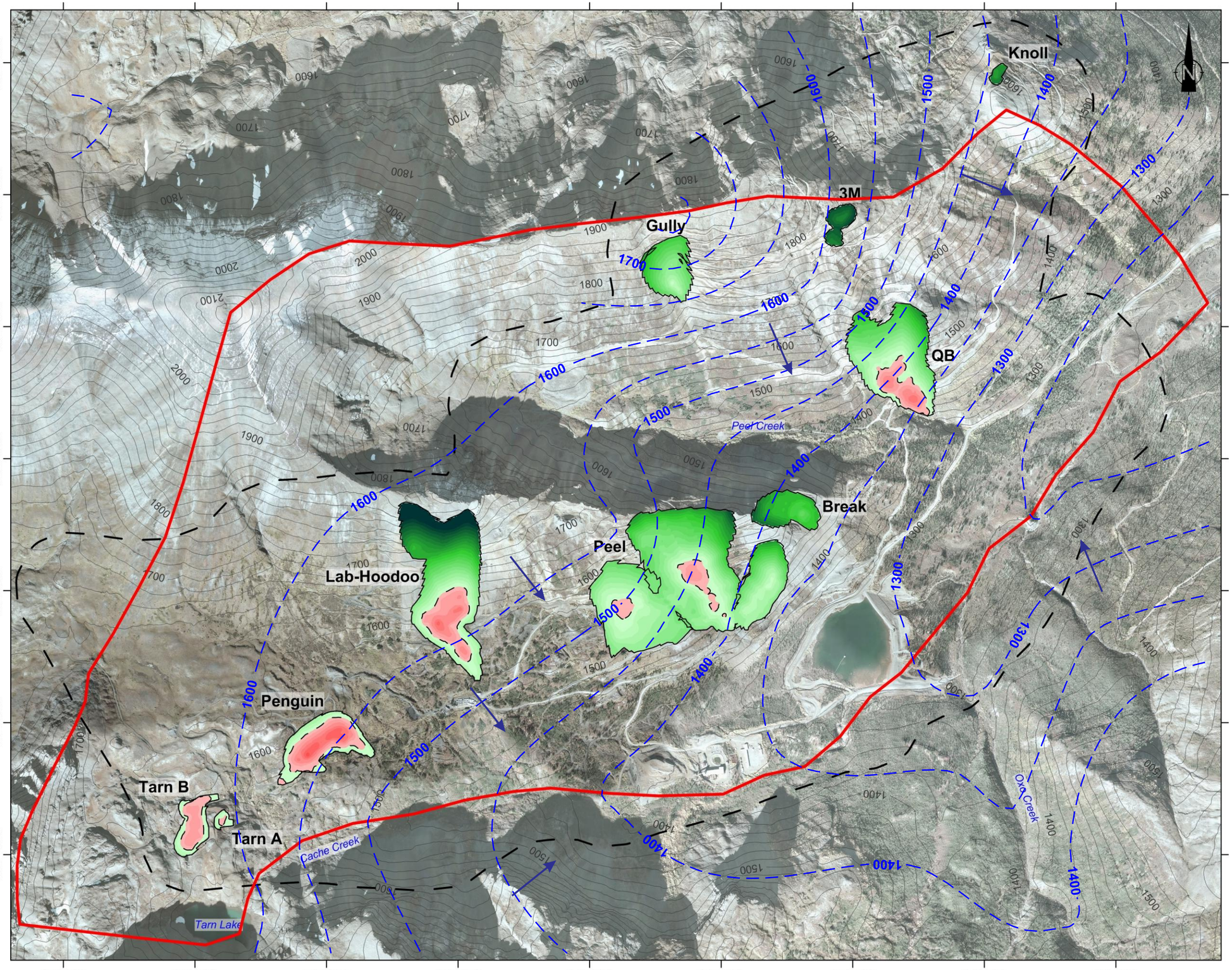
8.9.4.1 Groundwater Inflow to Open Pits and Underground Mines

Results of the hydrogeological assessment (see Section 4.11) indicate that some parts of the open pits will be below the local groundwater table. Some of the open pits will therefore require dewatering during the operational phase. Figure 8.9-1 shows the relative groundwater elevation in the open pits, suggesting that the lower portions of the Tarn A and B, Penguin, Lab-Hoodoo, Peel, and QB pits will be below the groundwater table (red coloured areas in Figure 8.9-1). The remaining pits (Break, Gully, 3M, and Knoll) will be above the groundwater table (green coloured areas in Figure 8.9-1) and will likely not require any dewatering.

The method by Marinelli and Niccoli (2000) was used to estimate the groundwater inflow to open pits. This method uses a steady-state analytical solution to calculate the inflow of groundwater into an open pit considering both lateral and vertical inflow through the bottom of the pit. The simplifying assumptions of this method are described in Marinelli and Niccoli (2000) and can be summarized as follows:

- Horizontal flow:
  - Steady-state, unconfined, horizontal radial flow
  - Uniformly distributed recharge at water table
  - Pit walls are approximated as a right circular cylinder
  - Flow is horizontal and Dupuit-Forchheimer approximation is used to account for changes in saturated thickness due to depression of groundwater table
  - Pre-dewatering groundwater table is approximately horizontal
  - Groundwater flow toward the excavation is axially symmetric
- Vertical flow:
  - Steady-state flow to one side of a circular disk sink of constant and uniform drawdown
  - Infinite aquifer in lateral and vertical extent
  - Hydraulic head is initially uniform
  - Initial head is equal to the elevation of the initial water table
  - Flow to disk sink is three-dimensional and axially symmetric
  - Aquifer materials are anisotropic and the principal coordinate directions for hydraulic conductivity are horizontal and vertical.

Especially the assumption of an infinite aquifer in lateral and vertical extent means this analysis will tend to overestimate the actual inflow rates given the mountainous terrain in the Site and the relatively small catchment areas. For this reason, these analytical results should be considered as very conservative.



LEGEND

- Project Area Boundary
- Contour (20 m)
- Hydraulic Head Contour (m asl), Feb 2011
- Groundwater Flow Direction
- Upper Cache and Peel Creek Catchments

200 180 160 140 120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200

Metres above groundwater table

Metres below groundwater table

Relative Groundwater Elevation within Proposed Open Pit:
- Positive values: metres above groundwater table
- Negative values: metres below groundwater table

NOTES
Base data source: 1:50,000 NTS
Imagery source: Aero Geometrics Ltd (2007)

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Relative Groundwater Elevation in Proposed Open Pits

250 125 0 250
Metres

CLIENT
Ketza River Holdings

eba A TETRA TECH COMPANY

FILE NO.				
W23101052_104_GroundwaterElevation.cdr				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
W23101052.104	SK	KSS		1
OFFICE	**DATE**			
EBA-WHSE	August 4, 2011			

Figure 8.9-1

Q:\Vancouver\Graphics\ENVIRONMENTAL\W231\W23101052_Ketza\104\W23101052_104_GroundwaterElevation.cdr

Based on these assumptions the horizontal and vertical inflow components can be estimated using the following analytical solutions:

- Horizontal flow:

$$h_0 = \sqrt{h_p^2 + \frac{W}{K_h}\left[r_0^2 \ln\left(\frac{r_0}{r_p}\right) - \frac{\left(r_0^2 - r_p^2\right)}{2}\right]}$$

$$r_p = \sqrt{\frac{A}{\pi}}$$

- where W is the distributed recharge flux, K_h is the horizontal hydraulic conductivity, r_p is the effective pit radius, A is the area of the pit below the local groundwater table, h_p is the saturated thickness above the base of the pit, r_0 is the radius of influence, and h_0 is the initial saturated thickness above the base of the pit.
- Given input values of W, K_h, r_p, h_p, and h_0, the radius of influence (r_0) is determined from the above equation by iteration. Once r_0 is determined, the horizontal inflow rate Q_1 is computed by:

$$Q_1 = W\pi\left(r_0^2 - r_p^2\right)$$

- Vertical, upward flow:

$$Q_2 = 4r_p\left(\frac{K_h}{m}\right)h_0$$

$$m = \sqrt{\frac{K_h}{K_v}}$$

- where Q_2 is the vertical, upward inflow to the pit, K_v is the vertical hydraulic conductivity, m is an anisotropy parameter.
- Total inflow to open pit:

$$Q = Q_1 + Q_2$$

Groundwater inflow to the open pits was estimated for mean hydraulic conductivities of the bedrock in the area of the respective open pit. Hydraulic conductivity values were determined using packer tests and/or pumping tests in monitoring wells in the area of the open pits (see Table 4.11-2). The mean hydraulic conductivities are used to represent the local bulk hydraulic conductivities in the respective mining areas.

The Lab-Hoodoo, Peel, and QB pits will be located on steep mountain slopes and the groundwater inflow rates estimated using the above described method are therefore halved, accounting for the fact that groundwater inflow will mostly occur from the mountain-side of the pit.

Table 8.9-1 presents the input parameters and calculated groundwater inflow rates to the open pits.

Table 8.9-1: Estimated Groundwater Inflow to Open Pits

Open Pit	Dewatering Area	Dewatering Depth	mean K-value	Estimated Total Inflow
	m^2	m	m/s	m^3/day
Lab-Hoodoo	27107	42	9E-07	315
Penguin	30545	53	9E-07	873
Tarn A	926	5	7E-08	1
Tarn B	13752	18	7E-08	18
Peel	16926	22	4E-08	9
QB	21554	36	9E-07	250

Two underground mines are below the Peel and Lab-Hoodoo open pits. Design details for the underground mines are not yet available and the following assumptions were therefore used to estimate groundwater inflow rates into the underground mine workings:

- Lowest elevation of underground mines:
  - Peel: 1,380 m asl
  - Lab-Hoodoo: 1,560 m asl
- Mean groundwater elevation in the area of the underground mines:
  - Peel: 1,475 m asl
  - Lab-Hoodoo: 1,575 m asl
- Depth of the underground mines below the groundwater table:
  - Peel: 95 m
  - Lab-Hoodoo: 15 m
- Total length of underground workings below the groundwater table:
  - Peel: 1000 m
  - Lab-Hoodoo: 1000 m
- Drift radius: 5 m

The method of Goodman et al. (1965) was used to estimate inflow to the underground workings:

$$Q = \frac{2\pi KL(H-h)}{\ln\left(\frac{2H-2h}{r}\right)}$$

where Q is the estimated inflow rate, K is the hydraulic conductivity, L is the length of the underground workings, H is the depth of the drift centre from the water table, h is the hydraulic head into the drift, and r is the drift radius.

The formula of Goodman et al. (1965) is based on the assumption of a homogeneous and isotropic aquifer with a horizontal groundwater table, and r<<H. This method also assumes an aquifer of infinite extent, which may not be the effective hydrogeological behaviour of the mined rockmass at this site. For this reason, these inflow rates are considered conservative.

Table 8.9-2 summarizes the estimated inflow rates to the Peel and Lab-Hoodoo underground mines per metre of underground development based on the above mentioned assumptions.

Table 8.9-2: Estimated Inflow Rates to Underground Mines

Underground Mine	Length of Drifts (m)	Drift Radius (m)	Depth below Groundwater (m)	Hydraulic Conductivity	Estimated Inflow Rates
				Mean (m/s)	Mean (m^3/day)
Peel	1000	2.5	95	4E-08	476
Lab-Hoodoo	1000	2.5	15	5E-07	1638

Table 8.9-3 shows a rough annual breakdown of inflow rates to the individual open pits based on the mining schedule (Figure 6.6-13).

Table 8.9-3: Annual Breakdown of Inflow Rates to Open Pits and Underground Workings

Mining Area	Mean Estimated Inflow (m^3/day)	Operational Phase		Annual Breakdown of Inflow Rates during Mine Operations (m^3/day)					
		from	to	2017	2018	2019	2020	2021	2022
Lab-Hoodoo Pit	315	2019	2021	-	-	315	315	315	-
Lab-Hoodoo Underground	1,638	2019	2021	-	-	1,638	1,638	1,638	-
Penguin Pit	873	2017	2019	873	873	873	-	-	-
Tarn A Pit	1	2021	2021	-	-	-	-	1.4	-
Tarn B Pit	18	2017	2018	18	18	-	-	-	-
Peel Pit	9	2017	2020	-	-	9	9	-	-
Peel Underground	476	2017	2020	476	476	476	476	-	-
QB Pit	250	2020	2022	-	-	-	-	250	250
Total Inflow Rates:				**1,367**	**1,367**	**3,312**	**2,439**	**2,205**	**250**

The estimated total inflow to open pits and underground mines will be in the order of 3,300 m^3/day (99,000 m^3/month) during Year 3 of the mine life. However, this number may overestimate actual dewatering volumes based on the simplifying assumptions of the methods used. Also, there is great uncertainty involved in the above estimate due to the current lack of design details for the underground mines.

Because design details for the underground mines are not currently available, a separate approach has also been used to provide a reasonable estimate of total dewatering volumes during the five-year mine life. This method is based on an approximate infiltration budget for the upper Cache Creek and Peel Creek watersheds in which the open pits and underground mines are located that will require dewatering during mining operation.

The infiltration budget for this area can be described as follows:

$$I = P - E - C \cdot (P - E)$$

where I is infiltration or groundwater recharge, P is precipitation, E is potential evapotranspiration, and C is the runoff coefficient. This method assumes that no change in groundwater storage will occur.

The mean annual precipitation in the area of the KRP is 714 mm (see Section 4.4). Evapotranspiration E in the KRP Area has been evaluated to be 284 mm (see Section 4.4). A runoff coefficient of 0.85 has been assumed based on the mountainous terrain with steep rocky slopes in the recharge areas.

The calculated average annual infiltration I is about 65 mm/yr. This represents 9% of average annual precipitation which is a reasonable value for this type of terrain. Figure 8.9-1 shows the catchment of the upper Cache Creek and Peel Creek that includes all open pits and underground mines which will likely require dewatering during operation. The total catchment area is about 7.8 km^2. This value is conservatively high since it includes areas down-slope of the mine workings, and also includes areas of groundwater discharge where groundwater recharge will be nil. The catchment area times the average annual infiltration rate gives a total annual infiltration of about 507,000 m^3/yr.

Given the number, size, and location of the open pits and underground workings that will require dewatering, we assume that about 25% of the total catchment infiltration could potentially be intercepted by dewatering. This number is considered to be conservative, especially given the fact that not all mine workings will be dewatered at the same time (see mining schedule in Figure 6.6-13).

The total dewatering flow (for all workings simultaneously) based on the above-presented infiltration budget can therefore be estimated at about 126,750 m^3/yr or roughly 10,600 m^3/month.

More accurate dewatering volumes will be determined in future during detailed mine design based on detailed design of the open pits and underground mines, additional hydrogeological investigations in the areas of the open pits and underground workings requiring dewatering (e.g., using numerical modelling techniques), and the design of the dewatering systems.

Dewatering options include active (perimeter or in-pit dewatering wells, drain holes) or passive (sumps) systems, which will be designed with safe open pit and underground mining operations in mind. Depending on the method and design of the dewatering system, dewatering may have to be started prior to mining of the respective open pit or underground mine and actual dewatering volumes will have to be determined based on the design details of the system and dewatering schedule.

Dewatering the open pits and underground workings will change the groundwater flow regime in the mining areas. Open pits and underground mines will act as local sinks with groundwater flow towards the dewatering wells, drain holes, or sumps. After dewatering ceases, groundwater levels will recover to similar conditions as pre-mining. Pit lakes will develop post-closure in Tarn, Penguin, Lab-Hoodoo, Peel, and QB pits at elevations below the local pre-mining static groundwater elevation. The deeper parts below the groundwater table of the Peel and Lab-Hoodoo underground mines will flood.

The use of perimeter wells for dewatering will result in water quality similar to the baseline groundwater quality in the vicinity of the open pit or underground mine (see Section 4.11). Water that is directly pumped from the open pits or underground workings and comes into contact with pit and drift walls or explosive residues may cause adverse effects on water quality, including low pH as well as high metals, ammonia, ammonium, and nitrate concentrations.

Water from dewatering the open pits and underground mines will be diverted into the TSF to avoid any uncontrolled release of potentially adversely affected water into the environment. The conceptual design of the TSF accommodates nominal flows of 10,000 m^3/month from dewatering of the mine workings. Revised dewatering volumes will be estimated during detailed mine design and if required, detailed design of the TSF will take into account these revisions.

8.9.4.2 Groundwater Flow through Open Pits and Underground Mines Post-Closure

Groundwater flowing through the open pits and underground mines after mine closure may have a negative effect on groundwater quality. ARD/ML test work has shown that most of the waste rock types in the Manto Zone are NAG with some minor PAG units, and that waste rock in the Shamrock Zone is more variable with significant amounts of PAG material (see Section 6.4). Shake flask results indicated that most waste rock types (both NAG and PAG) have a strong potential for metals leaching even at neutral or slightly alkaline pH. In the shake flask tests, multiple metals exceeded CCME ALG. Metals concentrations observed for some of the waste rock types exceeded CCME ALG by several orders of magnitude (see Section 6.4).

Groundwater flow passing through the open pits and underground mines can be roughly estimated using Darcy's Law:

$$Q = K \cdot i \cdot A$$

where Q is the groundwater flow rate, i is the hydraulic gradient, and A is the cross-sectional area of the flooded open pit or underground mine perpendicular to the direction of groundwater flow.

The flow rate of groundwater through the open pits and underground mines was estimated based on the following assumptions:

- Full recovery of the groundwater table to pre-mining elevations after dewatering ceased
- Cross-sectional area of the pit lakes was approximated by a triangle
- Cross-sectional area of Peel and Lab-Hoodoo underground mines were assumed to be 5,000 m^2 each (1,000 m combined length of drifts with a diameter of 5 m for each underground mine).

Table 8.9-4 presents the estimated groundwater flow rates through the open pits and underground workings after mine closure.

Table 8.9-4: Estimated Post-closure Groundwater Flow through Open Pits and Underground Mines

Open Pit or Underground Mine	Cross Sectional Area *A*	Hydraulic Conductivity *K*	Hydraulic Gradient *i*	Groundwater Flow Rate *Q*
	m^2	m/s	–	m^3/day
Tarn A Pit	568	7.00E-08	0.2	1
Tarn B Pit	375	7.00E-08	0.2	0.5
Penguin Pit	7,614	9.00E-07	0.2	118
Lab-Hoodoo Pit	4,543	9.00E-07	0.1	35
Lab-Hoodoo Underground	5,000	9.00E-07	0.05	19
Peel Pit	1,579	4.00E-08	0.3	2
Peel Underground	5,000	4.00E-08	0.3	5
QB Pit	2,586	9.00E-07	0.3	60
			Total Flow Rate:	**241**

The estimated groundwater flow rates vary from less than 1 m^3/day for the Tarn B Pit to about 120 m^3/day in the Penguin Pit. The total estimated groundwater flow rate through the abandoned mine workings will be about 250 m^3/day.

8.9.4.3 Tailings Storage Facility

Tailings will be produced from conventional milling of ore. The CIL process will result in a single thickened tailings stream for disposal in the TSF. Based on information from the DHA, (Appendix H1) the TSF will be in a groundwater discharge zone along Cache Creek. Overburden in this area consists of moraine sediments mixed with talus and colluvium, having a low hydraulic conductivity. Boreholes in the vicinity of the TSF indicate that overburden consists of clay and silt till with sand and gravel layers or lenses, with overall thickness ranging from about 5 to 20 m. These fine grained sediments may also act as a barrier for infiltrating seepage water and as a semi-confining layer for deeper groundwater. Groundwater flows toward Cache Creek from both sides of its valley (Figure 4.11-3). Along the Cache Creek valley bottom (i.e., along the axis of the creek and beneath the center of the TSF and down-stream Water Retention Pond), groundwater flows to the east-northeast with a horizontal gradient of about 0.08.

The TSF will contain thickened tailings from the mill and supernatant water which will largely consist of pore fluids expelled from the tailings after placement (along with a minor amount of direct precipitation onto the TSF area). The supernatant water is to be collected and recycled back to the mill for process water during mine operation. The materials in the TSF will be PAG and seepage of fluids out of the TSF could potentially be harmful to underlying groundwater quality and to receiving water bodies (e.g., Cache Creek downstream of the TSF). ARD caused by oxidation of sulphides in tailings, and/or ML can potentially affect groundwater quality and ultimately surface water quality. Three possible mechanisms of leachate production could result in effects to groundwater quality in this case:

- Groundwater flow into and through the TSF
- Infiltration of precipitation through the tailings
- Loss of process water from the tailings after placement.

The TSF dyke will be constructed on existing glacial moraine deposits which, although fine-grained and of low permeability, could potentially allow some seepage underflow beneath the TSF dyke if pond water were to bypass the liner. This underflow has the potential to mix with underlying groundwater and degrade its quality as well as downstream surface water quality.

However, the TSF dyke design and construction quality control includes measures to prevent underflow or effectively capture seepage if it should occur. There will be a geosynthetic clay liner placed on the base of the TSF and the upstream face of the dyke. The liner will be carefully assembled and inspected during installation to minimize any mechanical failures or punctures before starting to place tailings. Beneath this liner at the upstream face, there will be an upstream filter drain, with collector drain and drainage pipe leading to a sump, located at a central downstream area of the dyke (see Figure 6.6-5). In addition, a toe filter drain will be placed at the central base of the downstream face of the dyke, connected to the sump. Seepage water collected in the sump from the upstream filter drain and downstream toe filter drains will be pumped by pipeline back into the supernatant water pond. Details of dyke design are shown in Figure 6.6-7.

Groundwater discharge or flow up into the base of the tailings in the TSF could result in ARD or metals leaching (see Figure 4.11-5). However, this effect will be blocked as the TSF is to have a geosynthetic clay liner along its entire base before tailings placement. In addition, hydraulic conductivities of the silty and clayey morainal overburden deposits underlying the TSF are estimated (based on grain size descriptions) to be on the order of 10^{-7} to 10^{-9} m/s. These deposits are expected to act as a semi-confining layer to upward groundwater flow from bedrock beneath the TSF. Also, the tailings are predicted to have decreasing hydraulic conductivity over time after placement due to consolidation and release of pore fluids. Over time, consolidation will tend to make the tailings more mechanically stable, more dense and less permeable. Due to the combined effects of these factors, the upwards flow of groundwater into and through tailings in the TSF is not expected. This will also limit exposure of tailings to oxygen and limit chemical reactions which produce acidic drainage.

Potential loss of process water from tailings is expected as porewater will in part be expelled during gradual tailings consolidation after placement in the TSF. This pore water will either discharge to the supernatant water pond, or if pore water were to bypass the liner for any reason, it will seep under the dyke and be collected by the sump and return line system.

The TSF is intended to have an active supernatant water pond on its southwest end. This supernatant water will pool adjacent to the advancing tailings placement, which will slope down gently (2-2.5% slope) from the TSF dyke crest. Precipitation that falls on exposed tailings will runoff or discharge into the supernatant pond, or percolate through the tailings and be intercepted by the liner. As further protection, a drainage collection and recirculation system (upstream filter drain, collector drain, toe filter drain, and sump at toe of dyke) built into the TSF will collect seepage flowing under the dyke and return it to the supernatant water pond. Further, the TSF area is a groundwater discharge area with an upward hydraulic gradient. The upward gradient is expected to limit percolation of any seepage under the TSF dyke from entering the shallow groundwater flow system and discharging further down-stream.

KRH will place a low-permeability cover over the TSF during decommissioning and reclamation at mine closure. This cover will retard precipitation from entering the tailings after closure.

8.9.4.4 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. KRH has a spill contingency plan (see Section 10.0) in place to limit the potential effects of any chemical releases. As well, potential contamination of soils and groundwater will be identified during closure and reclamation to determine if chemicals exist at concentrations above regulated standards.

8.9.4.5 Waste Rock Dumps

There are nine waste rock dumps planned for the mine site: in the Manto Zone – Peel Dumps 1, 2 and 3, Penguin Dump, Tarn Dump and Lab-Hoodoo Dump; and in the Shamrock Zone – QB Dump 1 and 2 and Knoll (3D) Dump (see Figure 6.2-1). Two of these dumps (Peel Dump 3 and QB Dump 2) will contain a mix of PAG and NAG rock waste, while the remaining dumps are intended to receive only NAG waste. The mixed PAG and NAG Dumps will be constructed such that PAG waste will be encapsulated within NAG waste. Potential for acid runoff and/or metals leachate potentially affecting groundwater quality beneath and down-gradient of the sites will be mitigated through engineered waste rock pads and drainage collection.

A detailed geochemical assessment of acid generation and metal leaching potential for rock and ore materials around the mine site was conducted by EBA using ABA, shake flask ML and HCT (Section 6.4.2).

At the Site, NAG waste rock will be used for construction purposes (e.g., roads, embankments, fill, the TSF dyke, or foundations). Where waste rock is classified as PAG, it will be placed in the Peel Dump 3 or QB Dump 2, and encapsulated with NAG waste rock. In addition, waste rock will be segregated to minimize the effects of PAG waste rock. Waste segregation involves the removal and separate handling of various geologic units at the mine site. Mine workings with geologic units classified as PAG may also have other units classified as NAG. Segregation and separate handling of each unit minimizes the total volume of rock requiring treatment or special handling, and allows PAG and NAG materials to be stored and mitigated accordingly.

Waste rock stored on surface during mine operation will be exposed to oxygen and moisture and may potentially generate acidic drainage affecting shallow groundwater quality. Geochemcial characeterization indicates that NAG waste rock has the potential to leach metals in pH neutral conditions. Drainage from the NAG waste rock dumps also has the potential to affect shallow groundwater quality below and down-gradient of waste rock dumps.

The location and design of the waste rock dumps will mitigate potential groundwater quality concerns. The waste rock dumps will extend from the existing surface upwards, well above the existing groundwater table. Due to the typically coarse nature of the waste rock, percolation is expected to occur rapidly (on scale of hours to days) with a very short residence time for metals to leach from the rock. The waste rock dumps will be placed on a low-permeability waste rock pad and design will include a drainage collection layer and outlet pipe or structure. This layer will intercept infiltration and divert it to a collection point. The drainage water from each waste rock dump will be monitored. Discharge water which meets water quality discharge requirements will be released to the regular surface runoff diversion system at the site. That which does not meet water quality discharge standards will be conveyed and discharged to the TSF (except at the Knoll (3D) Dump, which drains north to Misery Creek). If necessary at the Knoll (3D) Dump,

a water treatment system will be installed to bring the infiltration water quality to an acceptable standard before release to surface runoff. At least one monitoring well (new or existing) will be used to monitor groundwater quality immediately down-gradient of each waste rock dump.

On closure of the mine, the waste rock dumps will be contoured, covered with a low-permeability cover and revegetated to render them geotechnically stable, inhibit infiltration and to avoid scour and gullying from precipitation and runoff.

8.9.4.6 ROM Stockpiles

A ROM stockpile is planned west of the crusher and immediately north of Cache Creek (see Figure 6.2-1). The ore on the stockpile pad will be PAG material and there is a potential for leachate to form from percolating precipitation water and affect underlying groundwater quality. As well, fugitive PAG dust may potentially blow off the stockpile under windy conditions and deposit directly into Cache Creek.

The ROM pad will be engineered to prevent infiltration of leachate into the groundwater, and include a runoff / leachate collection system with discharge directed to the TSF. There will also be measures for dust control to prevent escape of dust from the PAG rock and ore on the pad. The ROM stockpile will maintain at least a week's worth of ore so that the mill does not have to shut down in the event of a mining interruption. The stockpile can be managed such that the oldest material goes to the mill first in order to limit the exposure time and reduce the likelihood of ARD/ML generation.

8.9.5 Mitigation Measures

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 mitigations will also reduce or eliminate the potential indirect effects to receiving surface water bodies.

The mitigations and anticipated success of these mitigations are summarized in Table 8.9-5.

Table 8.9-5: Summary of Potential Effects, Mitigation Measures and Anticipated Success for Hydrogeology

Project Activity	VESEC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Dewatering mine workings	Quality of groundwater inflow into mine workings or extracted groundwater from perimeter of mine workings	Adverse effects on groundwater quality due to contact with pit and drift walls or explosive residues	Potential effect on water quality in Cache Creek within the LSA and RSA	Appropriate design of dewatering system to minimize contact of groundwater with PAG or ML rock types in open pits, underground mines, and explosive residues. Follow best practices for explosives handling and blasting Dewatering water will be diverted to TSF during operation			X

Table 8.9-5: Summary of Potential Effects, Mitigation Measures and Anticipated Success for Hydrogeology

Project Activity	VESEC	Direct Effect	Indirect Effect	Mitigation	Anticipated Success		
					None	Partial	Complete
Dewatering mine workings	Quantity of groundwater in the vicinity of mine workings requiring dewatering	Change of groundwater elevations and flow regime in area of dewatering	Change of base flow to Cache Creek and potential effect on Tarn Lake	Design of dewatering system to minimize dewatering volumes.		X	
Mine workings	Groundwater quality and quantity downgradient of open pits and underground mines	Flow through abandoned pits and underground workings creates potential for negative effects on groundwater quality	Potential effect on water quality in Cache Creek within the LSA and RSA	Groundwater quality monitoring downgradient of flooded mine workings after closure, and extraction and treatment or groundwater remediation if required to meet applicable water quality criteria		X	
TSF	Seepage underflow and groundwater quality down-gradient of dyke	Seepage underflow creates potential for changes in groundwater quality	Potential effect on water quality in Cache Creek down-gradient of TSF	Preventative design measures for TSF (e.g., full liner, drains, sump, recirculating system back to TSF); on closure, low-permeablility cover and full reclamation of TSF; monitoring groundwater and surface water quality down-stream of TSF			X
Waste Rock Dump Sites	Groundwater quality beneath and down-gradient of waste rock dump sites	Acid drainage or metal leaching from waste rock recharge to groundwater, affecting groundwater quality	Degraded quality of groundwater and receiving surface waters down-gradient of waste rock sites	Waste rock segregation into NAG and PAG, storing only NAG or encapsulated PAG material in waste rock dumps; construction of a liner and drainage collection system under waste rock piles as required; divert water that does not meet applicable water quality criteria to TSF; on closure, contouring, covering and revegetating waste rock sites			X
ROM Stockpile	Groundwater quality beneath and down-gradient of stockpile; dust exposure from stockpile	Acid drainage or metal leaching from ore recharge to groundwater, affecting groundwater quality; direct deposition onto receiving surface water bodies	Degraded quality of groundwater and receiving surface waters down-gradient of waste rock sites	Engineered ROM pad with runoff and leachate collected and conveyed to TSF; dust suppression measures on active stockpile; on closure, decommission pad along with rest of mine infrastructure			X

8.9.5.1 Mine Workings during Operations

Dewatering of the open pits and underground mines will result in dewatering volumes that require appropriate disposal. The dewatering system will be designed to minimize water volumes that have to be extracted to meet safe mining operations. The design of the dewatering system will also aim at minimizing the potential contact of groundwater with PAG or ML material in the open pits and underground workings to limit the risk of detrimental effects on water quality.

Safe practices will be applied when handling explosives and during blasting to reduce undetonated explosive residues to a minimum and to avoid water contamination with ammonia, ammonium, and nitrate.

The quality of water extracted for the purpose of dewatering the open pits and underground mines will be monitored. Samples will be analyzed monthly for routine chemistry as well as total and dissolved metals.

Dewatering water will be diverted to the TSF during operation to prevent any uncontrolled release of potentially adversely affected water to the environment.

8.9.5.2 Mine Workings Post-closure

The groundwater quality downgradient of the each open pit and underground mine is (partially) situated below the groundwater table will be monitored after dewatering has ceased for an initial period of 10 years. Longer monitoring may become necessary based upon results of the initial monitoring period. For this purpose monitoring wells will be installed in the areas down-gradient of the open pits and underground workings based on the detailed understanding of the hydrogeological regime.

Groundwater samples from these monitoring wells as well as samples from all pit lakes will be collected annually and analyzed for routine parameters, and total and dissolved metals. Analytical results will be compared to applicable Water Licence or site-specific standards and groundwater baseline water quality data.

The need for water treatment or groundwater remediation will be determined based on groundwater quality observed and may include water treatment in the pit lakes using in-situ treatment technologies or groundwater extraction and treatment down-gradient of the open pit and underground mines before the water discharges into Cache Creek.

Although most of the potentially affected groundwater will be captured and treated down-gradient of the abandoned mine workings before it reaches Cache Creek, some affected groundwater may bypass monitoring or groundwater extraction wells.

8.9.5.3 Tailings Storage Facility

To mitigate the possibility of water seepage from the TSF under the dyke and into Cache Creek, the dyke design includes the following:

- A geosynthetic clay liner on the upstream face and entire base of the TSF floor
- A permeable drain layer beneath the liner on the upstream face
- A collector drain at the base of the upstream face and drain pipe leading to a sump at the down-gradient toe of the dyke
- A toe filter drain beneath the central downstream portion of the dyke, also connected to the sump.

Any water collected by the drains and sump will be pumped back into the supernatant water pond. Additionally, the TSF is in a groundwater discharge area, with upwardly-directed hydraulic gradients. This will inhibit any local downwards-directed seepage from the TSF from comingling with shallow groundwater and escaping the capture zone of the toe filter drain and sump system, and potentially discharging farther downstream in Cache Creek.

During tailings placement at the TSF (year 1 to 5 of operation), seepage into the sump will be monitored regularly through visual inspections and records of sump system operation.

On closure, the TSF site will be fully reclaimed and transformed into an integrated component of the surrounding environment, emulating pre-mining conditions where possible. General aspects of the closure plan may include:

- Selective discharge of tailings around the TSF during the final years of operations to establish a final tailings beach that will facilitate surface water storage and reclamation
- Constructing an engineered cover, including runoff control and progressively re-vegetating the remaining embankment faces and exposed tailings surfaces using overburden stockpiled from stripping activities
- Constructing a permanent outlet channel to enable discharge of clean surface water from the covered TSF to the reclaimed fresh water reservoir and downstream reaches of Cache Creek
- Dismantling and removing the tailings and reclaim delivery systems, including the barge, all pipelines, structures, berms and equipment not required beyond mine closure
- Dismantling and removing other related TSF infrastructure, including drainage diversion channels, tailings distribution and deposition systems, the fresh water pump station, and pipelines
- Removing the seepage collection system when water quality objectives have been reached
- Removing and re-grading all access roads, ponds, ditches, and borrow areas not required beyond mine closure
- Stabilizing exposed erodible materials.

Groundwater and surface water around the TSF will be monitored during operation and after closure. The groundwater monitoring wells will be retained for use as long term monitoring devices. Post-closure requirements will include an annual inspection of the TSF and an on-going evaluation of impoundment water quality, sump flow rates and instrumentation records to confirm design assumptions for closure.

The following existing observation wells will be used for groundwater monitoring around the TSF:

- BH-10-01A (bedrock well on the upstream edge of the supernatant water pond)
- BH-10-05 (overburden well at the toe of TSF dyke)
- BH-10-06 (bedrock well about 150 m down-gradient of the TSF dyke)
- BH-10-09 (bedrock well about 330 m down-gradient of the TSF dyke).

These wells will be monitored for groundwater quality during the five year operational phase to confirm groundwater chemistry in this area. Monitoring will continue post-closure for an additional five years to verify that the geosynthetic liner and drain system effectively prevent ongoing seepage from the TSF.

Groundwater samples will be collected annually for the first three years following mine closure and biannually thereafter if necessary. The samples will be analyzed for major ions and total and dissolved metals. Analytical results will be compared with baseline hydrogeochemical data, and applicable water quality criteria.

8.9.5.4 Waste Rock Dump Sites

Groundwater recharge through the waste rock dumps will only occur seasonally. In the event that un-encapsulated PAG rock is inadvertently placed in the waste rock dumps, there is a potential for ARD leachate to enter groundwater and degrade its quality down-gradient. In addition, all of the waste rock types at the mine site (both PAG and NAG) have the potential to leach metals. Therefore drainage even from the NAG waste rock dump sites has the potential to degrade down-gradient groundwater quality.

Mitigation for these potential effects is in the handling of the waste rock, and the design and management of the waste rock dump sites. There will be segregation of waste rock to place only NAG rock, or to encapsulate PAG within NAG waste rock. PAG waste rock will be encapsulated within two designated waste rock dumps (Peel Dump 3 and QB Dump 2). All dump sites will be constructed with a low-permeability engineered pad with drainage collection to an outlet pipe or structure. KRH will visually inspect and record conditions at the waste rock dumps regularly during mine operations, to look for signs of oxidation of sulphide minerals. KRH will monitor drainage water quality to determine if ARD or ML is occurring. Drainage water that meets water quality discharge criteria will be released to the site surface water drainage system. Drainage that does not meet those criteria will be conveyed and discharged to the TSF. Groundwater down-gradient of the waste rock dumps will be monitored using the established network of wells presently on-site. At closure, the waste rock dumps will be contoured, covered with a low-permeability layer, and revegetated.

8.9.5.5 ROM Stockpile

In the event that the runoff and leachate collection system built into the stockpile pad does not function as designed, there is a potential for ARD or ML leachate to enter groundwater and degrade its quality down-gradient, and ultimately surface water quality where such groundwater discharges. In addition, PAG dust leaving the stockpile has the potential to blow directly into Cache Creek, potentially affecting surface water quality.

Mitigation will consist of an engineered ROM pad (concrete or compacted NAG rock) designed to collect and convey runoff and leachate to the TSF. The ROM pad will be constructed and commissioned under a high level of quality control so that it functions as designed before any ore is placed on the pad. Dust will be suppressed on the stockpiled ore when necessary through measures which could include wetting down with water, tarp coverings or constructing a shed structure over the stockpile to retain dust on the pad. On closure, any remaining ore will be disposed in one of the open pits. The pad structure will be decommissioned and removed if necessary along with rest of the mine infrastructure.

8.9.6 Residual Effects, Consequence, and Significance Determination

A significance ranking was performed for those effects where the mitigation is not expected to be complete. Consistent with the approach and criteria outlined in Section 7.1, significance ranking was performed for dewatering of the underground workings and its effects on the local groundwater flow regime and the potential effects of groundwater flow through the open pits and underground mines after closure.

Conservative assumptions were used to predict the significance of the potential hydrogeological effects by the KRP 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.

A summary of the significance determination of the hydrogeological residual effects is presented in Table 8.9-6.

8.9.6.1 Dewatering Effects on Groundwater Quantities

As indicated previously, mine dewatering may have an effect on base flow to Cache Creek with its headwaters in the mining areas. However, at these headwater locations, the natural base flow is likely 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.

Also, most of the open pits and underground workings are located relatively far away from Cache Creek and at higher elevation and it is unlikely that natural hydraulic gradients and groundwater flow direction will significantly change close to Cache Creek. Potential effects are only expected in the uppermost sections of Cache Creek and Tarn Lake due to dewatering of the Penguin and, more importantly, the Tarn Pits.

Monitoring well HYD-10-01 is located between the Tarn Pits and Tarn Lake. Packer test results from this monitoring well indicate that the hydraulic conductivity to a depth of about 45 m below grade, which roughly corresponds to the bottom Tarn Pit elevation, is relatively small (geometric mean of 2×10^{-8} m/s). To assess the potential effect of dewatering of the Tarn Pits on Tarn Lake, groundwater flow from the lake into the pits can be estimated using Darcy's Law:

$$Q = K \cdot i \cdot A$$

where Q is the groundwater flow rate, i is the hydraulic gradient, and A is the cross sectional area of Tarn Lake.

The following assumptions were made to estimate groundwater flow from Tarn Lake:

- The hydraulic conductivity of 2×10^{-8} m/s is representative for the hydraulic conductivity in the entire area between Tarn Pits and Tarn Lake
- The hydraulic gradient i will be determined by the elevation of the lake level at about 1620 m asl, the elevation of the bottom of Tarn Pits at about 1605 m asl, and the shortest distance between the pits and the lake of about 200 m (i.e., $i = 0.075$)
- The cross section area A of Tarn Lake is about 1500 m^2, based on the width of the lake of about 285 m, an assumed depth of 10 m, and under the assumption that A can be approximated by that of an triangle
- The volume of the lake is about 85,000 m^3, based on a surface area of about 26,000 m^2, an assumed depth of 10 m, and under the assumption that the volume can be approximated as that of a cone
- The dewatering will last for about nine months (Tarn B Pit) or three months (Tarn A Pit; Figure 6.6-13).

Based on the above assumption, the groundwater flow from Tarn Lake into Tarn Pit will be about 185 m^3/day. Based on a nine month maximum dewatering period, the total water loss from Tarn Lake due to dewatering will amount to about 50 m^3 or 0.06% of the total lake volume. The estimated water loss from Tarn Lake caused by dewatering of the Tarn Pits will therefore be negligible. Even using much more conservative assumptions (e.g., $K = 2 \times 10^{-7}$m/s and 20 m lake depth), the effect will still be small given a change of much less than 5% of the total lake volume.

Although Penguin Pit is about 500 m away from Tarn Lake, dewatering of the Penguin Pit may also have an effect on Tarn Lake because the bottom elevation of Penguin Pit is about 100 m lower than that of the Tarn Pits and the mining period is about two years. Making the same assumption as above and assuming a two year dewatering period for the Penguin Pit, the total estimated loss will be about 0.5% of the total lake volume or about 5% for the more conservative assumptions.

When mine dewatering (groundwater extraction) is stopped following completion of ore extraction, the water level in the surrounding rock mass will re-equilibrate to near pre-mining conditions and groundwater discharge to the creeks will eventually be returned to about pre-mining levels. The mining operation in the open pits and underground mines will only last for a total of five years with most of the areas only being mined and actively dewatered for one to three years (see Figure 6.6-13). Therefore, the effect of dewatering on groundwater quantities will be mostly short-term (i.e., reversible during the life of the KRP) or potentially long-term with reversible effects within a relatively short period of time after mine closure (i.e., less than 100 years).

The magnitude of the effect of dewatering on groundwater base flow to Cache Creek and Tarn Lake is low, the extent is local, the effect is medium-term in duration and fully reversible either during the life of the KRP or in a relatively short time after mine closure.

The overall significance of the effect of dewatering on groundwater quantity has been determined as being low.

8.9.6.2 Post-Closure Groundwater Seepage through Open Pits and Underground Mines

Groundwater passing through the open pits and underground workings, after the groundwater elevations have recovered to near pre-mining conditions, will ultimately discharge into Cache Creek.

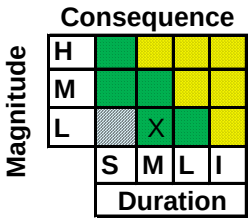
To determine the volume of groundwater that may discharge into Cache Creek, the estimated groundwater flow rate through the future abandoned mine workings was compared with the existing discharge in Cache Creek. Based on baseline flow data for Cache Creek (Station KR10), the estimated groundwater flow rate of about 240 m^3/day amounts to about 3% of the lowest discharge in Cache Creek in an average year (month of April), or about 8% of the lowest discharge in Cache Creek in a 10-year dry year (month of March; see Section 4.11). During other months the contribution of groundwater, which may pass through the abandoned mine workings to the overall discharge in Cache Creek, is expected to be less than 1%.

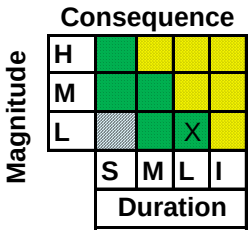
Groundwater quality monitoring associated with the Project will determine whether water treatment or groundwater remediation is required. This mitigation, if required, will greatly reduce the risk of affected groundwater discharging into Cache Creek and negatively affecting its water quality. As a result, the magnitude of this residual effect is considered low.

The overall significance of the residual effect of potential groundwater contamination by flow through the abandoned mine workings has been determined as being low.

Table 8.9-6: Hydrogeology Residual Effects Assessment

Evaluation of Residual Effect Local Study Area						
Description of Residual Effect (after Mitigation)	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Likelihood**
Dewatering effects on local groundwater flow regime, Cache Creek base flow, and Tarn Lake	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate
Negative effects on groundwater quality downgradient of abandoned mine workings	Low	Local	Long-term	Periodic	Reversible Long-term	Moderate





8.10 Aquatic Ecosystems and Fisheries Resources

This section provides an assessment of the potential effects of the KRP on aquatic and fisheries resources. Cache Creek is the main creek that flows through the Site and is a tributary of the Ketza River.

8.10.1 Identification of Valued Environmental and Socio-economic Components

The following aquatic ecosystems and fisheries resources VESECs have been identified for the KRP:

- Benthic invertebrates and periphyton
- Fish Habitat - Riparian
- Fish Habitat - Stream substrate
- Fish presence and abundance.

8.10.2 Identification of Temporal and Spatial Boundaries

Table 8.10-1 indicates the spatial and temporal boundaries considered in the assessment for each aquatic VESEC.

Table 8.10-1: Temporal and Spatial Boundaries for Valued Environmental and Socio-economic Components

Valued Environmental and Socio-economic Component	Temporal Boundary	Spatial Boundary
Benthic Invertebrates and Periphyton	Extend or last beyond the life of the KRP	RSA (Region surrounding the KRP / Ketza River drainage basin
Riparian Vegetation	Extend or last beyond the life of the KRP	RSA
Stream Substrate	Extend or last beyond the life of the KRP	LSA (Site)
Fish Presence and Abundance	Extend or last beyond the life of the KRP	Beyond RSA (Pelly River drainage basin)

8.10.3 Summary of Baseline Information

Historical data, combined with an aquatics study conducted in 2007 (EBA 2008e) and fisheries baseline studies conducted in 2007 (EDI 2007) and 2010 (EBA 2011d) provide the basis for determining the existing conditions at the site. The KRP area is located entirely within the Pelly River drainage, but borders the Headwaters of the Yukon River drainage. Both drainages are part of the Yukon River Watershed. The Site lies within the Ketza River drainage basin. The Site has numerous tributaries (some unnamed) that eventually flow into the Ketza River, which flows into the Pelly River (Figure 4.12-1). These tributaries include Cache Creek, Misery Creek, Peel Creek, Subsidiary Creek and Oxo Creek. The LSA for fish, fish habitat and aquatic ecosystems assessment is shown in Figure 4.12-1.

8.10.3.1 Fish and Fish Habitat

A number of fish species inhabit the Ketza River including, but not limited to, Humpback Whitefish (*Coregonus pidschian*), Broad Whitefish (*Coregonus nasus*), Round Whitefish (*Prosopium cylindraceum*), Northern Pike (*Esox lucius*), Inconnu (*Stenodus leucichthys*), Least Cisco (*Coregonus sardinella*), Long Nosed

Sucker (*Catostomus catostomus*), Slimy Sculpin (*Cottus cognatus*), and Arctic Grayling (*Thymallus arcticus*) (Northern Natural Resources Ltd 1977; BC Research 1986; Godin and Mackenzie-Grieve 1984; Norecol 1986; Osborne 1991; DFO 1991a).

Historical information has suggested that salmon do not spawn in the Ketza River (Northern Natural Resource Services Ltd. 1977) and that overall fish use is low (BC Research 1986). According to several historical reports, fish use within the Ketza River system near the Cache Creek confluence was limited and had low productivity (Northern Natural Resources Ltd 1977; BC Research 1986; Godin and Mackenzie-Grieve 1984; Norecol 1986; Osborne,1991; DFO 1991a). Cache Creek was assumed to be even less likely to support fish because of steeper gradients and limited fish cover. Little spawning, rearing, over-wintering and holding / feeding habitat was found in Cache Creek. The majority of fish found in the Cache Creek system included Slimy Sculpin and Arctic Grayling.

A 1984 baseline report for the Iona Silver Mine area (Godin and Mackenzie-Grieve 1984) included fisheries sampling and tissue analysis. Slimy Sculpin were captured in Cache Creek. The sculpins exhibited elevated levels for most metals in tissue samples, which is comparable to another study of Prickly Sculpin (*Cottus asper*) exposed to waste from TSFs from a large copper / lead / zinc mine (Reid and McGreer 1983). Arctic Grayling were also captured in the Ketza River and were found to have tissue metal concentrations that were 2 - 5 times higher than background levels for fish in the Pelly River drainage (Archibald 1981). This study was conducted prior to Canamax commercial production at the Ketza River Mine, which commenced in 1988. Grayling typically spend only the summer months in small streams, unless suitable deep water over-wintering habitat is available, and then retreat to major rivers to over-winter. The authors were therefore unable to establish a relationship between metal concentrations in fish tissues and those in the system. However, it was thought that these results may have been related to naturally high levels of metals in Cache Creek and the Ketza River.

The results of the 2007 field studies completed by EDI showed that the Cache Creek watershed has generally low fisheries productivity (EDI 2007). Results of fisheries sampling suggested that lower Cache Creek provides some year-round habitat for Slimy Sculpin, and that spring / summer seasonal rearing habitat for Arctic Grayling is most suitable in Cache Creek upstream of the Peel and Oxo Creek confluences. Lower reaches were found to be generally unsuitable, and limited over-wintering habitat was observed. The authors speculated that most Arctic Grayling in the system likely return annually to the main stem of the Ketza River to over-winter. No evidence of juvenile Chinook Salmon was observed during these 2007 studies.

It appears that the most used, and likely the most valuable, habitat in Cache Creek is in Reach 5 upstream of the mouth of Peel Creek. The highest numbers of grayling were captured in this reach and in the lower portion (Reach 1) of Oxo **C**reek, which flows into Reach 5. It is interesting to note that Osborne (1991) also captured three Grayling in Reach 5 of Cache Creek, upstream of Peel Creek. This portion of the watershed appeared to have notable periphyton (attached algae) growth as well as an abundance of benthic invertebrates such as mayfly and stonefly larvae. These indicators of productivity were not as abundant in Cache Creek immediately downstream of Peel Creek.

The natural barrier at the upstream end of Reach 5 prevents fish from using Cache Creek upstream of this point. Extensive fish sampling was conducted upstream (in Reach 6); no fish were captured or observed. Reach 6 did not contain any significant overwintering habitat and had a high gradient in many locations

(>15%). It should be noted that there is a very steep and long cascade at the outlet of Tarn Lake (located upstream of Reach 6). Tarn Lake was sampled with minnow traps; no fish were captured.

The observations taken at the KRP study sites during the 2010 spring sampling and assessment were consistent with prior observations at the site, suggesting that Cache Creek and the upper Ketza River are both relatively variable aquatic systems with respect to flow, turbidity, temperature, and sediment loading (EBA 2011d). The combination of these factors results in habitat characteristics that are not conducive to fish presence or spawning in spring due to the unpredictability of the systems. The key observations relevant to this conclusion include:

- High temperature variability on a daily basis
- Frequent increases in flow (i.e., flashiness of system)
- Heavy sediment loading and transport during melt or precipitation events (e.g., Turbidity changing from 8 NTU to 145 NTU within hours)
- Evidence of heavy and frequent sediment deposition
- A lack of observed Arctic Grayling and few observed sculpin.

In general, all eight sites sampled by EBA in the 2007 study contained generally well graded substrate that could potentially provide fish habitat. As suggested by previous studies, mean water depth was generally below 30 cm, so pools, and potentially even riffles, will likely freeze to bottom in winter months, excluding over-wintering habitat except in deep pools. The dominant type of cover encountered was overhanging vegetation and surface turbulence. Fast water, such as riffle or cascade/rapid, was often the dominant channel morphology. Riffle-run complexes are often utilized by fish for feeding while slower, gravelled areas are potential spawning grounds.

8.10.3.2 Aquatic Resources

Benthic Invertebrates

Historical studies of benthic invertebrates in Cache Creek and the Ketza River indicated that their abundance and distribution was generally low (BC Research 1986; Godin and Mackenzie-Grieve 1984; Norecol 1986; EC 1992).

Based on the benthic sampling conducted at eight stream sites, the benthic community was generally found to be representative of moderately unproductive aquatic ecosystems, with isolated effects from local development or geology (EBA 2008e). The benthic community in the upper Ketza River and upper Cache Creek systems were generally low abundance and diversity but with a taxonomic distribution characteristic of moderately healthy environments. In central Cache Creek, the benthic community was similar to upstream areas, with a lower abundance of invertebrates. The benthic community in Peel Creek as well as the lower reaches of the Ketza River was one of the least abundant sites sampled. The benthic community in lower Cache Creek was the simplest and least abundant of all sites. The benthic community in Oxo Creek was the most abundant of all sites and had a high taxonomic diversity.

Sampling at two headwater stream areas within the LSA provided good baseline reference data representative of local productivity potentials levels (KR14 – Oxo Creek and KR16 – Tributary to Cache Creek). At these sites, EBA (2008e) determined invertebrate densities of 759.7 and 678.3 individuals/m^2,

respectively. For the local area these observed densities are relatively high, however, ongoing water quality sampling by EBA (unpublished) has confirmed these tributaries to be relatively unaffected by base metal and acid contamination from local geological features.

EBA (2008e) noted marked reductions in both abundance and diversity in the tributaries directly influenced by local metals leaching and acid rock drainage. Station KR15, located in Peel Creek, a tributary of central Cache Creek, was heavily influenced by iron and arsenic. Density at this site was calculated at only 34.9 individuals/m^2, one of the lowest in the area.

The poor benthic characteristics of Cache Creek continued downstream into the Ketza River at KR12. When benthic communities at stations KR11 and KR12 are compared, it is evident that the benthos in the Ketza River upstream of the confluence of Cache Creek (KR11) is reasonably abundant and healthy since pollution intolerant organisms were present, such as stoneflies (Plecopetra) and mayfly larvae (Ephemeroptera). At this site, a density of 255 organisms/m^2 was recorded, over four times the 57.6 organisms/m^2 recorded in 1981. In contrast, Station KR12 located in the Ketza River but downstream of the confluence with Cache Creek had a density of only 34.8 individuals/m^2, compared to 140 and 312 individuals/m^2 recorded in 1981 and 1987, respectively. While moderate numbers of both Ephemeroptera and Plecoptera were recorded in prior studies, the lower Ketza River is now dominated by Diptera.

Periphyton

Based on EBA's periphyton data collected in 2007 (EBA 2008e), the central and upper reaches of Cache Creek had relatively high periphyton density and productivity (KR01, KR08, and to a lesser degree KR15). Oxo Creek (also in the upper Cache drainage) was found to have the second lowest productivity recorded, despite having an abundant benthic community. Station KR08 is located downstream of the existing TSF. Station KR10, also located within the main stem of Cache Creek but immediately above its confluence with the Ketza River, had the lowest periphyton density and productivity of all sites sampled during the 2007 program. Despite heavy iron precipitate, Station KR15 in Peel Creek was found to have higher productivity than lower Cache Creek or the Ketza River.

Stations KR11 and KR12, the two sites located within the Ketza River, were comprised of similar community structure and comparable periphyton productivity. The notable difference between these sites and the ones within the Cache Creek watershed, was the relative abundance of the three diatom genera *Navicula*, *Diatoma* and *Ceratoneis* (in descending order), whereas the general trend in the Cache Creek system in descending order of abundance was *Ceratoneis* followed by *Navicula* then *Diatoma/Gomphonema*. *Ceratoneis* is generally considered to be a genus that is indicative of cold, fast flowing, clean waters.

A search of existing data for the study area revealed no prior periphyton analyses to which the 2007 results could be compared. In a June 1981 study of the Ketza River upstream and downstream of the Cache Creek confluence, relative to the Iona Silver project, BC Research (1986) found little evidence of periphyton (algae) in the river, indicating low aquatic productivity. While no samples were taken or analysis conducted, Norecol (1986) also reported a low density of periphyton in Cache Creek.

Sediment Grain Size

The general pattern of distribution in grain sizes observed by EBA (2008e) in the Cache Creek and Ketza River systems appeared to be tied to relative location (energy level) within this mountain watercourse system. Generally, only a moderate degree of variation in size distribution existed between sites in the upper system, including Cache, Oxo, and Peel creeks.

Generally, the results of the grain size distribution were consistent with that of a high energy / high slope system that transitions to a moderate energy system. Stations in the upper reaches of the Cache Creek system were dominated by relatively larger silt deposits representative of low stream orders and fast flows. At KR08 (a lower gradient reach below the TSF), a slight increase in medium and smaller silts was observed. Finally, an increased proportion of clay and fine silts is observed where flows in Cache Creek and the Ketza River slow down and lose velocity in the Ketza River Valley. The Ketza River immediately upstream of the confluence with Cache Creek, had a relatively larger distribution of particle sizes.

As in previous studies at this site, some inter-sample variability was noted between replicate samples at the same site. However, a moderate degree of variability is to be expected naturally in such systems.

In previous studies of the upper reaches of the Cache Creek system, sediments were generally dominated by relatively larger materials (>75% of sediment over 0.60 mm), while less than 10% consisted of fine silts and clays. These results were similar to those of Godin and Mackenzie-Grieve (1984), who found the highest percentage of particles for replicates at upper stations sized at 0.50 mm. Similarly, the largest portion of material sampled by EC (1992) was equal to or greater than 2 mm (10 mesh sieve).

Overall, despite some natural variability between replicate samples, the distribution of sediments in the Cache Creek system was representative of that found in previous studies at the site. However, the marked difference in sediment levels between physically similar reaches in the Cache Creek and Ketza River systems suggests that Cache Creek may be subject to larger influxes of fine sediment from upstream sources. As noted in the previous studies, the observed fines in the lower Cache Creek and the Ketza River system may be directly or indirectly influencing the health of the aquatic environment by infilling interstitial spaces in the substrate or through metals contributions.

Stream Sediment Metals

EBA (2008e) found that the applicable CCME ALG were exceeded at each of the eight samples sites within the LSA, for at least one metal (arsenic). Elevated copper concentrations were recorded at several sites in the Cache Creek system, as well as elevated lead in central Cache Creek and the Ketza River. Chromium and zinc concentrations were also elevated at several sites. Some of the elevated metal concentrations may be attributed to natural background concentrations. Arsenic is present naturally in the aquatic and terrestrial environments from weathering and erosion of rock and soil. In areas of arsenic-enriched bedrock, background concentrations can be significantly elevated. Since arsenic occurs naturally in gold ore and surrounding bedrock, it is not surprising to find elevated concentrations of arsenic in the study area.

All three samples collected at each of the eight locations contained concentrations of arsenic well above the guidelines. The CCME ALG and BCWQG for arsenic is 5.9 mg/kg, while the CCME ALG PEL is 17 mg/kg. Arsenic concentrations along Peel Creek near the upper reaches of the study area (upslope from the TSF)

were the highest of all locations sampled, on average 277 times greater than BCWQG and 96 times greater than the CCME ALG. Among the other seven sites, the arsenic concentration averaged 21 times greater than the guidelines[4].

Despite the high concentrations recorded, results from this study were generally lower than results from prior studies in the area. In the Iona Mine area downstream of the Site, sediment metal analysis in 1981 (Godin and Mackenzie-Grieve 1984) indicated the highest reported concentration of arsenic in Cache Creek being 358 mg/kg. These concentrations are considered elevated but are not unexpected given that the area sampled has heavy mineralization, with naturally elevated concentrations of arsenic associated with the ore bodies. In upper Cache Creek, the 1987 study determined a mean arsenic concentration of 1880 mg/kg. In comparison, EBA found 638 mg/kg in 2007 samples. In central Cache Creek samples were collected in 1981, 1987, 1994 and 2005 and arsenic concentrations ranged from 223.6 to 260 µg/g or mg/kg. 2007 samples in this area averaged 121 mg/kg. Similarly, arsenic concentrations in lower Cache Creek and the Ketza River were lower than previously recorded samples. Moderate reductions were also noted in Oxo Creek and Peel.

The next most prevalent sediment metal was copper. All sites in Cache Creek system, including Oxo Creek and Peel Creek were above or near CCME ALG / BCWQG. However, lower Cache Creek and the Ketza River were not elevated. Compared to historical values collected between 1981 and 2005, all values were found to be at lower concentrations.

Cadmium concentrations were found to be elevated in the upper Cache Creek system, Peel Creek, Oxo Creek, as well as the Upper Ketza River. In comparison to historical values, cadmium concentrations appear to be slightly elevated in the upper Cache Creek and Oxo Creek areas. However, values in Peel Creek, lower Cache Creek and the Ketza River have been reduced over time.

Lead concentrations are above CCME ALG / BCWQG in Oxo Creek, Upper Cache Creek, as well as the Ketza River (EBA 2008e). While lead concentrations in Peel Creek were below CCME ALG / BCWQG, they were found to be elevated in comparison to samples in 2005. Central Cache Creek was found to have lead concentrations similar to past values, while all other sites were found to be reduced when in reference to prior concentrations.

Concentrations of zinc were found to be above CCME ALG concentrations in almost all areas in the upper Cache Creek system, including Peel Creek and Oxo Creek. Additionally, the upper Ketza River was found to have concentrations above CCME ALG . Despite these concentrations, values were found to have been reduced in every case in comparison to earlier values, and in some cases have reduced by a factor of 10 to 20.

Finally, chromium was above CCME ALG concentrations in the upper Ketza River (upstream from the Cache Creek system; EBA 2008e). While all historical values in the Cache Creek and Ketza River systems had been above these CCME ALG / BCWQG, all values in Cache Creek and the lower Ketza River were now found to be reduced compared to these historical studies. Reductions by as much as a factor table 5. were observed in comparison with results from 1981, 1987, and 1994 (Godin and Mackenzie-Grieve 1984; EC 1992; EC unpublished data).

[4] Average arsenic concentrations taken from all sites except KR15 divided by the guideline concentration of 5.9 mg/kg.

Overall, EBA's results from the 2007 sampling (EBA 2008e) suggest that most sediment metals concentrations are reduced in comparison with earlier recorded concentrations. In numerous cases, concentrations appear to be lower than those observed in 1981 baseline concentrations, although moderate inter-site variability in that study make long term trend comparisons difficult. Most interestingly, many concentrations have now been reduced in comparison to a large increase observed during the 1987 studies by EC (1992). For example, spikes in the concentration of cadmium, lead and zinc can be observed in that study. The 1987 EC sampling efforts followed an increase in mine pre-development in the study area (road development, clearing, grading, etc.), activities that may have mobilized local surface materials though erosion, sedimentation, and disturbance of watercourses. In addition to these studies, only a few direct comparisons were available from 1989, 1994, 2000, and 2005 data due to the inconsistency in sample collection sites and the wide variability in the seasonal collection of sediment samples (ranging from July 5 in 2005 to October 5 in 1994). However, despite this variability, general results from these studies do suggest relatively similar results in comparison to those in the 2007 EBA study.

In summary, EBA (2008e) found the concentration of several key metals to be highly elevated within the study area. These results along with those of previous studies in the area suggest that a number of local factors may influence the availability of sediment metals in the local area; including the breakdown and erosion of local natural mineralizations, past development activities, and/or other unknown factors.

8.10.4 Effects Characterization

This Section outlines the effects identified during the three main phases of development: construction, operations and decommissioning. The effects were based in part on guidance provided by DFO in the *Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff*.

The major KRP components during the construction phase that have the potential to effect fish and aquatic VESECs include:

- Road construction
- Site infrastructure
- Pre-production
- TSF
- Construction
- Water storage
- Water diversion and use
- Waste handling
- Fuel and hazardous material storage.

The major KRP components during the operation phase that have the potential to effect fish and aquatic VESECs include:

- Open pit mining
- Material processing
- Water storage
- Water diversion and use
- Water treatment
- Waste rock and tailings disposal
- Facility operation
- Fuel and hazardous material management
- Explosives management
- Power generation.

The major KRP components during the decommissioning phase that have the potential to effect fish and aquatic VESECs include:

- Infrastructure
- Removal
- Reclamation
- Surface water management
- Waste management.

For each component, a series of activities that can contribute to environmental effects have been identified in Table 8.10-2 to show the interaction between KRP components and activities that could or will contribute to effects.

Table 8.10-2: Project Components and Associated Activities Related to Aquatic Ecosystems and Fisheries Resources

Project Component	Associated Activities								
	Vegetation Clearing	Excavation and Grading	Use of Explosives	Use of Industrial Equipment	Placement of Material / Structures in Water	Wastewater Management	Water Extraction	Changing in Timing, Duration and Frequency of Flow	Debris Management
CONSTRUCTION									
Road Construction	x	x	x	x	x			x	
Site Infrastructure	x	x		x		x	x	x	x
Pre-Production	x	x	x	x	x	x	x	x	x
Water, Storage, Diversion and Use		x		x	x	x	x	x	
Waste Handling				x		x		x	x
Fuel and Hazardous Materials Storage									x
OPERATION									
Open Pit Mining	x	x	x	x		x	x	x	x
Material Processing				x		x	x		x
Water Storage, Diversion and Use					x	x	x	x	
Water Treatment						x		x	
Waste Rock and Tailings Disposal				x		x			x
Facility Operations						x	x		x
Fuel and Hazardous Material Management									x
Explosives Management			x						
Power Generation									x
DECOMMISSIONING									
Infrastructure Removal		x		x					x
Reclamation		x		x					x
Surface Water Management		x		x	x			x	
Waste Management		x		x		x			x

8.10.5 Mitigation Measures

The KRP activities that are most likely to contribute to an effect on fish and fish habitat include vegetation clearing for mine development, blasting and grading works, water diversion, water storage, water use and waste handling. The mitigation measures summarized in Table 8.10-3 will serve to minimize the potential effect of the activities on the aquatic and fisheries receiving environment.

Although changes to vegetation are expected, they can be mitigated through long term revegetation of the site. Because there is a lag associated with the time it takes for vegetation to become established, any residual effects on the aquatic environment are expected to be reduced over time.

Several measures have been put in place to limit effects to surface water. Water used to service the camp will come from an on-site well rather than from a surface water source. Process water will be recycled from the TSF so that water will not have to be diverted continuously from Cache Creek. Additional water will be obtained from the water retention pond.

The diversion channel will divert the flow from Cache Creek around the TSF and Water Retention Pond. Excess clean water in the water retention pond will be released via a spillway. Although earthworks will alter the Site topography substantially, once the water retention dam is breached during decommissioning it is expected that stream flow will be similar to pre-Project levels. Long term residual effects to water quantity are not anticipated.

Earth works have the potential to affect stream sediment composition. Appropriate erosion and sediment control mitigation will reduce the deposition of sediment into surface waters.

Mobilization of fines from waste rock may contribute to an effect on water quality. Elevated background levels of several metals have been documented and water quality data should be compared to background or baseline water quality data, particularly for metals and contaminants, which are described in further detail in Section 8.9.

Continued monitoring of water quality, water quantity and stream sediments (metals and grain size distribution) is proposed to evaluate possible effects to the receiving aquatic environment and to implement additional mitigation measures if determined to be necessary. Monitoring results should be compared to background or baseline levels and site specific criteria.

8.10.6 Residual Effects, Consequence and Significance Determination

Based on this assessment, the predicted residual effects of the KRP on aquatic VESECs are summarized in Table 8.10-4.

Predicted residual effects on the aquatic VESECs are anticipated to be generally localized to the Cache Creek watershed and the LSA. Most of the residual effects are expected to last for the projected life of mine (medium-term) but are also expected to be reversible following decommissioning and reclamation of the Site.

Given the limited aquatic productivity of the Cache Creek system and the implementation of the mitigation measures, including the future reclamation of the water retention pond, the overall significance of the KRP on the aquatic VESECs is assessed to be low, and the effects of the Project on the aquatic resources of the region are anticipated to be insignificant.

Table 8.10-3 outlines the proposed mitigation measures to address potential effects to VECs. This table also identifies whether a residual effect is likely to be present following the implementation of mitigation.

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Table 8.10-3 outlines the proposed mitigation measures to address potential effects to VECs. This table also identifies whether a residual effect is likely to be present following the implementation of mitigation.

Table 8.10-3: Potential Effects and Proposed Mitigation for Project Activities During Construction, Operations and Decommissioning

Project Activity	VECs Potentially Affected	Potential Environmental Effect	Proposed Mitigation	Likelihood of Residual Effect	Residual Effects Explained
Vegetation Clearing (Construction and Operation Phases)	Water Quality Water Quantity Riparian Vegetation Stream Substrate Fish Presence / Abundance	▪ Increased water temperatures from vegetation loss ▪ Erosion of banks/sedimentation from vegetation loss ▪ Change in nutrient/contaminant concentrations associated with vegetation loss (riparian buffers act to filter some sediments and nutrients/chemicals from water before it enters larger waterbodies) ▪ Increased overland flow as less rainwater is taken up by vegetation ▪ Changes in fish cover and fish habitat structure (i.e. large woody debris) from vegetation loss ▪ Reduction of food supply from vegetation loss	▪ All clearing and site works will be completed with reference to, where appropriate,the DFO *Land Development Guidelines for the Protection of Aquatic Habitat (*DFO 1993*), the Guidebook of Mitigation Measures for Placer Mining in the Yukon (*YPS 2008*) and the Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide* (YCOM 2010) ▪ A minimum 30 m riparian buffer will be maintained along streams wherever possible ▪ Vegetation removal will be limited wherever possible. Vegetation will be re-establish promptly in cleared areas where the project plan allows. Areas will be planted with native species ▪ Zones that are not to be disturbed will be delineated clearly so that equipment operators are familiar these boundaries ▪ Erosion and sediment control measures will be implemented in areas where vegetation has been removed and erosion may be a a concern ▪ Stream water quality will be monitored during all phases of the Project	Moderate	Vegetation loss can be effectively mitigated through replanting and restoration efforts. Because there will be permanent local changes to the topography of the site some localized residual effects to riparian vegetation are anticipated. The scale of these effects is predicted to be local and would affect only those areas within LSA. Affects to local hydrology would be mitigated through replanting efforts in the long term.
Excavation and Grading (Construction, Operation and Decommissioning Phases)	Water Quality Water Quantity Benthic Invertebrates / Periphyton Stream Substrate Fish Presence / Abundance	▪ Diversion of surface flows ▪ Increased erosion and sedimentation causing substrate changes, infilling of interstitial spaces and changes to benthic invertebrate and periphyton communities ▪ Changes in nutrient/contaminant concentrations associated with excavation / grading ▪ Changes in base flow associated with grading and altering local topography ▪ Changes in water temperature associated with alteration of groundwater flows to surface water ▪ Changes to stream bank character may cause increased erosion and may result in increased turbidity	▪ Material movement and grading will be limited wherever possible ▪ Vegetation will be retained wherever possible and implement erosion and sediment control measures where necessary ▪ All clearing and site works will be completed with reference to, where appropriate,the DFO Land *Development Guidelines for the Protection of Aquatic Habitat (*DFO 1993*), the Guidebook of Mitigation Measures for Placer Mining in the Yukon (*YPS 2008*) and the Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide* (*YCOM 2010*). Diversion works or channel restoration works that may be required will be undertaken with reference to the Guidebook of Mitigation Measures for Placer Mining in the Yukon ▪ Tailings and waste rock will be handled appropriately ▪ Areas will be retained with the intent of reinstating original flow patterns ▪ Stream water quality will be monitored during all phases of the Project ▪ Sediment that accumulates in the water retention dam will be tested to determine if removal of the sediments is needed during reclamation and breaching of the water retention dam.	High	Site topography will be permanently altered by grading and excavation work. Provided that mitigation is implemented and an adequate monitoring plan is in place to monitor water quality and quantity as well as substrates, no to low residual effects are predicted to result from excavation and grading in the LSA.

Table 8.10-3: Potential Effects and Proposed Mitigation for Project Activities During Construction, Operations and Decommissioning

Project Activity	VECs Potentially Affected	Potential Environmental Effect	Proposed Mitigation	Likelihood of Residual Effect	Residual Effects Explained
Use of Explosives (Construct and Operation Phases)	Water Quality Benthic Invertebrates / Periphyton Stream Substrate Fish Presence / Abundance	▪ Potential lethal effects to fish from explosives and hazardous material handling ▪ Potential effects to fish, eggs and larvae from the detonation of explosives ▪ Sedimentation from the use of explosives may affect benthic invertebrate and periphyton populations ▪ Potential effects to benthic invertebrates that are intolerant of toxins and potential changes to benthic invertebrate and periphyton communities from inputs of contaminants associated with explosives ▪ Changes in water chemistry from inputs of explosive materials (one of the byproducts of explosives is ammonia which can affect water chemistry) ▪ Soil sampling should be completed in the area of the explosives storage facility to determine if soil clean-up is required	▪ Procedures will be developed for handling explosives near surface water bodies. KRH will follow, where appropriate, DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998) ▪ The use of explosives will be limited wherever possible. Explosives will not be stored within 30 m of waterbodies. ▪ Appropriate erosion and sediment control measures will be implemented in proximity to surface water bodies where explosives may be used. Where possible, a vegetated buffer will be retained between explosives activity and watercourses. ▪ Clean-up measures will be implemented for spilled explosive products. ▪ Stream water quality will be monitored during all phases of the Project	Low	Provided mitigation is followed, there no residual effects are predicted to result from explosive use in the LSA.
Use of Industrial Equipment (Construction, Operation and Decommissioning Phases)	Water Quality Benthic Invertebrates / Periphyton Riparian Vegetation Stream Substrate Fish Presence / Abundance	▪ Potential for fuel spills associated with equipment ▪ Potential for erosion associated with equipment use ▪ Potential for trespass into no disturb areas	▪ All clearing and site works will be completed with reference to, where appropriate, *DFO Land Development Guidelines for the Protection of Aquatic Habitat* (DFO 1993), the *Guidebook of Mitigation Measures for Placer Mining in the Yukon* (YPS 2008) and the *Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide* (YCOM 2010). ▪ Zones that are not to be disturbed will be delineated clearly so that equipment operators are familiar these boundaries ▪ Erosion and sediment control measures will be implemented in areas where vegetation has been removed and erosion is a concern ▪ Equipment operators will be informed as to the importance of limiting erosion near water bodies, the importance of proper equipment maintenance and the necessity for spill response and management ▪ All equipment will be in good repair and will be equipped with a spill response kit ▪ All on-site personnel will be familiar with the spill plan, spill response materials and procedures ▪ No fuelling or hazardous materials storage will occur within 30 m of any watercourse ▪ Stream water quality will be monitored during all phases of the project including after decommissioning	Low	Provide mitigation is followed, no to low residual effects resulting from heavy equipment use in the local study area.
Placement of Material / Structures in Water (Construction and Operation Phases)	Water Quantity Benthic Invertebrates / Periphyton Stream Substrate Fish Presence / Abundance	▪ Potential mortality of fish eggs from equipment operating instream to install crossings or attachment point for diversion works ▪ Barriers to fish passage from improperly designed and installed road crossings ▪ Installation of instream structures such as diversion channel may cause erosion at discharge areas ▪ Potential changes in stream substrate and instream sediment from instream material/structures	▪ Site works will be completed with reference to, where appropriate, the DFO Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993), the Guidebook of Mitigation Measures for Placer Mining in the Yukon (YPS 2008) and the Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide (YCOM 2010). ▪ Any road and associated crossings that are no longer required for operation of the mine will be reclaimed ▪ Instream works and their footprint will be limited and avoided whenever possible	Moderate	Provided mitigation is followed and the water retention dam is breached, the residual effects to Cache Creek are expected to be low

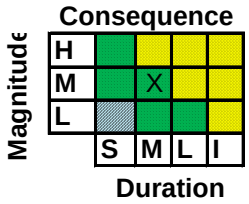
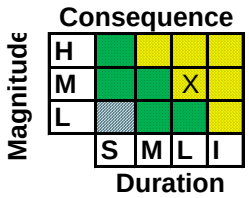
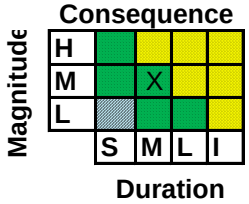
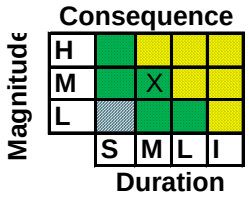
Table 8.10-3: Potential Effects and Proposed Mitigation for Project Activities During Construction, Operations and Decommissioning

Project Activity	VECs Potentially Affected	Potential Environmental Effect	Proposed Mitigation	Likelihood of Residual Effect	Residual Effects Explained
		▪ Structures may alter habitat cover and structure ▪ May be erosion associated with dam outfall ▪ Water retention may affect flow patterns and water quantity (some water will be sourced from a water wall to service camp) ▪ Changes in aquatic vegetation from instream structures may alter the food supply and nutrient concentrations (likelihood is low because instream vegetation cover was limited)	▪ Instream work will be completed before May or after early July to avoid the time period when grayling are likely to spawn and to allow time for the eggs to develop ▪ All clearing and site works will be completed with reference to, where appropriate, the *DFO Land Development Guidelines for the Protection of Aquatic Habitat (*DFO 1993*), the Guidebook of Mitigation Measures for Placer Mining in the Yukon (*YPS 2008*) and the Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide* (YCOM 2010). In particular, any diversion works or channel restoration works should reference the *Guidebook of Mitigation Measures for Placer Mining in the Yukon* ▪ DFO operational statements for road crossings will be followed, as appropriate, and natural drainage patterns will be maintained wherever possible ▪ Outfalls will be adequately armoured, as and where required, to prevent erosion and sedimentation ▪ Stream water quality will be monitored during all phases of the Project		
Wastewater Management (Construction, Operation and Decommissioning Phases)	Water Quality Water Quantity Benthic Invertebrates / Periphyton Fish Presence / Abundance	▪ Changes to water temperature associated with discharge of treated water, this may result in changes to migration and access to habitats ▪ Changes in contaminant concentrations as a result of treated wastewater ▪ Introduction of, chemicals, etc. into the system ▪ Changes in water chemistry may affect benthic invertebrate and periphyton populations ▪ Wastewater has the potential to transport contaminants to stream sediments	▪ Site works will be completed with reference to, where appropriate, the *DFO Land Development Guidelines for the Protection of Aquatic Habitat (*DFO 1993*), the Guidebook of Mitigation Measures for Placer Mining in the Yukon (*YPS 2008*)* and the *Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide* (YCOM 2010). ▪ Water diversion will limit the amount of surface water that enters the tailings storage facility and should sustain flows ▪ In addition to the main diversion channel redirecting partial flows from Cache Creek and Oxo Creek, there will also be a second open drainage ditch to collect surface runoff from the northwest and northeast of the TSF ▪ Efficient use of water on site will be encouraged. Water conservation measures will be implemented wherever feasible ▪ An approved sewage treatment system will be employed ▪ A state of the art system for recovering clean water during sewage treatment is being investigated, however in the eventuality it is not determined to be feasible or if it is periodically inoperable, then treated sewage effluent will be comingled into the TSF along with process water ▪ Water collected in seepage or catchment ditches and contaminated groundwater will be collected and treated ▪ Water quality and quantity and stream sediment metals will be monitored throughout the life of the Project ▪ Diversion ditches will be put in place upslope of the waste rock dumps and catchment ditches will be put in place downslope from the waste rock dumps to prevent water from the waste rock dumps from entering the receiving environment	Moderate (short term) Low (long term)	Provided all mitigation is followed and an adequate water quality and quantity monitoring program is in place, and provided that wastewater is handled according to plan and as per best management practices the residual effects from waste management are expected to be moderate over the short term and low over the long term. The moderate rating is given in consideration of the fact that there will be considerable waste rock and associated runoff present on site which may affect water quality. This effect is expected to diminish over time.

Table 8.10-3: Potential Effects and Proposed Mitigation for Project Activities During Construction, Operations and Decommissioning

Project Activity	VECs Potentially Affected	Potential Environmental Effect	Proposed Mitigation	Likelihood of Residual Effect	Residual Effects Explained
Changing in Timing, Duration and Frequency of Flow (Construction, Operation and Decommissioning Phases)	Water Quality Water Quantity Benthic Invertebrates / Periphyton Stream Substrate Fish Presence / Abundance	▪ Changes in flow patterns can result in changes to the water supply which may affect fish presence during rearing and spawning ▪ Changes in flows may affect cycling or flushing time and may alter water chemistry ▪ Changes in flow patterns may also affect the deposition of sediments (i.e. increased settling out of sediments resulting from reduced flows) which may have an effect on the benthic invertebrate and periphyton community	▪ Water quality and quantity will be monitored throughout the life of the Project ▪ Efficient use of water on site will be encouraged Water conservation measures will be implemented wherever feasible ▪ Any diversion works or channel restoration works will reference the *Guidebook of Mitigation Measures for Placer Mining in the Yukon* (YPS 2008). ▪ If any natural watercourse that contains fish is used as a water source, the water withdrawal apparatus will contain a fish screen of an appropriate size to exclude fish. Reference the *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO, 1995) for guidance on installing fish screens.	Moderate (short term) Low (long term)	Provided all mitigation is followed and an adequate water quality and quantity monitoring program is in place, effects to the timing, frequency and duration of flow are expected to be moderate over the short term
Waste Management (Construction , Operation and Decommissioning Phases)	Water Quality Benthic Invertebrates / Periphyton Stream Substrate Fish Presence / Abundance	▪ Waste rock from mining or site works that comes into contact with open water may alter water chemistry and in turn alter benthic invertebrate and periphyton communities ▪ Stream substrates may be altered by fines entering a stream from waste rock, tailings or other sources ▪ Fish may be adversely affected by changes in water quality or stream substrate resulting from fines inputs ▪ Acid rock drainage may present a risk to the local environment ▪ Improperly managed or stored wastes could contribute to contamination of streams.	▪ Site works will be completed with reference to, where appropriate, the *DFO Land Development Guidelines for the Protection of Aquatic Habitat (*DFO 1993*), the Guidebook of Mitigation Measures for Placer Mining in the Yukon* (YPS 2008) and *the Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide* (YCOM 2010). ▪ No hazardous materials storage will occur within 30 m of any watercourse ▪ Material movement will be limited wherever possible ▪ Riparian vegetation will be retained wherever possible to protect watercourses ▪ Tailings and waste rock will be handled appropriately ▪ Stream water quality will be monitored during all phases of the Project ▪ Consolidation of the tailings will occur during deposition and after operations are complete until excess pore pressures have dissipated. This will increase the density of the deposit and will allow for an impermeable cover to be placed over the tailings after mine closure to limit the ability of water to seep into the tailings ▪ A land treatment facility will contain and treat non-hazardous wastes ▪ Garbage will be incinerated on site, as appropriate ▪ Waste oil will be collected, managed and disposed of in an appropriate manner ▪ An approved sewage treatment facility will be employed	Moderate (short term) Low (long term)	Provided all mitigation is followed and an adequate water quality and quantity monitoring program is in place, and provided that waste rock is handled according to plan and as per best management practices, the residual effects from waste management are expected to be moderate over the short term and low over the long term. The moderate rating is given in consideration of the fact that there will be considerable waste rock present on site which may affect water quality. This affect is expected to diminish over time.

Table 8.10-4: Aquatic Ecosystems and Fisheries Resources Residual Effects Assessment

	Evaluation of Residual Effect Within the Local Study Area						
Description of Residual Effect (after Mitigation)	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Likelihood**	
Changes to riparian vegetation because of changes to topography	Moderate	Local	Medium-term	Isolated	Reversible Long-term	High	
Changes to reach 5 of Cache Creek and fish passage	Moderate	Local	Long-term	Continuous	Reversible Long-term	High	
Changes to water quality due to mobilization of fines from waste rock	Moderate	Local	Medium-term	Continuous	Reversible Long-term	Moderate	
Changes to stream sediments	Moderate	Local	Medium-term	Continuous	Reversible Long-term	Moderate	

8.11 Heritage Resources

Heritage resources, in the form of historic sites and archaeological or paleontological remains, are VESECs for this assessment. In the Yukon, heritage resources on public and private lands are protected by territorial and federal legislation and regulations. The YG is responsible for managing heritage resources (including historic sites, and archaeological and paleontological remains) on non-settlement land and outside of the national parks (YG TC 2010b).

The legislation and regulations that pertain to the protection of heritage resourced include *Yukon Environmental and Socio-economic Assessment Act* (2003), *Historic Resources Act* (2002), Archaeological Sites Regulation (2003), Yukon First Nations Umbrella Final Agreement (1993), *Quartz Mining Act* (2003), and Quartz Mining Land Use Regulation (2003). Specific sections of the legislation pertaining to protection of heritage resources are described in the following paragraphs.

The *Yukon Environmental and Socio-economic Assessment Act* (Section 5.2c) enables an assessment process in the Yukon that stipulates KRP proponents protect and maintain heritage resources.

The *Yukon Historic Resources Act* states:

> *64. No person shall destroy or alter any historic object, whether or not the person owns it, or any human remains, except in accordance with a historic resources permit.*

The Archaeological Sites Regulation, pursuant to the *Yukon Historic Resources Act*, necessitates that persons surveying heritage resources obtain permits to do so, as shown in the following sections of the regulation:

> *3. No person shall survey and document the characteristics of an archaeological site without a Class 1 or Class 2 permit.*
>
> *4. No person shall excavate, alter, or otherwise disturb an archaeological site, or remove an archaeological object from an archaeological site, without a Class 2 permit.*

Heritage resources related to Yukon First Nations are managed under Chapter 13 of the *Umbrella Final Agreement*. Yukon First Nation burial sites are protected in Section 13.9.1 of the *Umbrella Final Agreement*:

> *2. Where the Yukon First Nation Burial Site is on Non-Settlement Land, require the joint approval of Government and the Yukon First Nation in whose Traditional Territory the Yukon first Nation Burial Site is located for any management plans for the Yukon First Nation Burial Site; and*
>
> *3. Provide that, subject to 13.9.2, where a Yukon First Nation Burial Site is discovered, the Yukon First Nation in whose Traditional Territory the Yukon First Nation Burial Site is located shall be informed, and the Yukon First Nation Burial Site shall not be further disturbed.*

The Quartz Mining Land Use Regulation, pursuant to section 149 of the *Quartz Mining Act*, addresses the management of heritage resources (historic objects and burial grounds) in the Yukon in in Schedule 1(E):

> 8. *Operations must not be carried out within 30 metres of a known archaeological or paleontological site unless the Chief indicates, in writing, that such activities may be carried out.*
>
> 9. *Any sites containing archaeological objects, paleontological objects or human remains or burial sites discovered in the course of carrying out an exploration program must be immediately marked and protected from further disturbance and, as soon as practicable, the discovery reported to the Chief. No further activities may be carried out within 30 metres of the site until the Chief indicates, in writing, that the activities may be resumed.*

8.11.1 Identification of Temporal and Spatial Boundaries

Heritage resources have potential to interact with the KRP on a temporal and spatial scale. Temporally, if heritage resources are present in an area, they may interact on a continuous basis with a project, unless mitigated. Spatially, heritage resources may interact with a project if located within a project footprint, unless mitigated. Interaction will be continuous unless either the heritage resource is moved or the project footprint is moved to avoid the heritage resource.

No heritage resources were identified during the heritage resources assessments, and therefore, heritage resources will not interact with the KRP on a temporal or spatial basis. However, should a heritage resource be discovered, mitigation measures will be applied to reduce or possibly eliminate the KRP's interaction with the heritage resource.

8.11.2 Summary of Baseline Information

Heritage resource assessments of the KRP were completed in August 2007 and June 2008 by Salix Heritage Consulting and Matrix Research Ltd., respectively (Appendix J). The goal of the assessments was to identify heritage resources and assess the potential effects that the KRP could have on heritage resources.

The KRP is located in an area where past land use activities related to mining exploration and road construction have resulted in ground disturbance. Many areas in the KRP footprint were determined to have existing ground disturbance with little or no heritage resource potential.

Background research and surface surveys of the terrain at the KRP identified thirteen sites with heritage resource potential within the 2007 KRP footprint and the expanded 2008 KRP footprint (Figure 4.13-1). Two additional sites were identified outside of the KRP footprint (Figure 4.13-2).

Additional investigation was undertaken at the thirteen sites with heritage resource potential. Two sites were determined to have low heritage resource potential and were surveyed by means of visual inspection only. Sub-surface surveys were performed at eleven sites with moderate to high resource potential in the KRP footprint. In total, sixty-four sub-surface investigations were completed during the heritage resources assessments in 2007 and 2008 (Figure 4.13-1). No heritage resources were identified during the sub-surface or visual inspections.

The two sites that were identified outside of the KRP footprint include an airfield and previously surveyed paleontological site. No heritage resources were identified at the airfield near the Ketza Road. The paleontological site, located between the Ketza Road and the Ketza River, contains a collection of ice age fossil remains (Jackson and Harrington 1991). This site was not surveyed as it is not located within the KRP footprint and will not be disturbed by KRP activities.

The 2007 and 2008 heritage resources assessments did not identify any heritage resource conflicts with the KRP.

8.11.3 Effects Characterization

The heritage resource assessments conducted surface and sub-surface investigations at sites within the KRP footprint that had potential to contain heritage resources. No heritage resources were identified within the KRP footprint. A paleontological site was identified outside of the KRP footprint, approximately 2 km north of the Ketza Road (Figure 4.13-2). The 2007 heritage resources assessment concluded that the KRP was situated in a sub-boreal environment and people did not historically occupy this type of environment for long periods of time; consequently, anthropological heritage resources do not tend to form (Salix 2007).

8.11.4 Mitigation Measures

KRH is committed to the protection of heritage resources with a variety of measures including communication and engagement, education, and protection. For general management regarding heritage resources, KRH will comply with the *Yukon Mineral Exploration Best Management Practices for Heritage Resources* (YG TC 2010a) and the *Guidelines Respecting the Discovery of Human Remains and First Nation Burial Sites in the Yukon* (YG THB 1999).

KRH will provide education to its employees on the protection of heritage resources. KRH employees will be provided general heritage resource identification tools as described in the *Handbook for the Identification of Heritage Sites and Features* (YG TC 2005). KRH employees will be educated on the importance of leaving artifacts in place. Should an employee discover a heritage resource at the KRP they will be required to report the finding to a manager. The employees of KRH will be advised to not disturb heritage sites whether on or off the KRP footprint.

Although no heritage resources have been identified at the KRP, should a heritage resource be identified, KRH will comply with all applicable regulations pertaining to their protection. If a potential heritage resource is discovered, operations within 30 metres of the heritage resource will cease and a manager will be notified. The potential heritage resource will be marked and further protected from disturbance. KRH may erect physical barriers or cap the site with protective material to reduce the potential for damage. Marking the site may include the use of flagging tape, signs, and barriers depending on the site size.

Management personnel at KRH will report the discovery to the Chief of Mining Land Use as soon as practicable. If possible, the following information will be provided to the Chief of Mining Land use:

- Location of heritage resource (Latitude/Longitude or Universal Transverse Mercator coordinates along with the North American Datum year)
- Size of the heritage resource

- Description of the resource
- Description of the setting
- Photographs.

If the heritage resource appears to be a human burial site, management personnel will first report the finding to the Royal Canadian Mounted Police. KRH will follow the *Guidelines Respecting the Discovery of Human Remains and First Nation Burial Sites in the Yukon* for any suspected human burial site (YG THB 1999).

The discovery of paleontological heritage resources will be reported to Yukon Paleontology and/or the Chief of Mining Land Use. Should a paleontological resource be found, KRH will make efforts to preserve the resource as suggested in the *Yukon Mineral Exploration Best Management Practices for Heritage Resources* (YG TC 2010a). The paleontological resource may be covered, collected, or set aside out of the environment to help preserve the fossil until Yukon Paleontology advises further instruction. In some cases, such as small fragments, KRH may elect to report the paleontological findings seasonally over the lifespan of the KRP, as suggested in the YG TC (2010a) *Yukon Mineral Exploration Best Management Practices for Heritage Resources*.

KRH will continue to protect potential heritage resources until instructed otherwise by the authority to which the resources were reported. KRH will mitigate effects to newly discovered heritage resources with employee education, avoidance, a buffer zone, and reporting. In the event that a heritage resource is identified at the KRP, KRH will conduct further heritage resources assessments.

Examples of mitigation measures for heritage resources, as outlined in the *Yukon Mineral Exploration Best Management Practices for Heritage Resources* (YG TC 2010a), include:

- Locating new infrastructure such as camps and roads in previously excavated sites
- Locating camps where they can be accessed by existing road networks
- Using existing roads whenever possible
- Surveying new clearings for heritage resources
- When possible, situating access roads 100 m away from hydrological features and 30-60 m away from the edge of terraces, ridges and other elevated land forms
- Minimizing stream crossings
- Avoiding areas of high heritage potential such as defined terraces or ridges.

8.11.5 Consequence and Significance Determination

No heritage resources were identified in the heritage resources assessments. Should a heritage resource be discovered, mitigation will occur to protect the resource. There are no residual effects anticipated on heritage resources due to the KRP.

8.12 Aesthetics

8.12.1 Approach

To determine the potential effects of the KRP on the aesthetics of the area (such as viewscapes, recreational activities, or wilderness viewing), visibility was assessed using three-dimensional viewshed and line-of-sight analyses. Viewshed analysis identifies areas that can be seen from one or more observation locations. Line-of-sight analysis identifies the parts of the landscape that are visible (or not) in a straight line between selected observer and target locations. Visibility for both analyses is determined by considering topography, vegetation cover, and vegetation height.

Input data for both analyses included a hillshade generated from digital elevation model (DEM) information, which characterizes the topography of the area, and existing land cover mapping developed by the Earth Observation for Sustainable Development of Forests (EOSD) initiative of the Canadian Forest Service (Wulder et al. 2004). Land cover classes were assigned an approximate vegetation height based on the species and vegetation structure that were likely to be present. Heights generally ranged from <1 m for lower shrub cover to 6 m for trees. Land cover classes and vegetation heights help identify areas where lines of sight might be improved or obscured due to vegetation cover.

Yukon parks and protected areas, as well as recreational sites, campgrounds, and wilderness viewing areas were also considered for inclusion in the analyses, however, none were in close enough proximity to warrant inclusion. The closest recreational site is the Lapie Canyon campground (YG Environment 2011d) located west of Ross River, which is approximately 40 km to the north of the KRP.

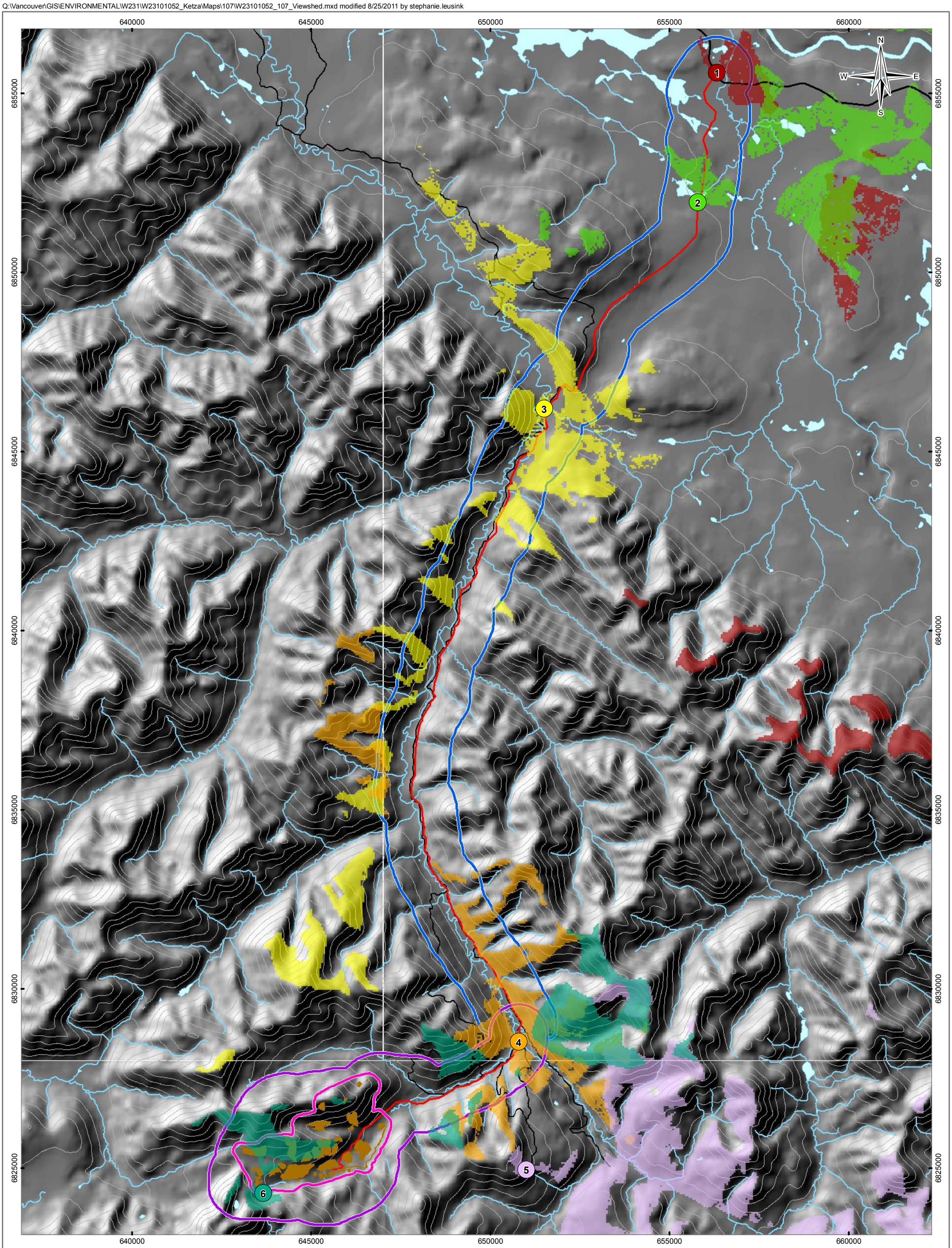
Six representative observer locations for both the viewshed and line-of-sight analyses were selected. These were selected as locations in the area that could be considered as preferred viewshed or outlook viewing locations by the public. The six locations, also shown on Figures 8.12-1 and 8.12-2, respectively, are:

- At the intersection of the Robert Campbell Highway and the Ketza Road (Observer Location #1)
- Near the proposed land treatment facility along the Ketza Road (Observer Location #2)
- Where the Ketza Road crosses the Ketza River (Observer Location #3)
- At the turnoff from the Ketza Road to the KRP (Observer Location #4)
- Beyond the turnoff to the KRP (Observer Location #5)
- At Tarn Lake (Observer Location #6)

8.12.2 Viewshed Analysis

Results of the viewshed analysis indicate that five of the observer locations (Locations #1 to #5) provide no change to existing views in the direction of the Project. Only one observer location (Location #6, Tarn Lake) provides a view of the infrastructure proposed as part of the KRP (Figure 8.12-1). Tarn Lake is located in a small basin within the Local Study Area (Figure 8.12-3). The entire Lab-Hoodoo Pit and portions of the Lab-Hoodoo Waste Rock Dump, Tarn Pit, Tarn Waste Rock Dump, Peel Pit, Peel Waste Rock Dump, and 3M Pit will be visible. All of these infrastructure components are located on high elevation, steep slopes that face Tarn Lake.

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LEGEND

Observer Locations
- #1
- #2
- #3
- #4
- #5
- #6

Visible Areas
- Point #1
- Point #2
- Point #3
- Point #4
- Point #5
- Point #6

- Infrastructure Footprint
- Project Footprint
- Local Study Area
- Ketza Road Study Area

- Ketza Road
- Robert Campbell Highway
- Minor Road
- Contour (100 m)
- Watercourse
- Waterbody

NOTES
Base data source: NTS 1:50,000; Aero Geometrics, Ltd.

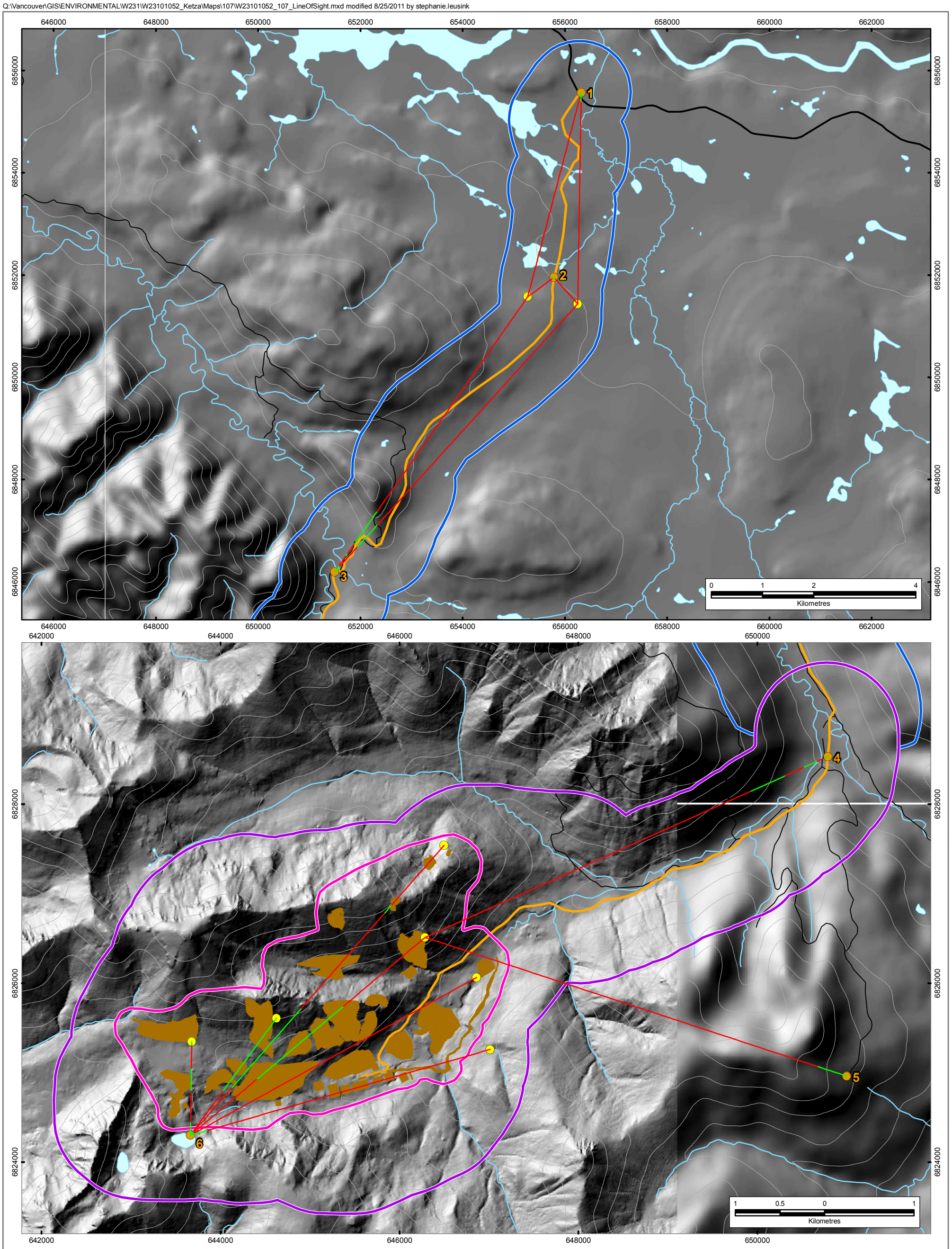
STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Viewshed Analysis

PROJECTION UTM Zone 8		**DATUM** NAD27		**CLIENT** Ketza River Holdings
Scale: 1:100,000 — 2 1 0 2 — Kilometres				
FILE NO. W23101052_107_Viewshed.mxd				eba A TETRA TECH COMPANY
PROJECT NO. W23101052.107	**DWN** SL	**CKD** TP	**APVD** TP	**REV** 0
OFFICE EBA-VANC	**DATE** July 26, 2011			**Figure 8.12-1**

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LEGEND

Line of Sight
- Visible
- Not visible
- Observer Location
- Target Location

- Infrastructure Footprint
- Project Footprint
- Local Study Area
- Ketza Road Study Area

- Ketza Road
- Robert Campbell Highway
- Minor Road
- Contour (100 m)
- Watercourse
- Waterbody

N W E S

NOTES
Base data source: NTS 1:50,000; Aero Geometrics, Ltd.

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Line of Sight Analysis

PROJECTION	DATUM
UTM Zone 8	NAD27

Scale: see individual map frames

FILE NO.
W23101052_107_LineOfSight.mxd

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.107	SL	TP	TP	0

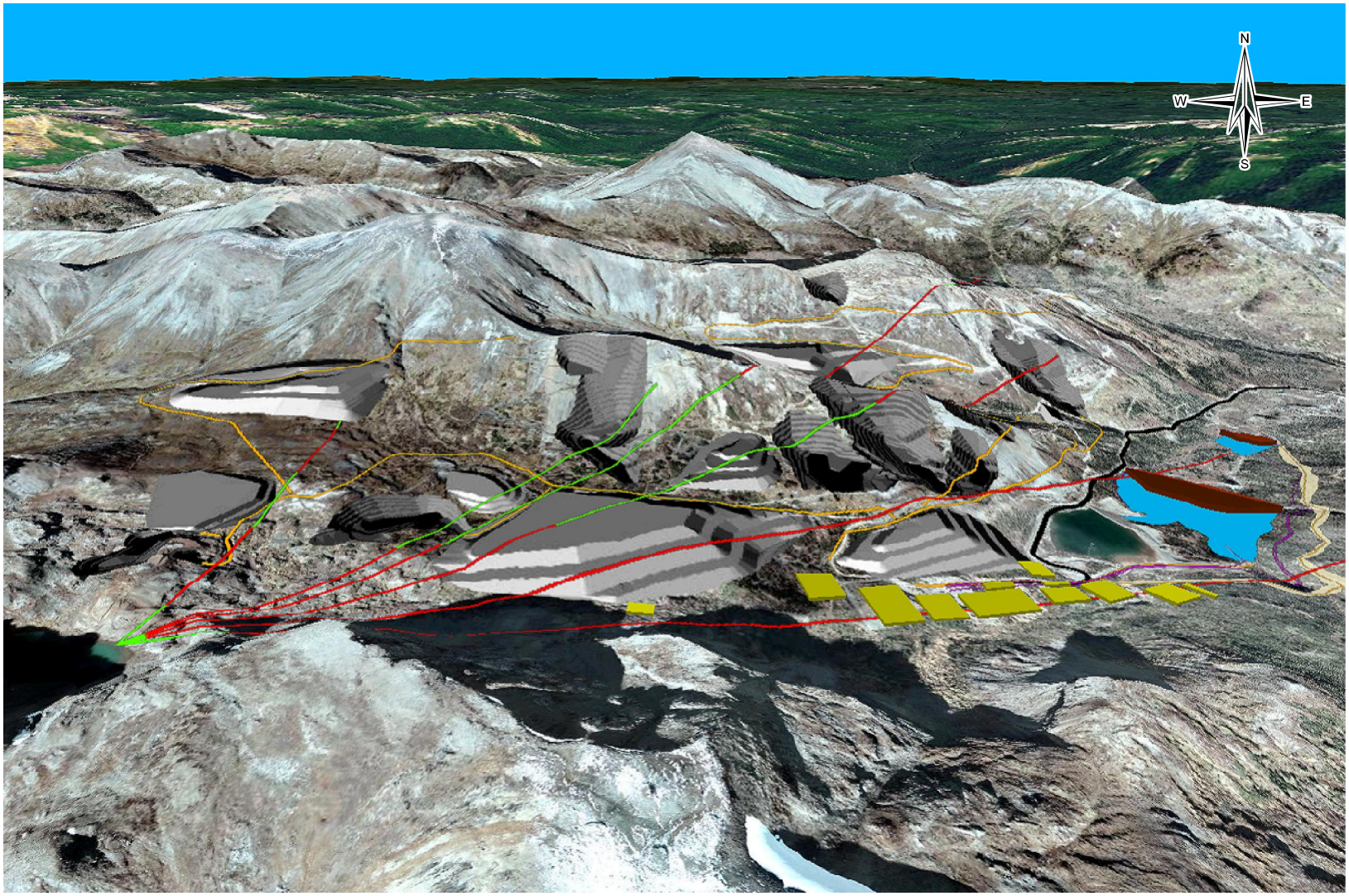
OFFICE	DATE
EBA-VANC	July 26, 2011

CLIENT
Ketza River Holdings

eba A TETRA TECH COMPANY

Figure 8.12-2

Q:\Vancouver\GIS\ENVIRONMENTAL\W231\W23101052_Ketza\Maps\107\W23101052_107_TarnLake3D.mxd modified 8/25/2011 by stephanie.leusink



LEGEND

Line Of Sight
- Visible
- Not Visible

- Ketza Road
- Proposed Haul Roads
- Pipelines
- Pits and Waste Dumps
- Proposed TSF and Water Retention Pond
- Dam Structure
- Infrastructure
- Diversion and Access Road

NOTES
Base data source: Aero Geometrics, Ltd.

STATUS
ISSUED FOR USE

Scale: N/A

PROJECTION	DATUM
N/A	WGS84

FILE NO.
W23101052_107_TarnLake3D.mxd

CLIENT
Ketza River Holdings

eba A TETRA TECH COMPANY

KETZA RIVER PROJECT

3D Representation of Line of Sight Analysis from Tarn Lake

PROJECT NO.	DWN	CKD	APVD	REV
W23101052.107	SL	TP	TP	0

OFFICE	DATE
EBA-VANC	July 26, 2011

Figure 8.12-3

8.12.3 Line-of-Sight Analysis

Similar to the viewshed analysis, the line-of-sight results indicate that only infrastructure on high elevation, south facing slopes will be visible from the Tarn Lake observer location (Location #6) (Figure 8.12-2 and 8.12-3). All other observer locations along the Ketza Road do not offer any view of proposed KRP infrastructure.

The location of the KRP, as well as the configuration of infrastructure at Site, are such that it is unlikely to diminish the enjoyment of wilderness viewing or recreational activities in the area. There are no residual effects to aesthetics and visual quality anticipated as a result of the KRP.

8.13 Effects of the Environment on the Project

The KRP may be affected by various environmental occurrences, including rockfalls, landslides, snow avalanches, earthquakes, and permafrost.

8.13.1 Rockfalls, Landslides, and Snow Avalanches

Discussions regarding the potential effects of rockfalls, landslides, debris flows and snow avalanches have been previously described (Section 8.1.2). The effects of these terrain hazards are mitigated by locating infrastructure in areas of low risk and developing and implementing management plans (e.g., Snow Avalanche Hazard Management Plan).

8.13.2 Earthquakes

Seismicity is variable in the Yukon and the central Yukon has lower seismicity (Hyndman et al. 2005).) For the Site, a preliminary seismic hazard assessment was completed using 2010 National Building Code Seismic Hazard Calculation for the coordinates 132.3˚ W and 61.5˚ N. The seismic hazard was found to be moderately low for all spectrum acceleration (Sa) and peak ground acceleration (PGA). Values for Sa(0.2) and PGA corresponding to a 2% probability of exceedance in 50 years are 0.21 and 0.11 g, respectively. An approximate relationship between the PGA and Richter Magnitude scale (Mercalli Structural Components and Systems, Richter Magnitude, PGA, and Duration: http://www.tilt-upretrofit.com/information/15-the-richter-scale.html) suggests a value of 5.2 on the Richter scale corresponding to the PGA of 0.11 g; a magnitude that could result in slight damage to well-designed buildings. In summary, there is a 2% chance that an earthquake with a magnitude over 5.2 on the Richter scale will occur at the Ketza River property over a 50 year period.

These ground motions for the Ketza River property will be incorporated into the design of major infrastructure components such as the water retention dam reservoir, the TSF, wastewater treatment plant, powerhouse, and ore processing plant. Procedures and protocols to be followed in the event of an earthquake will be included in the Emergency Response Plan.

8.13.3 Permafrost

Permafrost is discontinuous in the KRP area and may be encountered during access road construction or road widening of existing roads. Road construction activities in areas of permafrost and associated mitigation measures have been described within Section 8.1-2. Permafrost at the Site could potentially

have an effect on buildings and other infrastructure. As such, detailed foundations studies will be completed for buildings and other infrastructure (e.g., the TSF, waste sites, dams etc.).

8.13.4 Flooding

Flooding has the potential to affect KRP infrastructure, such as the TSF, water retention pond, and diversion ditches, as well as disrupt site access through road wash-outs and potential failure of stream crossing structures (e.g., bridges and culverts). The TSF has been designed to provide sufficient freeboard to accommodate the probable maximum flood, combined with wave run-up. The water retention pond is designed for a 1:200 year flood. Both facilities will be inspected frequently, particularly following storm events. Water treatment may be regarded as an option if emergency pumping from the TSF is to take place in order to maintain stability. Further details describing the flood considerations incorporated into the design of the TSF are provided in Section 10.

The diversion ditches are designed for a 1:200 year flood, and will be regularly and frequently inspected. All culverts and bridges on the access and haul roads are designed to accommodate a 100-year storm event. These structures will also be inspected frequently.

8.13.5 Fire

Natural fires, such as forest fires, and Project-specific fires, such as kitchen fires or fires caused by equipment, have the potential to affect the KRP. The management of Project-specific fires will be addressed through the development of site-specific procedures and regulatory requirements for fire suppression, including the use of the fire suppression system for the KRP. As such, these fires are not addressed further.

Forest fires are a natural component of the boreal ecosystem, at times burning large areas. The potential effect of a forest fire on the KRP is the loss of infrastructure, including buildings and bridges along the Ketza Road. Other potential effects include injury (ranging from minor smoke inhalation to burns) and loss of life. Mitigation measures for forest fires include use of on-Site fire suppression equipment (for smaller fires), fire suppression through assistance by the Yukon Wildland Fire Management Program, evacuation of the Site via the Ketza Road, or evacuation of the Site via helicopter. The EMO will play a role if there is a large emergency related to the KRP. Through the implementation of these mitigations no residual effects of fire on the KRP are anticipated.

9.0 SOCIO-ECONOMIC EFFECTS ASSESSMENT

YESAB's *Guide to Socio-economic Effects Assessments* (2006) lays out seven principles to provide broad and general direction on how a proponent is to conduct a socio-economic effects assessment:

- Achieve a broad understanding of the local and regional settings potentially affected by the action
- Focus assessment on key aspects of the human environment
- Provide valid and relevant information for use in decision-making
- Identify methods and assumptions and define significance
- Ensure that effect equity issues are described and analyzed
- Consider and recommend suitable mitigation and include in the assessment mechanisms to improve the likelihood of mitigation success
- Determine the best development alternative(s) rather than merely serving as an arbiter between socio-economic benefit and social cost.

We have been fully aware of these principles from the beginning of the effects assessment process for the Ketza River Mine that began in 2007, and have followed them throughout.

YESAB (2006) suggests a six-step process for conducting socio-economic effects assessments:

- Determine scope of project
- Determine scope of assessment
- Compile the socio-economic baseline
- Characterize potential effects
- Identify mitigation/enhancements
- Determine significance.

All of the above-noted steps are included in the socio-economic effects assessment for the KRP (Sections 9.1 to 9.5).

9.1 Scope of Project

Determining the socio-economic scope of a project requires that we:

- Identify and describe the principal project
- Identify and describe any accessory project or projects
- Summarize the broad project components and activities that will be included in the assessment
- Describe and document the rationale used to determine the socio-economic scope of the project.

A detailed description of the KRP can be found in Section 6.0.

A summary of the KRP components and activities that form the basis of the socio-economic effects assessment for the KRP is in Section 9.1.1.

The rationale for the socio-economic scope is provided in Section 9.1.2.

9.1.1 Project Components and Activities

Table 9.1-1 summarizes the major components and activities of KRH's Project that will form the basis for the socio-economic effects assessment over the three major phases of the KRP: construction, operation, and decommissioning (including post-closure monitoring).

Table 9.1-1: Project Scope Components and Activities

Component	Construction	Operations	Decommissioning
Camp	Expand existing camp to accommodate maximum construction workforce of 200.	Maintain to house 150 operations personnel	Remove for salvage and reclaim area
Potable water	Maintain existing Water Intake infrastructure and water treatment facility	Maintain	Remove for salvage or disposal
Waste water	Maintain sewage treatment plant	After treatment, waste water will go to groundwater	Remove for salvage or disposal
Solid waste	Maintain propane incinerator	All waste to be burned. Non-combustible, non-toxic waste buried in on-site landfill or transported to permitted facility	Remove incinerator for salvage or disposal
Mine			
Open pits	Pre-production stripping of the first of nine open pits	Continue pit development and mine ore	Reclaim
Underground		Develop two underground workings	Openings sealed
Mill	Build addition to existing mill building and install systems	Process 1,500 tonnes / day	Remove for salvage or disposal
Tailings	Construct facility for 3 million tonnes thickened tailings	Tailing disposal	Reclaim
Infrastructure			
Site roads	Upgrade existing site roads and build new ones as required	Maintain	Reclaim
Power plant	Install two 3MW diesel generators	Maintain	Remove for salvage
Ancillary facilities	Build truck shop, warehouse, admin building, powerhouse, assay lab, cold storage warehouse. Install water tanks, fuel storage tanks, and explosive storage facilities	Maintain	Remove for salvage
Transportation	Construction phase will require a large amount of road transport to the site	Road transport of fuel and supplies will be an ongoing activity, approximately 9 trucks / week	Decommissioning may result in a temporary increase in road traffic

9.1.2 Summary and Rationale: Socio-economic Scope

For the socio-economic effects assessment, the KRP's temporal scope will be from the commencement of construction of the KRP and its related infrastructure through to the end of the required monitoring period following the closure and reclamation of the site. Given the construction schedule, the planned mine life and the requirement for a minimum 3 year monitoring period of the Site following final closure and reclamation, the temporal scope of the KRP is 12.5 years as a minimum. The KRP's spatial scope covers all of the components and activities described in Section 9.1.1.

The rationale for the above definition of the KRP scope in the context of the socio-economic effects assessment is straightforward. It includes all components and activities required for the KRP to proceed from the beginning of construction through to the end of the post-closure monitoring period.

9.2 Scope of Assessment

Determining the scope of the socio-economic effects assessment (YESAB 2006a) includes:

- Developing a basic understanding of the socio-economic setting
- Identifying which communities, governments, organizations, and individuals have an interest in a Project
- Identifying what those interested parties value in relation to identified socio-economic based VESECs
- Determining whether the project is likely to have a significant effect on those VESECs
- Establishing the spatial and temporal boundaries for the assessment and documenting the rationale for choosing those boundaries.

The socio-economic setting in which the KRP will operate is laid out in Section 5.0 of this Project Proposal.

The communities, governments, organizations, and individuals that have an interest in the KRP are identified in Section 9.2.1.

What the identified interests value in relation to identified socio-economic based VESECs are in Section 9.2.2.

A preliminary determination of potential effects of the Project on identified socio-economic based VESECs is presented in Section 9.2.3.

Section 9.2.4 summarizes the spatial and temporal boundaries for the socio-economic assessment and presents a rationale for the choice of those boundaries.

9.2.1 Identified Interests

Communities, governments, organizations, and other groups have an interest in a KRP 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 the KRP *may* have an effect on an interest; it will not necessarily do so.

The KRP will likely have effects on components valued by a variety of interested parties. Table 9.2-1 below contains a summary list of entities that have been identified as having a likely socio-economic interest in the KRP.

Table 9.2-1: Identified Interests

Government of Canada	Aboriginal Affairs and Northern Development (AANDC)
	Human Resources and Skills Development (HRSDC)
	Health Canada (HC)
	Natural Resources Canada (NRC)
	Department of Fisheries and Oceans Canada (DFO)
Yukon Government Departments	Economic Development
	Education
	Emergency Measures Organization (EMO)
	Energy, Mines and Resources (EMR)
	Environment (YG Environment)
	Health and Social Services (HSC)
	Highways and Public Works
	Justice
	Tourism and Culture
	Women's Directorate
	Yukon College
	Yukon Workers' Compensation Health and Safety Board (YWCHSB)
First Nations	Ross River Dena Council (RRDC)
	Liard First Nation (LFN)
	Teslin Tlingit Council (TTC)
Municipalities	Town of Faro
Communities	Ross River
	Faro
Groups, Businesses and Organizations	Traditional land stewards
	Ross River trappers
	Ross River businesses.
	Faro businesses
	Liard First Nation businesses
	Teslin Tlingit Council businesses
	Yukon Stone Outfitters Ltd.
	Yukon Mine Training Association (YMTA)

9.2.1.1 Government of Canada

The government of Canada has few areas of responsibility in the Yukon that create likely socio-economic interests in the KRP. Possible areas of interest for the federal government include:

- Aboriginal Affairs and Northern Development Canada (AANDC)
  - Through its Northern Affairs Program AANDC has a mandate for the sustainable development of the North's communities and natural resources
  - AANDC also has the primary responsibility for meeting the federal government's duties and responsibilities to First Nations. This responsibility has particular bearing on the RRDC and the LFN, neither of which has settled land claims and so remain Indian Act Bands.
- Human Resources and Skills Development Canada (HRSDC)
  - HRSDC has a very broad mandate that includes managing the Employment Insurance program and a variety of training initiatives.
- Health Canada (HC)
  - Health Canada is responsible for funding the delivery of health services to First Nations.
- Fisheries and Oceans Canada (DFO)
  - DFO is responsible for managing the salmon fishery on Yukon River and its tributaries including the Pelly River.
- Natural Resources Canada (NRC)
  - Among its other responsibilities, NRC has a regulatory role in enforcing Canada's Explosives Act.

9.2.1.2 Yukon Government

Yukon Government represents all Yukon residents and provides a wide variety of services to the population of the territory. The following YG departments and other agencies have been identified as having an interest in the KRP:

- Economic Development's interests include:
  - Increasing the Yukon's Gross Domestic Product (GDP)
  - Increasing government revenues
  - Opportunities for Yukon businesses
  - Increasing Yukon First Nations participation in economic development.
- Education's interest in the KRP will likely be focused on providing for any increase in the population of school-age children brought by the KRP, and providing appropriate adult training and education programs to help Yukoners take advantage of employment opportunities

- Energy, Mines and Resources (EMR) has a regulatory role in the mining sector and has an interest in the effects large KRPs may have on forest resources, both in any clearing done and in the danger of forest fires. The Emergency Measures Organization (EMO) will play a role if there is a large emergency connected to the KRP
- Environment's socio-economic interest in the KRP will be the KRP's effect on hunting, fishing and trapping in the region
- Health and Social Services interests include any effect on its community nursing stations and its provision of emergency medical services, including medevacs. The interests of the Social side of HSC are likely to include effects the KRP may have on:
  - Alcohol and drug services
  - Social assistance
  - Child and family services
  - Youth justice services.
- Environmental Health Services branch of HSC 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 KRP
- Highways and Public Works' broad interest in the KRP arises from the department's core role in the construction and maintenance of safe and efficient transportation infrastructure in the Yukon. Specific interests will likely include the additional volume of road and air traffic generated, the routes used and any additional maintenance that may be required as a result
- Justice's interest in the KRP will be any effect the KRP has on crime, justice and policing in the Yukon
- Tourism and Culture's broad interests in the KRP are that tourism is recognized as an industry with economic value, and that likely effects on any particular tourism operator or event be mitigated. The interests of the Heritage Branch of the YG Department of Tourism and Culture is the protection of any archaeological or heritage resources that may be affected by the KRP
- 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 KRP include:
  - Family violence
  - Employment opportunities for women
  - Training opportunities for women.
- Yukon College has an interest in any project that may affect demand for training, both general preparation for work courses and more specific and targeted training

  Yukon Workers' Compensation Health and Safety Board (YWCHSB). The YWCHSB has an interest in all large projects in the Yukon through their role in workplace safety.

9.2.1.3 First Nations

The following First Nations have identified interests in the socio-economic effects assessment of the KRP:

- RRDC citizens are traditional land stewards of the area. The KRP is within the traditional territory of the RRDC, and Ross River is the closest community to the site. The First Nation's socio-economic interests in the KRP are wide-ranging:
  - Economic development, including employment and business opportunities along with the resulting increases in incomes
  - A broad array of health, cultural and social issues including alcohol and drug abuse
  - Crime and family violence
  - The cultural integrity and cultural continuity of the First Nation
  - Any impacts on health status and the economic aspects of subsistence activities
- LFN has an interest in the KRP because it is located on Kaska traditional territory. Socio-economic effects, however, are likely to be limited due to the KRP's distance from the home communities of the LFN. LFN's likely socio-economic interests in the KRP include:
  - Business and employment opportunities
  - The social issues that arise with an increase in incomes
  - The economic aspects of subsistence activities
- TTC has an interest in the KRP because it is located within the First Nation's traditional territory. TTTC's socio-economic interests in the KRP include:
  - Business and employment opportunities
  - The social issues that arise with an increase in incomes
  - The economic aspects of subsistence activities.

9.2.1.4 Municipalities

Faro has an interest in the KRP, particularly if some of the mine's employees choose to live in the community. Faro's interests focus on several possible socio-economic effects including:

- An increase in population
- An increase in its tax base
- Increased use of the infrastructure and services, including water, sewer, solid waste disposal, roads and recreation facilities, provided by the municipality.

9.2.1.5 Communities

The following communities have identified interests in the socio-economic effects assessment of the KRP:

- Ross River is the closest community to the site and the community as a whole (distinct from the RRDC) has wide-ranging socio-economic interests in the KRP

- Faro is located relatively close to the KRP. The community as a whole (distinct from the municipal government) has socio-economic interests in the development of the KRP, especially if some of the mine's new employees choose to make their home in the community.

9.2.1.6 Groups, Businesses and Organizations

Groups, businesses and organizations that appear to have interests in the KRP are:

- The traditional land stewards of the Ketza River area
- Ross River trappers who trap in the Ketza River area of the Ross River Group Trapline
- Businesses in Ross River, including the Nezziddi Development Corporation owned by the RRDC
- Businesses in Faro including Faro Real Estate Ltd., which owns much of the vacant housing in Faro
- TTC owned businesses (Tle' Nax T'awei Group)
- LFN businesses (LFN Development Corporation)
- Yukon Stone Outfitters Ltd., the area's outfitter
- YMTA, which has a direct interest in the training needs of Yukon mines.

9.2.2 Identification of Valued Environmental and Socio-economic Components

For the evaluation of socio-economic aspects of a proposed project, VESECs 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
- Their role in maintaining quality of life in a community.

Some socio-economic based VESECs are specific to a particular community or interest, but many overlap among communities and interests. The socio-economic related VESECs identified for the KRP are considered according to five groupings:

- Economy and Sustainable Livelihood
- Human Health and Well-being
- Community Vitality
- Infrastructure and Services
- Culture, History and Heritage.

Each of the broad VESEC groupings have a number of individual VESECs that are aligned with more specific interests or issues. It is these sub-components that are much more likely to have quantifiable indicators.

Socio-economic based VESECs for the KRP have been identified through a variety of means:

- Community meetings and workshops — including some held specifically to identify and validate VESECs for the KRP, held in Ross River, Faro and Teslin between 2007 and 2011 (see Section 2.0 for details)

- Existing community plans and strategies including the ICSPs for Faro and the RRDC
- Meetings between KRH and representatives of the TTC and LFN (see Section 2.0 for details)
- Responses by many interests (and especially government interests) to other similar KRPs submitted to YESAB for Executive Committee level screening.

Table 9.2-2: Socio-economic Based Valued Environmental and Socio-economic Components Associated with the Project

Economy and Sustainable Livelihood	Traditional economic activities — hunting, fishing, trapping, food gathering
	Economic growth
	Diverse and stable economy — discouraging boom and bust
	Employment
	Employability — education, training and experience
	Broad participation in economic development
	Business opportunities
	Government revenues
Human Health and Well-Being	Individual health
	Family Stress
	Reducing alcohol and drug abuse
	Gathering traditional medicine
	Public health and safety — increased traffic, hazardous material transport
	Workplace health and safety
Community Vitality	Population — number of children
	Healthy local business sector — reducing the cost of living
	Reducing crime
	Reducing discrimination and racism
	Political structure, leadership and capacity
	Community events and volunteerism
	Recreational facilities and opportunities
Infrastructure and Services	Housing and land availability
	Transportation infrastructure — roads and airports
	Municipal services — water, sewer, solid waste
	Healthcare services
	Police services
	Child care
Culture, History and Heritage	Language preservation and restoration
	Traditional knowledge and practice preservation and restoration
	Heritage and historic sites

9.2.3 Preliminary Determination of Potential Effects

There is potential for VESECs to be influenced both positively and negatively by the KRP. Some influences are more apparent, for example, the opening of the mine is expected to result in a clear and measurable increase in the Yukon's GDP. Others are less apparent, or may be affected in a more complex manner. The preliminary determination of potential effects on socio-economic based VESECs is summarized in Table 9.2-3.

Table 9.2-3: Preliminary Determination of Potential Socio-economic Effects

Economy and Sustainable Livelihood	
Traditional economic activities — hunting, fishing, trapping, food gathering	Direct effect if the increased industrial activity in the region reduces the ability of people to pursue activities. Indirect effect as a result of the KRP increasing the size and importance of the local wage economy.
Economic growth	The KRP will directly affect economic growth, both at the Yukon and community levels.
Diverse and stable economy — discouraging boom and bust	KRP will have a direct effect on Yukon and regional economic diversification.
Employment	Direct effect through all phases of the KRP. Job opportunities will be available.
Employability — education, training and experience	Only indirect effects on education system if employees come to live in the Yukon with their families. Direct effect on training as KRH will employ apprentices and provide other forms of training to employees, likely in partnership with other organizations. Direct effect on experience as employment at the KRP will provide work experience.
Broad participation in economic development	Direct effects through the KRP providing job and business opportunities to the entire cross-section of Yukon society.
Business opportunities	The KRP will provide a wide variety of business opportunities through all phases of the KRP.
Government revenues	The KRP will directly increase government revenues through various taxes and royalties.
Human Health and Well-Being	
Individual health	The KRP will likely have indirect effects on individual and family health through offering employment and increasing incomes.
Family stress	The KRP will likely have indirect effects, both positive and negative, on family stress through increases in employment and incomes.
Reducing alcohol and drug abuse	The KRP will likely have an indirect effect on alcohol and drug abuse through increases in employment and incomes.
Gathering traditional medicine	Potential direct effect if the increased industrial activity in the region reduces the ability of people to pursue the gathering of traditional medicines.

Table 9.2-3: Preliminary Determination of Potential Socio-economic Effects

Economy and Sustainable Livelihood	
Public health and safety — increased traffic, hazardous material transport	The KRP will have potential direct effects on public health and safety through all phases of the KRP including: increased traffic, the possibility of off-site accidents and spills, the transportation of hazardous materials to the mine and the operations of the camp. Note that there is no transport of ore from the mine.
Workplace health and safety	The KRP will have direct effects on the health and safety of its own workforce.
Community Vitality	
Population — number of children	The KRP may have an effect if employees choose to move to communities in the region.
Healthy local business sector — reducing the cost of living	The KRP may affect business capacity through the business opportunities it will offer in all phases.
Reducing crime	The KRP will likely have an indirect effect on crime levels through the increase in incomes provided by employment and business opportunities.
Reducing discrimination and racism	Effects will depend on KRH's policies and their enforcement.
Political structure, leadership and capacity	Indirect effects stemming from existing issues and disagreements among the three affected First Nation governments.
Community events and volunteerism	KRH may have an effect through the sponsorship of community events. No significant effect on volunteerism is anticipated.
Recreational facilities and opportunities	No significant effect anticipated unless Faro or Ross River population increases significantly.
Infrastructure and Services	
Housing and land availability	No significant effect anticipated unless Faro or Ross River population increases significantly.
Transportation infrastructure — roads and airports	Direct effects through increased traffic especially on the Ketza Road. No significant effect on airports anticipated.
Municipal services — water, sewer, solid waste	No significant effect anticipated unless Faro or Ross River population increases significantly.
Healthcare services	Local health infrastructure and services will be directly affected by the KRP.
Police services	No significant effect anticipated unless Faro or Ross River population increases significantly.
Child care	Effect will depend on amount of local employment and whether Faro or Ross River population increases significantly.
Culture, History and Heritage	
Language preservation and restoration	No significant effect anticipated.
Traditional knowledge and practice preservation and restoration	This information is confidential. The RRDC acknowledges that KRH has taken traditional knowledge into account in its plans and, if relevant, adequately mitigated any adverse effects.
Heritage and historic sites	Effects dependent on whether heritage sites are discovered or disturbed by the KRP. Known existing sites are to be protected from disturbance. The location of some heritage sites is confidential and the RRDC acknowledges that KRH has taken heritage and sacred sites into account in its plans.

9.2.4 Summary and Rationale: Scope of Socio-economic Assessment

As noted above, some VESECs are specific to a particular community or interest, but many overlap among communities and interests. To produce a socio-economic assessment, we group the valued socio-economic components by geographic scope, and the rationale for doing so, in the sections below.

9.2.4.1 Canada

The KRP will not produce socio-economic effects that are significant on a Canada-wide scale. With an estimated capital cost of $66 million and employment during operation estimated at 270 jobs, the KRP will be statistically imperceptible in a $1.7 trillion economy with 17.3 million people employed.

Canada as a whole, outside of the Yukon, is therefore not included in the assessment of the KRP.

9.2.4.2 Yukon

The Yukon as a whole will be affected by the KRP. Of particular importance will be the territory-wide effects on economic growth, employment, territorial tax revenue, and both workplace and public health and safety. There may also be some territory-wide cumulative effects.

9.2.4.3 Ross River and the Ross River Dena Council

The social and economic effects of a mining project tend to be more concentrated in the communities nearest to the mine, and especially those relatively close by road. Ross River is the closest community to the KRP and it is in the heart of the RRDC's traditional territory.

9.2.4.4 Faro and the Town of Faro

Like Ross River, Faro is relatively close to the KRP by road. Faro has the housing and infrastructure to accommodate a significant population increase and the Town 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 KRP and, if that increase is significant, experience more socio-economic effects.

9.2.4.5 Liard First Nation

The LFN's home communities of Upper Liard, Two Mile and Two and a Half Mile and Watson Lake are distant from the KRP but the LFN is included in the scope of the socio-economic assessment because the KRP is located on Kaska traditional territory.

9.2.4.6 Teslin Tlingit Council

The TTC's home community of Teslin is distant from the KRP but is included in the scope of the socio-economic assessment because the KRP is located on Teslin Tlingit traditional territory as accepted by YESAB.

9.2.4.7 Groups, Businesses and Organizations

Specific groups, businesses and organizations, as listed below, have identified interests in the KRP. All are Yukon-based and, as such, it is expected that any Project-related effects to these entities will occur within the Yukon:

- The traditional land stewards of the Ketza River area
- Ross River trappers who trap in the Ketza River area of the Ross River Group Trapline
- Businesses in Ross River, including the Nezziddi Development Corporation owned by the RRDC
- Businesses in Faro including Faro Real Estate Ltd.
- TTC owned businesses (Tle' Nax T'awei Group)
- LFN businesses (LFN Development Corporation)
- Yukon Stone Outfitters Ltd., the area's outfitter
- YMTA.

9.2.4.8 Temporal Scope of Assessment

As noted in Section 9.1.1, the temporal scope of the KRP will be a minimum of 12.5 years from beginning of construction to the end of the post-closure monitoring period. This includes 1.5 years for the construction phase, 5 years of operations (which will include progressive reclamation), 1 year of decommissioning and a minimum of 3 years of post-closure monitoring.

Therefore the temporal scope of the socio-economic assessment will cover 13 years, from the beginning of construction through to the end of the post-closure monitoring period.

9.3 Summary of Socio-economic Baseline Information

In an effects assessment, the baseline provides the necessary indicators for answering the question; what effects will a project have on the community or other interest? The baseline indicators are what we measure anticipated changes against. In YESAB's *Guide to Socio-economic Effects Assessments*, the following direction on selecting baseline indicators is given (YESAB 2006a):

> *"The social and economic assessment indicators are derived from the VESECs [Valued Environmental and Socio-economic Components] 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."*

Thus, the socio-economic baseline data presented in this section of the Project Proposal have not been put together simply to provide a backdrop for the effects assessment or as a background primer for those not familiar with the affected communities. Rather, all of the data on the communities, and for the Yukon that make up the baseline has been selected to provide useful indicators for measuring the anticipated effects

on each of the identified VESECs for the proposed development, operation and closure of the Project. The baseline indicators will also provide the means for longer term socio-economic effects monitoring as the KRP proceeds. It is also important to note that the anticipated effects of the KRP on the baseline indicators assist in devising effective mitigation and enhancement measures during the effects assessment itself.

However, there is not always a clear and direct indicator for each of the VESECs. Where this is the case, we have either selected indicators that, singly or together, can provide indirect or proxy means of measurement or we have not provided a quantifiable indicator at all where there is no value in doing so. In these cases we acknowledge the VESEC (it is often the case in the social sciences that the things we have no means of measuring are given insufficient weight in an assessment), and describe any indirect or anecdotal evidence for our assumptions of how the KRP will affect it. Providing an indicator that has only a tenuous or tangential relationship to the VESEC at best will not assist in the assessment and may distract from what is actually valued. We are trying to avoid including data simply because it is available.

9.3.1 Data Sources

The socio-economic baseline relies almost entirely on published data. Sources of data include:

- Statistics Canada 2006 Census: A large number of the indicators come from Census data
- Yukon Bureau of Statistics (YBS) data on population, some economic variables, and societal data
- Canada Revenue Agency (CRA) for data on income and Goods and Services Tax (GST)
- Yukon government departments and other agencies
- Municipal data

9.3.2 Baseline Indicators: Linkages and Rationale

Each of the broad VESECs initially identified in Section 9.2.2 has a number of more concrete sub-components that have been identified by different interests. It is these sub-components that are much more likely to have quantifiable indicators. Table 9.3-1 shows the linkages among the VESECs, their sub-components, and the interests that have demonstrated they value those sub-components. Finally, each is linked to the indicator(s) that have been selected to represent the sub-components and, by extension, the broader VESECs of which they form part.

Table 9.3-1: Baseline Indicators: Linkages to Valued Environmental and Socio-economic Components and Interests

VESEC	Sub-Component	Interest	Indicator
Economy and Sustainable Livelihood	Traditional economic activities: hunting, fishing, trapping, food gathering	Ross River Dena Council Liard First Nation Teslin Tlingit Council Traditional land stewards Ross River trappers YG Department of Environment	Harvest data (Source: YG Environment) Description
	Economic growth	Yukon Economic Development	Yukon GDP (Source: YBS)

Table 9.3-1: Baseline Indicators: Linkages to Valued Environmental and Socio-economic Components and Interests

VESEC	Sub-Component	Interest	Indicator
		Ross River Dena Council Town of Faro	Personal income by community (Source: CRA)
	Diverse and stable economy — discouraging boom and bust	Ross River Dena Council Liard First Nation Teslin Tlingit Council Town of Faro Yukon Tourism Yukon Stone Outfitters Ltd.	Employment by industry (Source: Statistics Canada) Population fluctuations over time (Source: YBS) Average income per person over time (Source: CRA)
	Employment	Ross River Dena Council Liard First Nation Teslin Tlingit Council Town of Faro Yukon Economic Development	Employment, unemployment and participation rates (Source: Statistics Canada)
	Employability — education, training and experience	Ross River Dena Council Yukon Education Yukon College Yukon Mine Training Association	Highest level of education (Source: Statistics Canada) Number of courses and completion rates for selected training courses (Source: YMTA) Occupational breakdown (Source: Statistics Canada)
	Broad participation in economic development	Ross River Dena Council Yukon Economic Development Yukon Women's Directorate	First Nation's participation and employment rates Women's participation and employment rates (Source: Statistics Canada)
	Business opportunities	Ross River businesses Faro businesses Liard First Nation businesses Teslin Tlingit businesses	Description (see also Healthy business sector sub-component below)
	Government revenues	Town of Faro Yukon government Federal government	Municipal taxes (Source: Town of Faro) Yukon and federal income taxes by community (Source: CRA) GST by community (Source: CRA)
Human Health and Well-Being	Individual health	Yukon Health and Social Services Ross River Dena Council	Selected Health Survey statistics (Source: Statistics Canada)
	Family stress	Ross River Dena Council Yukon Women's Directorate	Description
	Reducing alcohol and drug abuse	Yukon Health and Social Services Ross River Dena Council	Alcohol sales data (Source: Yukon Liquor Corporation) Reported drug incidents and criminal code traffic incidents data (Source: YBS)

Table 9.3-1: Baseline Indicators: Linkages to Valued Environmental and Socio-economic Components and Interests

VESEC	Sub-Component	Interest	Indicator
	Gathering traditional medicine	Ross River Dena Council	Description
	Public health and safety — increased traffic, hazardous material transport	Yukon Highways and Public Works Yukon Environmental Health Yukon Energy Mines and Resources	Traffic accident rates (Source: YHPW) Description
	Workplace health and safety	Yukon WCHSB	Mining accident rate and average days lost to injury (Source: YWCHSB and WorkSafeBC)
Community Vitality	Population — number of children	Faro Town of Faro Ross River	Community population, growth pattern and number of children (Source: YBS) School enrolment data (Source: YG Education)
	Healthy local business sector — reducing the cost of living	Ross River Ross River Dena Council Faro Town of Faro	Number of business licences (Source: Town of Faro) Number of businesses and employees (Source: YBS) Cost of living differential (Source: YBS)
	Reducing crime	Ross River Faro	Community crime rates: broad all, violent, property (Source: YBS)
	Reducing discrimination and racism	Ross River Dena Council	Income differentials between First Nations and others (Source: Statistics Canada)
	Political structure, leadership and capacity	Ross River Dena Council Liard First Nation Teslin Tlingit Council Town of Faro	Description
	Community events and volunteerism	Ross River Faro	Description
	Recreational facilities and opportunities	Ross River Faro Town of Faro	Description
Infrastructure and Services	Housing and land availability	Town of Faro Yukon Energy Mines and Resources Faro businesses	Dwelling units (Source: 2006 Census) Housing prices (Source: Real estate listings) Available lots (Source: YG EMR)
	Transportation infrastructure — roads and airports	Yukon Highways and Public Works	Description Traffic count data (Source: YHPW)
	Municipal services — water, sewer, solid waste	Town of Faro	Description

Table 9.3-1: Baseline Indicators: Linkages to Valued Environmental and Socio-economic Components and Interests

VESEC	Sub-Component	Interest	Indicator
	Healthcare services	Yukon Health and Social Services	Description
	Police services	Yukon Justice	Description
	Child care	Ross River Faro	Number of child care spaces available (Source: YHSS)
Culture, History and Heritage	Language preservation and restoration	Ross River Dena Council	Speakers of aboriginal language (Source: Statistics Canada) Description
	Traditional knowledge and practice preservation and restoration	Ross River Dena Council	RRDC confidential TK report
	Heritage and historic sites	Ross River Dena Council Yukon Heritage Branch	Description

Baseline information is presented according to each VESEC, in the following subsections.

9.3.3 Baseline: Economy and Sustainable Livelihood

The affected communities and First Nations place a high value on a sustainable, diverse, and stable community economy that provides local employment and business opportunities, and helps to support local government. Promoting the self-sufficiency of community members and avoiding the excesses of a boom and bust economy are also valued.

9.3.3.1 Traditional Economic Activities – Hunting, Fishing, Trapping, Food Gathering

Traditional economic activities—hunting, fishing, gathering and trapping—form an important part of life for both First Nation and non-First Nation Yukoners. Data on these activities is sparse. Trapping data and reported big game harvest numbers normally provide useful baseline indicators. However, the KRP is located in the very large group trapline (RTC 405) managed by the RRDC and trapping harvest data is not available. Data from the entire area will also not be useful as an indicator for the KRP area itself.

Table 9.3-1 summarizes the number of big game animals harvested by non-First Nation hunters, including those guided by the area's outfitter in the KRP region (First Nation hunters are not required to report their harvest). The data covers the years from 2001 through 2010 and is broken out by game management sub-zones. The group of game management sub-zone 10-01 through 10-05 cover the area bordered by the South Canol to the west, the Robert Campbell Highway to the north, the Hoole River to the east and the Nisutlin River to the south.

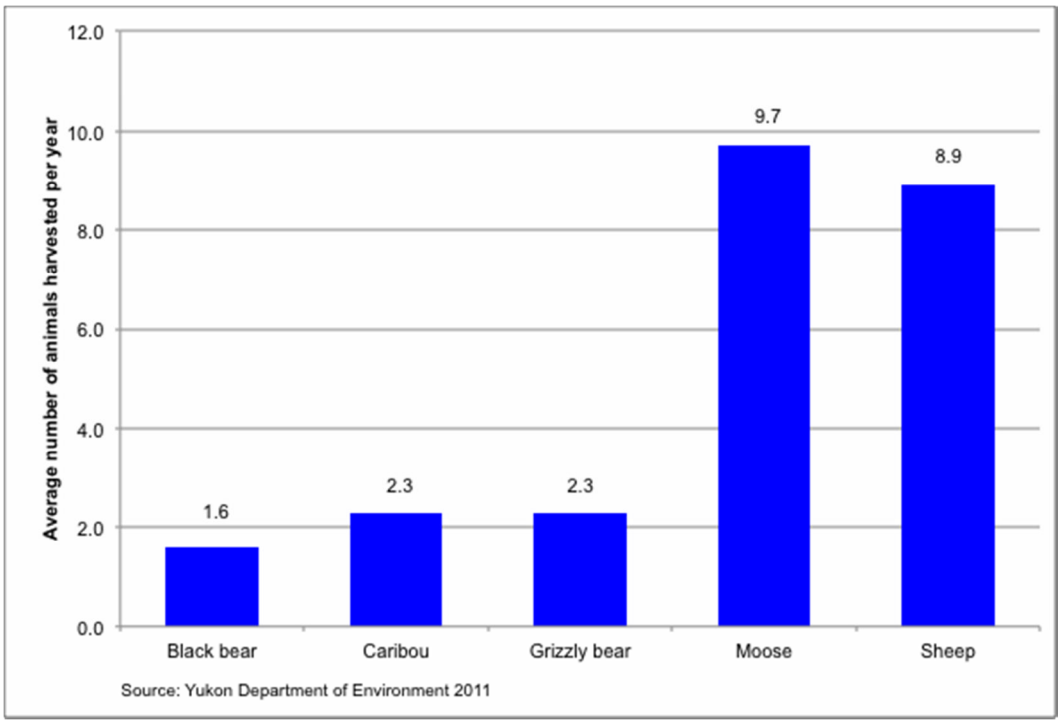


Figure 9.3-1: Average Annual Big Game Non-Native Harvest in Game Management Zones 10.01, 10.02, 10.03, 10.04, and 10.05 (2001 – 2010)

The data backs up anecdotal evidence from community meetings that the area has a wide variety of big game that is hunted.

9.3.3.2 Economic Growth

Economic growth and the size of the economy are measured by GDP[5]. Territorial GDP is calculated annually by the Statistics Canada and is republished by the Yukon Bureau of Statistics.

Figure 9.3-2 shows that the Yukon's real (after taking out the effects of inflation) GDP has increased by 29% or 2.6% annually, going from $1.2 billion to close to $1.6 billion in the last ten years while GDP per person grew at an average rate of 1.6% over the same period. Canada's real GDP grew by 16.6% over the same period.

[5] "Gross Domestic Product (GDP) is a measure of the value of the Yukon's total production of goods and services. These are goods and services which are exchanged for money in the market economy… GDP provides a tool for monitoring trends in economic production, forecasting economic activity, assessing the sources of economic growth or decline, and for econometric model-building" Yukon Bureau of Statistics (2011c).

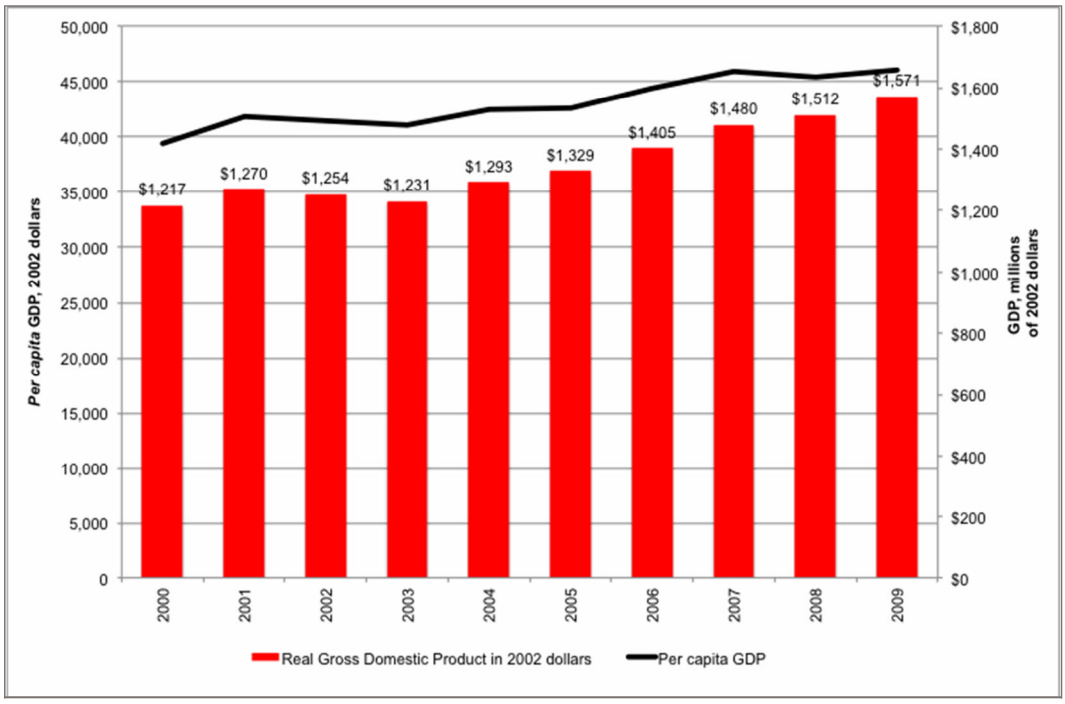


Figure 9.3-2: Yukon Real GDP and GDP per Person (2000 – 2009)

Statistics on the GDP of individual Yukon communities are not kept, but a good indicator of the size of the local money economy is the aggregate personal income obtainable from income tax statistics published by the Canada Revenue Agency.[6] There are no data relating specifically to the LFN and the TTC.

[6] Income-based GDP is one way of measuring the size of an economy. According to the Yukon Bureau of Statistics (2011c), "Income-based GDP consists of the sum of all incomes from productive activity from land, labour, capital and entrepreneurship. These earnings primarily include: (a) wages, salaries and supplementary labour income; (b) capital consumption allowances; (c) taxes; (d) corporation profits before taxes; (e) interest and miscellaneous investment income; and, (f) net income of unincorporated business." The aggregate personal income declared to Revenue Canada includes the entire list except the profits and capital consumption allowances for corporations owned by community members.

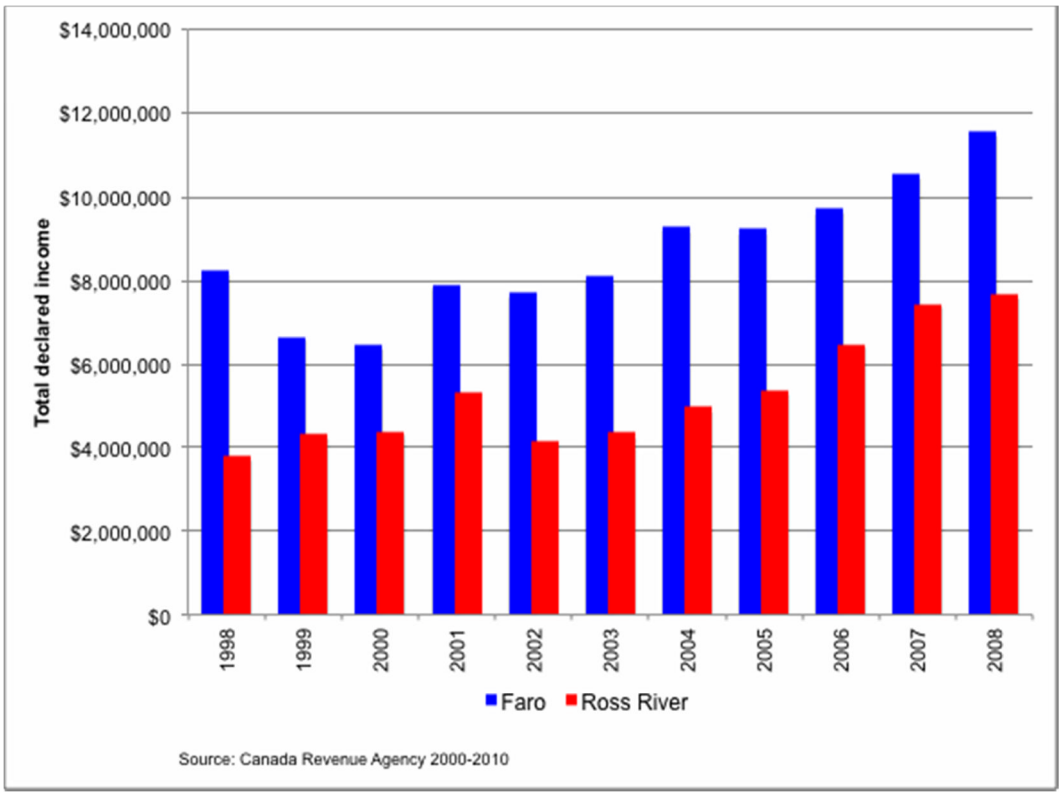


Figure 9.3-3: Faro and Ross River Total Declared Income (1998 - 2008)

Total declared income in Ross River and Faro has been increasing fairly steadily since the turn of the century with the upturn in mineral prices and the consequent increase in mineral exploration. In 2008, the last year for which income tax data is currently available, total income in Faro was $11.5 million and in $7.7 million in Ross River. Over the last 10 years, annual income growth in the two communities averaged, respectively, 5.7% for Faro and 5.9% for Ross River. Incomes increased faster in the two communities than the Yukon average of 5.4% annually.

9.3.3.3 Diverse and Stable Economy – Discouraging Boom and Bust

The level of diversity and stability in an economy has two components: the array of industries present in the area and the lack of dependence of the local economy on any one industry. However, one broad indicator is the long-term trend in real GDP. While the Yukon's GDP grew relatively steadily in the last five years, there have been considerable ups and downs in the past, mainly related to the opening and closing of different mines. Figure 9.3-4 shows the path the Yukon's GDP took in the last 30 years. Notable are the crashes in 1981-83 and in 1993 and 1997-98, all related to the closure of the Faro mine.

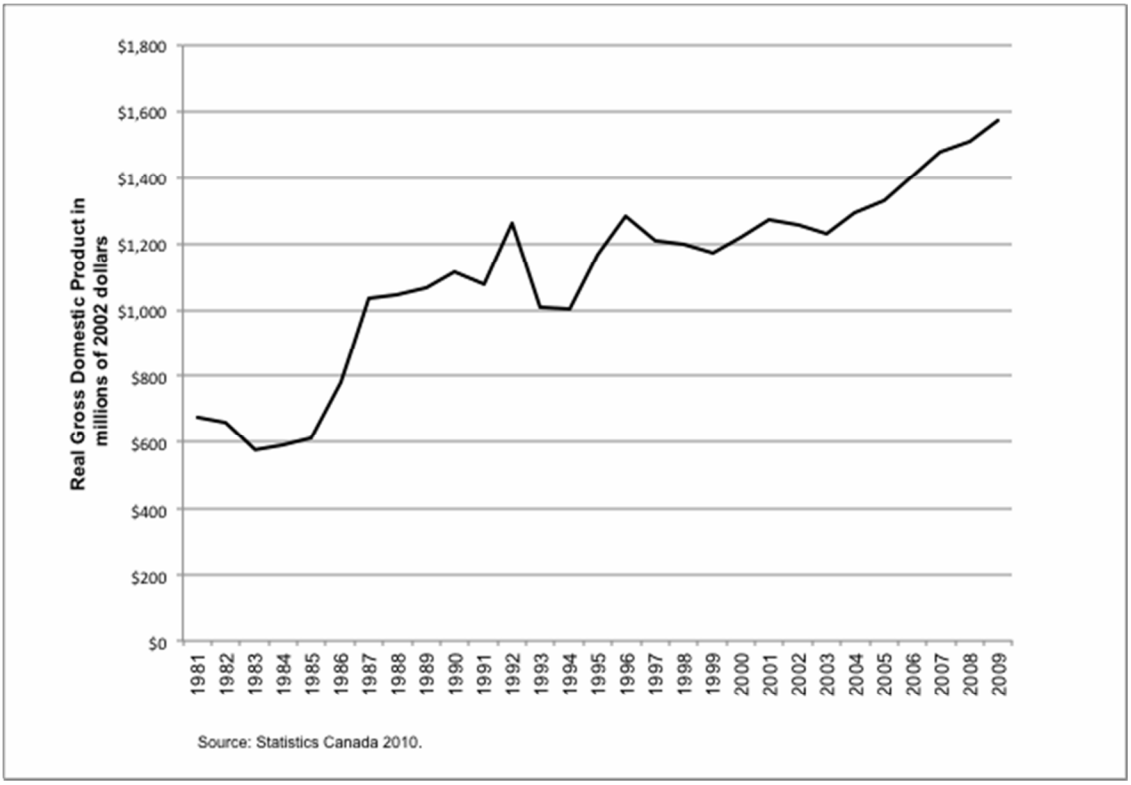


Figure 9.3-4: Yukon Real GDP (1981 – 2009)

Another indicator of a boom and bust economy is if the industrial distribution of employment is skewed toward one industry. The Census provides some information on the industrial distribution of employment, albeit at a fairly aggregated level. Table 9.3-2 shows the industrial distribution of employment in Ross River and Faro in 2006. However, the random rounding process used in Census data combined with the small numbers in a community such as Ross River and Faro makes the indicator somewhat unreliable.

For example, there were more than zero people employed in retail trade in Ross River in 2006, but random rounding means that any number between zero and ten may end up being reported as zero.

Table 9.3-2: Employment by Industry, Faro and Ross River (2006)

	Faro		Ross River		Yukon
	Number	%	Number	%	%
Renewable Resources	0	0.0%	10	5.7%	1.0%
Mining, Oil and Gas	25	14.7%	30	17.1%	3.6%
Construction, Utilities and Manufacturing	10	5.9%	15	8.6%	9.5%
Wholesale and Retail Trade	15	8.8%	0	0.0%	11.9%
Transportation and Warehousing	15	8.8%	0	0.0%	4.5%
Finance, Insurance and Real Estate	0	0.0%	10	5.7%	2.9%
Education	15	8.8%	20	11.4%	6.8%
Health Care and Social Services	15	8.8%	15	8.6%	9.1%
Accommodation and Food Services	10	5.9%	10	5.7%	8.9%
Public Administration	45	26.5%	55	31.4%	24.0%
Other Services	20	11.8%	10	5.7%	17.6%
Total Labour Force By Industry	170	100.0%	175	100.0%	100.0%

Source: Statistics Canada 2004-2009

Boom and bust economies tend to be marked by significant swings in either average income per person or community population or both. Figure 9.3-5 shows annual percentage changes in population for Faro while Figure 9.3-6 provides annual percentage changes in population for Ross River and the Yukon. Note the different scales in the two following figures as Faro suffered from wild fluctuations in its population as the mine closed and reopened. While not as dramatic, Ross River population did follow similar patterns. Even the Yukon's population was perceptibly affected by the Faro mine.

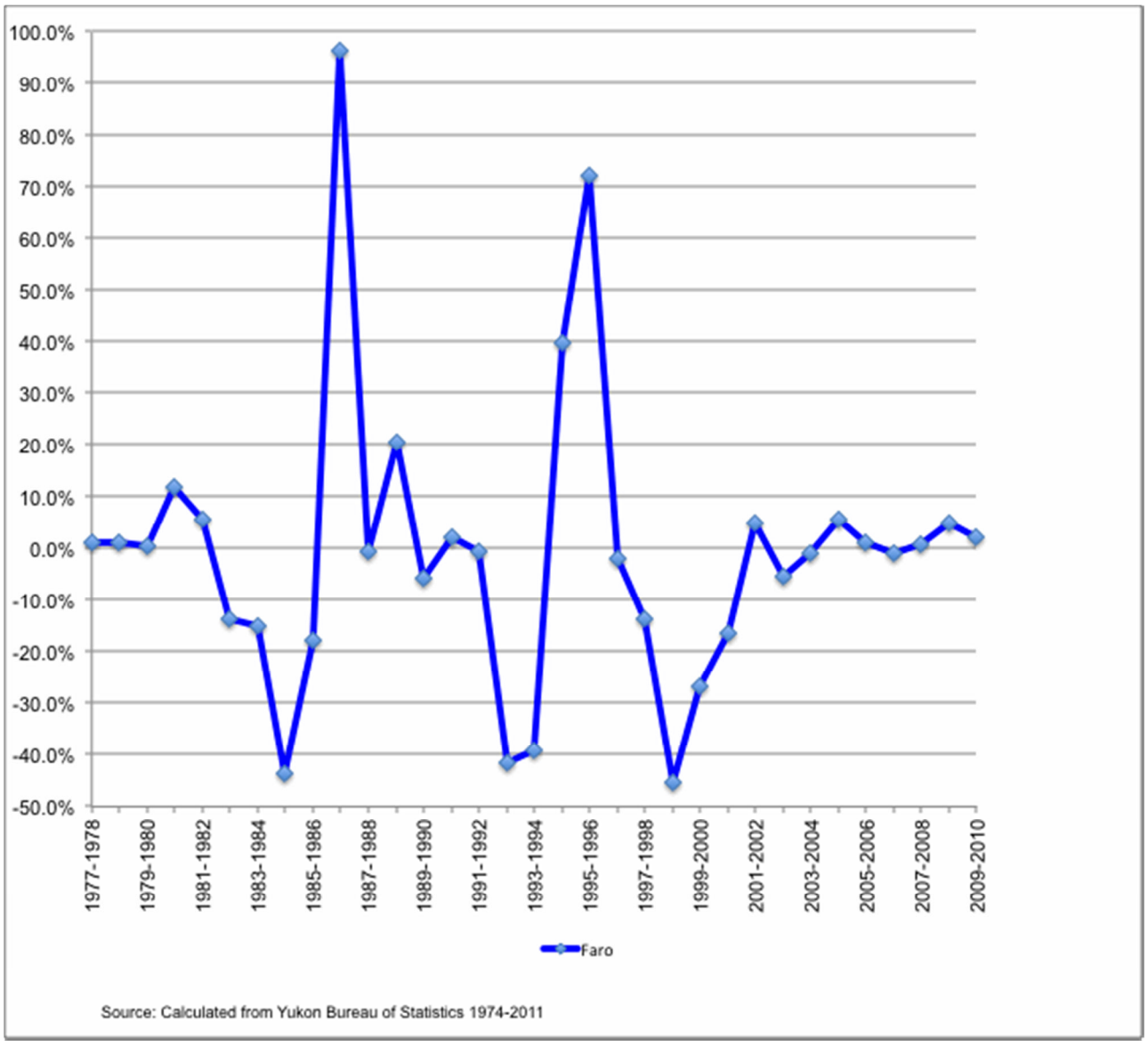


Figure 9.3-5: Annual Percentage Changes in Population, Faro (1974 – 2010)

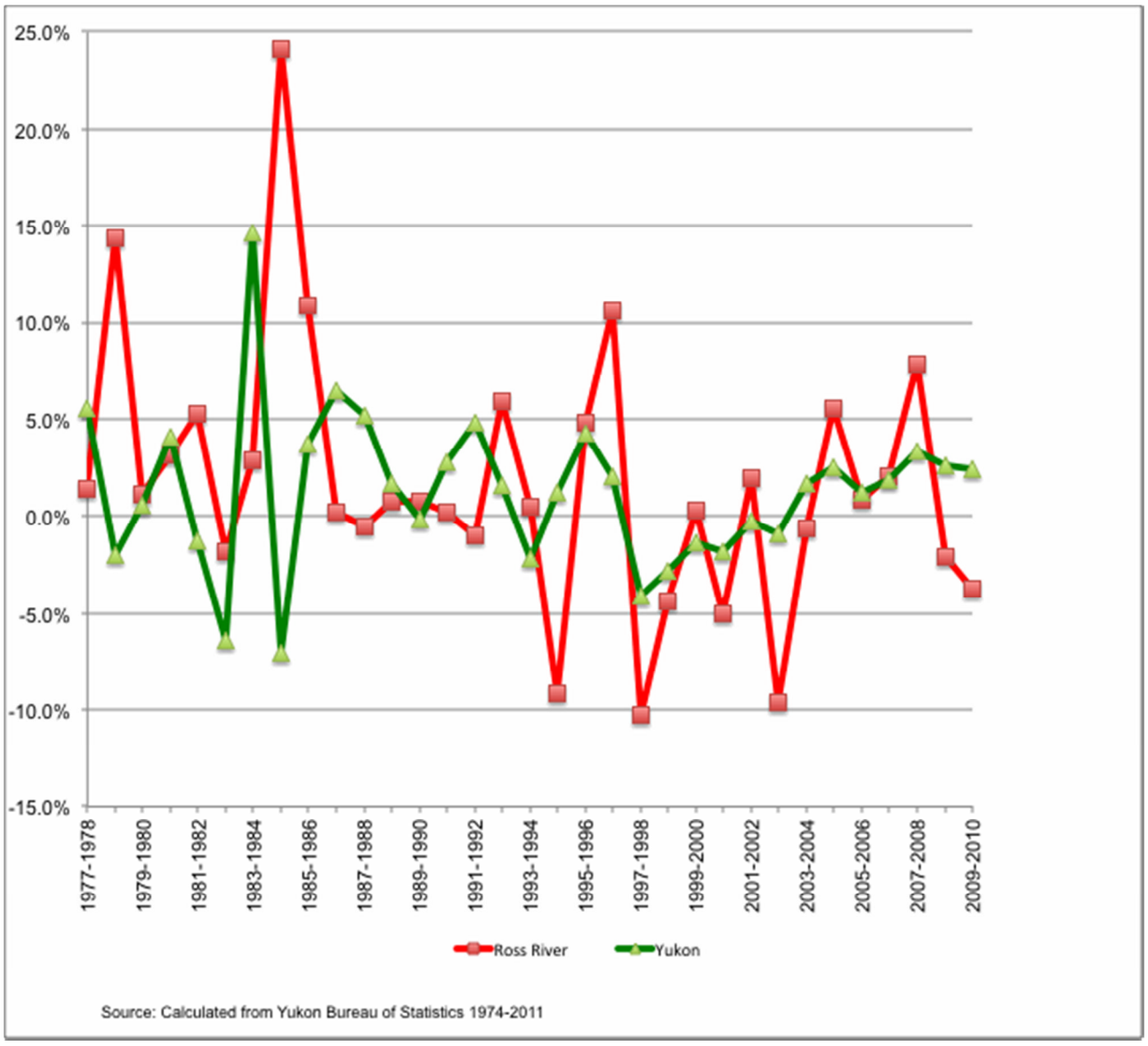


Figure 9.3-6: Annual Percentage Changes in Population, Ross River and Yukon (1974 – 2010)

9.3.3.4 Employment

Employment indicators include total employment, employment rate, unemployment rate, and labour force participation rate. At the community level, the only available labour force data are from the long form of the national Census that was carried out every five years by the federal government. In past censuses, at the request of YG, all people living in rural communities were requested to fill out the long form, which included information relating to income and employment. The last Census was held in May 2006 and the data for the affected communities and the Yukon are compared in Figure 9.3-7.

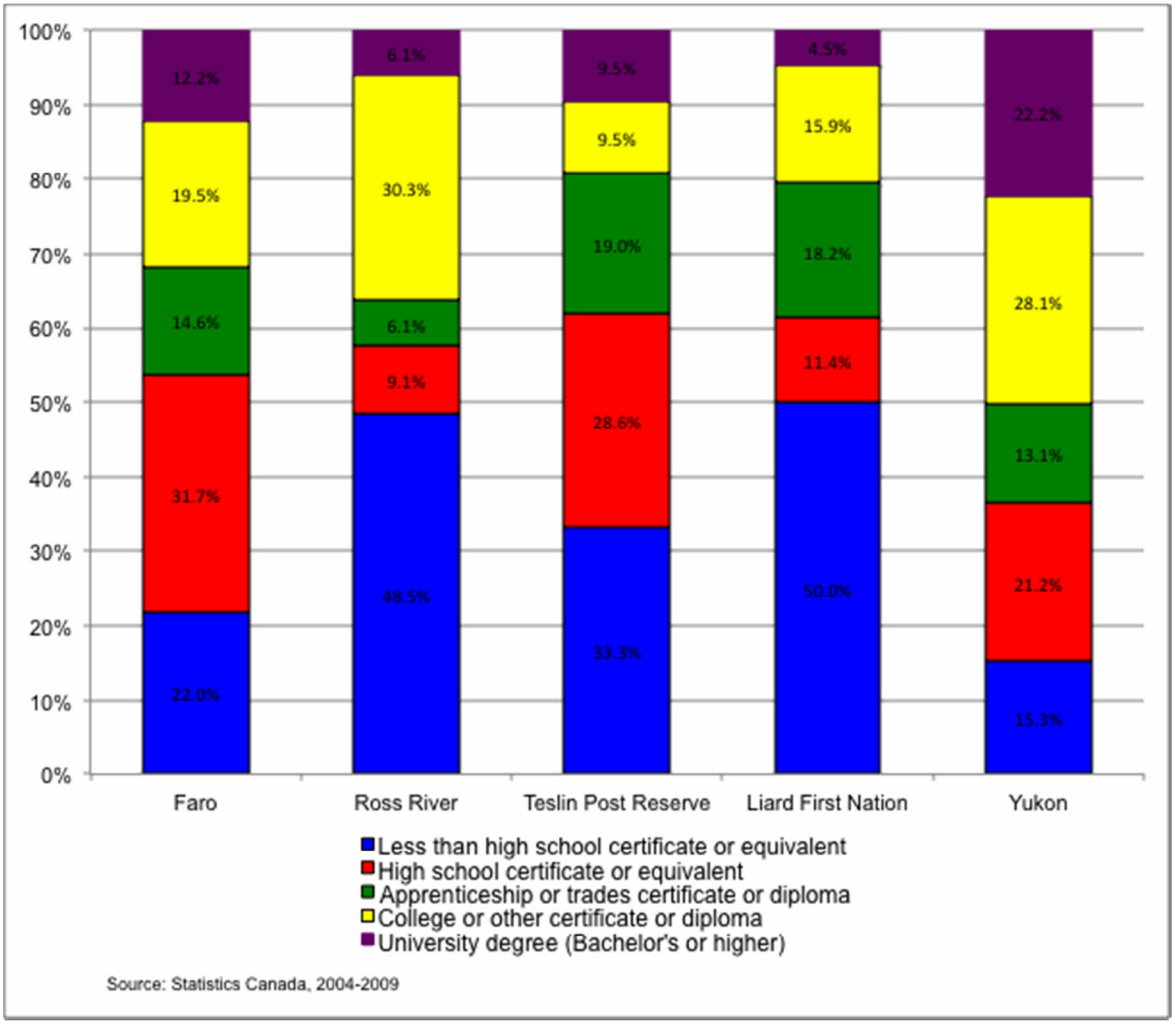


Figure 9.3-7: Labour Force Participation, Employment and Unemployment Rates, Affected Communities (2006)

This data will not be available in the 2011 Census. The Teslin Post Reserve data only comprises part of the Teslin Tlingit population living in the Teslin area, as many live in the Village of Teslin. Similarly, the LFN data include only people living on LFN controlled land (Upper Liard, Two-Mile-Village and Two-and-a-Half-Mile Village) and does not include LFN citizens living in Watson Lake.

The participation rate is the proportion of residents aged 15 through 64 years who worked for pay in the year prior to the Census. The employment rate is the proportion of residents aged 15 through 64 years who were working for pay at the time of the Census. The unemployment rate is the proportion of residents aged 15 through 64 years who were not working for pay at the time of the Census, but were actively looking for work. As is typical, rural communities have higher unemployment rates, lower participation rates and lower employment rates than the Yukon as a whole, which is dominated by Whitehorse numbers.

9.3.3.5 Employability – Education, Training and Experience

Employability can be measured by the level of training and education, as well as work experience of the subject population.

The highest level of education held by 15 through 64 year olds in the affected communities is shown in comparison with the Yukon's numbers in Figure 9.3-8. In Ross River and the LFN controlled communities, about half of the population had not finished high school. That figure was about one third in the Teslin Reserve and less than a quarter in Faro, compared to about 15% for the Yukon as a whole. Ross River has a fairly high proportion of people with college level qualifications at about 30%, considerably higher than any other affected community.

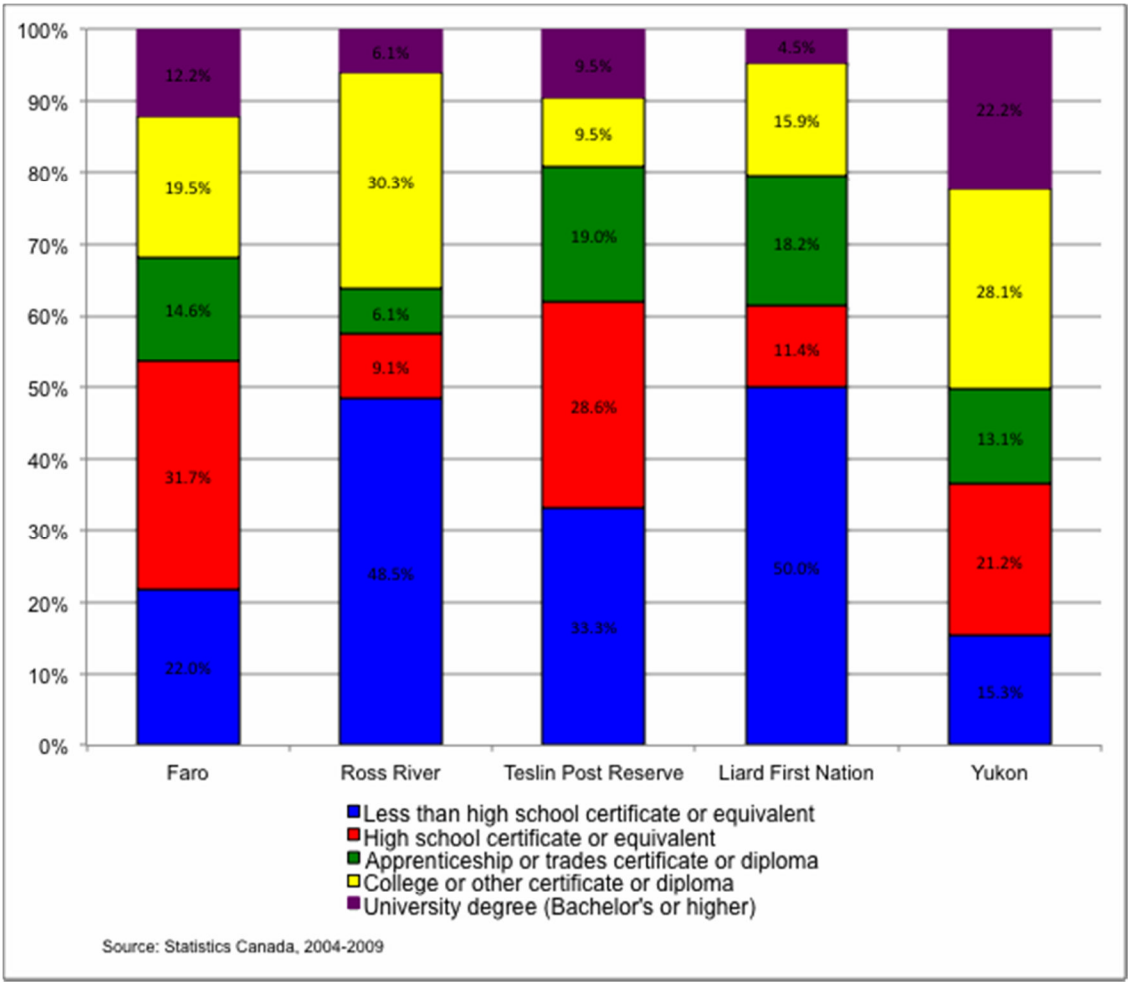


Figure 9.3-8: Highest Level of Education Attained, Affected Communities (2006)

Figure 9.3-9 shows the occupational breakdown of the labour force in the affected communities compared to the Yukon Territory in 2006. At the time of the Census in May 2006, more than one third of the affected communities' labour force worked in occupations classified as trades, transport, equipment operators, and occupations unique to primary industry, compared to little more than 20% for the Yukon as a whole.

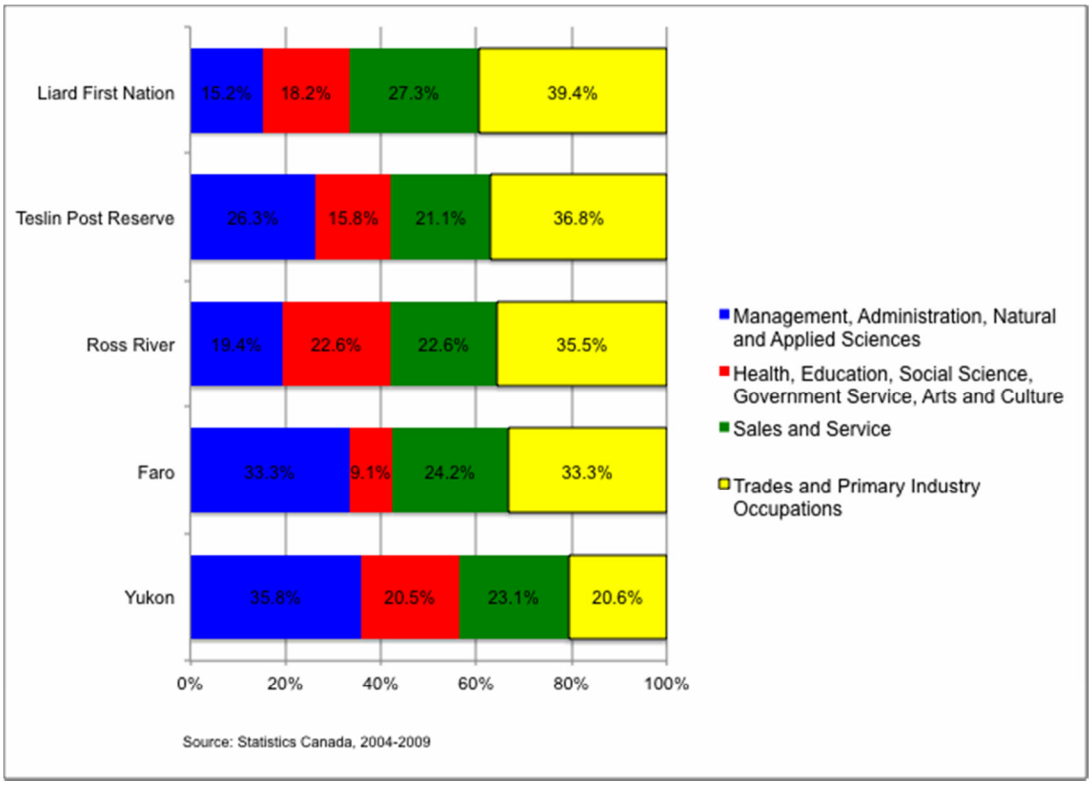


Figure 9.3-9: Broad Occupational Breakdown, Affected communities (2006)

The number of YMTA courses offered and completion rates for selected training courses will provide good indicators of training activity. Starting in 2009-10 the YMTA started publishing data on courses offered and number of trainees, but not on completion rates.

Table 9.3-3: Number of Trainees by Sponsor for Affected Communities, Yukon Mine Training Association (2009 – 2010)

Sponsor	Number of trainees
LFN	17
RRDC	16
TTC	25
Yukon Zinc	62
Others	506
Total	626

Source: Yukon Mine Training Association, 2010

9.3.3.6 Broad Participation in Economic Development

The economic participation of women and of First Nation people of both sexes can be measured by comparisons of labour force participation and employment rates of men versus women, and of First Nations versus all Yukoners.

Figure 9.3-10 compares the female versus male data for labour force participation rate while Figure 9.3-11 presents employment rates in the affected communities and the Yukon. Figure 9.3-12 presents data for the same rates for all Yukoners compared to aboriginal Yukoners.

Separate data for the First Nation labour force in the affected communities are not available. However, the Yukon-wide data on the First Nation labour force can act as a reasonable proxy as Ross River is an 80% aboriginal community and the Teslin Post and LFN data are for people living on First Nation land. These data are shown in Figure 9.3-12.

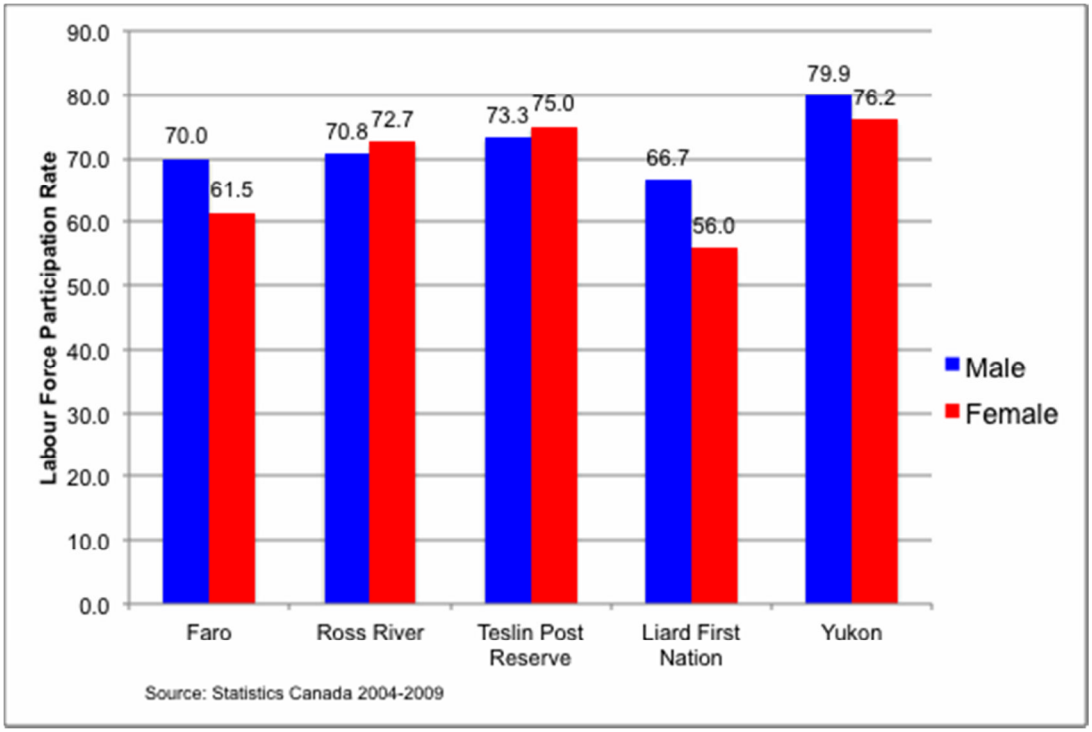


Figure 9.3-10: Male and Female Labour Force Participation Rates, Affected communities and Yukon (2006)

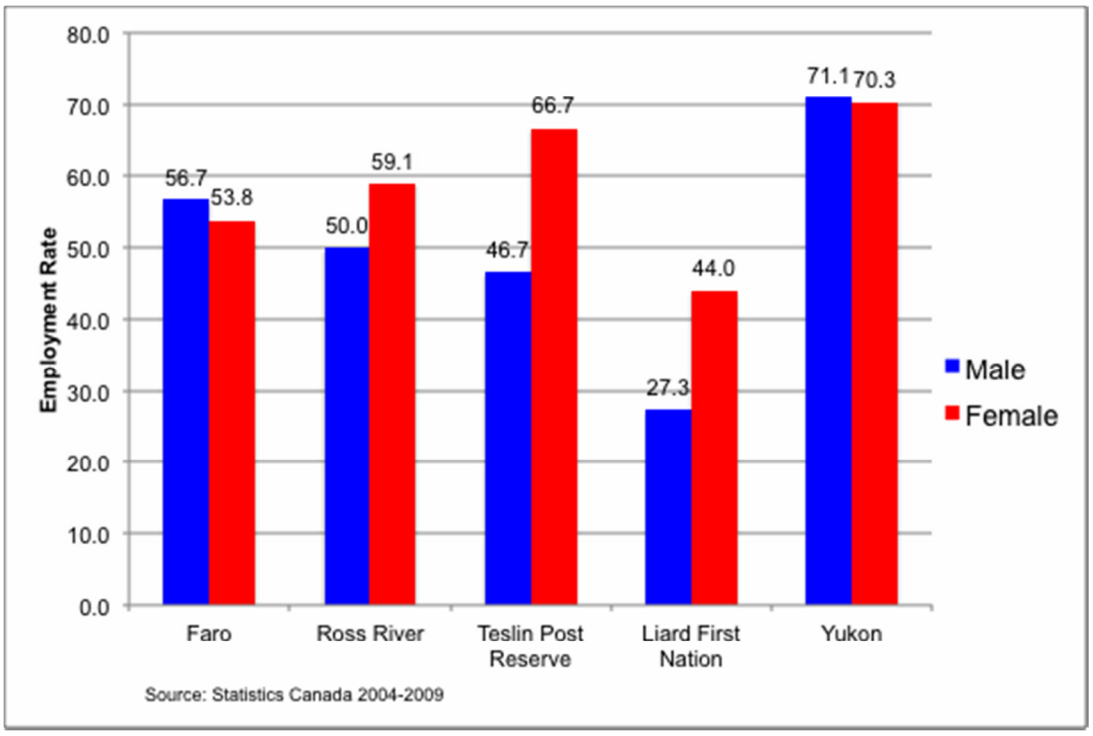


Figure 9.3-11: Male and Female Employment Rates, Affected communities and Yukon (2006)

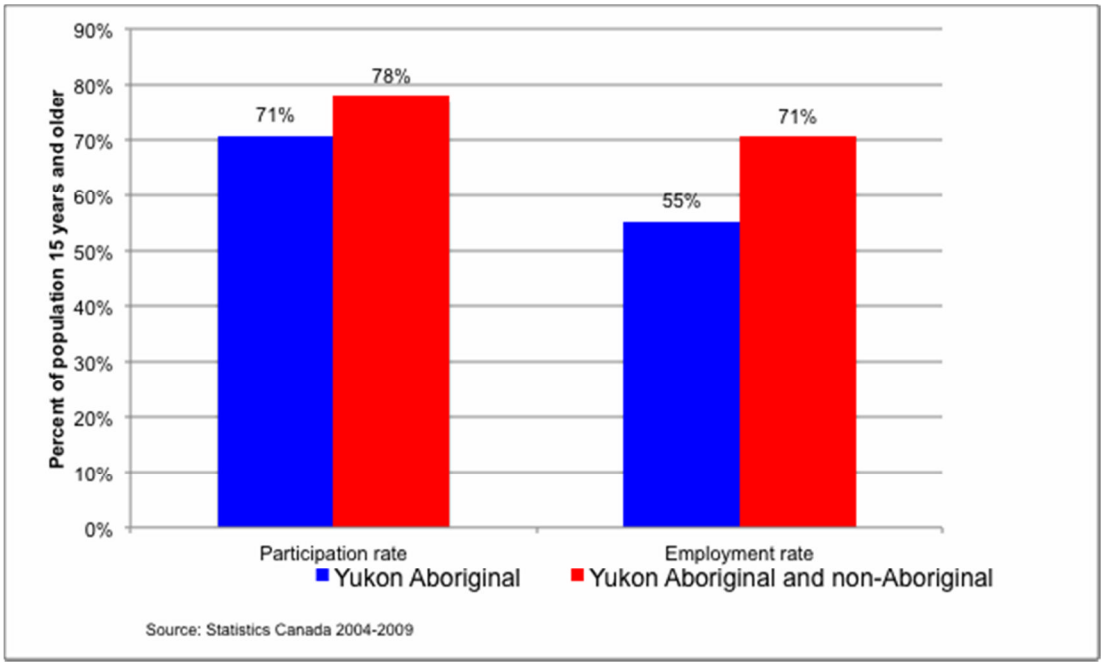


Figure 9.3-12: Labour Force Participation Rates and Employment Rates, Aboriginal and Entire Working Age Population, Yukon (2006)

9.3.3.7 Business Opportunities

There are a number of Ross River and Faro businesses that have the ability to offer goods and services to development KRPs and could benefit from business opportunities arising from the construction and operation of the KRP. The 2010 Yukon Bureau of Statistics' business survey identified 14 businesses in Ross River with 31 employees and 25 in Faro with 43 employees. As well, the development corporations of the two other affected First Nations could also provide goods and services to the mining operation.

The following lists some of the businesses based in Ross River and Faro that offer goods and services potentially applicable to the KRP.

Ross River

- Nezziddi Development Corporation including:
  - Dena General Store (Groceries)
  - Tulidlini Petroleum (Fuel)
- C McLeod Contracting (Heavy Equipment)
- Canol Mobile Welding (Welding)
- Jackfish Lake B&B (accommodation)
- Ross River Service Centre (Groceries, expediting)
- T Moon Construction (Heavy Equipment)
- Canol Hotel (Accommodation, restaurant)

Faro

- Bear's Den B&B (accommodation)
- Blue House B&B (accommodation)
- Coldwell Banker Redwood Realty (Real estate broker)
- Discovery Store (Groceries)
- Faro Real Estate (housing)
- Faro Studio Hotel (accommodation, restaurant)
- Nature Friends B&B (accommodation)
- North Star B&B (accommodation)
- Valley B&B (accommodation)

In addition, the LFN Development Corporation, business and economic development arm of the LFN, has a number of joint ventures. The Tle' Nax T'awei Group is the development art of the TTC and owns and manages a number of businesses mainly in Whitehorse.

9.3.3.8 Government Revenues

Relevant government revenues include municipal property taxes, federal and territorial income taxes paid by residents in each community and indirect taxes collected in each community. The GST is the main indirect tax, but others include federal and territorial excise taxes on fuel, tobacco and alcohol, and royalties on natural resource products. More specifically, Government revenues collected in the affected communities include:

- Municipal taxes collected by the Town of Faro
- Property taxes and grants in lieu collected by the Yukon government in Ross River
- Federal income tax collected by the federal government in Faro and Ross River
- Yukon income tax collected for the Yukon government by the federal government in Faro and Ross River
- Teslin Tlingit income tax collected for the TTC by the federal government, as well as Federal and Territorial income tax
- GST collected on transactions in Faro and Ross River by the federal government.

Table 9.3-4: Town of Faro Property Tax Revenues (2007 – 2010)

Year	Taxes, Including Grants in Lieu
2007	$640,362
2008	$690,568
2009	$644,229
2010	$629,648

Source: Town of Faro 2010, 2011

Table 9.3-5: Net GST Collected, Faro and Ross River (1997 – 2006)

Year	Faro	Ross River
1997	$8,602.82	$20,791.28
1998	$550.57	$41,249.76
1999	$5,355.60	$44,274.39
2000	$4,404.15	$27,547.59
2001	$2,705.86	$23,723.25
2002	$11,761.52	$57,241.82
2003	($828.16)	$35,899.82
2004	$4,840.75	$49,610.33
2005	$5,080.55	$94,007.77
2006	$1,348.46	$85,674.69

Source: Canada Revenue Agency 2007

Table 9.3-6: Federal and Territorial Income Tax Collected, Faro and Ross River (1999 – 2008)

	Faro		Ross River	
Year	Federal Income Tax Collected	Territorial income Tax Collected	Federal Income Tax Collected	Territorial Income Tax Collected
1999	$651,000	$321,000	$406,000	$192,000
2000	$618,000	$299,000	$367,000	$172,000
2001	$749,000	$342,000	$413,000	$186,000
2002	$684,000	$296,000	$303,000	$129,000
2003	$774,000	$337,000	$343,000	$149,000
2004	$920,000	$402,000	$388,000	$163,000
2005	$867,000	$401,000	$375,000	$173,000
2006	$963,000	$434,000	$511,000	$229,000
2007	$946,000	$429,000	$548,000	$255,000
2008	$1,099,000	$503,000	$621,000	$281,000

Source: Canada Revenue Agency 2000-2007

9.3.4 Baseline: Human Health and Well-Being

9.3.4.1 Individual Health

There are no health data available at the community level. Morbidity and mortality rates are published for the Yukon only. However, the Yukon Bureau of Statistics republishes health indicators drawn from Statistics Canada's Canadian Health Survey. To the extent the affected communities are similar to the Yukon as a whole; the selected Yukon-wide indicators shown in Table 9.3-7 may provide a reasonable proxy for individual health in the affected communities.

Table 9.3-7: Selected Health Indicators, Yukon (2007 – 2010)

	2007	2008	2009	2010
Perceived very good or excellent health (%)	55.8	61.6	60.8	57.8
Perceived high life stress (%)	20.9	21.4	19.9	17.4
Overweight or obese (%)	52.3	49.5	51.1	47.1
Diabetes (%)	5.3	2.3	4.2	5.4
High blood pressure (%)	15.7	10.8	14.1	12.1
Regular medical doctor (%)	76.7	76.9	77	76.8
Sense of community belonging (%)	71	72.7	71.1	81.1
Life satisfaction; satisfied or very satisfied (%)	91.3	89.2	90.6	93.4

Source: Statistics Canada 2011b.

9.3.4.2 Family Stress

Indicators of family stress could include the percentage of the population that is divorced or separated (Figure 9.3-13).

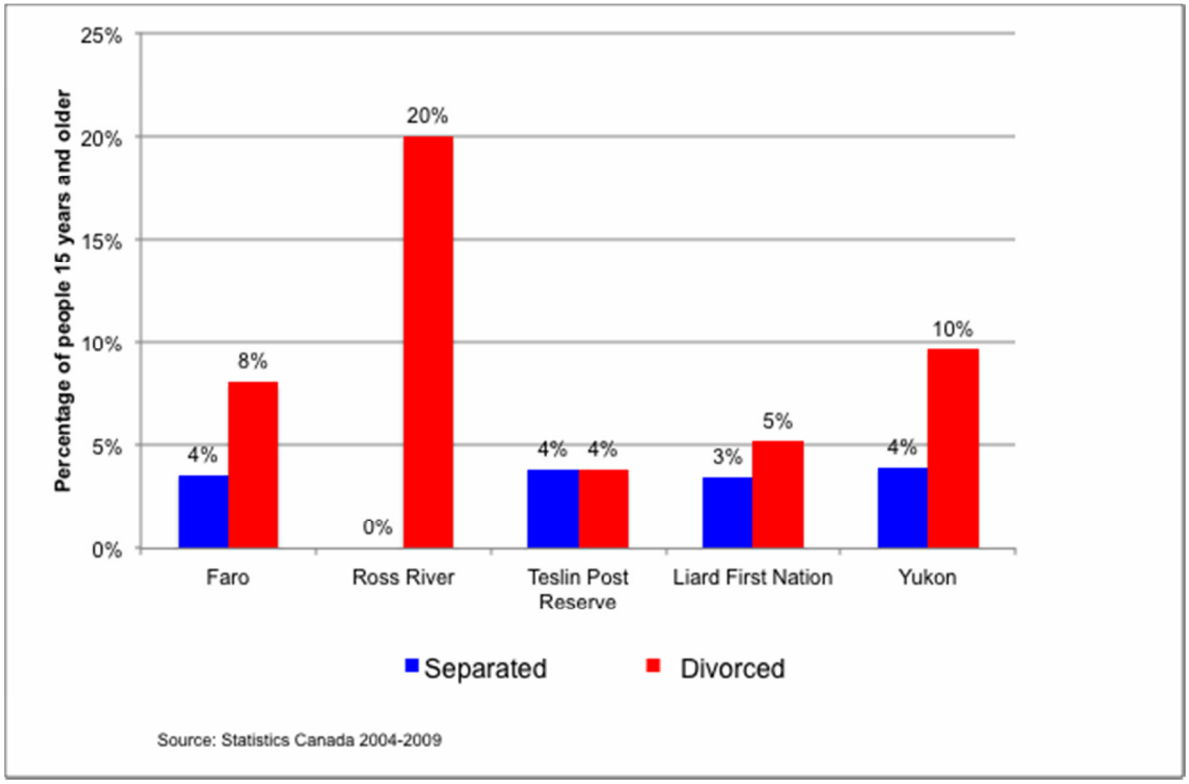


Figure 9.3-13: Percentage of Divorced and Separated People 15+ years of age, Affected communities and Yukon (2006)

9.3.4.3 Reducing Alcohol and Drug Abuse

Ideally, indicators for alcohol and drug use will be consumption per capita, but such data are not available. Indirect indicators include drug-related and alcohol-related crime statistics and alcohol sales per capita. Note that the relevant crime statistics are somewhat dated as the latest available are for 1995 through 2003. Figure 9.3-14 presents the average annual number of drug-related criminal incidents and criminal code traffic incidents, the bulk of which are impaired driving charges.

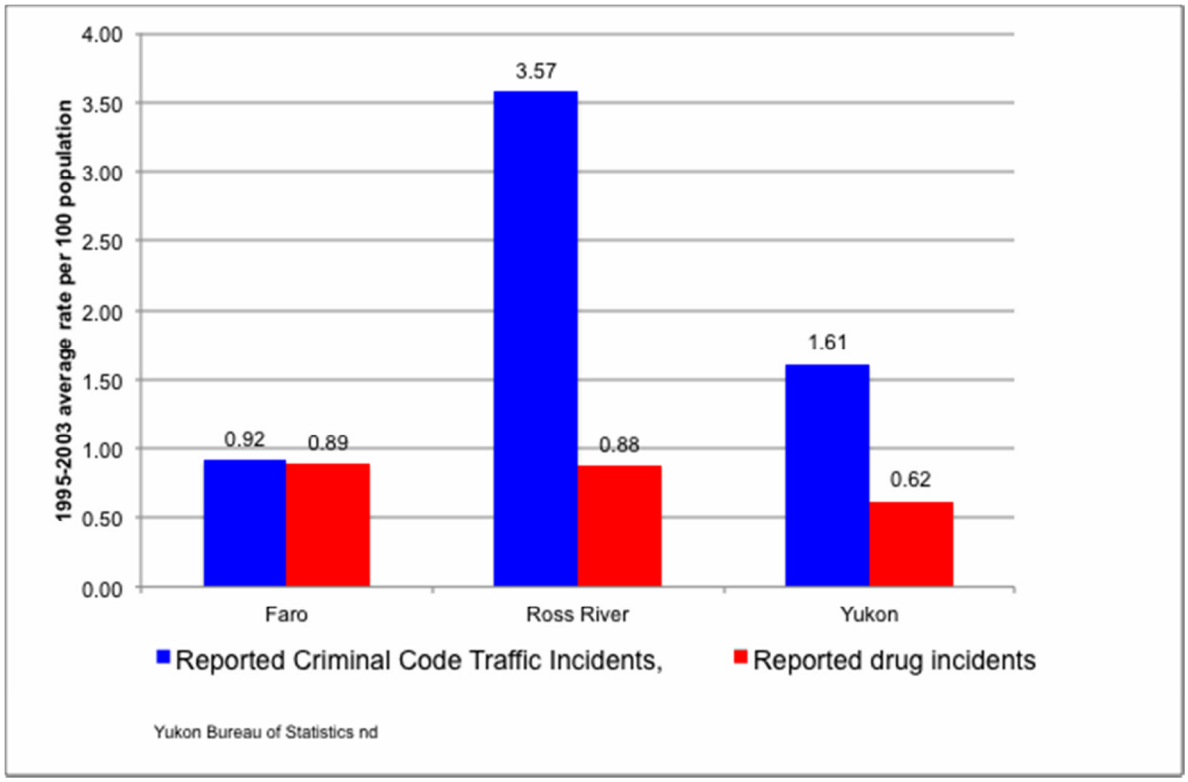


Figure 9.3-14: Average annual number of drug and traffic related criminal incidents, Faro and Ross River (1995 – 2003)

Yukoners buy more alcohol and spend more on it than residents of any other province or territory according to data from Statistics Canada. Table 9.3-8 shows volume of alcohol sold by type and total spending on alcohol by people aged 15 years or older in Canada and the Yukon in 2007.

Table 9.3-8: Litres of Alcohol Sold and Spending on Alcohol, Canada and Yukon (2010)

	Canada	Yukon
Litres of spirits sold per capita aged 15+ years	7.5	15.1
Litres of wine sold per capita aged 15+ years	16.2	21.0
Litres of beer sold per capita aged 15+ years	83.6	143
Spending on alcohol per capita aged 15+ years	$709	$1,272

Source: Statistics Canada 2011c.

Table 9.3-9: Litres of Alcohol Sold and Spending on Alcohol, Faro (2010)

Litres of spirits sold at Faro liquor store	9,900
Litres of wine sold at Faro liquor store	2,900
Litres of beer sold at Faro liquor store	73,700
Value of sales at Faro liquor store	$545,000

***Note:** Annual sales are calculated from April 1, 2009 to March 31, 2010

Source: Yukon Liquor Corporation 2010

Finally, the Canadian health survey provides data on people who are heavy drinkers. Figure 9.3-15 presents the population aged 12 and over who reported having 5 or more drinks on one occasion, at least once a month.

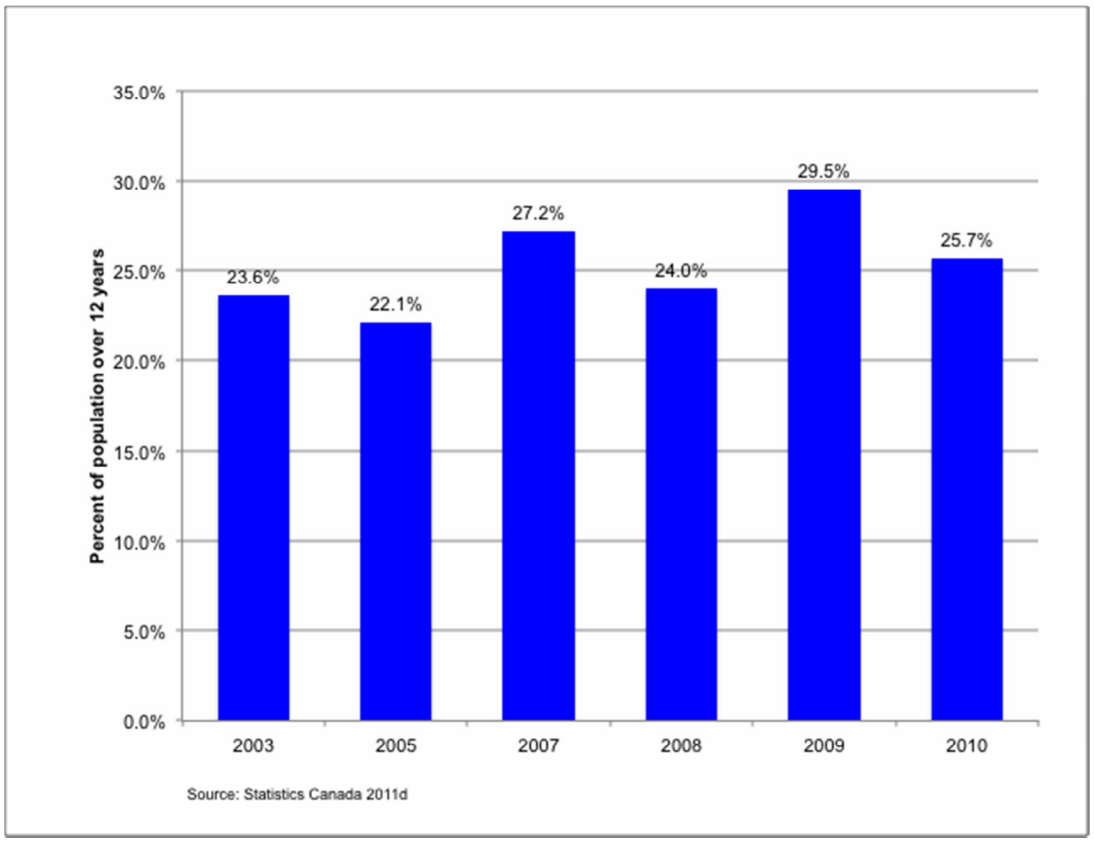


Figure 9.3-15: Percentage of Yukoners 12+ years Reporting having 5 or more drinks on one occasion, at least once a month

9.3.4.4 Gathering Traditional Medicine

This information forms part of the confidential Traditional Knowledge of the RRDC and, as per the *Traditional Knowledge Protocol* between RRDC and KRH, cannot be revealed or presented.

9.3.4.5 Public Health and Safety – Increased Traffic, Hazardous Material Transport

The major highway that will serve the KRP is the 583 km long Robert Campbell Highway that stretches from Watson Lake on the Alaska Highway to Carmacks on the Klondike Highway. The average daily traffic counts for locations on the Robert Campbell Highway most likely to see the effects of any increased traffic caused by the KRP are shown in Table 9.3-10.

Table 9.3-10: Traffic Counts, Selected Locations, Robert Campbell Highway

Location	Time frame	Average Daily Traffic Count
KM 355.2 Robert Campbell Highway (Jack Fish Lake Road, South Canol Intersection)	1996 to 2008 (May to Oct)	125
Km 364.4 Robert Campbell Highway (Lapie River Bridge West of Ross River)	1989 to 2008 (May to Oct)	92
Km 469 Robert Campbell Highway (Drury Creek)	2008 to 2009 (Year round)	88
Km 110 Robert Campbell Highway (Tuchitua Maintenance Camp)	1997 to 2009 (Year round)	69

Source: Yukon Highways and Public Works 2010

9.3.4.6 Workplace Health and Safety

The Yukon Workers' Compensation Health and Safety Board does not currently publish data by industry on the rate of injury reports or on days lost per injury. This is primarily due to the small number of firms operating in most industries causing issues with confidentiality.

Health and safety data from mining in BC can be used as a proxy for the Yukon as regulations and standards are quite similar. For the period of April 2007 through March 2008, there were 2.3 injury reports per 100 person-years of employment in BC mines including: underground and open pit metal and coal mines, and quarries (BC EMPR 2009). WorkSafeBC (2010), the provincial workers' compensation board, reports that injured workers in the mining and petroleum industries are off work for an average of 70 days per injury report in 2009.

9.3.5 Baseline: Community Vitality

9.3.5.1 Population – Number of Children

Figure 9.3-16 shows the population of Ross River and Faro compared to Yukon's over the 20 year period from 1991 to 2010.

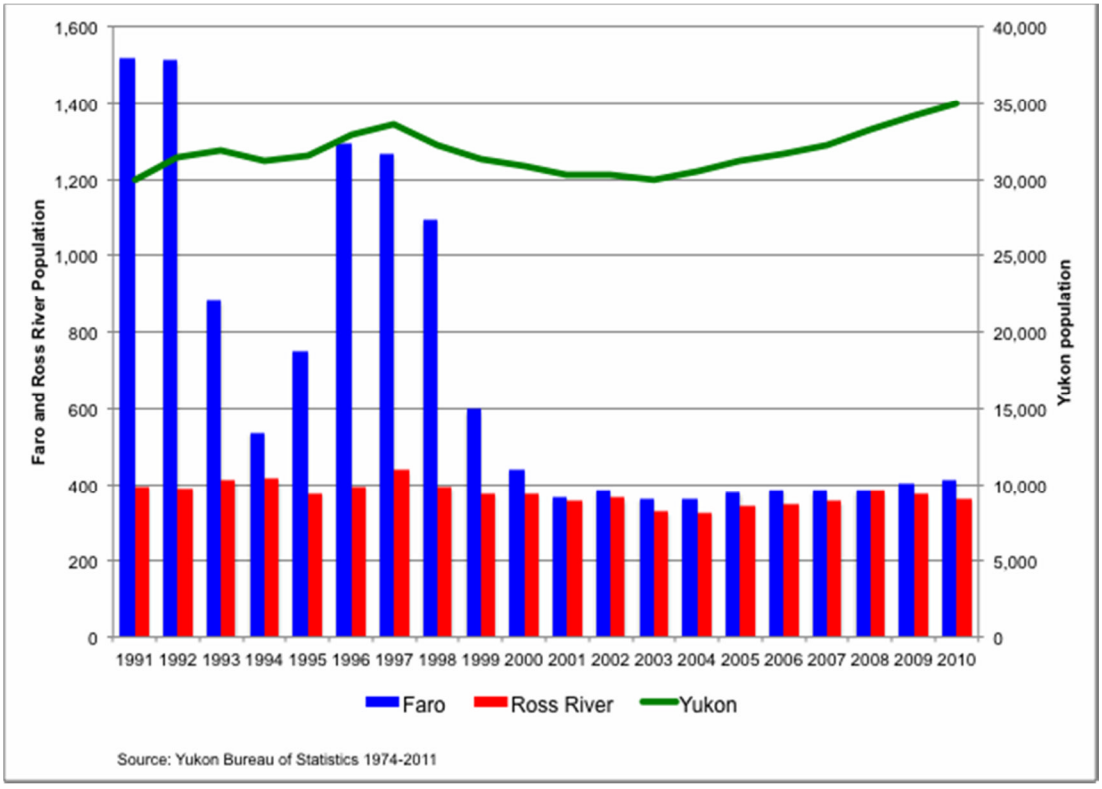


Figure 9.3-16: Population of Faro, Ross River and Yukon (1991 – 2010)

The Yukon Bureau of Statistics provides data on population age groups in Yukon communities for December of each year, except for the last year where the latest data is for June 2010. Figure 9.3-17 shows Ross River and Faro population of young people, aged zero through 24 years, for December 2006 through December 2009 and June 2010.

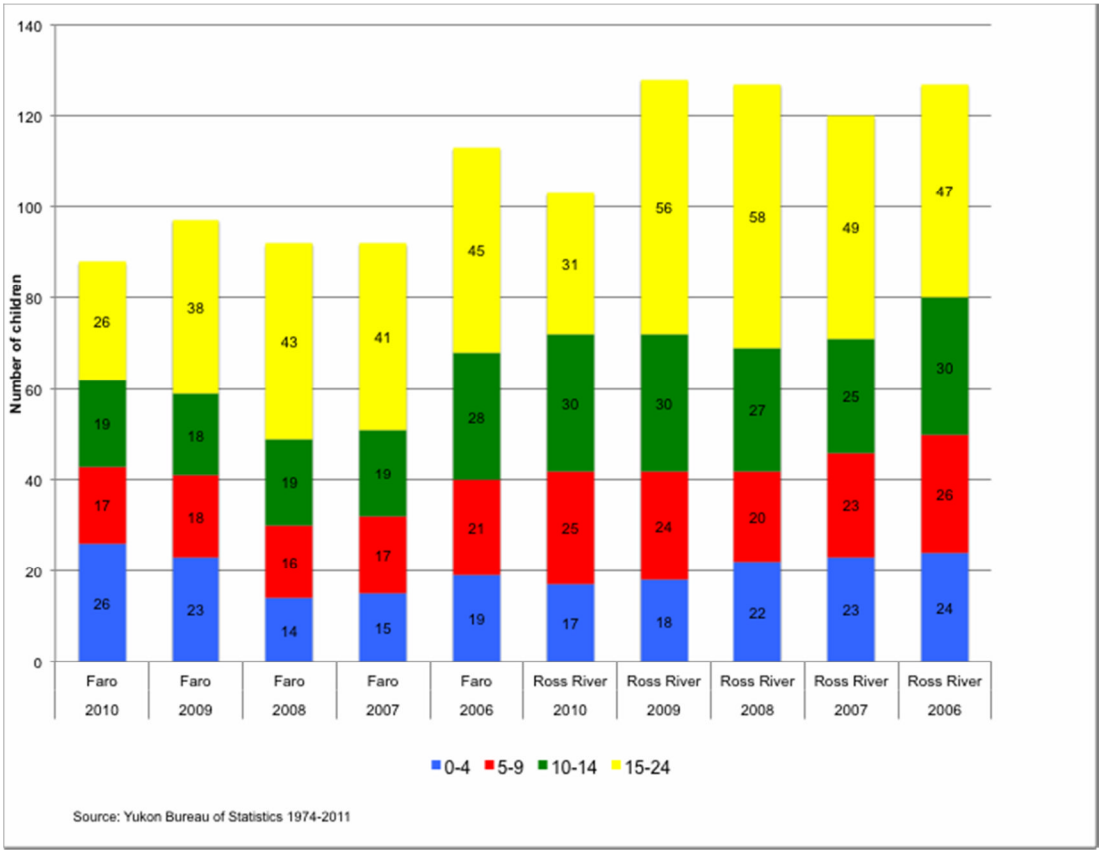


Figure 9.3-17: Population of People Aged 0-24 Years in Faro and Ross River (2006 – 2010)

A good indicator for the number of children in the community is the data on enrolment in the schools as provided by the Yukon's Department of Education. School enrolment in Faro and Ross River is shown in Table 9.3-11.

Table 9.3-11: School Enrolment, Faro and Ross River (2004 – 2010)

	Del Van Gorder School (K through Grade 12) (# Students)	Ross River School (K through Grade 10) (# Students)
June 2004	53	67
June 2005	53	73
June 2006	51	73
June 2007	51	64
June 2008	44	67
June 2009	44	63
June 2010	42	62

Source: Yukon Bureau of Statistics 2011a

9.3.5.2 Healthy Local Business Sector — Reducing the Cost of Living

A healthy business sector not only provides economic benefits, it strengthens the community by providing more services, potentially reducing the cost of living in the community, and reducing the need for community members to work elsewhere.

The Yukon Bureau of Statistics conducts a business survey which contains data on the number of businesses found in each community and how many people these businesses employ. Figure 9.3-12 shows the results of the 2006 to 2010 business survey for Faro and Ross River.

Table 9.3-12: Number of Businesses and Employees (2008 – 2010)

Community	Year	Number of Businesses	Number of Employees	Average Number of Employees
Faro	2006	33	62	1.9
	2007	30	72	2.4
	2008	33	49	1.5
	2009	n/a		
	2010	25	43	1.7
Ross River	2006	11	24	2.2
	2007	12	57	4.8
	2008	12	36	3.0
	2009	n/a		
	2010	14	31	2.2

Source: YBS 2006, 2007, 2008, 2011f

Another indicator for Faro is the number of business licences issued by the Town annually as shown in Table 9.3-13. Note that the numbers do not exactly match the numbers of businesses found by the Yukon Bureau of Statistics survey. The discrepancy is likely due to the voluntary nature of the survey.

Table 9.3-13: Number of Faro Business Licenses (2005 – 2009)

Year	Number of Licences
2005	56
2006	39
2007	38
2008	40
2009	43

Source: Town of Faro 2010, 2009

A healthy business sector in a small community can help reduce the cost of living or more specifically, the differential in cost of living between the community and a larger centre. Table 9.3-14 the spatial price index (i.e., the relative cost of goods and services) for Faro compared to Whitehorse for a number of staples.

Table 9.3-14: Faro Spatial Price Index* (2005 – 2009)

	2005	2006	2007	2008	2009
Total Survey Items	107.7	116.7	113.4	118.9	119.9
Meat	88.0	107.1	..	152.2	123.1
Dairy/Eggs	111.5	104.8	126.3	108.1	114.6
Fruit/Vegetables	124.0	121.2	149.1	128.3	144.0
Bread/Cereal	106.3	115.9	116.5	106.2	107.4
Other Foods	112.7	140.0	100.6	122.6	138.4
Household Operations	106.3	119.5	103.2	104.2	102.7
Health and Personal Care	107.5	..	..	..	163.1
Gasoline	110.6	111.1	..	..	..
Cigarettes	102.2	106.9	103.8	103.3	101.5

Note: *Whitehorse = 100.0

Source: Yukon Bureau of Statistics 2010

9.3.5.3 Reducing Crime

Figure 9.3-18 shows the overall crime rate in Faro and Ross River compared to the Yukon for 2003 through 2009.

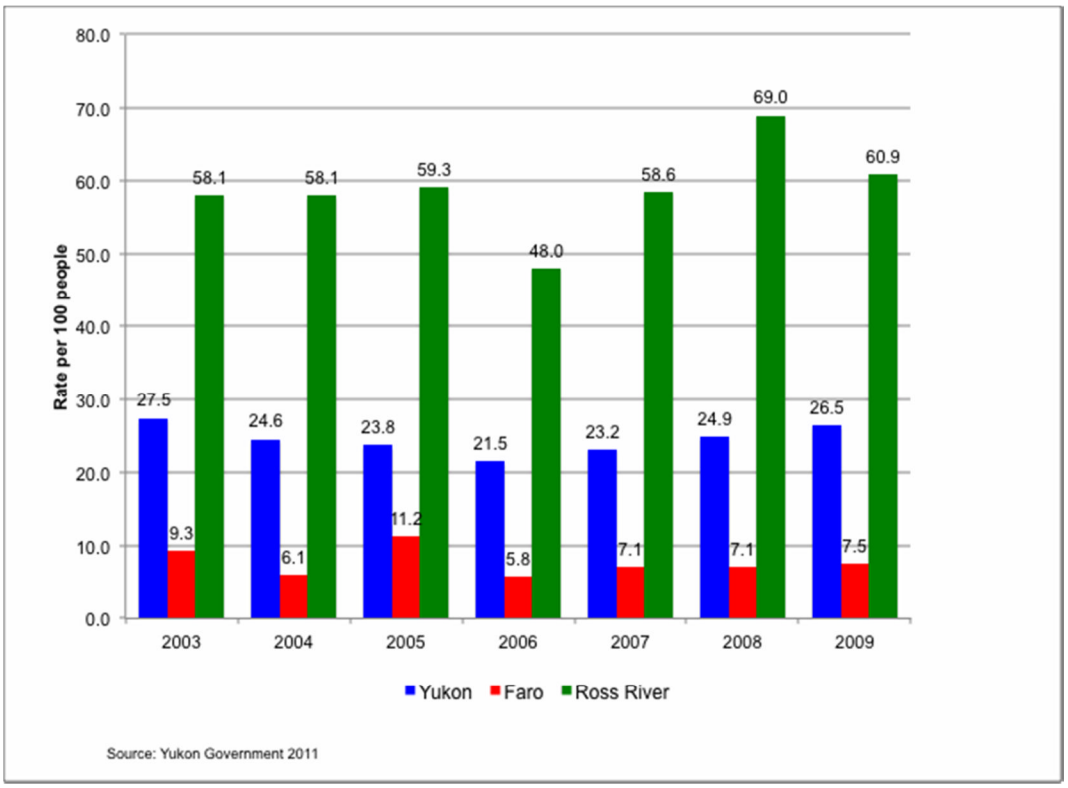


Figure 9.3-18: All Reported Criminal Code Violations per 100 inhabitants. Faro, Ross River and Yukon (2003 – 2009)

9.3.5.4 Reducing Discrimination and Racism

Discrimination and racism are difficult to quantify. There is some economic literature that uses income differences between ethnic groups as a proxy for quantifying the economic effects of discrimination and racism.

The best means to analyze earnings differentials is to estimate an earnings function on large-scale databases of individual incomes and characteristics. An earnings function is a regression equation with a minimum of age, sex, and education as explanatory variables for the logarithm of earnings.

The earnings function technique has been mainly used to explore male/female wage and income differentials, but it has also been used to examine racial income differences in the United States. Any unexplained difference is usually ascribed to "discrimination" or "privilege".

Despite the large literature on racial income differences in the US, we know of only three published studies done on aboriginal/non-aboriginal differences in Canada. All three studies examine the effect of readily measurable characteristics such as sex, education, and location. The first, published in 1994, based on 1986 Census data (1985 income), found an unexplained wage gap of aboriginal Canadians working full time, full year earning about 11% less than non-aboriginal Canadians (George and Kuhn1994).

Pendakur and Pendakur (1998) examined total wage earnings rather than wage rates using 1990 income data from the 1991 Census. They found a gap of 12.5% between aboriginal men and Canadian-born white men, and a gap of 9.9% with the overall male average. This study excluded the Atlantic provinces and the territories because the small number of cases in the Census Public Use database made statistically meaningful comparisons questionable. A third study by Bernier (1997) confirmed the findings of George and Kuhn (1994), and of Pendakur and Pendakur (1998).

Simple income differentials are not necessarily evidence of discrimination; other factors need to be accounted for such as age, education, location, attachment to the labour force. These are complicated in that they can also be affected by discrimination (e.g., because they are discriminated against, certain groups such as First Nations get smaller rewards from education resulting in reduced incentive for getting higher education).

Data on aboriginal versus non-aboriginal incomes for Ross River or Faro in the Census are not available as the small population makes confidentiality a concern. For Yukon, though, aboriginal people over 15 years had a median income of $20,690 in 2005 according to Census 2006, while the median income for all Yukoners over 15 years was $31,352 or 51.5% higher. (Statistics Canada 2011e)

9.3.5.5 Political Structure, Leadership and Capacity

Of the three affected First Nations, only the TTC have self-government. The RRDC and the LFN are still Indian Act bands as they have not signed a land claims agreement or a self government agreement.

Ross River is the home community of the RRDC, a Kaska First Nation that has not agreed to a land claim or self-government under the Umbrella Final Agreement but sees itself as exerting its authority over its traditional territory. Ross River has no municipal government.

Watson Lake, and several smaller communities around it is the home community of the LFN. The LFN is a Kaska First Nation that, like the RRDC, has not agreed to a land claim or self-government under the UFA but sees itself as exerting its authority over its traditional territory, which has the same boundaries as the RRDC.

There is no municipal structure in Ross River, although a desire to develop one has been expressed for many years. Faro is an incorporated community with a municipal government; it is recognized as a Town under the Yukon Municipal Act.

9.3.5.6 Community Events and Volunteerism

Community life in small communities depends heavily on volunteers and volunteer organizations. There is no data available on the number of volunteers or volunteer hours worked in the communities, but a list of some of the volunteer driven organizations in Faro and Ross River is given below.

Volunteer organizations in Faro include:

- Volunteer fire, ambulance and search and rescue organizations
- School, college and library boards
- Faro Arts and Recreation Association
- Anvil Range Arts Society

- Faro Golf Club
- Entrepreneurship Society
- Canadian Rangers.

Volunteer organizations in Ross River include:

- Volunteer fire, ambulance and search and rescue organizations
- School, college and library boards
- Sportsman Club
- Canadian Rangers.

Annual events held in Faro include:

- Sheep and Crane Viewing Festival
- Canada Day Celebration
- Faro Open Golf Tournament
- Mini Arts Festival and Wild Game BBQ
- Yukon 360 Canoe Race
- Fireweed Festival
- Ice Worm Squirm.

There are many social and community events held in Ross River. It will be difficult to even begin to count them as, for example, most community consultations include a meal and become a social event. However, two major annual events in Ross River are the Canada Day celebrations and the week-long Cultural Exchange held at Coffee Lake.

As well, the two communities collaborated in building the Dena Ch'o trail on the north side of the Pelly River in 2007.

9.3.5.7 Recreational Facilities and Opportunities

Faro has a well equipped recreation centre that includes:

- Full-sized gym with stage and stocked equipment room
- 15 metre seasonal swimming pool
- Full-sized indoor hockey rink with ice making capacity
- Youth lounge
- Squash court
- Weight room
- Multi-purpose room with kitchen.

The recreation centre also has a four-sheet curling rink that is not currently being used. Faro also boasts an unusual 9-hole golf course that winds its way through the center of the community.

Ross River has far fewer recreation facilities, with a hockey rink that lacks ice making capacity which recently burned down, a small covered swimming pool, and a baseball field.

9.3.6 Baseline: Infrastructure and Services

9.3.6.1 Housing and Land Availability

The census counts both the total number of dwellings in a community and the total number that are occupied. Table 9.3-15 shows that data for Faro and Ross River for May 2006 when the Census was carried out. There were a large number of unoccupied dwellings in Faro, the result of past mining activity and subsequent mine closures. Those dwellings were mainly owned by Faro Real Estate Ltd.

Table 9.3-15: Dwellings and Occupied Dwellings, Faro and Ross River (2006)

	Total Dwellings	Total Occupied Private Dwellings
Faro	463	149
Ross River	175	128

Source: Statistics Canada 2004-2009

One of the YG's Land Services Branch's responsibilities is the development of Crown land in or near Yukon communities in order to maintain a supply of building lots adequate to meet the demand for lots. The Land Services Branch is normally the only source of new building lots in most Yukon communities as there is little or no privately owned land that can be subdivided and developed. As of July 6, 2011 there were no lots available for sale in either Faro or Ross River through the Land Services Branch (YG EMR 2011)

A search of an assortment of real estate websites in June 2011 found no houses for sale in Ross River. The Town of Faro's website showed a total of six homes for sale in July 2011 but that does not include any of the housing stock still owned by Faro Real Estate Ltd. (Town of Faro 2004).

No data is published on rental costs or housing prices. The 2006 Census has an estimate of the value of owned dwellings:

Table 9.3-16: Average Dwelling Value, Faro and Ross River (2006)

Community	Average Dwelling Value
Ross River	$98,652
Faro	$64,755

Source: Statistics Canada 2004-2009

9.3.6.2 Transportation Infrastructure — Roads and Airports

The major highway that will serve the KRP is the 583 Km Campbell Highway that stretches from Watson Lake on the Alaska Highway to Carmacks on the Klondike Highway. That highway is maintained by the Department of Highways and Public Works

The Yukon Department of Highways and Public Works also maintains the different airports and aerodromes in the Yukon.

Table 9.3-17: Yukon Government Airports/Aerodromes

Aerodrome	Maintenance	Runway Size	Runway Surface	CARS	Terminal Building
Faro Airport	Year Round	4,000' x 100'	Gravel	Yes	Yes
Ross River	Year Round	5,113' x 100'	Gravel	No	Yes
Watson Lake Airport	Year Round	5,500' x 150'	Asphalt	Yes	Yes
Whitehorse International Airport*]	Year Round	9,497' x 150'	Asphalt	FFS/ATS	Yes

Source: YG Department of Highways and Public Works 2011

As well, there is a helicopter base (Trans North Helicopters) at the Ross River Airport.

9.3.6.3 Municipal Services — Water, Sewer, Solid Waste

The Town of Faro operates a piped water system that relies on three groundwater wells. Some parts of the water system have been shut down where there are no occupied residences. According to the Town of Faro's ICSP, the water system is deteriorating and has persistent leakage problems (Faro 2007). The Town has been working on replacing the worst of the old pipes which consist of a mix of asbestos/concrete, steel/iron, and polyethylene.

Faro also operates a municipal piped sewage system with a multi-cell lagoon that provides secondary treatment. Because the community has had far fewer residents than the system was designed for, the lagoon has not had a discharge into the Pelly River for 15 years. Like the water system, the sewage pipes are a mixture of types and have deteriorated since their installation.

According to the 2009 Yukon Comprehensive Solid Waste Study, the Town of Faro operates a no-burn landfill that accepts approximately 180 tonnes/year of waste of all kinds with an estimated 60 tonnes/year diverted through the recycling efforts of various kinds (EBA 2009b).

Because Faro relies on accessing a wide assortment of different funds for specific municipal infrastructure KRPs such as pipe replacement, the proportion of the municipal budget that is devoted to operations and maintenance is not a particularly useful indicator.

Ross River depends on trucked water supply from a community well and either on septic systems or individual holding tans for sewage disposal. There is a primary treatment lagoon. Problems have occurred with the water supply and residents are leery of using the trucked water.

9.3.6.4 Healthcare Services

The HSC staffs and maintains community health centres in Faro, Ross River and Pelly Crossing. Community Nurse Practitioners, in the absence of a physician, provide daily clinics for medical treatment, community health programs, and 24-hour emergency services. Clients requiring more specialized care are referred to a hospital.

The YG is currently planning to replace the existing Watson Lake hospital with a new regional hospital in the community that will also serve other communities in the region.

9.3.6.5 Police Services

The RCMP staffs and maintains detachments in Faro and Ross River.

9.3.6.6 Child Care

As of July 2011, based on data published by the HSC, there is one licensed daycare in Ross River approved for 30 children. There are no licensed day homes in either Faro or Ross River and no licensed daycare in Faro (HSC 2011).

9.3.7 Baseline: Culture, History and Heritage

9.3.7.1 Language Preservation and Restoration

There is no community-level data on Kaska or Tlingit speakers. However, the 2006 Census does provide some Yukon-wide data on aboriginal speakers of aboriginal languages as summarized in Table 9.3-18.

Table 9.3-18: Aboriginal Languages in the Yukon (2006)

	Percent of Aboriginal Respondents
Aboriginal language as mother tongue	11.7%
Aboriginal language as primary language in the home	2.0%
Knowledge of aboriginal language	16.4%

Source: Statistics Canada 2011f

The RRDC and the LFN both promote and encourage the learning and use of the Kaska language. The Johnson Elementary School in Watson Lake, the Watson Lake High School, and the Ross River School all offer Kaska language school programs. Two Kaska language teachers work in the Ross River School while five teach in the two Watson Lake schools. The Yukon Native Language Centre offers teaching materials in Kaska and the Kaska Tribal Council published a noun dictionary in 1997.

9.3.7.2 Traditional Knowledge and Practice Preservation and Restoration

This information forms part of the confidential Traditional Knowledge of the RRDC and, as per the *Traditional Knowledge Protocol* between RRDC and KRH, cannot be revealed or presented.

9.3.7.3 Heritage and Historic Sites

This information forms part of the confidential Traditional Knowledge of the RRDC and, as per the *Traditional Knowledge Protocol* between RRDC and KRH, cannot be revealed or presented. Additional information from the heritage overview assessments are provided in Section 8.11.

9.4 Socio-economic Effects Assessment

In the sections below we:

- Characterize and assess the potential effects that the KRP will have on the identified VESECs
- Lay out mitigation measures for negative effects or enhancement measures for positive effects
- Describe the rationale and methods used to characterize and assess effects and identify mitigation and enhancement measures.

The anticipated effects of the KRP are grouped into the five clusters of VESECs, as first described in Section 9.2.2. Where VESECs overlap among the identified interests, the potential effect to each of those interests is characterized. For each VESEC, mitigation or enhancement measures planned by KRH to maximize the social and economic benefit of the KRP and minimize social and economic costs are described. Where applicable, the effects are identified according to the primary KRP phases (i.e., construction, operation, and closure/reclamation) that they may occur in.

9.4.1 Project Effects: Economy and Sustainable Livelihood

The following subsections describe the potential Project effects on the Economy and Sustainable Livelihood VESEC subcomponents.

9.4.1.1 Traditional Economic Activities – Hunting, Fishing, Trapping, Food Gathering

Traditional economic activities are of particular importance to the RRDC, the LFN, the TTC, the traditional land stewards of the area, and the Ross River group trappers. YG Department of 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 KRP is likely to have a number of effects on traditional economic activities, particularly hunting and trapping. Potential effects include:

- Improved access to an area through improved maintenance of existing roads (e.g., Ketza Road) can make pursing traditional economic activities, such as hunting, easier for local people, both First Nation and non-First Nation
- 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
- Increased traffic and industrial activity in the region may act to drive wildlife away from the immediate site and along the road corridors to the KRP
- Access through the site itself to areas beyond it will be limited for safety reasons
- 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 KRP is not expected to have any significant effect on YG 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. Although we do not have access to the harvest data for the region around the mine or for the Ross River group trapline (RTC 405) as a whole, other trapping harvest data shows a pattern of wide annual variations in harvest levels. The variation in harvest 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 including the traditional management practice of ceasing trapping in an area for a number of years to allow populations to recover.

Mitigation Measures:

- KRH will have a strictly enforced policy forbidding employees to bring firearms or other weapons into camp and will have a no hunting rule for employees while they are staying in camp. This, combined with employees being bussed in to camp, will ensure that no employees will be hunting in the region during their rotations.
- KRH will strictly enforce a no hunting policy by anyone on the Site itself for safety reasons. Company experience at its Jerritt Canyon mine in Nevada is that the wider site (RSA) can become a refuge for animals because of the hunting ban.
- Access through the mine site will be controlled for safety reasons.
- KRH plans a standard 2-week in, 2-week out rotation for all employees. The two week period of time off will likely provide sufficient time for First Nation employees to pursue traditional economic activities.
- KRH, through its MOU with the RRDC, will use existing mechanisms to compensate the Ross River trappers for loss of access due to the company's activities once the MOU is signed.

9.4.1.2 Economic Growth

The Project's broad effect on the Yukon's economy can be measured by the gross value of its anticipated output. The planned mine life is five years with a planned annual production of 60,000 ounces of gold and 60,000 ounces of silver.

Predicting the price of metals is always a very uncertain business. The YG economic forecasts rely on the TD Economics Group for metal price forecasts; however, these currently extend only to the end of 2012. For the purposes of estimating the KRP's effect on the Yukon's GDP the TD Economics Group's average price over the five year period 2008 through 2012 was used (with 2011 and 2012 prices being forecasts and 2008 through 2010 being actual prices) (TD Economics 2011).

At an average gold price of $1,185 per ounce the annual gross value of 60,000 ounces of production will be $71.1 million. At an average silver price of $19.94 per ounce, the annual gross value of 60,000 ounces of production will be $1.2 million for a total gross value of $72.3 million.

In 2009 the Yukon's GDP at current prices was $2.03 billion. Statistics Canada's 2007 Input-Output model for the Yukon (the latest available) gives a multiplier of 0.80 for calculating the combined direct and indirect impact of metal mining on the Yukon's GDP. The KRP's average annual gross production value of $72.3 million translates into an annual impact of $57.8 million on the Yukon's GDP. The KRP can therefore be expected to increase the size of the economy by a significant 2.8%.

There will also be a one-time injection of funds to construct the mine that will have an effect on the territorial economy. The total capital cost estimate for the KRP is $68.8 million. Using the 0.80 multiplier for metal mining, this spending will translate into a $36.7 million annual impact on the Yukon's economy over the 18 month construction period.

No data is kept on the size of community economies. However, we use total declared income data from Revenue Canada as a proxy for the size of a community's money economy. We can therefore calculate the effect of increased incomes of community residents on that community's money economy as shown in Table 9.4-1.

Table 9.4-1: Annual Increase in Community Incomes, Operations Phase

	2008 Total Declared Income	Estimated No. of Employees	Average Additional Income Per Employee	Additional Income in Community	Percent Effect
Ross River	$6,520,000	10	$37,750	$377,500	5.8%
Faro	$10,344,000	10	$75,500	$755,000	7.3%
Watson Lake	$31,103,000	15	$37,750	$566,250	1.8%
Teslin	$11,703,000	5	$37,750	$188,750	1.6%

Some points on the estimates shown in Table 9.4-1:

- Data from the 2005 tax year is the latest available from Revenue Canada
- The number of employees by community is based on estimates developed in Section 9.4.1.4
- Average additional income per employee is based on the $75,500 average across all categories of employee during the operations phase
- Additional income for Faro-based employees is the entire $75,500 because it is assumed that all 10 of the Faro employees relocated to the community due to the efforts of the Town and KRH to encourage employees to relocate. New residents' full incomes will be net new community income.
- Because of the higher rates of unemployment and under employment in the other communities and the overall lack of available housing, it is assumed that most or all of KRH employees will already be resident in the community. Additional income for other community employees is set at half of the $75,500 to avoid the implicit assumption that all of them had zero income before going to work for KRH.

9.4.1.3 Diverse and Stable Economy – Discouraging 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 production when the ore is gone. However, the construction and operation of a mine can be designed to extend its life and therefore extending the period over which economic benefits flow to local communities.

As already noted, the construction of the KRP is scheduled to be complete in 18 months. This short construction period is due to much of the infrastructure (e.g., the access road, the existing mill building) being in place. It is not financially or logistically feasible to extend the construction phase in order to provide longer-term economic benefits

The currently delineated ore reserves allow for the planned five years of operations with 1, 500 tpd through-put at the mill. Significantly reducing the through-put in order to extend the mine life and provide longer-term economic benefits will mean significantly reducing the rate of return on investment as many of the fixed costs needed to get the mine operational cannot be reduced in proportion to the through-put reduction. Because the fixed costs are high in proportion to the overall value of the ore, extending the mine life of a relatively small ore body by reducing the mining rate is not financially feasible.

However, mines frequently add to their reserves through new discoveries as they mine and so extend the mine life even as they deplete the resource. Like most mining companies, KRH is optimistic that economically viable new deposits will be delineated on the property once mining begins.

Mitigation Measure:

- KRH will continue to explore the property and nearby properties (e.g., Silver Valley) to delineate further ore reserves and extend the mine life.

9.4.1.4 Employment

Employment is often seen as the single most important potential benefit of mining development, especially at the community level. However, there is now no need for people to live relatively near their place of work in the mining industry. 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 of Canada and are not constrained by small 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 her which northern mine she works 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.

In the 18-month construction phase of the Project, KRH plans to use its equipment and 75 employees to develop the open pits and do other related work. The number of contract employees is not yet known.

The general form the labour required for the construction of the KRP will be:

- Heavy civil construction
- Civil construction
- Structural construction
- Mechanical construction
- Electrical construction
- General and administrative
- Camp services.

It has been estimated that 19 out of the 75 KRH employees (25%) expected to work on KRP construction will be Yukon residents based on the data available from the Cantung mine. A further assumption is that Yukon residents will get an additional 75 person-years of the contract employment created during the 18 month period of construction given that approximately 20% of the Yukon's work force works in occupations that will make up the bulk of the work including the trades, transport and equipment operators.

KRH will require a total of 230 of its own employees to operate the KRP. In addition, a contractor will require approximately 40 employees to mine the underground portions of the KRP. KRH may also look to contracting out food and security services, which will reduce its employee numbers by 14 while the contract firms will add that number of workers.

During production therefore, a total of 270 people will be employed at the KRP.

Table 9.4-2 below summarizes the labour, including contract labour, required for the operation of the KRP. For more detail see Section 5.0.

Table 9.4-2: Operations Employment

Position	Number of Employees
Open Pit Operations	56
Underground Operations	40
Mine Maintenance	28
Mine Staff	28
Mill Staff	20
Mill Operations	30
Mill Maintenance	32
Camp and Administration	36
Total	**270**

The total payroll during operations is expected to be $20.4 million annually, giving an average cost per employee of $75,500 across all job categories.

KRH will begin progressive reclamation during the operational phase of the KRP and is planning to require one year following operations to complete reclamation work followed by three years of monitoring. The number of employees or person-years of employment in this phase has not yet been determined but experience from other mines suggests that a total of 8 person-years of employment for Yukon residents will be a prudent estimate.

The only hard data on the proportion of Yukoners working at Yukon mines is that in January 2008 the Cantung mine (located just over the border in the NWT but serviced through Watson Lake) had 57 Yukon residents (28%) out of 200 employees (North American Tungsten 2009). Anecdotal evidence from other mines currently operating in the Yukon suggests that the overall proportion may be approximately 20% to 25%. We are therefore estimating that 25% of all employment at the KRP will go to Yukon residents.

How are the Yukon resident employees likely to be distributed by community? Using the data from the Cantung distribution (50% Whitehorse, 40% Watson Lake including 20% LFN, and 10% other communities) as a rough guide and allowing for those we are assuming will relocate to the Yukon, the estimated distribution by community is as shown in Table 9.4-3 below.

Table 9.4-3: Estimated Employment Distribution by Community, Operations Phase

	Number of Employees
Ross River	10
Faro	10
Watson Lake	15
Teslin	5
Whitehorse	28
Outside the Yukon	202
Total	**270**

The estimates shown in Table 9.4-3 include the following assumptions apart from the use of the 2008 distribution of Cantung employees:

- Ross River has a very small existing labour force and, although unemployment and underemployment are high, it is not realistic to expect large number of employees in the community. However, people in Ross River have had a long-standing relationship with the KRP and the short commute by bus makes it a more attractive employer than distant sites
- All of Faro's 10 employees are assumed to have been recruited from outside the Yukon but will relocate in Faro (see Section 9.4.4.1).

Enhancement Measure:

- KRH 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 Teslin.

9.4.1.5 Employability – Education, Training and Experience

As noted in Section 9.4.1.4 above, the need for people to live relatively near their place of work in the mining industry is past. 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.

As noted above, the overall proportion of people currently working at Yukon mines is likely in the range of 20%. Therefore, we are expecting a low proportion of KRP employees to relocate to the Yukon (see Section 9.4.3.1 below). Given that few will relocate, there will not be any significant increase in children and therefore no significant effect on the education system either in the communities or the Yukon as a whole.

However, the KRP may have a small beneficial effect on education through offering a scholarship to students from the communities of Ross River, Faro, Watson Lake and Teslin.

The KRP will have a direct positive effect on the training of its workforce as KRH will employ apprentices and provide other forms of training to employees, in partnership with other organizations such as the YMTA and Yukon College.

Enhancement Measures:

- As part of its operations, KRH will offer a variety of training programs for its employees including: basic job training, health and safety training, equipment operation and mill operations
- For employees recruited locally, KRH is planning to offer hands-on training in mine and mill operations in its Jerritt Canyon mine in Nevada before the KRP opens
- In order to facilitate employees benefiting from their gains in work experience and training, KRH will have a policy of initially posting all employment positions internally, and, with a particular focus on First Nation candidates, help create individual training and succession plans
- KRH has also proposed to help create, with YG, the YMTA and other mining companies, a standard mine employee "passport" to make skills and experience more readily transferable between employers.

9.4.1.6 Broad Participation in Economic Development

KRH has demonstrated its commitment to providing employment and contracting opportunities to a wide cross-section of Yukon society through the years of the exploration phase of the KRP. First Nation people and Kaska particularly, have been a large part of the exploration workforce. At some points they have been the majority of the workforce. Women have been and are employees as well. KRH has regularly employed First Nation contractors for work such as road maintenance and has used the Dena General Store and Tu'lidlini Petroleum as suppliers.

Enhancement Measure:

- KRH will continue to actively recruit First Nation and female employees and continue to work with local contractors and suppliers through the construction, operation and closure of the KRP.

9.4.1.7 Business Opportunities

During the construction phase of the KRP, most business opportunities available to Yukon or local contractors will be in the building construction sector. KRH will have its own employees and equipment do the majority of the pre-production development of the open pits and other earth-moving work. And some of the construction phase contracts will by necessity go to specialized firms (e.g., the supply and installation of mill equipment).

Enhancement Measure:

- As part of its ongoing planning, KRH will attempt to offer scaled down construction contracts that will not prevent Yukon-based firms from bidding.

During the operational phase, the following goods and services will possibly be contracted out:

- Transportation – Hot shots and cargo
- Food services
- Camp maintenance services
- Vehicle maintenance services
- Environmental monitoring services
- Fuel supply
- Propane supply
- Road construction and maintenance
- Exploration drilling.

In addition the KRP will require a wide range of standard goods and services from office supplies to information technology services.

Enhancement Measure:

- As part of ongoing discussions with the RRDC, the LFN, and the TTC, KRH will explore ways of maximizing First Nation participation in the KRP's operational phase business opportunities.

During the closure and reclamation phase of the KRP here will likely be a number of business opportunities including

- Building demolition contracts
- Earth moving contracts
- Reseeding and re-vegetation contracts
- Environmental monitoring.

Enhancement Measure:

- As part of ongoing discussions with the RRDC, the LFN, and the TTC, KRH will explore ways of maximizing First Nation participation in the Project's closure and reclamation phase business opportunities.

9.4.1.8 Government Revenues

The KRP will directly increase government revenues through various taxes, fees, royalties, and other payments. However, the bulk of the KRP's effect on government revenues will be indirect, through the income taxes and property taxes paid by employees.

The Town of Faro will see a modest increase in its property taxes if, as we expect, about ten KRP employees relocate from outside the Yukon to Faro (see Section 9.4.3.1 below). The town collects an average of about $1,600 annually in property taxes per single family dwelling. The increased revenue will therefore be a very modest $16,000, but the marginal cost of providing infrastructure to the additional residents is close to zero.

The RRDC and the LFN may gain additional revenue, but this is entirely dependant on their negotiations of Socio-economic participation agreements (SEPAs) with KRH. Terms of SEPAs tend to be confidential even when they are in place and the amount that may be raised in this manner cannot be estimated. As neither the RRDC nor the LFN are self-governing First Nations under the UFA, they will not collect the First Nation share of income taxes paid by residents on settlement land.

The TTC, as a self-governing First Nation will collect some income taxes from any KRH employee living on settlement land in addition to any SEPA that the TTC signs with KRH.

YG collects mining royalties under the Quartz Mining Act. The royalty is a tax payable annually, on an escalating rate basis, for any profits from mining 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.

The amounts collected in more recent years are shown in Table 9.4-4.

Table 9.4-4: Yukon Mineral Royalties and Lease Payments

Fiscal Year	Amount
2002/03	$71,137
2003/04	$317,066
2004/05	$249,509
2005/06	$208,707
2006/07	$235,416
2007/08	$287,806
2008/09	$203,628
2009/10	$255,475
2010/11	$162,000 forecast
2011/12	$187,000 forecast

Source: Yukon Government 2003-2011

Given these very modest numbers, and the great difficulty in estimating just what the royalty the KRP will be subject to, no estimate will be presented.

The largest source of government revenues for both the federal and territorial governments from the KRP is the income tax paid by the KRP employees.

Table 9.4-5 Estimated Total Income Tax, Yukon Employees, by Project Phase

	Federal Income Tax	Yukon Income Tax
Construction Phase	$851,753	$406,341
Operations Phase	$2,798,030	$1,334,840
Closure and Reclamation	$98,754	$47,112
Total	**$3,748,537**	**$1,788,293**

The income tax estimates shown in Table 9.4-2 are based on the following:

- The average annual income across all jobs in all phases is $75,500 (this is based on the operations phase jobs average that has been assumed to hold roughly true for the other phases)
- From 2008 Canada Revenue Agency (2000-2010) data that the average tax payer earning between $70,000 and $80,000 annually paid 10.9% of their total income in federal income tax and 5.2% of their total income in Yukon income tax
- It has been assumed that 19 out of the 75 KRH employees (25%) expected to work on KRP construction will be Yukon residents. A further assumption is that Yukon residents will get an additional 75 person-years of the new employment created during the 18 month period of construction
- It has been assumed that 68 (25%) out of the total of 270 people (including the 40 working for the underground contract miner) employed during the 5- year operations phase will be Yukon residents
- For the closure and reclamation and monitoring phase we are estimating a total of 12 person-years of employment over four years for Yukon residents.

9.4.2 Project Effects: Human Health and Well-Being

The following subsections describe the potential Project effects on the Human Health and Well-Being VESEC subcomponents.

9.4.2.1 Individual Health

Better individual health is clearly associated with higher incomes and higher education levels. Statistics Canada (2003)writes:

> *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 relatively well-paid employment, along with the possible increases in education and skill levels through apprenticeships and training, the KRP will likely have an overall positive effect on individual health in all employee's communities.

However, the combination of a sudden increase in income and the need for individuals employed at the mine to be away from their families for the two-week rotation can have negative effects on family health and well-being. Studies done in the NWT show 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, in conjunction with rotational employment, commuting, the stress of single parenting, integrating an absent parent back into the family, can lead to increased substance abuse, behaviour problems for children, and sometimes, family violence (NWT Status of Women Council 1999).

Enhancement Measure:

- To help employees and their families maintain good health, KRH will be offering a dental and extended health plan to all employees at the KRP.

9.4.2.2 Family Stress

The KRP will not have any direct effect on family stress and related domestic abuse and violence. However, by providing relatively long-term and generally well-paid work the KRP will have indirect effects, both positive and negative.

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 family stress.

However, a large increase in income can also lead to a greater degree of alcohol and drug use as these become more affordable. This in turn can lead to increases in domestic abuse and violence. In research from other jurisdictions and similar KRPs, 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).

Another potential source of stress for employee families is the nature of camp-based work with a two week in, two week out rotation. KRH is aware that these rotations can be onerous for employees, and especially those with families. However, given the location of the Project very short rotations (4 days on and 4 days off for example) are simply not possible for most employees. That there is evidence that longer rotations with equal time on and off is more sustainable for families in the long term. In general, a two-in, two-out rotation is a reasonable compromise given the fundamental needs of both the employer and the employees. Longer rotations, for example, three weeks in, three weeks out, may be even better for employee family life but will be worse for the workers. Working a full three weeks of 12-hour shifts has been implicated in higher workplace accident rates. Finally, allowing Ross River residents to commute to work daily will not be permitted given the safety concerns of the long commute before and after a full 12 hour shift, combined with concerns over site security and the enforcement of the dry camp rules.

9.4.2.3 Reducing Alcohol and Drug Abuse

Substantial increases in income can lead to increases in drug and alcohol abuse as these become relatively more affordable. Although KRH cannot be responsible for any employee's actions while on their own time, the company also wishes to reduce drug and alcohol abuse among its employees by emphasizing a safe worksite, reduce employee turnover, and to help protect the general health and well-being of its employees.

Mitigation Measures:

- The camp will be dry through all phases of the Project; no alcohol or recreational drugs will be permitted
- KRH will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter
- KRH, while making workplace safety the first priority, will take a graduated disciplinary approach to employees suffering from drug or alcohol abuse issues and work with the employee if he or she wishes to enter a treatment program.

9.4.2.4 Gathering Traditional Medicine

It is not anticipated that the KRP will have an effect on gathering traditional medicine. The two week period of time off each month will likely provide sufficient time for First Nation employees to pursue gathering of traditional economic activities. The RRDC is satisfied that the effect on gathering in and around the mine site has been adequately mitigated. The information on traditional medicines is part of the confidential *Traditional Knowledge Protocol* between the RRDC and KRH.

9.4.2.5 Public Health and Safety – Increased Traffic, Hazardous Material Transport

There are three major areas of public health and safety that the KRP may affect:

- Traffic safety
- Spills or major accidents
- Environmental health concerns around the disposal of sewage and garbage in the camp at the mine site.

The KRP will increase the amount of truck traffic on the Robert Campbell Highway during the construction phase, have a small effect during operations, and have no significant effect during the closure and reclamation phase.

The YG has a traffic counter is located near the intersection of the South Canol Road at Km 355.2, approximately 15 km north of the Ketza River bridge. The counter is in place only seasonally (May through October) and captures traffic from and to both the South Canol Road (which intersects the Campbell at Km 354.7) and the Robert Campbell Highway further south (Yukon Highways and Public Works 2009). Data from the counter shows an average daily traffic volume of 76 vehicles per day during the summers from 2004 through 2008.

During the construction phase of the KRP, daily traffic volumes will vary widely but it is estimated that the KRP will require an average of 10 round trips per day by transport trucks plus a further 10 round trips by smaller vehicles. Although this is a significant increase given the very low level of current use, it cannot be considered very heavy traffic.

During the operations phase, there will be far less truck traffic. An average of 9 round trips per week by transport trucks will be needed along with a small number of trips by the personnel bus and smaller vehicles. Because the KRP will produce doré bars it will not need to ship out concentrate and therefore there will be no ore trucks adding to the traffic.

During the closure and reclamation 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 less during winter.

Mitigation Measures:

- To increase the safety of its employees, contractors and the general public using the Ketza Road, KRH will install a radio communication system on the road to allow truck drivers to communicate their presence and location on the road to all users.

Because the KRP will require the transport of substantial quantities of diesel fuel, propane, explosives, and a variety of mill reagents including cyanide, 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. To mitigate for this, KRH will:

- Develop a protocol (prior to commencing construction of the Project) with YG's Emergency Measures Organization that outlines, within an Emergency Response Plan, all roles and responsibilities in the event of accidents or spill events
- Implement the accident and spill response plan as per the Emergency Response Plan.
- Maintain a trained emergency response team, along with an assortment of relevant equipment available to respond to accidents and spills.
- Transport cyanide needed for mill processes to site only in solid briquette form, to eliminate the possibility of a liquid cyanide spill during transport.

Public health will not be compromised at the Site as KRH 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 YG (See Section 6.0).

9.4.2.6 Workplace Health and Safety

The health and safety of those working for and on the KRP is a top priority for KRH. The company will rigorously follow all applicable safety laws and regulations in all aspects of its operations. All employees will receive the safety training they require to do their jobs properly and safely. A rigorously enforced dry camp will also improve workplace safety.

There will be a fully trained nurse/Emergency Medical Technician(EMT) on site at all times with all required medical supplies and equipment. Included in that equipment will be a properly equipped vehicle dedicated for medical evacuations if necessary. In addition, helicopter medevacs will be available when needed.

Underground mining can pose its own unique workplace safety risks. The previous operation of the mine underground showed that the ground conditions are not ideal and require particular attention to safety. The planned approach for the underground portions of the mine is to have a specialized underground mining contractor do the work using short, sub-level stoping. The selected sub-contractor will rigorously follow all applicable safety laws and regulations for the underground operations.

Mitigation Measures:

- KRH will rigorously follow all applicable safety laws and regulations in every aspect of its operations
- KRH will provide every employee with the training required to safely do their work
- KRH will have a fully qualified nurse/EMT on site with all required medical supplies and equipment, and will have an on-call helicopter medevac service available at all times.

9.4.3 Project Effects: Community Vitality

The following subsections describe the potential KRP effects on the Community Vitality VESEC subcomponents.

9.4.3.1 Population – Number of Children

Both Ross River and Faro have identified community population as a VESEC sub-component. 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. In particular, 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 and as the overall number of children shrinks, the incentive grows for parents of school age children to move to where there are more school age children, and therefore also more extracurricular activities and a broader social environment for their children. Families with children are also seen as more likely to be more active participants in the community and more likely to volunteer to create more community activities and events.

In the past, residents of Ross River and RRDC leadership expressed strong reservations about an influx of newcomers, wanting the community to grow slowly instead. This outlook appears to have shifted somewhat and there appears to be more community support for population growth.

As noted in Section 9.4.4.1 below, Faro has the available housing and related infrastructure available for people to relocate to the community while Ross River does not. As an enhancement measure, KRH is planning to offer a relocation incentive and is considering the purchase of vacant housing to offer its employees. With a relocation incentive in place, and perhaps company housing made available, it is expected that some employees will choose to relocate and become Yukon residents. We are estimating that

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 will not add stress to the available infrastructure or services in the community, rather, they will be considered a positive effect.

Because of the lack of available housing and land, we consider it unlikely that Ross River will gain any population as a result of the KRP.

9.4.3.2 Healthy Local Business Sector – Reducing the Cost of Living

The value expressed in this sub-component is broader than simply having local community businesses capture additional contracts from the KRP (see Section 9.4.1.7 above for business opportunities). It is the desire for a broader and deeper local business sector that serves the community as a whole, increases the circulation of money within the community, and helps reduce the cost of living.

The KRP is expected to have an indirect positive effect on this sub-component through providing well paid employment and business opportunities to local firms. Higher incomes locally will lead to greater demand for goods and services, encouraging the diversification and growth of existing businesses and the establishment of new ones.

9.4.3.3 Reducing Crime

People feeling safe and secure in a community, and especially safe from excessive or pervasive crime, plays a large role in community vitality. The KRP 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.

9.4.3.4 Reducing Discrimination and Racism

KRH will attempt to have a positive effect on reducing discrimination and racism by doing all it can to eliminate discrimination and racism in the workplace.

Mitigation Measure:

- KRH 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
- KRH will have a hiring preference for local First Nation citizens.

9.4.3.5 Political Structure, Leadership and Capacity

The construction, operation and closure of the KRP will likely have no significant effect on local, First Nation, or territorial governance, political structures or decision making capacity.

However, the KRP has exposed some strong differences of views between First Nation governments as noted in Section 2.0 of this KRP Proposal. In particular, the RRDC has strongly expressed the opinion that the traditional territory boundary of the TTC as accepted by YESAB (and that ensures the TTC a role in the assessment process) is incorrect and that the TTC has no interest in the area of the KRP. KRH has no means of addressing this issue or in mitigating its effects.

In addition, the RRDC has taken the position that, although it may choose to participate in the *YESAA* process, it is not bound by the Act or by decisions made by YESAB that affect its traditional territory. This position is based in part on the definition of Yukon Indian Person in the Act. RRDC citizens are not enrolled under a final land claims agreement and so do not fall under the definition. As with the disagreement over traditional territory boundaries, KRH has no means of addressing this issue or in mitigating its effects.

9.4.3.6 Community Events and Volunteerism

Since 2008, KRH has been a regular sponsor of community events. In particular, KRH has sponsored an annual gathering by the RRDC at the mine site itself where ceremonies connected to a sacred site take place.

Enhancement Measures:

- KRH will look for opportunities to provide support for selected community events

The KRP will likely have no significant effect on volunteerism in the affected communities.

9.4.3.7 Recreational Facilities and Opportunities

Recreation opportunities and facilities will not be directly affected by the KRP. However, KRH has made several donations toward recreational facilities in Ross River since 2008, including a recent donation to assist with the rebuilding of the community's recreation centre.

9.4.4 Project Effects: Infrastructure and Services

9.4.4.1 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. KRH 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 June 23, 2011, the YG had no lots for sale in Faro. However, a search of real estate listings resulted in 7 houses for sale by owner. Faro Real Estate Ltd. still has approximately 200 units available for sale.

Ross River does not have capacity to house new residents. In July 2011 there were no houses listed for sale or rent in Ross River, either through a real estate agent or through private sale. Further, the YG 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.

9.4.4.2 Transportation Infrastructure – Roads and Airports

The construction and operation of the KRP will have an effect on the Robert Campbell Highway and the Ketza Road. However, given the relatively low levels of traffic expected (see Section 9.4.2.5) the effect will not be large.

Although the Ketza Road is owned by the YG, KRH has been maintaining it using contractors from Ross River. Although the company will like to see the YG take over maintenance, it is prepared to continue to use local contractors for maintenance.

The KRP will have no effect on local airports as it is not planning to fly employees in. Instead, employees will be transported by bus from Whitehorse, through Faro and Ross River and then on to the site.

9.4.4.3 Municipal Services – Water, Sewer, Solid Waste

The KRP 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 9.4.3.1).

The KRP will not use the solid waste disposal facilities at Ross River or Faro at any stage of the Project. All combustible waste will be incinerated on site by propane incinerator. The incinerator ash and ordinary non-combustible waste will be disposed of in a land treatment facility. Hazardous and special wastes will be trucked off site for approved disposal. If feasible, waste oil will be burned to provide heat for buildings. Brush and wood created by clearing during the construction phase will be handled according to a plan to be developed with the YG.

9.4.4.4 Healthcare Services

The KRP is not expected to have any effect on the provision of health care services in the communities unless an unexpectedly large number of employees decide to relocate to Faro or Ross River over the course of the Project.

9.4.4.5 Police Services

The KRP is not expected to have any effect on the provision of police services in the communities unless an unexpectedly large number of employees decide to relocate to Faro or Ross River over the course of the Project.

9.4.4.6 Child Care

Child care, or the lack of it, might present a significant hurdle for parents who wish to take advantage of employment that requires them to be away from home for two weeks at a time. Obviously this hurdle is especially high for single parents. There is no organized childcare available on a round-the-clock basis for two weeks at a time. The only viable option for most parents in this situation is to rely on spouses or extended family for child care.

While KRH is aware of this issue, the company has no practical means of addressing it or in mitigating its effects.

9.4.5 Project Effects: Culture, History and Heritage

9.4.5.1 Language Preservation and Restoration

The KRP will not have any direct effect on language preservation and restoration. First Nation people who choose to work at the mine will, if they have not been working full-time prior, have less time to pursue these activities. However, the two-week in, two-week out rotation should allow sufficient consecutive days off to pursue most activities.

9.4.5.2 Traditional Knowledge and Practice Preservation and Restoration

The KRP will not have any direct effect on traditional knowledge and practice preservation and restoration. First Nation people who choose to work at the mine will, if they have not been working full-time prior, have less time to pursue these activities. However, the two-week in, two-week out rotation should allow sufficient consecutive days off to pursue most activities.

The RRDC Traditional Knowledge is confidential and the RRDC has acknowledged that KRH has taken traditional knowledge into account in its plans and will appropriately mitigate any adverse effects.

9.5 Significance Determination

Significance analysis is used to determine the anticipated level of success following implementation of mitigation or enhancement measures. 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 9.5-1 describes the definitions used to determine the significance or value attributed to each criterion.

Table 9.5-1: 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	—	—	—

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Economy and Sustainable Livelihood													
Traditional Economic Activities	Potentially reduced opportunity to pursue traditional economic activities	KRH plans a standard 2-week in, 2-week out rotation for all employees. The two week period of time off will likely provide sufficient time for First Nation employees to pursue traditional economic activities	-	2	NA	1	1	2	2	3	NS	3	3
Traditional Economic Activities: Hunting	Easier access to area for hunting; hunting reduces big game population	KRH policies will include no firearms or other weapons allowed, and no hunting by employees while on rotation. No hunting by anyone allowed on the site and access through the site will be controlled for safety reasons	-	3	5	2	3	2	3	3	NS	2	2
Traditional Economic Activities: Trapping	Disruption and loss of access	KRH, through its MOU with the RRDC, already has in place a mechanism to compensate the Ross River trappers for loss of access due to the company's activities	-	3	5	2	2	3	4	3	NS	4	3
Economic Growth: Yukon	The KRP's average annual gross production value of $72.3 million translates into an annual impact of $57.8 million on the Yukon's GDP. The Project can therefore be expected to increase the size of the economy by a significant 2.8%		+	2	NA	3	NA	2	NA	4	P	4	1

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Economy and Sustainable Livelihood													
Economic Growth: Communities	Increased incomes expected to increase the size of community economies (Ross River +5.8%, Faro +7.3%, Watson Lake +1.8% and Teslin 1.6%)		+	2	NA	3	NA	2	NA	4	P	4	1
Diverse and Stable Economy: Discouraging Boom and Bust	By its very nature, mining has a tendency toward creating a boom and bust cycle, particularly in small communities	Construction, operation, decommissioning, and monitoring phases total approximately 13 years. KRH will continue to explore its property for further reserves and attempt to extend the operating life of the mine	-	3	NA	2	1	3	2	2	NS	3	2
Employment: Construction Phase	Yukon residents will get an estimated 100 person-years of employment during the construction phase	KRH 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 Teslin	+	1	NA	3	NA	2	NA	3	P	4	1

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Economy and Sustainable Livelihood													
Employment: Operations Phase	During operations, an estimated 68 (25% of the mine workforce) will be Yukon residents	KRH 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 Teslin	+	2	NA	3	NA	2	NA	4	P	4	1
Employment: Decommissioning and Reclamation Phase	An estimated 8 person-years of employment for Yukon residents	KRH 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 Teslin	+	1	NA	3	NA	2	NA	3	P	4	1
Employability: Education	No significant increase in children and therefore no significant effect on the education system either in the communities or the Yukon as a whole	On operating the KRP, KRH will offer an annual scholarship to a qualified student, or students, from Ross River, Faro, Watson Lake or Teslin who are pursuing a post-secondary education, particularly in a mining related field	+	2	NA	2	NA	2	NA	3	P	4	1

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Economy and Sustainable Livelihood													
Employability: Training and Experience	The KRP will have a direct positive effect on the training of its workforce as KRH will employ apprentices and provide other forms of training to employees and provide work experience through employment	KRH will offer a variety of standard programs for its employees. For employees recruited locally, KRH is planning to offer hands-on training in mine and mill operations in its Jerritt Canyon mine in Nevada KRH will have a 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
Broad Participation in Economic Development	Direct effects through KRP providing job and business opportunities to the entire cross-section of Yukon society	KRH will continue to actively recruit First Nation and female employees and continue to work with local contractors and suppliers through the construction, operation and closure of the Project	+	3	NA	2	NA	2	NA	4	P	4	1

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Economy and Sustainable Livelihood													
Business Opportunities	There will be business opportunities for local and Yukon firms through every phase of the project	As part of its ongoing planning, KRH will attempt to offer scaled down construction contracts that will not prevent Yukon-based firms from bidding As part of ongoing discussions with the RRDC, the LFN, and the TTC, KRH is exploring ways of maximizing First Nation participation in the Project's operational phase business opportunities	+	3	NA	2	NA	2	NA	2	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		+	2	NA	2	NA	2	NA	4	P	4	1

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Human Health and Well-Being													
Individual Health	By offering steady and well-paid employment and offering education and skills development through apprenticeship and training, KRH will likely have a small overall positive effect on individual health	To help employees and their families maintain good health, KRH will be offering a dental and extended health plan to all employees at the KRP	+	2	NA	2	1	3	3	2	NS	3	2
Family Stress	The combination of a sudden increase in income and the absence of the employed spouse/ parent during each shift rotation can have negative effects on family health and well-being	KRH will implement a 2-week in, 2-week out rotation. Available literature indicates that longer rotations (with extended periods at home) decrease the overall stress on family relationships	-	2	NA	2	1	3	3	2	NS	3	2

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Human Health and Well-Being													
Reducing 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. KRH will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter KRH, while making workplace safety the first priority, will take a graduated disciplinary approach to employees suffering from drug or alcohol abuse issues and work with the employee if he or she wishes to enter a treatment program	-	2	NA	2	1	3	3	2	NS	2	2
Gathering Traditional Medicine	Potentially reduced opportunity to pursue traditional economic activities	KRH plans a standard 2-week in, 2-week out rotation for all employees. The two week period of time off will likely provide sufficient time for First Nation employees to pursue traditional activities	-	2	NA	1	1	2	2	3	NS	3	3

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Human Health and Well-Being													
Public Health and Safety: Increased Traffic	Increases in highway traffic not expected to be significant in any phase	To increase the safety of its employees, contractors and the general public using the Ketza Road, KRH will install a radio communication system on the road to allow truck drivers to communicate their presence and location on the road to all users	-	3	NA	2	1	3	2	3	NS	3	2
Public Health and Safety: Hazardous Material Transport	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	KRH will ensure that the cyanide needed for mill processes will be transported in solid briquette form only to ensure that there will be no possibility of a spill of liquid cyanide during transport KRH will have a trained emergency response team, along with an assortment of relevant equipment available to respond to accidents and spills	-	2	NA	3	3	2	2	2	NS	2	2
Public Health and Safety: Disposal Of Sewage And Garbage	Public health and safety will not be compromised at the Ketza River Mine	KRH 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 YG	-	3	2	1	1	2	1	2	NS	1	1

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Human Health and Well-Being													
Workplace Health and Safety	Workplace health and safety will not be compromised at the KRP	KRH will follow all applicable safety laws and regulations in every aspect of its operations KRH will provide every employee with the training required to safely do their work KRH will have a fully qualified EMT on site with all required medical supplies and equipment and have an on-call medevacs service available at all times	-	3	NA	2	1	2	3	2	NS	2	2
Community Vitality													
Population: Number of Children	Estimate that the population of Faro will increase by 20 to 25 people total with the relocation of 10 employees to the community. No significant increase in the number of children	KRH is planning to offer relocation incentives for new employees 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	+	2	NA	2	NA	2	NA	4	P	3	2

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Community Vitality													
Healthy Local Business Sector: Reducing the Cost of Living	The Project is expected to have an indirect positive effect on this sub-component through providing well paid employment and business opportunities to local firms.	Higher incomes locally will lead to greater demand for goods and services, encouraging the diversification and growth of existing businesses and the establishment of new ones	+	2	NA	2	1	3	3	2	NS	3	2
Reducing Crime	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 mitigations in “Reducing alcohol and drug abuse”	+/-	2	NA	1	1	3	3	4	NS	3	2
Reducing Discrimination and Racism	KRH will attempt to have a positive effect on reducing discrimination and racism by doing all it can to eliminate discrimination and racism in the workplace	KRH 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	-	2	NA	1	1	3	3	4	NS	3	2
Political Structure, Leadership and Capacity	The KRP is not expected to have an 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

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Community Vitality													
Community Events and Volunteerism	Since 2008, KRH has been a regular sponsor of community events. In particular, KRH has sponsored an annual gathering by the RRDC at the mine site itself where ceremonies connected to a sacred site take place No effect on volunteerism is expected	KRH will continue to sponsor the annual gathering at the mine site in June of each year KRH will, in consultation with Ross River, Faro, the LFN and the TTC, provide sponsorship to at least one other event in each community annually	+	2	NA	1	NA	2	NA	4	P	3	1
Recreational Facilities and Opportunities	Recreation opportunities and facilities will not be affected by the KRP		NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Infrastructure and Services													
Housing and Land Availability	The Project will have an effect on availability only if KRH employees or KRH buy housing in Faro	KRH is planning to offer relocation incentives for new employees 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 KRH is also considering the purchase of a number of currently vacant houses in Faro that would become company housing for mine employees	+	2	NA	1	NA	2	NA	4	P	3	1

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects									Likelihood	
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Infrastructure and Services													
Transportation Infrastructure: Roads and Airports	No significant effect on Robert Campbell Highway but some effect on Ketza Road traffic No effect on airports	KRH has been maintaining Ketza Road using contractors from Ross River. Although the company would like to see the YG take over maintenance, it is prepared to continue to use local contractors for maintenance	-	2	5	3	1	2	2	4	NS	4	1
Municipal Services: Water, Sewer, Solid Waste	No effect expected		NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Health Care Services	No effect expected		NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Police Services	No effect expected		NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Child Care	No effect expected		NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA
Culture, History and Heritage													
Language preservation & restoration	The KRP will not have any direct effect on language preservation and restoration	The two-week in, two-week out rotation should allow sufficient consecutive days off to pursue most activities	NA	3	NA	1	NA	3	NA	NA	NS	NA	NA

Table 9.5-2: Significance Analysis, Socio-economic Effects

VESEC	Potential Effects	Proposed Mitigation or Enhancement	Residual Effects								Likelihood		
			Direction	Duration	Extent	Magnitude	Reversibility	Resilience	Risk	Frequency	Significance	Probability	Uncertainty
Culture, History and Heritage													
Traditional Knowledge and Practice Preservation and Restoration	The KRP will not have any direct effect on traditional knowledge and practice preservation and restoration	The two-week in, two-week out rotation should allow sufficient consecutive days off to pursue most activities	NA	3	NA	1	NA	3	NA	NA	NS	NA	NA

10.0 ACCIDENTS AND MALFUNCTIONS

YESAB's *Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions* (YESAB 2005) requests that an assessment of potential effects resulting from accidents and malfunctions associated with Project components be included as part of the Project Proposal. Standard policies and practices are fundamental to managing the risks associated with potential accidents and malfunctions.

KRH corporate policies, industry standards, best management practices, regulations, and/or guidelines will be incorporated into an Emergency Response Plan (ERP) and Safety Manual. Preliminary versions of these documents are attached as Appendices N1 and N2, respectively. Management systems and mitigation measures contained in the ERP include:

- accident and malfunction prevention through the proper training and education of staff
- accident and malfunction prevention through proper and routine equipment maintenance
- compliance with all permit and license requirements and conditions issued as part of Project approval
- conduct of a risk assessment during the detailed design stage of the Project and,
- regular assessment and monitoring of any risks identified at all stages of the Project, including detailed engineering design, construction, operation, and closure and decommissioning.

The ERP for the KRP will identify response procedures for accidents and malfunctions as well as the roles and responsibilities of on-site personnel and the resources required to address issues. Avoiding or mitigating the effects of accidents and malfunctions which may be harmful to site personnel and/or the environment is contingent, in part, on emergency response preparedness. The ERP provides a means of preparing site personnel in the event of medical or chemical emergencies, and malfunctions such as the failure of infrastructure or equipment. Becoming familiar with the ERP for the KRP will be included as part of the overall site orientation for all staff, and special training will be provided to responsible personnel, as required. The ERP will be fully developed in advance of the commencement of the construction phase of the Project.

Accidents or malfunctions can be associated with any human activities carried out or natural events that may occur during the construction, operation, and closure and decommissioning phases of the KRP. Only those accidents and malfunctions that have some probability of occurring during the various stages of the Project are assessed below. The environmental consequences of potential accidents or malfunctions incurred at any stage of the Project would be largely limited to:

- The failure of hazardous materials (e.g., fuel, chemical reagents, explosives) transportation, storage, and handling systems
- The failure of major mine site infrastructure (e.g., pit slopes, waste rock dumps, tailings storage facility)
- Vehicle and industrial accidents.

10.1 Emergency Response Plan Overview

The ERP provides courses of action to be taken in response to emergency situations such as accidents, malfunctions, or system failures that may result from natural events (e.g., extreme weather, natural disaster) or human error. The ERP will relate directly to other Project plans such as the Spill Contingency Plan, Tailings Management Plan, and general operating procedures and safe work procedures that will be established for the KRP. The types of situations that the ERP will address include:

- Release of hazardous or toxic substances
- Threats to personnel and/or infrastructure
- Medical emergencies
- Missing persons
- Fires and explosions
- Natural disasters
- Site evacuation.

The ERP will serve as a resource for site personnel that outlines response procedures as well as communication procedures with external agencies that may become involved as a result of the emergency situation. An overview of the ERP will be presented to all staff as part of the general site orientation. An Emergency Response Team (ERT) will also be formed in order to have properly trained, dedicated staff ready to respond to emergency situations. All ERT members will receive training and certification, where applicable, in general emergency response, spill contingency measures, and communication procedures. Preparedness training will be conducted in accordance with the *Occupational Health and Safety Act*, 2002, as well as other applicable legislation and will identify:

- internal and external communication protocols
- available internal and external resources (e.g., materials, equipment, ERT members)
- response procedures (e.g., first on the scene, clean-up, disposal, remediation, and reporting)
- applicable environmental factors (e.g., adverse weather conditions, steep or unstable terrain, snow/ice)
- use of personal protective equipment
- properties of substances transported, handled, stored, and used on site (e.g., Material Safety Data Sheets [MSDS] and Workplace Hazardous Materials Information System [WHMIS])
- on and off-site transportation protocols (including the transport of substances regulated under the *Transportation of Dangerous Goods Act*, 1992).

The level of training for each ERT member will vary depending on their respective roles. Teams will be organized by KRH and will cover a comprehensive range of emergency situations. All training records will be maintained by KRH and will be stored at the office on-site. Contractors will have to meet minimum

training standards (to be established by KRH) for safety and emergency response and will be made aware of the ERP prior to the start of work on-site.

The ERP will be tested periodically to verify that response crews are familiar and comfortable with the procedures that are in place. It will also be reviewed annually to verify it is consistent with current best management practices in the areas of emergency response and spill management, and is reflective of any operational changes that may influence the effectiveness of the procedures that are in place. Any updates that are identified will be incorporated into the ERP within six months of the annual review.

10.2 Hazardous Materials Storage, Transportation, and Handling

Hazardous materials include fuels, lubricants, explosives, and chemical reagents that will be used or produced during the various stages of the KRP. A Hazardous Materials Spill Contingency Plan will be developed for the Project in order to efficiently and effectively respond to environmental emergencies and/or accidental spills that may occur during the construction, operation, or closure/decommissioning phases of the KRP.

The Hazardous Materials Spill Contingency Plan will present the procedures and methods for spill notification, response mobilization, containment, recovery, and remediation for a range of accidents or malfunctions that may require the initiation of an emergency, medical, or environmental response. The Hazardous Materials Spill Contingency Plan also considers the possibility that more than one type of response may be required for any one incident.

10.2.1 Storage-related Spills

10.2.1.1 Fuel and Other Petroleum Products

The fuel storage facility will be appropriately situated away from any waterbody. Fuel and petroleum products will be stored in above-ground, double-walled storage tanks behind a bermed area lined with an impermeable barrier. The facility will have corrosion and leak detection systems and the bermed area will provide secondary containment with a volumetric capacity that conforms to CCME environmental codes of practice for petroleum product storage (CCME 2003b). The bermed area will also be equipped with spill kits. Regular inspection and maintenance of the storage tanks and bermed area will be part of mine operations.

With the application and implementation of the preventative and mitigation measures as outlined, it is unlikely that any significant fuel spills will occur. As a result, it is equally unlikely that any potential negative effects to the terrestrial or aquatic environments of the KRP area will arise.

10.2.1.2 Cyanide

Cyanide will be stored at the Ketza River site in both a solid and liquid form. Solid cyanide will be in a briquette form, packed at the manufacturing plant into heavy duty polythene bags and waterproof, woven polypropylene super sacks. The super sacks would then be packaged further into 50 kg or 100 kg steel drums or palletized as 1,000 kg plywood boxes that are loaded into a sealed shipping container for transport.

Once at site, the solid cyanide will be stored in the sealed shipping container and super sacks it was transported in until required for processing. The entire shipping container will be placed on a pad in a specially contained and secure area.

When required for use, entire super sacks of cyanide will be transferred to a lined, contained mixing area where the solid cyanide is transformed into a liquid. Liquid cyanide will be stored in specialized, upright metal tanks in a secured location. The liquid cyanide storage facility is designed to accommodate entire super sacks, thus eliminating the possibility of storing unsealed or exposed cyanide in solid (briquette) form.

Regular inspection and maintenance of all cyanide storage facilities will be part of routine mine operations. All cyanide storage areas (both solid and liquid) will be equipped with spill kits.

10.2.1.3 Other Materials

Explosive materials (ANFO and emulsion) will be securely stored on surface in accordance with federal explosives storage guidelines (e.g., those provided under the *Explosives Act*, 1985). Separate, temporary explosives and detonator magazines will be used during construction, with permanent, separate magazines established during operations. Because explosives and detonators are spatially separate, it is highly improbable that unplanned explosions will occur. Only certified, properly trained personnel or contractors will be permitted to handle explosives and regular supply inventories will be conducted.

All other chemicals and reagents will be stored in their original containers in accordance with manufacturer, WHMIS, and MSDS specifications.

10.2.2 Transportation-related Spills

For any material being transported to/from the KRP site, accident prevention will be the first line of defense against any transportation-related spills. Preventative measures include using qualified personnel for hauling and transportation-related activities, adherence to posted speed limits and Yukon traffic laws, conducting regular inspections and maintenance along KRP roads, and using vehicles that are properly and regularly maintained.

10.2.2.1 Fuel and Other Petroleum Products

Should an accident occur on any KRP road that results in a fuel spill, KRH's priorities will be first to secure the health and safety of personnel, protect the environment, and protect equipment. Spill response and containment will be carried out according to the ERP and Hazardous Materials Spill Contingency Plan established for the Project, as well as any applicable contractor response plans, should a contractor be involved. The response will consider the size of the spill, location, terrain, proximity to water, soil types, weather, time of day (e.g., daytime vs. night), and temperature. All of these factors will influence the speed, efficiency, and effectiveness of the spill clean-up. Responsible personnel will also be notified, including the Yukon Spills Hotline (867.667.7244) if the spill is in excess of the amounts specified in Schedule A under the *Environment Act* Spills Regulations.

To minimize the potential environmental effects associated with a fuel spill that could occur during loading and unloading operations, personnel responsible for handling fuels will follow detailed standard practices to prevent, contain, and recover any spilled fuel. Fuelling of all vehicles and equipment will occur at a safe distance away from any waterbody, including wetlands.

10.2.2.2 Cyanide

Cyanide will be transported to the KRP by truck in the factory packed, sealed shipping container described above. Shipping the cyanide as a solid is one of the safest and most preferred methods of transport available due to the multiple containment systems that are in place. If an accident were to occur, it is unlikely the shipping container would be breached, let alone the other containment structures.

In the highly unlikely event that all levels of containment were breached as a result of an accident, mobilization of cyanide into the environment would be greatly restricted due to its solid form. If on land, the cyanide can be cleaned up simply by shovelling it into bags. Following clean-up of the solid cyanide, a solution of sodium hypochlorite (similar to household bleach) would be administered to any contaminated areas. The chlorine contained in the solution acts as an oxidizing agent, reducing any residual cyanide into harmless carbon dioxide and nitrogen.

10.2.2.3 Other Materials

Other products transported by truck which could cause harmful effects if accidentally released include ammonium nitrate, glycol, lime, and small quantities of acids, salts, and organic emulsifiers. Explosives will only be transported to site by specially trained, authorized personnel or contractors, using vehicles specially equipped to handle explosives. Transport of explosives will be carried out only in accordance with federal Transportation of Dangerous Goods (TDG), Workplace Hazardous Materials Information System (WHMIS), and *Explosives Act* specifications.

Routine inspections of ditches and pipelines will occur throughout the operations phase, and regular maintenance and timely repair will help prevent malfunctions. Severe weather events or natural disasters can disrupt the transportation of materials. Targeted assessments will be conducted after such events to determine if infrastructure integrity was affected.

10.2.2.4 Contractors

Spills caused by KRH contractors that occur beyond the KRP area (e.g., along the Robert Campbell Highway) will be the responsibility of the contractor. To mitigate this risk, KRH will:

- verify all contractors have adequate Hazardous Materials Spill Contingency Plans and training in place (this may be a requirement of employment at the Ketza River site)
- require that proper inspection documentation for all trucks and tankers hauling fuel or other hazardous materials be maintained, and be available for presentation upon request, and
- require that copies of all driver qualifications be presented upon request.

Should a spill occur on a public road or bridge by a KRH contractor, KRH will provide assistance if required or requested. While on-site, contractors will abide by the ERP and Hazardous Materials Spill Contingency Plan established for the KRP.

10.3 Mine Site Infrastructure

Failure of major mine infrastructure could result in serious injury to on-site personnel and/or damage to property and the environment. Failures may result from human error or natural disasters such as extreme weather or seismic events such as earthquakes. The KRP is located in an area with low to moderate seismic activity. A seismic hazard assessment was completed using probabilistic calculations based on design tables from the 2005 National Building Code of Canada (NRCC 2005). These calculations revealed a Peak Ground Acceleration (PGA) of 0.11 g for an event having a 2% probability of being exceeded in 50 years (i.e., a return period of 2,475 years) and 0.056 g for an event with a 10% probability in 50 years (i.e., a return period of 475 years).

10.3.1 Pit Wall Failure

A geotechnical model was developed for each pit to formulate the preliminary design of pit slope angles. The models were based on pre-feasibility level geotechnical investigations carried out in 2008 and 2010 (EBA 2011g, Appendix M1; EBA 2011h, Appendix M2). The reliability of the optimum bench face angles (BFA), inter-ramp angles (IRA), and overall pit slope angles presented in the geotechnical open-pit pre-feasibility assessments (EBA 2011g, 2011h) are commensurate with the level of investigation conducted for this stage of Project development. The level of confidence in the geotechnical model, and as a consequence of the pit slope angle design, will increase as the Project progresses into more detailed stages of design (e.g., feasibility and final) which would include the collection of additional data.

Determining the degree of slope stability consisted of minimizing the risk related to the safety of operating personal and equipment, as well as the risk to the reserve. At the same time, economic needs also required consideration, so slope angles were optimized to keep waste stripping to a minimum. It should be noted, however, that safety is not to be compromised as the economics of the chosen slope angle is optimized.

Potential failures in mines can be divided into three categories:

1. large failures compromising the overall pit slopes
2. small failures, often resulting from rock falls at a bench scale
3. inter-ramp failures compromising the stability of a few benches.

Even though major failures are more notorious in open pit mining, they are rare, and smaller failures typically result in the majority of injuries. To prevent accidents due to potential failures, continuous monitoring (using both visual assessments and instrumentation) of the rock slopes during excavation and mine operation is required. Corrective actions, should they be needed, might consist of flattening a slope that is considered to be of marginable stability and has the potential to fail, assessing the need to depressurize a portion of the slope by installing localized drains, and re-assessing excavation methods (blasting) to reduce overbreak of the bench faces and to maintain the required bench width to minimize rock falls.

Slopes, benches, and ramps will always be inspected following a seismic occurrence or severe weather event, irrespective of magnitude.

With the application of the design considerations described, along with regular monitoring and annual engineering inspections, the likelihood of a pit wall failure is remote. Nevertheless, were a failure to occur, KRH personnel and equipment would be immediately deployed to secure the area. The environmental consequences of such an event would be minimal, largely because the location of the event would be restricted to the pit footprint.

10.3.2 Waste Rock Dump Failure

The waste rock dumps have been designed to industry standards and a pre-feasibility-level of engineering. Final slopes will not exceed 2H:1V and the dumps will be constructed and graded to prevent ponding or impoundment of precipitation which would be the single largest source of instability.

Regular inspections of the waste dumps will be carried out throughout the mine life and will include the installation and monitoring of geotechnical instrumentation. Any changes in readings that suggest a movement towards increasing instability will result in response procedures that may include restricting or denying access to the area until the issue is resolved.

10.3.3 Tailings Storage Facility Failure

10.3.3.1 Design Strategies to Minimize Risk

The Tailings Storage Facility (TSF) has been designed to provide environmentally secure storage for the disposal of approximately 3 million tonnes of thickened tailings and associated process water from the mining operation. Several strategies to minimize risk were assessed and incorporated into the TSF design and are described in more detail below.

Site Hazard Classification

Part of the conceptual design stage involved conducting a hazard assessment to enable appropriate design earthquake and storm events to be determined for the TSF. The selection of appropriate design earthquake and flood events was based on classification of the tailings dam using criteria provided by the Canadian Dam Association's (CDA) Dam Safety Guidelines (CDA 2007) (Table 10.3-1). Classification of a tailings dam considers the potential incremental consequences of failure, that is, the consequences of failure are incremental to the impacts that would occur from the earthquake or flood event but without failure of the facility. The consequences of failure include life, safety, economic, social, and environmental effects.

Table 10.3-1: Suggested Design Flood and Earthquake Level

Dam Consequence Classification (CDA)	Annual Exceedance Probability EQ Design Ground Motion
Low	1/500
Significant	1/1,000
High	1/2,500
Very High	1/5,000
Extreme	1/10,000

Source: CDA (2007)

The area downstream of the TSF is largely uninhabited, with no residences along Cache Creek. The potential for loss of life following a dam failure is therefore considered to be low. If failure of the TSF resulted in the release of tailings and/or process water, it would likely have some environmental impact. The economic and socio-economic impact would also be high. Consequently, a "High" consequence category (hazard classification) has been assigned to the TSF.

Design Flood

An Inflow Design Flood (IDF) was included as part of the safety assessment of the TSF and to determine flood storage requirements. The size of the IDF increases with increasing consequences of failure. Based on the "High" hazard classification assigned to the TSF, an appropriate IDF was determined to be 1/3 between the 1,000-year event and the Probable Maximum Flood (PMF). Two PMFs were considered, including summer-autumn PMF and spring PMF (the latter of which involved the calculation of two separate PMFs to characterize the combined result of more extreme snow and rainfall events).

Seismicity

The Dam Safety Review Guidelines (CDA 2007) provide suggested design earthquake levels as a function of dam consequence classification (Table 10.3-1 above). The Geological Survey of Canada (GSC) has produced four probabilistic seismic hazard models "H", "R", "F" and "C" (Halchuk and Adams 2008) that form the basis of the seismic design provisions of the 2005 National Building Code of Canada (NRCC 2005).

To capture epistemic uncertainty in a source, two complete probabilistic seismic hazard models were created for Canada, with the "H" model considering relatively small source zones drawn around historical clusters of seismicity and the "R" model considering larger regional zones reflecting seismotectonic units. The "F" model was developed for the relatively asesmic central part of Canada and is based on global continental earthquake activity rates and the "C" model considers a line source with a magnitude 8.2 on the Cascadia subduction zone. The seismic design parameters provided in NRCC (2005) are based on the highest value from the four models for each grid point assessed across Canada.

Peak Ground Accelerations (PGA) for a "Class C" site were obtained from the Earthquakes Canada website (NRCAN 2011) for various return periods to characterize PGA values for the KRP site (Table 10.3-2).

Table 10.3-2: Design Peak Ground Acceleration for the Ketza River Project

Annual Exceedance Probability (AEP)	Peak Ground Acceleration (g)
1/100	0.026
1/475	0.056
1/1000	0.077
½,475	0.11

Source: NRCAN (2011)

The relative contribution of the earthquake source to the seismic hazard in terms of distance and magnitude can be obtained by deaggregation of the seismic hazard result. The deaggragation data for the "H" and "R" GSC models have been obtained from Earthquakes Canada which provides the mean and modal magnitude of the seismic hazard for the KRP site (Table 10.3-3).

The GSC model only considers relative contributions from the mean seismic hazard at the source, where as other models such as that of the USGS for the continental US also considers various levels of epsilon (ε) where ε = 1 indicates the contribution from the mean plus one standard deviation. Typically for geotechnical analysis the mean magnitude plus ε = 1 is considered an appropriate design magnitude. In the absence of the calculation of ε, the standard deviation of the magnitudes of the earthquake sources contributing to the seismic hazard has been calculated from the GSC model, with the mean magnitude plus 1 standard deviation considered appropriate for geotechnical analysis (Table 10.3-3).

Table 10.3-3: Design Earthquake Magnitudes for the Ketza River Project

Annual Exceedance Probability (AEP)	Geological Survey Canada (GSC) Model	Peak Ground Acceleration (PGA)	Modal Magnitude	Mean Magnitude	Standard Deviation	Mean plus 1 Standard Deviation
1/475	R	0.046	4.875	5.43	0.53	5.95
1/475	H	0.056	4.875	5.55	0.58	6.13
½,475	R	0.095	4.875	5.52	0.57	6.1
½,475	H	0.11	4.875	5.62	0.6	6.22

Note: The GSC "H" model forms the basis of the NRCC (2005) seismic design parameters for the Ketza River mine site.

TSF Construction

The TSF will be fully lined with a geosynthetic (bentomat) liner along the face of the embankment and base. The phased construction of the TSF will be scheduled to allow for sufficient storage volume and to avoid overtopping and the need for interim spillways on the embankment crest. The embankment design provides sufficient freeboard to accommodate probable maximum flood (PMF) scenarios, combined with wave run-up.

The glacial till and soils in the TSF area will form a competent, non-liquefiable foundation for the embankment. The starter embankment foundation will require clearing, stripping, contouring, and compaction in preparation for fill and liner placement. An average topsoil stripping depth of 0.5 m has been assumed within the embankment footprint. Where possible, alluvial materials that may be encountered during construction will be excavated and replaced with low-permeability fill.

Grading of the base of the TSF will be required to facilitate the placement of the liner and to allow it to tie in to the embankment face liner. Liner placement and welding can only occur during late spring, summer and early fall, so the construction schedule will need to be optimized during future design phases to be sure that all base preparation has been completed prior to liner installation, including ahead of likely periods that may favour PMF conditions.

Tailings Deposition

Discharge into the TSF will be sequential and planned to maximize efficient storage, maintain the surface water pond in the desired location, coordinate with embankment construction, and minimize dust emission potential.

Thickened tailings typically form a beach with a slope of about 2 to 2.5 percent. Selective tailings deposition will be used to keep the pond clear of the embankments thereby reducing seepage potential and improving embankment stability.

Seepage Analyses

Steady state seepage analyses were carried out to estimate the amount of seepage from the TSF, both through the embankment and liner. The seepage rate through the liner and underlying foundation materials and embankment fill zones is influenced by the following factors:

- Permeability of the embankment zones
- Permeability of the foundation materials
- The thickness and permeability of the tailings stored within the TSF
- Seepage gradients in the embankment and foundation zones
- The seepage area.

The seepage flow rate is expected to vary over the life of the TSF as the facility is gradually filled with tailings. The tailings deposit will increase in thickness and decrease in permeability due to on-going consolidation during operations.

Liner seepage estimates are based on US Army Corp of Engineers (2004, 1993) guidelines for anticipated defects and construction damage, while foundation conditions incorporated into the seepage analyses are based on information provided by the site investigation programs that were carried out.

The seepage rate through the embankment foundation is predicted to be approximately 9 l/sec (0.009 m^3/sec) at start-up, decreasing to about 2 l/sec (0.002 m^3/sec) at the end of tailings deposition when the embankment crest is at an elevation of 778 m. The seepage rate is initially higher due to the proximity of the start-up water pond adjacent to the embankment. During later operations the supernatant pond will be separated from the embankment by a wide tailings beach.

Seepage monitoring / recycle wells will facilitate the recycling of intercepted seepage water back into to the TSF.

Embankment Stability Analyses

Embankment stability analyses were carried out to investigate the stability of the embankment under both static and seismic conditions. The assessments involved checking the stability of the embankment arrangement for each of the following cases:

- Static conditions during operations and post-closure
- Earthquake loading from the Operating Basis Earthquake (OBE) and the Maximum Design Earthquake (MDE)
- Post-earthquake conditions using residual (post-liquefaction) tailings strength.

In accordance with recommendations from the International Congress on Large Dams (ICOLD 1995) and standard industry practice, the tailings dam is required to have a Factor of Safety greater than or equal to 1.5 under static conditions. For post-earthquake conditions a minimum Factor of Safety of approximately 1.1 to 1.2 is generally required to ensure there is no potential for a flow-slide failure following liquefaction.

The TSF would be expected to function in a normal manner after the OBE. Limited deformation of the tailings embankment is acceptable under seismic loading from the MDE, provided that the overall stability and integrity of the TSF is maintained and that there is no release of stored tailings or water (ICOLD 1995). Some remediation of the embankment may be required following the MDE.

The Factors of Safety for upstream and downstream static stability for the embankment configuration are a minimum of 1.8.

The seismic stability assessment of the TSF has included dynamic response analyses and a liquefaction assessment of the tailings deposit and underlying foundation soils. Predicted maximum ground accelerations and velocities have been used to estimate seismically induced deformation of the embankment. The findings of the liquefaction assessment indicate that the entire depth of the tailings deposit is potentially liquefiable for the MDE and OBE. No liquefaction is predicted in the foundation soils for the MDE or OBE.

Maximum embankment deformations of approximately 1 to 2 metres are predicted along the critical slip surface under seismic loading from the MDE. The corresponding vertical displacement of the embankment crest is likely to be less than 1 metre. The current design allows for a minimum embankment freeboard of 2 metres (and will often be more during operations). Therefore, predicted deformations from the MDE will not result in an uncontrolled release of tailings or supernatant water. The dam crest would likely need to be restored to its pre-event elevation following the MDE. Predicted embankment deformations from the OBE are minor (less than 0.1 metres) and would not impact on-going operations at the TSF.

Post-earthquake conditions, which use residual (post-liquefaction) tailings strengths, were also analysed for the embankments. The upstream and downstream Factor of Safety for all embankments is greater than 1.2. The long-term increase in tailings strength and reduction in pore water pressures will improve the overall stability and integrity of the TSF after closure.

It is recommended that detailed seismic stability and deformation analyses be conducted as part of future design studies due to the higher seismicity of the region and the large ground motions associated with the MDE.

Instrumentation and Monitoring

Geotechnical instrumentation will be installed in the tailings embankment and foundation during construction and over the life of the KRP. Instruments will be monitored during the construction and operation of the TSF to assess embankment performance and to identify any conditions different to those assumed during design and analysis. Amendments to the on-going designs and/or remediation work can be implemented to respond to the changed conditions, should the need arise. Instrumentation will also be installed to monitor displacement within the fill and foundation and to monitor water quality of groundwater seepage.

Vibrating wire type piezometers will be installed in the embankment fill, foundation soils, and tailings materials to measure pore water pressures during initial construction and operation of the TSF. The piezometers will be distributed throughout the various foundation and fill zones to provide a spectrum of monitoring data.

Inclinometers will be installed into the foundation material below the downstream slope to monitor foundation deflections during construction and operations. The inclinometers will be installed in pre-drilled boreholes and extended as the embankment is raised to provide continued monitoring.

Movement monuments will be installed on the embankment crest following the completion of selective embankment raises to monitor deflections along the slope and crest of the embankment. Periodic surveying of the monument locations will provide early warning of movements and possible acceleration of movement, which often occurs prior to failure.

The instrumentation monitoring would be done routinely both during construction and operations. Following initial installation of the geotechnical instrumentation, measurements would be taken and analyzed on a daily basis to monitor the response of the embankment and foundation soils. The monitoring frequency for the piezometers and inclinometers may be decreased to bi-monthly readings once the effects of initial construction have dissipated. Surface movement monuments would be surveyed twice per year during operations. Water quality monitoring of the seepage through the embankment and foundation would be monitored as per permit requirements.

10.3.3.2 Possible Failure Modes

The term “failure” can be defined in a multitude of ways, from allowing impacted seepage to escape containment to a full blown breach of the dam. Foster et al. (2000) reviewed a database on dam failures (up to 1986) worldwide prepared by ICOLD and determined the most common modes of failure for earthfill dams worldwide. These are presented below, with percentages of total failure in brackets:

- Embankment overtopping (34%)
- Piping through the embankment (33%)
- Piping through the foundation (15%)
- Downstream and upstream slope instability (4%)
- Other causes (earthquake, 16% total).

The percentages presented above reflect the characteristics of that database, not the likelihood of those failures developing at the KRP TSF Dam. It is important to note that the database presents cases where multiple modes of failure were believed to have occurred. As such, the percentage total is greater than 100%.

None of the failure modes identified above result in a full breach of the dam (i.e., only a portion of the tailings and water within the TSF would be mobilized and escape the impoundment). However, a conservative approach for the KRP has been adopted, with outbreak impact modelling based on the highly unlikely event that there is a full breach of the dam.

During a full dam breach, the outflow would travel along Cache Creek down to its confluence with the Ketza River in less than 1 hour and would continue along the Ketza River down to its confluence with the Pelly River in less than 10 hours. The area in the vicinity of the Robert Campbell Highway crossing would be inundated, however without information confirming the bridge deck elevation, it is difficult to assess if the bridge would be overtopped. The incremental loss related to loss of life is therefore unspecified.

For the KRP TSF, the following failure modes are considered to be plausible (Table 10.3-4). All failure modes identified below will result in only a partial breach, so that impacts will be less than modelled for the full breach described above. It should also be noted that the location of the Water Storage Reservoir (WSR) downstream of the TSF would provide some secondary containment and dilution for solids or water released from the TSF.

Table 10.3-4: Possible Failure Scenarios of the Ketza Tailings Storage Facility

Failure Mode	Risk	Effect
Overtopping	The design inflow flood is exceeded	Some release of supernatant water and erosion of the downstream shell of the embankment.
Downstream slope instability	High water levels within the dam increases the risk of downstream slope instability, either during static conditions or during a significant seismic event.	Depending on the extent of the instability, it may result in the loss of freeboard and potential for release of tailings and/or supernatant water.
Soil liquefaction	There may be portions of the dam shell that are underlain by sand, which may be susceptible to deformation when subjected to the design earthquake.	Deformation of the embankment shell, resulting in a loss of freeboard and potential overtopping.
Piping through the embankment or foundation	The defect in the liner could result in seepage through or under the dam.	Release of impacted water into the downstream reach. If un-mitigated for a long period, may result in more substantial seepage loses and potential for erosion.
Tailings line break	Mechanical or cold weather impacts to HDPE pipes.	May impact Cache Creek Diversion, however, majority of line is within TSF catchment, so that pilled material would "flow" towards TSF.
Diversion ditch failure	Slope instability resulting in blockage of the ditch Storm exceeding design event	Diverted flow would report to the TSF. Freeboard within the TSF should be sufficient to store the excess until the problem can be fixed. If freeboard is not sufficient, overtopping may occur. Downstream of TSF, the diversion water would report to the WSR and be released to Cache Creek through the spillway.

Table 10.3-4: Possible Failure Scenarios of the Ketza Tailings Storage Facility

Failure Mode	Risk	Effect
Reclaim system failure	Mechanical or electrical failure of the reclaim system	Sufficient freeboard is maintained at all times to provide sufficient storage for excess water. Prolonged shut down may result in overtopping.
Liner malfunction/defect	Tear or environmental degradation resulting in loss of liner	Thick tailings beach and low-permeability subgrade will limit seepage volumes. Seepage should be intercepted and re-cycled thru the seepage pump back system. Any further seepage should report to the WSR where it could be collected and re-cycled.
Failure of Canamax TSF	High water levels within the dam increases the risk of downstream slope instability, either during static conditions or during a significant seismic event.	Depending on the extent of the instability, it may result in the loss of freeboard and potential for release of tailings and/or supernatant water into the new TSF downstream, which could lead to overtopping of the new TSF

With the application of the design considerations described, along with regular monitoring and annual engineering inspections of the TSF, a complete failure would be an extremely remote possibility. Nevertheless, were the main tailings embankment to fail, an unknown quantity (dependent on the scale of the failure) of tailings could be released into the downstream environment. Released tailings would initially flow in the direction of the water retention pond. If the volume of tailings released was sufficient to reach the water retention pond, some tailings could conceivably migrate into Cache Creek.

This again is considered to be an extremely remote possibility, because if such a failure were to occur, KRH personnel and equipment would be immediately deployed to initiate measures to help contain the released tailings.

The environmental consequences of such an event would be minimal, largely because the tailings would be contained either between the TSF and water retention pond, or immediately downstream of the water retention pond in Cache Creek. The effects to the downstream environment, particularly any fish bearing waters, are considered of moderate magnitude, local extent, and reversible in the long-term.

10.4 Vehicle and Industrial Accidents Resulting in Injury

Vehicle and industrial accidents may result in injuries ranging from those not requiring medical treatment to fatalities, in a worst-case scenario. Minor injuries will be addressed by trained, responsible, on-site personnel as identified in the ERP. Records and reporting procedures will be followed and will conform to WCB requirements.

More severe injuries may require attention from off-site personnel. Responsible KRH personnel will perform triage, stabilize patients, arrange for off-site transport, and communicate with off-site responders, where applicable. All records and reporting procedures will conform to WCB requirements.

In the event of a fatality, the scene will be immediately secured and RCMP notified in preparation for an official investigation. Records and reporting will conform to WCB and other jurisdictions, as required. Operations may be temporarily suspended during the investigation until otherwise specified by the appropriate authorities.

10.5 Summary of Mitigation Measures

To minimize the occurrence of accidents or malfunctions and to minimize possible risks to the environment from such potential accidents or malfunctions, a number of preventative and mitigation measures will be implemented, which include:

- Implementation of best management and industry practices, as appropriate, to ultimately prevent or minimize the occurrence of accidents or malfunctions.
- Compliance with Land Use Permit and Water Licence requirements and conditions.
- Conformance with existing applicable federal, territorial and Yukon Workers' Compensation Health and Safety Board (YWCHSB) standards.
- Compliance of all KRP-related traffic with existing Yukon traffic laws.
- Effective application of KRH's Emergency Response Plan, including having preventative measures in place as well as trained personnel with appropriate equipment and access to resources.

10.5.1 Project Construction Phase

The following key mitigation measures will be used throughout the Project construction phase:

- Fuel for construction equipment will be transported to the mine site by fuel truck from local suppliers in Whitehorse.
- All mine site traffic will comply with existing Yukon traffic laws.
- Fuel and other hydrocarbons will be stored in accordance with CCME environmental codes of practice for storage of these products (CCME 2003b).
- All vehicles and equipment will be re-fuelled at a safe distance from any lake or wetland areas.
- Spill containment and clean-up activities will be implemented in accordance with KRH's Spill Contingency Plan (a preliminary Spill Contingency Plan is provided in Appendix N3).
- Spills will be immediately reported to the Yukon Spill Hotline (867.667.7244) when required.

10.5.2 Project Operations Phase

The following key mitigation measures will be used throughout the Project operations phase:

- All KRP traffic will comply with existing Yukon traffic laws.
- Fuel for the operations phase will be transported by fuel tanker trucks from Whitehorse to the main fuel storage facility at the mine.
- The fuel storage facility will consist of double-walled tanks within a bermed area. The fuel storage facility will employ corrosion and leak detection systems and will have secondary containment in accordance with the CCME's environmental code of practice for storage of petroleum products (CCME 2003b).

- All vehicles and equipment will be re-fuelled at a safe distance from lake or wetland areas.
- Explosive ingredients (e.g., ANFO and emulsion) will be trucked to the mine site and transported on site by a truck specially equipped to handle explosives, in accordance with federal Transportation of Dangerous Goods (TDG), Workplace Hazardous Materials Information System (WHMIS) and *Explosives Act* requirements.
- The explosives and caps magazine will be stored securely in an area away from infrastructure in conformance to the Land Use Permit, Quartz Mining Licence, and federal *Explosives Act* requirements.
- Hazardous chemicals or materials will be transported and stored strictly in accordance with applicable laws and regulations. Material Safety Data Sheets (MSDS) will be readily available to all staff responsible for handling hazardous materials.
- Cyanide in briquette form will be trucked to site in a factory packed, sealed shipping container. Cyanide briquettes will be stored securely in the shipping container they were transported in until needed. Liquid cyanide will be stored securely in special containers prior to being used during processing. Safeguards will also be in place for both the solid and liquid cyanide storage facilities, such as containment within sealed containers and behind berms.
- ROM ore will be delivered to the process plant by trucks, and will either be deposited directly into the ore feed hopper or placed onto the ore storage pad.
- KRP operations will comply with Land Use Permit and Water Licence requirements and conditions.
- KRP operations will conform to existing applicable federal, territorial and YWCHSB standards.
- All hazardous wastes (if any) recovered from spill incidents will be treated and/or disposed of in an approved manner.
- Any spills will be immediately reported to the Spill Hotline (867.667.7244) when required and spill containment and clean-up activities will be implemented in accordance with KRH's Spill Contingency Plan (a preliminary Spill Contingency Plan is provided in Appendix N3).

With the application and implementation of the preventative and mitigation measures as outlined, it is unlikely that significant fuel, chemical, or hazardous materials spills will occur. As a result, it is equally unlikely that any potential adverse effects to the terrestrial or aquatic environments of the KRP area will arise.

11.0 SUMMARY OF EFFECTS

11.1 Summary of Effects and Mitigations

This Section provides a summary of mitigation and enhancement measures proposed to be applied to the potential environmental and socio-economic effects of the KRP.

Table 11.1-1 summarizes effects and mitigations. Effects and mitigations are identified and further outlined for each of the effects assessments completed in Sections 8 and 9.

11.2 Summary of Residual Effects

This Section provides a summary of residual environmental effects and consequences of the KRP, following the application of mine design and mitigation measures.

Table 11.2-1 provides a summary of residual effects and consequences for environmental based VESECs, as further outlined for each of the effects assessments completed in Section 8. Table 9.5-2 shows that there are no negative residual effects for valued socio-economic based VESECs, further outlined in Section 9.

11.3 Statement of Significance

Under *YESAA*, proponents are required to conduct an analysis of significance as part of their environmental and socio-economic assessment documentation. The methods for determining significance have been outlined in Section 7.0.

Each residual effect was evaluated according to the expected change in overall condition of the VESEC being assessed and was assigned a rank of either Low, Medium, or High significance. If no residual effects were predicted to occur, no further evaluation of the effect was carried out, and a significance rating was not assigned.

When evaluating significance, precautionary principles were also used, so that where there was uncertainty about significance, the final evaluation was based on the greater of the possible effects. Table 11.3-1 shows the summary of significance determination for each VESEC with residual effects.

With the application of mitigation measures, the assessment of each VESEC has found the significance of the effects to be Low. The overall significance of the effects on the Project are considered to be low.

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
Natural Landscape, Soil Stability and Terrain Hazards		
Section 8.1.3 – Natural Landscape	1	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
	2	Selection of borrow sites will consider aesthetics, i.e., visual effects of development
	3	Where possible, borrow sites will be developed in areas where visual effects will be minimized
	4	Minimizing the effect to the natural landscape will be considered when designing and clearing for mine infrastructure development
	5	Where there is a potential for soil erosion, exposed soils will be revegetated with native species to enhance soil stability
	6	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
	7	Erosion will be mitigated by seeding, armouring or other techniques recommended by a qualified professional
	8	Slope stability studies will be completed to aid road design and construction
	9	If unstable slopes are identified, they will be avoided or suitable construction methods will be used to increase stability in these sections
	10	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
Section 8.1.3 – Soil Stability	11	Road cutslopes will be finished at stable slope gradients. The actual finished slope gradient of cutslopes will depend on the characteristics of surficial material
	12	Final cutslope gradient will be determined by an experienced professional following assessment of site specific soil texture
	13	Fillslopes will generally be prepared by removing vegetation and organic soils prior to placement of fill material
	14	If fillslopes are constructed in terrain with naturally steep slopes, (e.g., greater than approximately 30%), a qualified professional will determine the appropriate design, including road construction using full bench and end haul methods, or using an engineered fill or other designed structure
	15	Terrain at potential fillslopes will be assessed during predesign 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
	16	Culverts or bridges, as appropriate, will be placed at all natural watercourses. The diameters of culverts will be sized according to anticipated flow conditions, using appropriate methods of analysis
	17	Appropriate structures to pass potential debris flows will be designed where required
	18	Recommendations for culvert-spacing in areas with infrequent natural watercourses will be developed during assessment for final detailed design

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	19	Micro-watersheds will be defined to avoid the over-concentration of natural drainage runoff to culverts
	20	Inlets and outlets of culverts will be armoured, where required, to protect against erosion and disperse the flow energy on to natural slopes and streams
	21	Sumps will be installed as required at culvert entrances to help trap sediment
	22	Road maintenance will include monitoring and clearing of culverts, if required, to maintain culvert functionality during periods of peak volume runoff
	23	If sections of permafrost are identified during the geotechnical evaluation for detailed road design, specifications will be developed for these areas to minimize potential degradation of permafrost
	24	In order to mitigate the effects on permafrost in areas of road widening, these areas will be constructed to minimum widths acceptable for safe vehicle use in the mining operations, where possible
	25	KRH will employ slope stabilization in areas of sloughing
	26	Best management approaches will be used to reduce the potential to introduce sediment to streams during construction
	27	Sediment fences will be placed in ditches and other appropriate locations if intercepted runoff contains unacceptable levels of suspended sediment, as defined by the anticipated Water Licence required for this Project
	28	If necessary, construction will be suspended during periods of high precipitation to reduce the potential to introduce unacceptable levels of suspended sediment to streams
	29	Where fine-textured soils on cleared slopes are identified as having erosion potential from precipitation and run-off, revegetation of the slopes, or another appropriate cover method, will be implemented as a mitigative technique as required through prescriptive measures provided by a qualified professional
	30	Upon completion of road construction, KRH 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 the road surface, cut slopes and fill slopes
	31	The integrity and function of ditches and culverts and the integrity and stability of bridge abutments will checked regularly
	32	KRH will conduct monitoring to identify potential erosion processes that could result in unacceptable levels of suspended sediment in streams
	33	If monitoring of potential erosion in streams indicates that action is required, then practical measures will be implemented such as adding sediment fences in key locations and the temporary diversion of runoff away from streams
Section 8.1.3 – Human Safety	34	KRH will conduct on-going monitoring of slopes as a component of other on-going field monitoring (e.g., road monitoring).
	35	The magnitude and probability of occurrence of rockfalls will be evaluated during predesign geotechnical evaluation, and an appropriate mitigation strategy will be implemented, as required

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	36	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, and undertake appropriate mitigative actions, as required
	37	KRH will continue to control avalanche conditions proactively, whenever a hazard is observed or anticipated
	38	Development activity in areas of high avalanche hazard will be monitored, and if required, limited during periods of high avalanche probability
	39	A snow avalanche safety program is already in place at the KRP site, and it will continue to be operated. Appropriate safety equipment will be available on site during construction, operations, and decommissioning
Climate		
Section 8.2.4	40	KRH will consider connecting to the regional electrical power grid, to potentially reduce its diesel consumption at Site, and subsequently, its GHG emissions
	41	KRH will investigate and consider the feasibility of using commercially-available alternate energy sources
	42	Generators, vehicles and other machinery used on-site will be operated in an efficient manner
	43	KRH will conduct regular maintenance of all equipment
Air Quality		
Section 8.3.5	44	Particulate monitoring will be carried out at appropriate locations, where and as needed
	45	Employees will wear appropriate Personal Protective Equipment (PPE) in higher dust areas, to reduce the potential for particulate matter inhalation
	46	KRH will apply dust suppressants (such as water or calcium chloride), as required in areas of high activity under dry conditions, to minimize airborne dust
Noise Levels		
Section 8.4.5	47	Camp walls will be insulated, which will help minimize noise levels
	48	The camp layout / design positions on-site accommodation facilities away from more active mining areas, which will help minimize noise levels
	49	Noise related to blasing activities will be controlled and minimized to the extent possible, for example through the use of constructed berms, dampening mats, or other methods.
Ecosystems and Vegetation		
Section 8.5.4	50	KRH will minimize the site footprint and maximize the use of previously disturbed areas
	51	KRH will stabilize exposed soils early to limit soil loss through erosion
	52	Where possible, KRH will avoid Ecosystem Units that are sensitive or have higher rare plant habitat potential
	53	KRH will restrict on-site activities (e.g., ATV use) to the Project footprint/disturbed areas
	54	KRH will conduct reclamation trials to determine effective treatment options

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	55	KRH will reclaim disturbed areas to ecosystems that are viable and self-sustaining
	56	KRH will limit the extent of exposed soil and re-vegetate/cover exposed areas as soon as possible
	57	KRH will implement a program to verify equipment transported to and used on site is clean. KRH will conduct periodic monitoring of disturbed sites, particularly roadsides, for the presence of invasive species
	58	KRH will develop and implement a strategy for invasive species removal if present
	59	KRH will minimize ponding and pooling of water on disturbed surfaces
	60	KRH will apply appropriate dust suppressant as required, and in accordance with Yukon Environmental Programs Branch guidelines for the use of dust suppressants (YG Environment 2002)
	61	KRH will take reasonable measures to reduce vehicle traffic volumes
	62	KRH will post and monitor appropriate vehicle traffic speed limits
Wildlife		
Woodland Caribou – Section 8.6.3.4	63	A no hunting policy for all KRH employees and contractors will be implemented
	64	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas (i.e., mineral licks)
	65	A wildlife right-of-way policy will be implemented for all mine-related traffic
	66	Dust suppressants will be applied, where and as required
	67	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	68	Following mine closure, all infrastructure will be removed from the site and the footprint will be reclaimed
	69	The harassment of wildlife, including Woodland Caribou, will be prohibited, as defined under the *Wildlife Act* (Yukon)
	70	All helicopter traffic will avoid Woodland Caribou and other large mammals
	71	Caribou observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	72	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Woodland Caribou
	73	KRH will minimize the development footprint and maximize use of previously disturbed areas
	74	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	75	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	76	Storage and disposal of all hazardous waste will be carried out in an approved manner
Moose – Section 8.6.4.4	77	A no hunting policy for all KRH employees and contractors will be implemented

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	78	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas such as along the section of the access road that parallels the Ketza River
	79	A wildlife right-of-way policy will be implemented for all mine-related traffic
	80	Dust suppressants will be applied, where and as required
	81	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	82	Following mine closure, all infrastructure will be removed from the site and the footprint will be reclaimed
	83	The harassment of wildlife, including Moose, will be prohibited, as defined under the *Wildlife Act* (Yukon)
	84	All helicopter traffic will avoid Moose and other large mammals
	85	Moose observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	86	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Moose
	87	KRH will minimize the development footprint and maximize use of previously disturbed areas
	88	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	89	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	90	Storage and disposal of all hazardous waste will be carried outin an approved manner
Thinhorn Sheep – Section 8.6.5.4	91	A no hunting policy for all KRH employees and contractors will be implemented
	92	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas such as along the section of the access road that parallels the Ketza River
	93	A wildlife right-of-way policy will be implemented for all mine-related traffic
	94	Dust suppressants will be applied, where and as required
	95	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	96	Following mine closure, all infrastructure will be removed from the site and the footprint will be reclaimed
	97	The harassment of wildlife, including Thinhorn Sheep, will be prohibited, as defined under the *Wildlife Act* (Yukon)
	98	All helicopter traffic will avoid sheep and other large mammals
	99	Thinhorn Sheep observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	100	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases which will assess and address any other possible effects on Thinhorn Sheep

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	101	KRH will minimize the development footprint and maximize use of previously disturbed areas
	102	KRH will salvage organic or mineral topsoils for future re-application during reclamation
	103	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	104	Storage and disposal of all hazardous waste will be carried out in an approved manner
Grizzly Bear – Section 8.6.6.4	105	A no hunting policy for all KRH employees and contractors will be implemented
	106	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas, such as along the section of the Ketza Road that parallels the Ketza River
	107	A wildlife right-of-way policy will be implemented for all mine-related traffic
	108	As is the current practice at the Site, to minimize potential attraction / habituation of bears to the KRP, all work sites will be kept clean and free of garbage. All food waste, garbage, and non-hazardous waste will be burned in an on-site incinerator, and non-combustible waste will be disposed in an approved manner
	109	All hazardous waste will be stored and disposed in an approved manner
	110	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	111	Following mine closure, all of the infrastructure will be removed from site and the footprint will be reclaimed
	112	The harassment of wildlife, including Grizzly Bears, will be prohibited, as defined under the Wildlife Act (Yukon)
	113	All helicopter traffic will avoid Grizzly Bears and other large mammals
	114	Grizzly Bear observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	115	A wildlife monitoring program will be implemented during the construction, operation, and closure / reclamation phases which will assess and address any other effects on Grizzly Bears
	116	KRH will minimize the development footprint and maximize use of previously disturbed areas
	117	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	118	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	119	Storage and disposal of all hazardous waste will be carried out in an approved manner
Wolverine – Section 8.6.7.4	120	As is the current practice at the site, to minimize potential attraction/habituation of Wolverines to the KRP, all work sites will be kept clean and free of garbage. All food waste, garbage, and non-hazardous waste will be burned in an on-site incinerator. Non-combustible waste will be disposed in an approved manner
	121	A no hunting policy for all KRH employees and contractors will be implemented

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	122	Speed limits will be posted and enforced, especially in areas near sensitive wildlife areas, such as along the section of the Ketza Road that parallels the Ketza River
	123	A wildlife right-of-way policy will be implemented for all mine-related traffic
	124	All hazardous waste will be stored and disposed in an approved manner
	125	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures, including the appropriate protocol for addressing nuisance Wolverines
	126	Following mine closure, all of the infrastructure will be removed from site and the footprint will be reclaimed
	127	The harassment of wildlife, including Wolverines, will be prohibited, as defined under the *Wildlife Act* (Yukon)
	128	All helicopter traffic will avoid Wolverines and large mammals
	129	Wolverine observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	130	A wildlife monitoring program will be implemented during the construction, operation, and closure / reclamation phases which will assess and address any other effects on Wolverines
	131	KRH will minimize the development footprint and maximize use of previously disturbed areas
	132	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	133	KRH will re-contour, scarify, and seed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat
	134	Storage and disposal of all hazardous waste will be carried out in an approved manner
Raptor Nesting (Cliff Habitat) – Section 8.6.8.4	135	A nest survey will be conducted at the Site at the start of the breeding season each year, to locate any active raptor nests. If active raptor nests are found near work sites, appropriate measures will be taken to avoid disturbance of these nests during the breeding season (May 1 to August 1)
	136	Helicopter traffic will avoid raptors and active raptor nests
	137	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	138	Raptors observed by KRH employees and contractors within the KRP area will be recorded in a wildlife reporting log
	139	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases to assess and address any other possible effects on raptors
	140	KRH will minimize development footprint and maximize use of previously disturbed areas
	141	KRH will salvage organic and/or mineral topsoils for future re-application during reclamation
	142	KRH will re-contour, scarify, and reseed disturbed areas with appropriate and approved native seed mixes to restore productive wildlife habitat

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	143	Storage and disposal of all hazardous waste will be carried out in an approved manner
Upland Breeding Birds (Passerines) – Section 8.6.9.4	144	To reduce the effects of localized direct habitat loss, the Project footprint will be minimized as much as possible (including use of existing cleared lands). During the final abandonment phase, infrastructure pads, roads and development sites will be re-contoured and scarified as required to ensure surface stability, and to encourage re-establishment of native vegetation
	145	If upland breeding bird nests are encountered in close proximity to active work sites, appropriate measures will be taken, as possible, to minimize clearing activities that would disturb actively-used nests during the breeding season
	146	Dust suppressants will be applied, where and as required
	147	A no hunting policy for all KRH employees and contractors while working on-site will be enforced
	148	An employee training program will be conducted to ensure employees understand the importance of abiding by all wildlife mitigation measures
	149	A wildlife monitoring program will be implemented during the construction, operation, and closure/reclamation phases to assess and address any other possible effects on Upland Breeding Birds
Surface Water Quality		
Section 8.7.5	150	In areas of high activity under dry conditions, KRH will apply dust suppressants, such as water or calcium chloride, to minimize airborne dust, in accordance with Yukon Environmental Programs Branch guidelines for the use of dust suppressants (Yukon Environment 2002)
	151	A minimum 30 m riparian buffer will be maintained along streams, wherever possible
	152	KRH will limit vegetation removal, wherever possible. KRH will re-establish vegetation in cleared areas, where the Project plan allows.
	153	KRH will stabilize exposed erodible materials
	154	KRH will follow and maintain natural drainage patterns wherever possible
	155	KRH will use geochemical characterization to minimize PAG volumes and to understand long term ARD/ML behavior
	156	KRH will monitor drainage water quality to determine if ARD or ML is occurring
	157	Hazardous materials will not be stored within 30 m of any watercourse
	158	KRH will maintain and monitor equipment to ensure it is in good condition and leak free
	159	All motorized vehicles will be equipped with a spill response kit
	160	KRH staff will be familiar with the Emergency Response Plan which will be applied as soon as a spill or leak has been detected
	161	KRH will place fuel storage tanks in secondary containment
	162	Dust will be suppressed on the stockpiled ore when necessary through measures which could include wetting down with water, tarp coverings or constructing a shed structure over the stockpile to retain dust on the pad

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	163	KRH will visually inspect and record conditions of the waste rock dumps during mine operations, to look for signs of oxidation of sulphide minerals
	164	All waste rock stockpiles will be constructed with a low-permeability basal layer (pad) with drainage collection to an outlet pipe or structure
	165	KRH will segregate waste rock into NAG and PAG for storage in waste rock piles (PAG rock will be encapsulated so piles are net-NAG).
	166	KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of pads or liners
	167	Surface runoff from affected Site areas, including pits, waste rock dumps, and stockpiles will be directed to the TSF or treated to site specific water quality criteria as identified in the approved Water License for the KRP.
	168	A passive water treatment system may be included near waste rock dumps and/or open pit outfalls
	169	KRH will use geochemical characterization to minimize PAG volumes and to understand long term ARD/ML behavior
	170	Where possible, waste rock dumps will be placed on existing ground surface (above the existing groundwater table)
	171	Surface runoff from impacted Site areas, including pits, waste rock dumps and stockpiles will be directed to the TSF or treated to site specific water quality criteria as identified in the KRP's approved Water License.
	172	KRH will follow best practices for explosives handling and blasting
	173	All waste rock stockpiles will be constructed with a low-permeability basal layer with drainage collection to an outlet pipe or structure
	174	KRH will sample water from monitoring wells down-gradient of the waste rock stockpiles for potential leaks or failure of liners
	175	KRH will adhere to the Waste Management Permit for incinerating
	176	All food wastes and garbage will be incinerated regularly
	177	KRH will implement preventative design measures for TSF (e.g., full liner, drains, sump, recirculating system back to TSF); on closure, low-permeability cover and full reclamation of TSF; monitoring groundwater and surface water quality downstream of the TSF
	178	Groundwater and surface water around the TSF will be monitored during operations and after closure. The groundwater monitoring wells will be retained for use as long term monitoring devices
	179	Dewatering water will be diverted to the TSF during operation
	180	KRH will design the dewatering system to minimize dewatering volumes
	181	Surface runoff water that meets water quality discharge criteria will be released to the surface water drainage system. Drainage that does not meet those criteria will be conveyed and discharged to the TSF
	182	Water discharged from the TSF, Water Retention Pond, and waste rock piles will meet site specific water quality criteria as identified in the anticipated Water License for the KRP prior to discharge to the receiving environment
	183	Worksites will be kept clean and free of garbage

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	184	Non-combustible waste will be handled appropriately and either transferred to an off-site approved landfill or managed within an approved on-site landfill contained on an impermeable foundation and covered
	185	Leaks or spills will be contained and treated according to the Emergency Response Plan
	186	KRH will store hazardous materials as instructed by the manufacturer
	187	KRH will direct surface runoff away from/off the TSF at closure
	188	Selective discharge of tailings around the TSF will be conducted during the final years of operations to establish a final tailings beach that will facilitate surface water storage and reclamation
Hydrology		
Section 8.8.4	189	Downstream effects will be mitigated by controlling the rate and location of water withdrawal. If the water retention pond is not built prior to the construction and upgrading of haul roads, water will likely be sourced from Peel Creek
	190	The rate of water withdrawal, in total for all mine-related water uses, will be limited to 10% of Peel Creek flows to mitigate downstream withdrawal effects
	191	Ditches will follow local topography and drainage patterns
	192	Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream
	193	Temporary ditches will follow local topography and drainage patterns. Ditches and culverts will be sized for anticipated flow conditions to maintain continuous flows downstream
	194	The TSF will be filled during periods of high flow. Depending on the filling schedule, a maximum of 10% of the total natural Cache Creek flows at the Peel Creek confluence will be used.
	195	The TSF and water retention pond will not be filled concurrently
	196	A diversion structure will be built to maintain base flows from Peel Creek downstream and limit the filling rate during construction of the water retention pond
	197	Ditch inspections and maintenance will be conducted on a regular basis to ensure ditches are working properly
	198	Downstream effects will be mitigated by controlling and monitoring the rate and timing of water withdrawal from the water retention pond
	199	Discharges will be regulated to mimic natural pre-development flow conditions and prevent downstream channel erosion
	200	A streambed will be constructed through the water retention pond footprint to mimic and re-establish natural Peel Creek conditions
	201	Discharges will be regulated to prevent unwanted downstream channel erosion and mimic natural pre-development flow conditions
Hydrogeology		
Section 8.9.5	202	KRH will design the dewatering system to minimize contact of groundwater with PAG or ML rock types in open pits, underground mines, and explosive residues

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	203	KRH will follow best practices for explosives handling and blasting
	204	Dewatering water will be diverted to the TSF during operation
	205	KRH will design the dewatering system to minimize dewatering volumes
	206	KRH will monitor groundwater quality downgradient of flooded mine workings after closure, and extract and treat or remediate groundwater if required to meet applicable water quality criteria
	207	KRH will implement preventative design measures for the TSF (e.g., full liner, drains, sump, recirculating system back to TSF); on closure, a low-permeability cover and full reclamation of TSF.
	208	KRH will segregate waste rock into NAG and PAG for storage in waste rock piles (PAG rock will be encapsulated so piles are net-NAG). A liner and drainage collection system may be constructed under the waste rock piles, as required
	209	KRH will divert water that does not meet applicable water quality criteria to the TSF
	210	On closure, KRH will contour, cover and revegetate waste rock sites
	211	KRH will install an engineered ROM pad with runoff and leachate collected and conveyed to TSF
	212	KRH will implement dust suppression measures on the active ROM stockpile
	213	Water collected by the drains and sump that does not meet applicable water quality criteria will be pumped back into the TSF
	214	Selective discharge of tailings into the TSF will be conducted during the final years of operations to establish a final tailings beach that will facilitate surface water storage and reclamation
	215	During closure, KRH will construct an engineered cover, including runoff control, and progressively re-vegetate the remaining embankment faces and exposed tailings surfaces using overburden stockpiled from stripping activities
	216	KRH will construct a permanent outlet channel to enable discharge of clean surface water from the covered TSF to the reclaimed fresh water reservoir and downstream reaches of Cache Creek
	217	KRH will dismantle and remove the tailings and reclaim delivery systems, including the barge, all pipelines, structures, berms and equipment not required beyond mine closure
	218	KRH will dismantle and remove other related TSF infrastructure, including drainage diversion channels, tailings distribution and deposition systems, the fresh water pump station, and pipelines
	219	KRH will remove the seepage collection system when water quality objectives have been reached
	220	KRH will remove and re-grade all access roads, ponds, ditches, and borrow areas not required beyond mine closure
	221	KRH will stabilize exposed erodible materials
	222	Groundwater and surface water around the TSF will be monitored throughout the life of the Project. The groundwater monitoring wells will be retained for use as long term monitoring devices

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	223	Post-closure requirements will include an annual inspection of the TSF and an evaluation of impoundment water quality, sump flow rates and instrumentation records to confirm design assumptions for closure
	224	All dump sites will be constructed with a low-permeability basal layer with drainage collection to an outlet pipe or structure
	225	KRH will visually inspect and record conditions at the waste rock dumps during mine operations, to look for signs of oxidation of sulphide minerals
	226	KRH will monitor drainage water quality in accordance with with water quality criteria indicated in the anticipated Water License for the Project, to determine if ARD or ML is occurring
	227	Drainage water that meets water quality discharge criteria will be released to the surface water drainage system. Drainage that does not meet those criteria will be conveyed and discharged to the TSF
	228	On closure, the waste rock dumps will be contoured, covered with a low-permeability layer and revegetated
	229	The ROM pad will be designed and constructed (using concrete or compacted NAG rock) to collect and convey runoff and leachate to the TSF. The ROM pad will be constructed and commissioned under a high level of quality control, to ensure it functions as designed, before any ore is placed on the pad
	230	Dust will be suppressed on the stockpiled ore when and as necessary
	231	On closure, the pad structure will be decommissioned and removed if necessary along with rest of the mine infrastructure
Aquatic Ecosystems and Fisheries Resources		
Section 8.10.5	232	Water used to service the camp will usually come from an on-site well (rather than from a surface water source)
	233	KRH will recycle process water from the TSF so that water will not have to be diverted continuously from Cache Creek
	234	Additional water will be obtained from the water retention pond
	235	The diversion channel will divert the flow from Cache Creek around the TSF and Water Retention Pond. Excess clean water in the water retention pond will be released via a spillway
	236	Appropriate erosion and sediment control measures will help reduce sediment deposition into surface waters
	237	A minimum 30 m riparian buffer will be maintained along streams wherever possible
	238	KRH will limit vegetation removal wherever possible. KRH will re-establish vegetation in cleared areas where the project plan allows. Areas will be planted with native species whenever possible
	239	Zones that are not to be disturbed will be delineated clearly so that equipment operators are familiar these boundaries
	240	Erosion and sediment control measures will be implemented in areas where vegetation has been removed and erosion may be a concern

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	241	Stream water quality will be monitored during all phases of the Project
	242	Material movement and grading will be limited wherever possible
	243	Vegetation will be retained wherever possible and KRH will implement erosion and sediment control measures as and where necessary
	244	All clearing and site works will be completed with reference to, where appropriate, the DFO Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993), the Guidebook of Mitigation Measures for Placer Mining in the Yukon (YPS 2008) and the Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide (YCOM 2010). Diversion works or channel restoration works that may be required, will be undertaken with reference to the Guidebook of Mitigation Measures for Placer Mining in the Yukon
	245	Tailings and waste rock will be handled appropriately
	246	Areas will be retained with the intent of reinstating original flow patterns
	247	Sediment that accumulates in the water retention dam will be tested to determine if removal of the sediments is needed during reclamation and breaching of the water retention dam
	248	Procedures will be developed for handling explosives near surface water bodies. KRH will follow, where appropriate, DFO's Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters (Wright and Hopky 1998)
	249	The use of explosives will be limited wherever possible. Explosives will not be stored within 30 m of waterbodies.
	250	Appropriate erosion and sediment control measures will be implemented in proximity to surface water bodies where explosives may be used. Where possible, a vegetated buffer will be retained between explosives activity and watercourses.
	251	Clean-up measures will be implemented for spilled explosive products.
	252	Equipment operators will be informed as to the importance of limiting erosion near water bodies, the importance of proper equipment maintenance, and the necessity for spill response and management
	253	On-site personnel will be familiarized with the spill plan, spill response materials and procedures
	254	No fuelling or hazardous materials storage will occur within 30 m of any watercourse
	255	Any road and associated crossings that are no longer required for operation of the mine will be reclaimed
	256	Instream works and their footprint will be limited and avoided whenever possible
	257	Instream works will be completed before May or after early July to avoid the time period when grayling are likely to spawn and to allow time for the eggs to develop
	258	DFO operational statements for road crossings will be followed, as appropriate, and natural drainage patterns will be maintained wherever possible
	259	KRH will armour outfalls, as and where required, to prevent erosion and sedimentation
	260	KRH will limit the amount of diverted surface water that enters the tailings storage facility, so that flows are sustained

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	261	In addition to the main diversion channel redirecting partial flows from Cache Creek and Oxo Creek, there will also be a second open drainage ditch to collect surface runoff from the northwest and northeast of the TSF
	262	KRH will encourage efficient use of water on-site. Water conservation measures will be implemented wherever feasible
	263	An approved sewage treatment system will be employed
	264	A state of the art system for recovering clean water during sewage treatment is being investigated, however in the eventuality it is not determined to be feasible or if it is periodically inoperable, then treated sewage effluent will be comingled into the TSF along with process water
	265	Water collected in seepage or catchment ditches and contaminated groundwater will be collected and treated
	266	Water quality and quantity and stream sediment metals will be monitored throughout the life of the Project
	267	Diversion ditches will be put in place upslope of the waste rock dumps, and catchment ditches will be put in place downslope of the waste rock dumps, to prevent water from the waste rock dumps from entering the receiving environment
	268	If any natural watercourse that contains fish is used as a water source, the water withdrawal apparatus will contain a fish screen of an appropriate size to exclude fish. Reference the Freshwater Intake End-of-Pipe Fish Screen Guideline (DFO 1995) for guidance on installing fish screens
	269	Riparian vegetation will be retained wherever possible to protect watercourses
	270	Tailings and waste rock will be handled appropriately
	271	Stream water quality will be monitored during all phases of the Project
	272	Consolidation of the tailings will occur during deposition and after operations are complete until excess pore pressures have dissipated. This will increase the density of the deposit and will allow for an impermeable cover to be placed over the tailings after mine closure to limit the ability of water to seep into the tailings
	273	KRH will operate a land treatement facility to contain and treat non-hazardous wastes
	274	Garbage will be incinerated on site, as appropriate
	275	Waste oil will be collected, managed and disposed of in an appropriate manner
Heritage Resources		
Section 8.11.4	276	KRH will comply with all applicable regulations pertaining to the protection of heritage resources.
	277	KRH will comply with the *Yukon Mineral Exploration Best Management Practices for Heritage Resources* (YG TC 2010a) and the *Guidelines Respecting the Discovery of Human Remains and First Nation Burial Sites in the Yukon* (YG THB 1999)
	278	KRH will provide education to its employees on the protection of heritage resources. KRH employees will be provided general heritage resource identification tools as described in the *Handbook for the Identification of Heritage Sites and Features* (YG TC 2005)

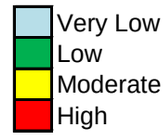
Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
	279	KRH employees will be informed as to the importance of leaving artifacts in place
	280	Should an employee discover a heritage resource at the KRP, they will be required to report the finding to a manager
	281	KRH employees will be advised to not disturb heritage sites whether on or off the KRP footprint
	282	If a potential heritage resource is discovered, KRH will adhere to actions as presented in the Traditional Knowledge Protocol
	283	If a heritage resource appears to be a human burial site, management personnel will first report the finding to the Royal Canadian Mounted Police
	284	Should a paleontological resource be found, KRH will adhere to actions as presented in the Traditional Knowledge Protocol
	285	KRH will continue to protect potential heritage resources until instructed otherwise by the authority to which the resources were reported
	286	KRH will mitigate effects to newly discovered heritage resources with employee education, avoidance, a buffer zone, and reporting
Socio-economics		
Section 9.4.1	287	KRH plans a standard 2-week in, 2-week out rotation for all employees. The two week period of time off will likely provide sufficient time for First Nation employees to pursue traditional economic activities
	288	KRH policies will include no firearms or other weapons allowed, and no hunting by employees while on rotation. No hunting by anyone allowed on the site and access through the site will be controlled for safety reasons
	289	KRH, through its MOU with the Ross River Dena, will use existing mechanisms to compensate the Ross River trappers for loss of access due to the company's activities
	290	Construction, operation, decommissioning, and monitoring phases total approximately 13 years. KRH will continue to explore its property for further reserves and attempt to extend the operating life of the mine
	291	Ketza River Holdings 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 Teslin
	292	KRH will offer a variety of standard programs for its employees. For employees recruited locally, KRH is planning to offer hands-on training in mine and mill operations in its Jerritt Canyon mine in Nevada. KRH will have a policy of initially posting all employment positions internally, and, with a particular focus on First Nation candidates, help create individual training and succession plans
	293	KRH will continue to actively recruit First Nation and female employees and continue to work with local contractors and suppliers through the construction, operation and closure of the Project
	294	As part of ongoing discussions with the Ross River Dena Council, the Liard First Nation, and the Teslin Tlingit Council, KRH is exploring ways of maximizing First Nation participation in the Project's business opportunities

Table 11.1-1: Summary of the Proposed Mitigation Measures

Component	Item #	Proposed Mitigation Measure
Section 9.4.2	295	To help employees and their families maintain good health, Ketza River Holdings will be offering a dental and extended health plan to all employees at the Ketza River Mine
	296	The camp will be dry through all phases of the Project, no alcohol or nonprescription drugs will be permitted. KRH will follow the industry standard and institute mandatory drug and alcohol testing for potential new employees and random testing thereafter
	297	KRH, while making workplace safety the first priority, will take a graduated disciplinary approach to employees suffering from drug or alcohol abuse issues and work with the employee if he or she wishes to enter a treatment program
	298	To increase the safety of its employees, contractors and the general public using the Ketza River road, KRH will install a radio communication system on the road to allow truck drivers to communicate their presence and location on the road to all users
	299	KRH will transport cyanide needed for mill processes to site only in solid briquette form. KRH will have a trained emergency response team, along with an assortment of relevant equipment available to respond to accidents and spills
	300	KRH 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
	301	KRH will follow all applicable safety laws and regulations in every aspect of its operations. KRH will provide every employee with the training required to safely do their work. KRH will have a fully qualified EMT on site with all required medical supplies and equipment and have an on-call medevacs service available at all times
Section 9.4.3	302	KRH 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
	303	KRH will look for opportunities to provide support for selected community events
Section 9.4.4	304	KRH has been maintaining Ketza Road using contractors from Ross River. Although KRH would like the Yukon Government to assume maintenance, KRH is prepared to continue to use local contractors for maintenance

Table 11.2-1: Summary of Residual Effects Assessments within the Local or Regional Study Area



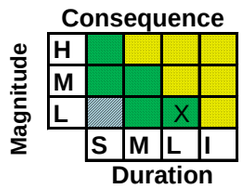
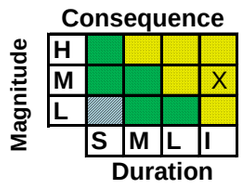
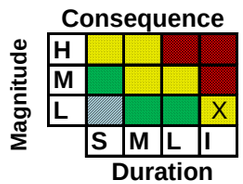
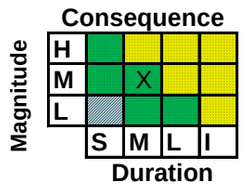
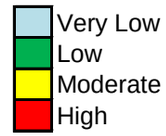
Component	Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Natural Landscape, Soil Stability, and Terrain	Stripped soils	Low	Local	Long-term	Isolated	Reversible Long-term	High	
Natural Landscape, Soil Stability, and Terrain	Permafrost degradation	Moderate	Local	Long-term	Isolated	Irreversible	High	
Climate	GHG emissions	Low	Beyond Regional	Medium-term	Continuous	Irreversible	High	
Air Quality	Exposure to particulate matter / dust emission	Moderate	Local	Medium-term	Periodic	Reversible Short-term	High	

Table 11.2-1: Summary of Residual Effects Assessments within the Local or Regional Study Area



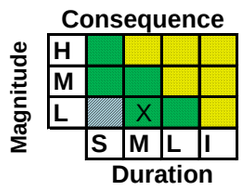
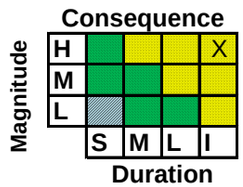
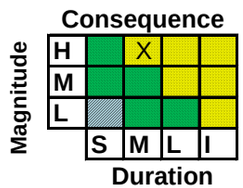
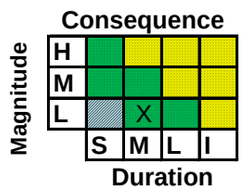
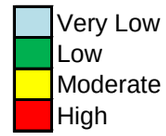
Component	Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Consequence
Noise	Noise	Low	Local	Medium-term	Periodic	Reversible Short-term	High	
Ecosystems and Vegetation	Removal/burial of Ecosystem Units and plant species (pits, waste rock storage areas)	High	Local	Long-term	Isolated	Irreversible	High	
Ecosystems and Vegetation	Removal/burial of Ecosystem Units and plant species (other infrastructure)	High	Local	Medium-term	Isolated	Reversible Long-term	High	
Ecosystems and Vegetation	Dust deposition and potential introduction of invasive plant species	Low	Local	Medium-term	Periodic	Reversible Long-term	High	

Table 11.2-1: Summary of Residual Effects Assessments within the Local or Regional Study Area



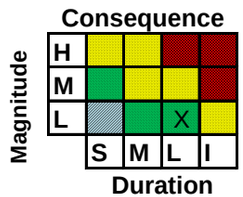
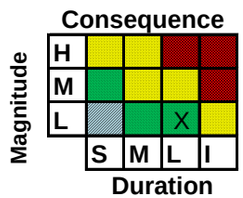
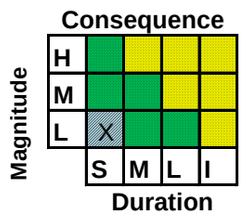
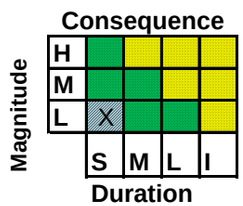
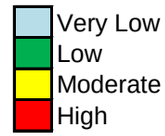
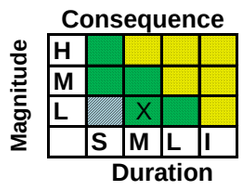
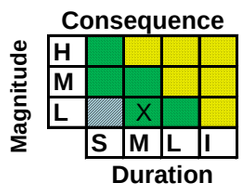
Component	Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Surface Water Quality	Drift and fill method for underground workings after decommissioning: Exposed rock in drifts could be a source of ARD and/or ML	Low	Regional	Long-term	Continuous	Reversible Long-term	Moderate	
Surface Water Quality	Open pit method after decommissioning: Exposed rock in open pits could be a source of ARD and/or ML	Low	Regional	Long-term	Continuous	Reversible Long-term	Moderate	
Surface Water Quality	Operation and Decommisioning of the WRP: Accumulated sediments and metals could be flushed downstream during a flooding or pumping event	Low	Local	Short-term	Isolated	Reversible Short-term	Low	
Surface Water Quality	TSF Operation and Decomissioning: Accumulated processing chemicals, sediments and/or metals could be flushed downstream through pumping	Low	Local	Short-term	Isolated	Reversible Long-term	Low	

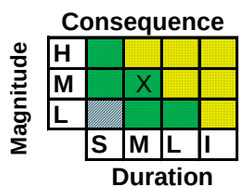
Table 11.2-1: Summary of Residual Effects Assessments within the Local or Regional Study Area



Component	Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Hydrology	Reduced flows during construction and maintenance of roads	Low	Local	Medium-term	Isolated	Reversible Short-term	High
Hydrology	Reduced flows dowstream during initial filling of TSF	Low	Local	Medium-term	Isolated	Reversible Short-term	Low
Hydrology	Reduced flows downstream during initial filling of WRP	Moderate	Local	Medium-term	Isolated	Reversible Short-term	Low
Hydrology	Reduced flows downstream during filling of the WRP after water use and reclaim	Moderate	Local	Medium-term	Isolated	Reversible Short-term	Low







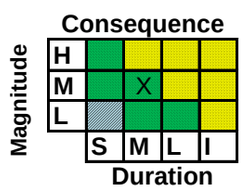
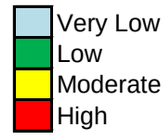


Table 11.2-1: Summary of Residual Effects Assessments within the Local or Regional Study Area



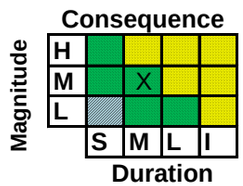
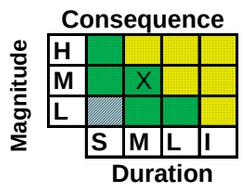
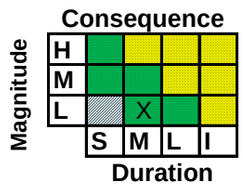
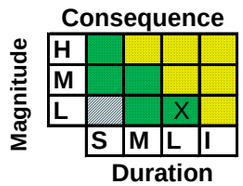
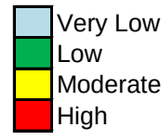
Component	Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Hydrology	Reduced flows downstream from surface runoff from Site dumps and pits diverted into TSF	Moderate	Local	Medium-term	Isolated	Reversible Short-term	Low	
Hydrology	Increased flows downstream from decommissioning WRP	Moderate	Local	Medium-term	Isolated	Reversible Short-term	Low	
Hydrogeology	Dewatering effects on local groundwater flow regime, Cache Creek base flow, and Tarn Lake	Low	Local	Medium-term	Periodic	Reversible Long-term	Moderate	
Hydrogeology	Negative effects on groundwater quality downgradient of abandoned mine workings	Low	Local	Long-term	Periodic	Reversible Long-term	Moderate	

Table 11.2-1: Summary of Residual Effects Assessments within the Local or Regional Study Area



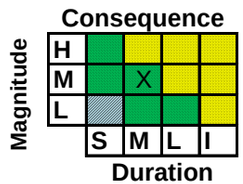
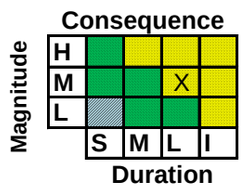
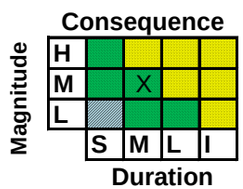
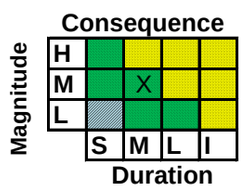
Component	Description of Residual Effect (after Mitigation)	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	
Aquatic Ecosystems and Fisheries Resources	Changes to riparian vegetation because of changes to topography	Moderate	Local	Medium-term	Isolated	Reversible Long-term	High	
Aquatic Ecosystems and Fisheries Resources	Changes to reach 5 of Cache Creek and fish passage	Moderate	Local	Long-term	Continuous	Reversible Long-term	High	
Aquatic Ecosystems and Fisheries Resources	Changes to water quality due to mobilization of fines from waste rock	Moderate	Local	Medium-term	Continuous	Reversible Long-term	Moderate	
Aquatic Ecosystems and Fisheries Resources	Changes to stream sediments	Moderate	Local	Medium-term	Continuous	Reversible Long-term	Moderate	

Table 11.3-1: Summary of Consequence and Significance Evaluation for Residual Effects

Description of Residual Effect (after Mitigation)	Consequence	Significance
Stripped Soils	Low	Low
Permafrost degradation	Moderate	Low
GHG Emissions	Moderate	Low
Exposure to particulate matter / dust emission	Low	Low
Noise	Low	Low
Removal/burial of Ecosystem Units and Plant Species (Pits, Waste Rock Storage Areas)	Moderate	Low
Removal/burial of Ecosystem Units and Plant Species (Other Infrastructure)	Moderate	Low
Dust Deposition and Potential Introduction of Invasive Plant Species	Low	Low
Drift and fill method for underground workings after decommissioning: Exposed rock in drifts could be a source of ARD and/or ML	Low	Low
Open pit method after decommissioning: Exposed rock in open pits could be a source of ARD and/or ML	Low	Low
Operation and Decommisioning of the Water Retention Pond: Accumulated sediments and metals could be flushed downstream during a flooding or pumping event	Very Low	Low
TSF Operation and Decomissioning: Accumulated processing chemicals, sediments and/or metals could be flushed downstream through pumping	Very Low	Low
Reduced flows during construction and maintenance of roads	Low	Low
Reduced flows dowstream during initial filling of TSF	Low	Low
Reduced flows downstream during initial filling of WRP	Low	Low
Reduced flows downstream during filling of the WRP after water use and reclaim		
Reduced flows downstream from surface runoff from Site dumps and pits diverted into TSF	Low	Low
Increased flows downstream from decommissioning WRP	Low	Low
Dewatering effects on local groundwater flow regime, Cache Creek base flow, and Tarn Lake	Low	Low
Negative effects on groundwater quality downgradient of abandoned mine workings	Low	Low
Changes to riparian vegetation because of changes to topography	Low	Low
Changes to reach 5 of Cache Creek and fish passage	Moderate	Low
Changes to water quality due to mobilization of fines from waste rock	Low	Low
Changes to stream sediments	Low	Low

12.0 CUMULATIVE EFFECTS ASSESSMENT

12.1 Regulatory Context

YESAA states that "in conducting an assessment of a project or existing project, a Designated Office, the Executive Committee, or a Panel of the Board must consider:"

> *The significance of any adverse cumulative environmental or socio-economic effects that have occurred or might occur in connection with the project or existing project in combination with the effects of:*
>
> *(i) other projects for which proposals have been submitted under subsection 50(1), or*
>
> *(ii) other existing or proposed activities in or outside Yukon that are known to the designated office, executive committee or panel of the Board from information provided to it or obtained by it under this Act (Section 42(d)).*

YESAA does not provide a definition of cumulative effects, nor guidance on the means of addressing this requirement. YESAB defines cumulative effects with respect to the assessment of projects as *changes to environmental or socio-economic components caused by an activity (related to a project being assessed) in combination with other past, present, and future activities.* YESAB guidelines have attempted to explicitly outline the different phases during project development that should be taken into account during the cumulative effects assessment, including pre-development, present, project, and post-project periods.

YESAB recommends the following framework for completion of a cumulative effects assessment.

1. Identify Regional VESECs
2. Identify and Characterize Cumulative Effects Baseline Information
3. Determine Spatial Bounding of Assessment
4. Identify Other Projects and Activities, and Residual Effects
5. Determine Temporal Bounding of the Assessment
6. Identify and Characterize Potential Cumulative Effects and their Mitigation
7. Rank Significance of Cumulative Effects.

The cumulative effects assessment for the KRP is outlined and discussed in the following sections. The KRP cumulative effects assessment process follows the guidelines as outlined in *Assessor's Guide to the Assessment of Cumulative Effects* (YESAB 2006b) and *Guide to Socio-economic Effects Assessment* (YESAB 2006a).

12.2 Ketza River Project Cumulative Effects Assessment

Cumulative effects represent the sum of all natural and human-induced influences on the cultural, physical, biological, and economic components of the environment within a period of space and time. The effects assessment for the KRP identifies a range of local effects on the various cultural, physical, biological and economic components (Sections 8 and 9). The next step is to determine if these potential local and regional

effects would combine with the effects from other current and reasonably foreseeable projects and activities in the region. At the same time, the influence of natural changes in environmental conditions is considered. Thus, the goal is to determine the chance and strength of potential incremental cumulative effects from the Project on cultural, physical, biological and economic components of the environment.

The Project's contribution to cumulative effects is assessed based on its effects on VESECs that are also affected by other land uses within defined spatial and temporal boundaries. Communities, roads, other developments, and hunting are examples of other land uses. Overall cumulative effects are effects of all land uses on a VESEC, including effects caused by the Project.

For a number of components the chance that cumulative effects from the KRP would occur is negligible or non-existent. This is largely because the geographical extent of identified potential residual effects associated with the Project does not overlap the geographical extent of other projects and activities. Sections 8 and 9 provide in-depth discussions of potential effects to the biophysical and human environment, respectively. As discussed in those sections, potential residual effects to VESECs determined to extend beyond the LSA and having the potential to add to effects from other land uses are considered. Where all adverse effects on a particular VESEC were completely mitigated, cumulative effects on that VESEC are not considered further (YESAB 2006b). Also, any potential residual effects confined to the LSA and not adding to effects from other projects and land uses are not considered cumulative effects and therefore, are not assessed

12.2.1 Regional Valued Environmental and Socio-economic Components

VESECs selected for the KRP effects assessment (Sections 8 and 9) are presented in Table 12.2-1. The potential cumulative effects on all these VESECs are considered. No additional VESECs are considered.

Table 12.2-1: VESECs Identified in Effects Assessments (Sections 8 and 9)

VESEC	Reason for Choice	TYPE[1] (●)				
		Focal Species	Representa-tion	Special Elements	Ecological Processes	Socio-economic
Natural Landscape				●		
Soil (Stability)				●		
Human Safety				●		●
Climate	Global Warming			●		●
Air Quality	Health and Safety concerns			●		●
Noise Levels	Health and Safety concerns; disturbance			●		●
Sensitive Ecosystems	Effect on Biodiversity				●	
Rare Plant Habitat Potential	Species of Special Concern; Biodiversity			●	●	
Woodland Caribou	Species of Special Concern, culturally important	●	●		●	●

Table 12.2-1: VESECs Identified in Effects Assessments (Sections 8 and 9)

VESEC	Reason for Choice	TYPE[1] (●)				
		Focal Species	Representa-tion	Special Elements	Ecological Processes	Socio-economic
Moose	Importance in large mammal predator-prey dynamics and food source	●	●		●	●
Thinhorn Sheep	Importance in large mammal predator-prey dynamics, social and economic importance	●	●			●
Grizzly Bear	Species of Special Concern, social and economic importance	●	●			
Wolverine	Biological indicator, cultural and economic significance	●	●			
Raptor Nesting Habitat	Conservation status, cultural importance		●	●	●	
Upland Breeding Birds	Representative of ecosystem health	●	●		●	
Water Quality	Surface water not used directly by people (i.e., drinking) but is used directly by aquatic and terrestrial plants and animals, which people use in turn			●	●	
Hydrology: Water Quantity Flow timing	Total water removed from the system and the resulting concentration of arsenic were found to be major contributing factors for supporting fish and benthic habitats			●	●	
Groundwater Quality	Potential effects on local aquifers which will eventually discharge to surface water and potentially affect surface water quality			●		
Groundwater Quantity	Potential effects on local aquifers			●		
Benthic Invertebrates	Indicator of ecosystem health				●	
Fish Habitat – Riparian Vegetation	Life cycle importance, Biodiversity				●	
Fish Habitat – Stream Substrate	Life cycle importance, Biodiversity				●	
Fish Presence and Abundance	Representative of ecosystem health				●	
Heritage Resources	Cultural importance			●		
Culture: values, tradition, language, spirituality	YESAB's Guide to Socio-economic Effects Assessments					●
Social cohesion, quality of life and ability to adapt positively to pace of economic change	YESAB's Guide to Socio-economic Effects Assessments					●
Land usability for traditional economy and/or other alternative economic activities.	YESAB's Guide to Socio-economic Effects Assessments					●

[1]Table and associated categories are taken from YESAB (2006).

12.2.2 Cumulative Effects VESEC Baseline Information

Sections 4.0 and 5.0, and their related appendices, present the existing local and regional conditions for the biophysical environment and socio-economic conditions. This information provides the baseline for the cumulative effects assessment of the VESECs. No additional applicable information is required for the cumulative effects assessment process.

12.2.3 Spatial Boundaries

The boundaries for the KRP RSA, or WRSA were designed to quantify baseline conditions at a scale that was large enough to assess the maximum predicted geographic extent (i.e., zone of influence) of potential direct and indirect effects from the KRP on most VESECs. Potential project-related effects at the regional scale include potential changes to downstream water quality and quantity, vegetation communities, wildlife habitat quality, wildlife and fish, and people that use these ecosystem services. Cumulative effects are typically assessed at a regional spatial scale and, where relevant, may consider influences that extend beyond the RSA. For cumulative effects to water resources, the geographic scope includes all areas that the proposed project may potentially affect, including the Pelly River drainage basin. The geographic scope for assessing effects to the human environment is selected to encompass any potentially affected communities.

The cumulative effects assessment area identified for the KRP is shown on Figure 12.2-1, and corresponds to the Kaska Dena Territory, which was used for the socio-economic effects assessment (Section 9). The spatial extent of the Kaska Dena Territory encompasses a large area with past / existing projects and planned projects, which require consideration in the cumulative effects assessment.

12.2.4 Temporal Boundaries

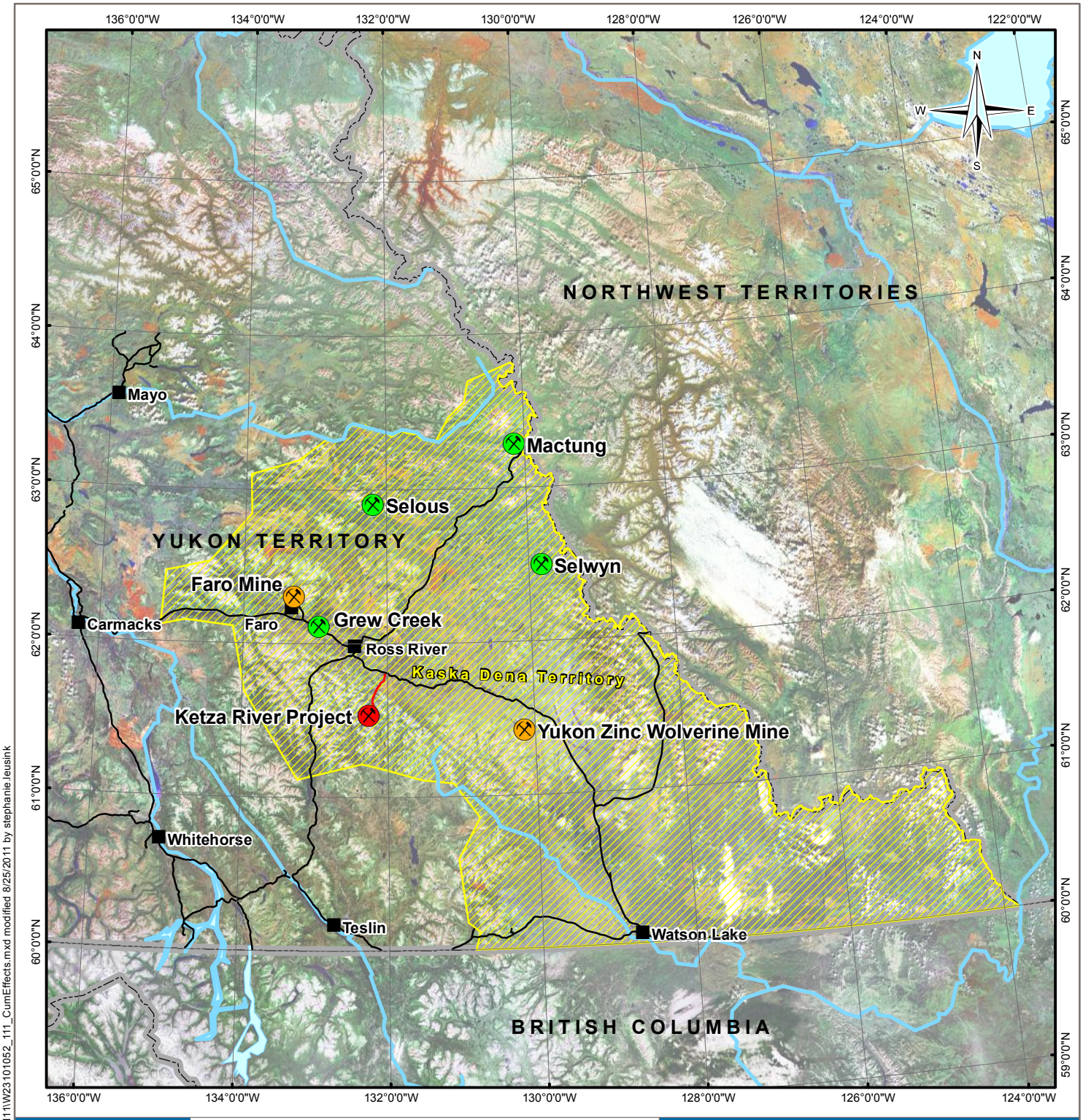
The approach used to determine the temporal boundaries of potential cumulative effects from natural and human-related disturbances on VESECs is based on an understanding of the potential residual (post-mitigation) effects of the KRP, linked to an understanding of the likely duration of these potential effects. The temporal boundary for the cumulative effects assessment extends through the life of the project, including following reclamation.

12.2.5 Regional Developments

A review of previous and existing, and reasonably foreseeable projects within the spatial scope of the KRP cumulative effects assessment was completed. The projects considered as having the potential to contribute to KRP's potential effects are described below. Their locations relative to the KRP are shown on Figure 12.2-1.

12.2.5.1 Previous and Existing Developments

The following projects are currently operating within the KRP's cumulative effects assessment area and therefore, their effects on the Project VESECs are considered. The project descriptions are taken from each project proponent's webpage (link provided).



LEGEND

- Ketza River Project
- Past/Existing Project
- Planned Project
- Kaska Dena Territory
- Town or Community
- Major Road
- Ketza Road
- Political Boundary
- Watercourse
- Waterbody

NOTES
Base data source: Yukon Geomatics

STATUS
ISSUED FOR USE

KETZA RIVER PROJECT

Cumulative Effects Assessment Area

PROJECTION	DATUM	CLIENT
Albers	NAD83	Ketza River Holdings

Scale: 1:4,000,000
50 25 0 50 100
Kilometres

FILE NO.				
W23101052_111_CumEffects.mxd				
PROJECT NO.	**DWN**	**CKD**	**APVD**	**REV**
W23101052.111	SL	GC	GC	0
OFFICE	**DATE**			
EBA-VANC	July 26, 2011			

eba
A TETRA TECH COMPANY

Figure 12.2-1

Q:\Vancouver\GIS\ENVIRONMENTAL\W23\W23101052_KetzaMaps\111\W23101052_111_CumEffects.mxd modified 8/25/2011 by stephanie.leusink

Wolverine Mine (Yukon Zinc)

(http://www.yukonzinc.com/en/operations_index.cfm)

The Wolverine Mine is located in southeast Yukon, Canada, 282 km northeast (as the crow flies) from the capital city Whitehorse, and 190 km by road north of Watson Lake and 180 km south of Ross River via the Robert Campbell Highway. The Wolverine property encompasses 107 square kilometres, and is accessible either via a 26 km access road west from the Robert Campbell Highway or a 1,200 metre long all-season gravel airstrip. The Wolverine Project is approximately 114 km east of the KRP.

Yukon Zinc's Wolverine Mine is a high grade zinc-silver-copper-lead-gold underground mine, with on-site milling capabilities of 1,700 tpd to produce zinc, copper and lead concentrates. The current mine life is 9.5 years based on a 5.2 Mt deposit and there is potential to expand the reserve through drilling.

Yukon Zinc completed major site construction at Wolverine throughout 2009 and 2010. Mill commissioning commenced in mid-2010, and production will increase to design capacity in 2011. The concentrate from Wolverine will be trucked to the British Columbia port at Stewart.

Yukon Zinc is fully permitted to operate the Wolverine Mine. Yukon Zinc was issued a Quartz Mining License by the Yukon Government in December 2006 and a Type A Water Licence by the Yukon Water Board in October 2007. Through all phases of permitting, consultation was conducted with various Federal and Yukon government agencies, the Kaska First Nation including RRDC and LFN, and other stakeholders.

Faro Mine Reclamation

(http://www.faromine.ca/news/2009/02/recommended_closure_plan_for_t.html)

The Faro Mine area is approximately 102 km northwest of the KRP. Reclamation planned for the mine site will address various elements of human health and safety and protection of the environment, maximize socio-economic benefits for affected First Nations and other Yukon residents, and manage long-term risks in a cost effective manner. The overall estimated cost for the project is $450 - $590 million. The recommended closure plan involves a stabilize-in-place approach. This approach will include upgrading dams to ensure tailings stay in place during natural events such as earthquakes and floods. In addition, all waste rock will be re-sloped to improve long-term stability and engineered soil covers will be installed over all tailings and waste rock. The plan also provides for state-of-the-art collection and treatment systems for contaminated water.

The major construction phase is expected to take about 15 years. Ensuring jobs and business opportunities for affected Yukon First Nations and Yukon residents is one of the key objectives of this project. The construction phase will be followed by an adaptation phase of approximately 20-25 years in which all of the various on-site elements (e.g.,soil covers, structures, collection and treatment systems) will be tested, monitored, and improved as required.

12.2.5.2 Reasonably Foreseeable Projects

This section summarizes the potential future projects included in the KRP cumulative effects assessment. The reasonably foreseeable projects included are projects or activities that have been proposed and scoped to a reasonable level of detail to predict anticipated pressures on the Project's VESECs. The project descriptions are taken from each project proponent's webpage (link provided).

Mactung (North American Tungsten Corporation, Ltd)

(http://www.natungsten.com/s/Mactung.asp)

The Mactung property is located in the Selwyn Mountain Range and covers the area around Mt. Allan, approximately eight kilometres northwest of MacMillan Pass. The nearest settlement accessible by road, Ross River, is 250 km away to the southwest along the Canol Road, a drive that takes about six hours. The property is located at latitude 63º17'N and longitude 130º10'W, approximately 224 km from the KRP. The Project is forecast to run at 2,000 tpd from an underground operation using conventional long hole plus cut and fill mining methods. The ore will be processed into both a premium gravity concentrate and a flotation concentrate.

Mine life is 11.2 years for the underground mine with the potential to expand by 17 years with an open pit, exploiting near surface, lower grade indicated and inferred mineral resources. The capital expenditure estimate is comprised of a project capital cost of $356.5 million plus a contingency of $45.6 million.

In December 2010, the Company commenced the process of project review by YESAB; a decision document by YESAB is expected to take between 12 and 15 months.

Grew Creek (Golden Predator Corporation)

(http://www.goldenpredator.com/Grew-Creek.html)

The road-accessible Grew Creek Property is located along the Robert Campbell highway, midway between Faro and Ross River, Yukon. The Grew Creek Project is approximately 74 km southeast of the KRP.

The Company optioned the property from prospector Al Carlos in July 2010, and may acquire a 100% interest in the property.

In September 2010 and May 2011, the Company staked an additional 305 claims at the Grew Creek Property and acquired a 100% interest in 10 claims, increasing the total number of claims to 666 claims covering approximately 135 km^2.

Selwyn Project (Selwyn Resources, Ltd)

(http://www.selwynresources.com/en/selwyn_overview.cfm)

The Selwyn Project is located in eastern Yukon and straddles the border with the Northwest Territories (NWT). More than 90 percent of the Selwyn district is in the Yukon, with only the southeast end extending across the border into the NWT. The Selwyn Project is approximately 167 km northeast of the KRP.

The Selwyn Project is the consolidation of the Howard's Pass Joint Venture lands acquired from Placer Dome and Cygnus mines Ltd., and Selwyn's wholly owned lands in the Selwyn District. Selwyn has completed more than $70 million of exploration on them. The property consists of 7,450 ha of mineral claims in the Yukon and 2,162 ha of Mining Lease lands in the Northwest Territories, referred to as the Howard's Pass Joint Venture. In addition, Selwyn has 19,294 ha of mineral claims in the Yukon and 3,373 ha of wholly owned claims in the Northwest Territories.

Selwyn has carried out extensive baseline environmental and engineering studies in 2006, 2007, 2008 and 2009 to gather the information necessary to enter the permitting process in Spring 2010 under the *YESAA* process. A preliminary assessment of the site features and the character of the ores suggests that a mine can be developed in a manner that results in minimal long term environmental impact. The non-acid generating characteristics of the mineralization are very important in mitigating water contamination issues and waste management.

Selwyn has developed a tentative permitting and development schedule that would see the completion of permitting by mid-2012 and receipt of permits in late 2012 in conjunction with completion of a bankable feasibility study. It is expected that construction will take 18 to 24 months and commissioning of the mill will occur in mid-2014.

Selous Project (Overland Resources, Ltd.)

(http://www.overlandresources.com/ProjectOverview.html)

Overland Resource's Yukon Base Metal Project comprises 502 Mineral Claims covering approximately 100km^2 surrounding the high grade Andrew (renamed Selous) Zinc Deposit. Overland Resources Limited owns a 90% interest in the project. The Selous Project is located approximately 110 km north of Ross River, Yukon, in mountainous terrain at an elevation of approximately about 1,400 m.

The Selous Project is approximately 153 km north of the KRP. It is anticipated that a Project Proposal for the development of a zinc open pit mine will be submitted under *YESAA* in 2012.

12.2.6 Potential Cumulative Effects and Proposed Mitigation Measures

Sections 8 and 9 of this Project Proposal present an assessment of potential effects of the KRP on all of the key environmental and socio-economic components (VESECs) in terms of anticipated residual effects, and their defining characteristics, including: nature / geographic scope, direction, magnitude, timing/duration, frequency, reversibility, likelihood / confidence and significance (definitions of these criteria are provided in Table 7.1-2).

The following sections discuss the potential for cumulative effects of KRP components to combine with other past, present or future projects in the cumulative effects assessment area (Figure 12.2-1).

12.2.6.1 Natural Landscape, Soil Stability, and Terrain Hazards

Through conducting surficial geology and terrain hazard baseline studies, the following VESECs have been identified:

- Natural landscape
- Stability of soils
- Human safety.

The natural landscape component was identified due to its importance to both ecological processes as well as social values. Soil stability was selected as it is an ecological processes that is inherent to the health of an ecosystem. Human safety was selected as a VESEC due to the potential effects of terrain hazards such as rockfalls, snow avalanches, debris flows and landslides to affect the safety of on-site employees. The local effects characterization for these VESECs is provided in Section 8.1.

The effects of KRP activities on the VESECs of water quality, soil stability and human safety from a geology and terrain hazards standpoint are considered low, following the implementation of mitigation measures, with no potential residual effects anticipated. 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 consequence of the effects has been assessed by considering the magnitude, extent and duration of the Project-related activities. The overall significance of the residual 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 subjected to limited recreational use due to its remote location and limited level of access which means that the residual aesthetic effects are limited to a small number of people. Decommissioning and reclamation of the mine infrastructure and roads will reduce the overall visual effects, and over time the residual effects will continue to diminish.

Therefore, due to the relatively remote location of the site, the reversibility of the effects in the long-term, and the limited geographic extent, the aesthetic residual effect to humans will be minimal.

Any incremental residual effects that may occur from the KRP on these VESECs have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.2 Climate

Climate is recognized as a VESEC for the Project. Climate, particularly in northern regions, is of concern in relation to global warming, due to a global increase in GHG emissions which threaten the ecosystems which northern communities depend on. With global emphasis being placed on climate and its rate of change, this VESEC is of high importance to society, at a community, territorial and national level.

As outlined in Section 8.3, mitigation measures are proposed to reduce potential contributions of GHG emissions from the KRP. Any remaining GHG emissions will contribute to the territorial GHG inventory and will have a cumulative effect with the projects identified within the cumulative effects assessment area (Figure 12.2-1).

KRH will implement the mitigation measures as proposed to reduce GHG emissions to the fullest extent possible at KRP. GHG emissions from the other projects identified in the cumulative effects assessment area will be cumulative; however, measures to reduce regional GHG emissions is beyond KRH's responsibility.

Following the implementation of mitigation measures the cumulative effect of GHG emissions on the traditional territory was determined to be low.

12.2.6.3 Air Quality

Air quality is identified as a VESEC, as KRP activities will produce emissions that have the potential to directly affect human health and safety and indirectly affect wildlife resources, particularly in the vicinity of the mine, and potentially down valley as airborne constituents. Of particular concern with mining operations are total suspended particulates (TSP), specifically particulates less than 10 µm in diameter (PM_{10}). Section 8.4 discusses potential local effects of dust emissions.

Dust emissions are primarily limited to the airshed of the LSA, and potential air quality effects are considered to be of very low significance outside of the LSA. Dust emission inside the LSA is of moderate significance because meteorological conditions, which will likely lead to high levels of particulate matter (PM) near the surface, will likely be periodic in nature. Moreover, air quality will return to baseline after completion of the KRP.

Potential effects from dust will be local in geographic extent. With the implementation of the prescribed mitigation measures, KRP activities are not anticipated to result in any significantly adverse residual effects. Any incremental residual effects that may occur from the KRP have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.4 Noise

Noise level has been designated as a VESEC, as it is anticipated that the Project will elevate noise levels above baseline within the LSA. Potential effects will be local in geographic extent and confined to the duration of the Project. KRP activities are not anticipated to result in any significantly adverse residual effects. Any incremental residual effects that may occur from the KRP on this VESEC has negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.5 Ecosystems and Vegetation

VESECs considered in the effects assessment (Section 8.5) include ecosystems and plant species in general, as well as ecosystems that may be particularly sensitive to disturbance and those with a higher potential to support rare plant habitat (Table 8.5-1). Sensitive ecosystems include wetlands and those with a high lichen or Sphagnum component.

Within the KRP area, the removal or burial of ecosystem types and plant species will occur during construction and the effects will remain until the closure and decommissioning phase (Table 8.5-7). The effects are considered to be of high magnitude and of moderate consequence overall. Activities resulting in the irreversible disturbance of Ecosystem Units (e.g., through pit excavation and deep burial by waste rock) have also been assigned a moderate consequence due to the localized nature of the disturbance and the presence of affected ecosystems elsewhere in the LSA.

Effects to Ecosystem Units and plants from dust deposition and the potential introduction of invasive plant species have been assessed as being of low magnitude, persisting over the life of the KRP (e.g., medium-term). The effects will occur periodically and will be reversible over the long-term.

The residual effects described for ecosystems and vegetation have been determined to be of low significance overall due primarily to their localized and largely reversible nature. Any incremental residual effects that may occur from the KRP on these VESECs have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.6 Wildlife

The Project has the potential to directly or indirectly affect wildlife species within the RSA or LSA throughout the life-cycle of the KRP. KRP components that may potentially affect wildlife and wildlife habitat include the construction, operation, decommissioning and reclamation phases.

Wildlife VESECs considered in the effects assessment (Section 8.6) include Woodland Caribou, Moose, Thinhorn Sheep, Grizzly Bears, Wolverine, Raptor Nesting Habitat and Upland Breeding Birds. The effects assessment determined that potential adverse effects of the KRP on the wildlife VESECs are expected to be low in magnitude and local in geographic extent. With the implementation of the prescribed mitigation measures, KRP activities are not anticipated to result in any significantly adverse residual effects. Any incremental residual effects that may occur from the KRP on these VESECs have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.7 Surface Water Quality

Surface water quality is a VESEC in itself. High water quality increases ecological productivity, and subsequently, socio-economic benefits. The surface water in the RSA is not used directly by people (i.e., drinking), but it is used directly by aquatic and terrestrial plants and animals which people use in turn. The potential effects on surface water quality are assessed in spatial and temporal scales within Section 8.7.

After mitigation measures are applied, there is the potential for residual effects associated with:

- The drift and fill method for underground workings: exposed rock in drifts could be a source of ARD and/or ML
- Open pit method: Exposed rock in open pits could be a source of ARD and/or ML
- Short sub-level open stopping underground method: Exposed rock in stopes could be a source of ARD and/or ML.

These potential residual effects are attributed high consequence because of their potential to affect surface water in the RSA. Potential residual effects associated with ARD/ML will not occur over a short time period. Monitoring of groundwater and surface water will indicate if this potential residual effect is occurring, as metals concentrations will increase and pH levels will decrease. If the potential effect is observed, further mitigation measures will be developed and applied as soon as possible. Additional mitigation measures may include groundwater treatment, surface water treatment and re-engineering of the underground and/or open pit workings.

After mitigation measures are applied, there is the potential for residual effects associated with:

- Operation of the Water Retention Pond: Accumulated sediments and metals could be flushed downstream during a flooding or pumping event
- TSF Operation: Accumulated processing chemicals, sediments and/or metals could be flushed downstream through pumping.

These potential residual effects are associated with release of water from the Water Retention Pond and TSF; and have been assessed as having a low consequence. With application of the mitigation measures outlined in Tables 8.7-2 and 8.7-3, this is unlikely to occur to an extent that surface water quality downstream will be affected.

All five potential residual effects discussed above are anticipated to be confined to the mine footprint or LSA. There is a low probability of residual effects on surface water quality extending slightly downstream post-closure; however, none of the potential residual effects are anticipated to extend beyond the RSA.

Any incremental residual effects that may occur from the KRP have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.8 Hydrology

Potential residual effects to surface water quantity (hydrology) identified from Section 8.8 include:

- Reduced flows during construction and maintenance of roads
- Reduced flows downstream during initial filling of TSF
- Reduced flows downstream during initial filling of water retention pond
- Reduced flows downstream from surface runoff from Site dumps and pits diverted into TSF
- Increased flows downstream from decommissioning water retention pond.

These potential residual effects will be largely confined to the development footprint and areas slightly downstream. It is unlikely these residual effects would extend beyond the Cache Creek watershed or outside the LSA.

Residual effects to surface water hydrology resulting from the KRP have a negligible to nil potential of overlapping in time or space with residual effects from other developments. Therefore they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.9 Hydrogeology

Potential residual effects to groundwater quantity and groundwater quality identified in Section 8.9 include:

- Dewatering effects on groundwater quantity
- Groundwater flow through abandoned mine workings and potential effects on groundwater quality.

Both potential residual effects are anticipated to be confined to the mine footprint. There is a low probability of a residual effect on groundwater quality extending slightly downstream post-closure; however, neither potential residual effect is anticipated to extend beyond the LSA.

Any incremental residual effects that may occur from the KRP on these VESECs have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.10 Aquatic Ecosystems and Fisheries

The following VESECs have been identified for the aquatic ecosystems and fisheries components of the KRP:

- Water quality
- Water quantity
- Benthic invertebrates and periphyton
- Fish Habitat - Riparian
- Fish Habitat - Stream substrate
- Fish presence and abundance.

Predicted residual effects on the aquatic VESECs are anticipated to be generally localized to the Cache Creek watershed and the immediate Project footprint. The majority of the residual effects are expected to last for the projected life of mine (medium-term) but are also expected to be reversible following decommissioning and reclamation of the Site. Given the limited aquatic productivity of the Cache Creek system and the implementation of the mitigation measures, including the future reclamation of the water retention pond, the overall significance of the KRP on the aquatic VESECs is assessed to be low, and the effect of the KRP on the aquatic resources of the region are anticipated to be insignificant.

Any incremental residual effects that may occur from the KRP on these VESECs have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, they are not assessed for cumulative effects (YESAB 2006b).

12.2.6.11 Heritage Resources

No heritage resources were identified during baseline studies (Section 8.11). One study indicated that due to the terrain type, it was unlikely that heritage resource sites would be found in the area. Therefore, there are no residual effects identified. Therefore, heritage resources are not assessed for cumulative effects (YESAB 2006b).

12.2.6.12 Aesthetics

Residual visual / aesthetic effects on the natural landscape, following implementation of mitigation measures, will remain. The overall consequence of the potential effects has been assessed by considering the magnitude, extent, and duration of the Project-related activities. The overall significance of the residual 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 subjected to limited recreational use due to its remote location and limited level of access which means that the residual aesthetic effects are limited to a small number of people. Decommissioning and reclamation of the mine infrastructure and roads will reduce the overall visual effects, and over time the residual effects will continue to diminish.

Therefore, due to the relatively remote location of the site, the reversibility of the effects in the long-term, and the limited geographic extent, the aesthetic residual effect to humans will be minimal. Any incremental aesthetic residual effect that may occur from the KRP has the potential to combine with any residual aesthetic effects from other projects in the cumulative effects assessment area. The closest project, Grew Creek (Figure 12.2-1) is approximately 74 km from the KRP, and is currently in the planning stages. Potential residual aesthetic effects from the Grew Creek project cannot be determined at this time. Any cumulative aesthetic effects that may result (if any) will be limited to a small number of people.

12.2.6.13 Socio-economics

Cumulative effects are changes that are likely to result from a project in combination with other projects or activities that have been or will be carried out. YESAB's Guide to Socio-economic Effects Assessments (2006) states that cumulative socio-economic effects should estimate potential cumulative effects on:

- Culture – values, tradition, language, spirituality
- Social cohesion, quality of life and ability to adapt positively to pace of economic change
- Land usability for traditional economy and/or other alternative economic activities.

The cumulative socio-economic effects for this Project will consequently depend on the status of other projects in the area. There are a number of other previous and existing, and reasonably foreseeable mining projects in Kaska traditional territory, as described in Sections 12.5.1 and 12.5.2.

The next step is to determine if these potential local and regional effects would combine with the effects from other current and reasonably foreseeable projects and activities in the region. At the same time, the influence of natural changes in environmental conditions needs to be considered. Thus, the goal is to determine the chance and strength of potential incremental cumulative effects from the Project on cultural, physical, biological and economic components of the environment.

Culture

The combined effect of the KRP on cultural activities such as the traditional economy, traditional knowledge, and language is expected to be minimal. Traditional economy-related activities may be affected by the KRP through increased access and harvesting of resources. To mitigate these effects, KRP policies will include no hunting while on rotation and access to the KRP will be controlled. The KRP will not have any direct effect on traditional knowledge and language preservation. Employees of the KRP will have opportunity to practice cultural activities while on their off rotation from the mine as KRP plans on having a standard 2-week in, 2-week out rotation.

There is the possibility that people of different cultures will be employed at the KRP and the other developments in the LSA. KRH will strictly enforce a workplace policy prohibiting any form of discrimination or racism and encourage First Nations employment at the KRP. Furthermore, KRH will encourage in-migrants to the Yukon to relocate to Faro instead of Ross River; thereby alleviating some of the pressure that the Kaska culture may face from the introduction of new cultures.

The effects on culture generated by the KRP are anticipated to be mitigated by KRH. Any incremental residual effect that may occur from the KRP on cultural activities have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, cumulative effects on cultural activities are not expected.

Economy

The effects of the KRP on the economy, employment, and business opportunities are expected to be beneficial. As indicated in Section 9.3, the KRP is expected to grow the GDP of the Yukon by 2.8%; this increase translates into an annual influx estimated to be $57.8 million to the Yukon GDP. Increased employment opportunities are a likely result of the KRP and an estimated 25% of KRP employees will be from the Yukon. To enhance employment opportunities at the KRP, KRH is recruiting Yukon residents with a particular focus on First Nations and the communities of Ross River, Faro, Watson Lake, and Teslin.

To encourage a diverse and stable economy, KRH plans on continuing to explore for further ore reserves and possibly extend the life of the KRP. By its very nature, mining has the tendency to create boom and bust economies and KRH plans to discourage this event with further exploration. As the start-up schedule for the foreseeable projects is not yet known, it is possible that project schedules may only overlap during the operations phase. This could potentially assist in encouraging a stable economy in the LSA.

During the KRP operational phase, contract business opportunities providing goods and services are anticipated and Yukon based companies will be invited to bid on contracts. KRH is exploring the possibility of maximizing First Nation participation for contracts during the operational phase. Additional developments in the LSA may provide further opportunities for local business.

Government revenues are anticipated to increase as a result of the KRP. In addition to the KRP, if the current and foreseeable developments become active, a cumulative increase in government revenue could occur. Increased government revenue can lead to greater expenditures and potentially positively influences on health care, education and law enforcement capacities in the LSA.

The economic opportunities generated by the KRP are anticipated to have a positive effect in the LSA. Any incremental residual effect that may occur from the KRP on the economy have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, cumulative effects on the economy are not expected.

Society

The effects of the KRP on social cohesion, quality of life, and ability to adapt positively to the pace of economic change are expected to be positive. In consideration of social cohesion, KRH has been a regular sponsor of community events and has made donations to recreational facilities in Ross River. To reduce stress on families, KRP plans on having a 2-week in, 2-week out rotation. The longer rotation will provide extended periods of time at home with family and opportunities to pursue recreational activities.

The quality of life of residents in the LSA is expected to benefit from the KRP. Residents can expect increased employment opportunities with the possibility of education and skills development. Increases in income are strongly correlated with a greater sense of self-worth, improved individual health, and better family stability and health. Furthermore, employees at the KRP will be offered extended health care benefits.

Maintaining or enhancing the well-being of employees of the KRP will be a key focus for KRH. Substantial increases in income have been indirectly linked to increases in drug and alcohol abuse. While KRH cannot be responsible for employees on their own time, KRH will encourage healthy living amongst its employees and the KRP camp will be dry. Industry standard drug and alcohol testing will be applied for potential new employees and it is expected that all new and foreseeable developments in the LSA will also encourage healthy living amongst their employees. KRH will take a graduated disciplinary approach to employees suffering from drug and alcohol abuse issues; however, workplace safety will always remain the first priority.

KRH will help employees/residents adapt positively to the pace of economic change. In-migration as a result of the KRP is expected to be minimal; however, the relocation of employees as a result of industry development is viewed as a positive effect, especially in Faro. Should the current and foreseeable developments become highly active, there could be further in-migration into the LSA. A resulting demographic increase may have a positive effect on businesses, infrastructure, and schools. One of Faro's primary goals as a community is to increase its population in order to make the community more vibrant and economically stable.

Faro has the immediate capacity to house new residents and KRH will encourage new non-resident employees to choose Faro as their residence. This will help prevent housing pressures in Ross River. A reduction in the cost of living is anticipated as an indirect effect of the KRP; higher incomes locally will lead to an increased demand for goods and services, and subsequently, encourage diversification and growth in local businesses.

The effects on society generated by the KRP are anticipated to have an overall positive effect in the LSA. Any incremental residual effect that may occur from the KRP on society will have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, cumulative effects on society are not expected.

Land Use

The land usability for traditional economy and/or other alternative economic activities may be affected by the KRP and other developments. Improved or increased access to projects by means of road building could lead to easier access to wilderness areas. The increased ease of access, however, could further lead to increased hunting pressures. To mitigate these effects, KRP policies will include no hunting while on rotation and access to the KRP through the Ketza Road will be controlled. KRH, through its MOU with the RRDC, will have in place a mechanism to compensate the Ross River trappers for loss of access due to the KRP.

The effects on land use generated by the KRP are anticipated to be mitigated by KRH. Any incremental residual effect that may occur from the KRP on land use will have negligible or nil potential to overlap in time or space (i.e., interact) with residual effects from other developments. Therefore, cumulative effects on land use are not expected.

12.2.7 Significance of Potential Cumulative Effects

The effects assessment determined that for all VESECs, after the application of the proposed mitigation measures, the residual environmental and socio-economic effects of the KRP are anticipated to be negligible and insignificant.

Furthermore, any potential residual environmental effects are generally limited to the immediate KRP footprint area and LSA, and most are rapidly reversible once activities cease.

As such, effects of this nature cannot typically operate in a cumulative manner.

REFERENCES

Adamscewski, J., Florkiewicz, R., Farnell, R., Foster, C., and Egli, K. 2010. Finlayson Caribou Herd Late-Winter Population Survey, 2007. Government of Yukon, Department of Environment, Fish and Wildlife Branch.

Alberta Energy and Utilities Board (EUB). 1999. Noise Control Directive User Guide – 4th Edition. Guide 38. Calgary, Alberta.

Alberta Environment. 2001. Guide to the Code of Practice for Watercourse Crossings.

Alexander, S.A, Doyle, F.I., Eckert, C.D, Grünberg, H., Hughes, N.L., Jense, M., Johnson, I., Mossop, D.H., Nixon, W.A., and Sinclair, P.H. 2003. Birds of the Yukon Territory. UBC Press, Vancouver, British Columbia.

AMAX-Northwest Mining Company Limited (AMAX). 1983. Initial Environmental Evaluation: MacTung Project, Yukon and Northwest Territories.

Anderson, L., Abbott, M., Finney, B., and Edwards, M.E. 2002. The Holocene Lake-level History of Marcella Lake, Southern Yukon Territory, Canada. In: The Geological Society of America Northeastern Section – 37th Annual Meeting, Session No. 19 Program Abstract. Springfield, Massachusetts.

Angold, P.G. 1997. The Impact of a Road Upon Adjacent Heathland Vegetation: Effects on Plant Species Composition. Journal of Applied Ecology, 34: 409-417.

Archibald, P.L., and Burns, B.E. 1981. A Baseline Survey of the Water Quality and Conditions in the Stream of the Howard's Pass Area, Yukon Territory. Environmental Protection Service, Yukon Branch, Pacific Region No. 81-13. January 1981.

Auerbach, N.A., Walker, M.D., and Walker, D.A. 1997. Effects of Roadside Disturbance on Substrate and Vegetation Properties in Arctic Tundra. Ecological Applications, 7(1): 218-235.

Banci, V. 1994. Wolverine. In: Ruggiero, L.F., Aubry, K.B., Buskirk, S.W., Lyon, L.J., and Zielinski W.J. (Ed.) The Scientific Basis for Conserving Forest Carnivores: American Marten, Fisher, Lynx and Wolverine in the Western United States General Technical Report RM-254, p. 99-127. U.S Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Barichello, N., Carey, J., and Sumanik, R. 1989. Short-term Effects on the Ketza River Gold Mine on the Distribution and Demography of Thinhorn Sheep (Ovis dalli). Yukon Renewable Resources.

Barrick Gold Corporation. 2010. Environment – Our Goal: Minimizing our Footprint. Retrieved in 2011 from http://barrickresponsibility.com/2010/en/environment/emissionseffluents.html#

British Columbia Ministry of Energy, Mines, and Petroleum Resources. 2009. 2008/2009 Annual Service Plan Report. Retrieved in 2011 from http://www.bcbudget.gov.bc.ca/Annual_Reports/2008_2009/empr/empr.pdf

British Columbia Ministry of Environment (BC MOE). 1996. Ambient Water Quality Criteria for Silver – Overview Report. Retrieved June 14, 2011 from http://www.env.gov.bc.ca/wat/wq/BCguidelines/silver/silver.html#toc/

British Columbia Ministry of Environment (BC MOE). 1999. Ambient Water Quality Guidelines for Zinc – Overview. Retrieved June 14, 2011 from http://www.env.gov.bc.ca/wat/wq/BCguidelines/zinc/zinctech.pdf

British Columbia Ministry of Environment (BC MOE). 2001. British Columbia Approved Water Quality Guidelines (criteria) 1998 Edition. Environmental Protection Division, British Columbia Ministry of Environment. Victoria, British Columbia. Updated August 24, 2001.

British Columbia Ministry of Environment (BC MOE). 2008. Ambient Water Quality Guidelines for Iron. Retrieved June 14, 2011 from http://www.env.gov.bc.ca/wat/wq/BCguidelines/iron/iron_tech.pdf

British Columbia Ministry of Environment and Parks (BC MOEP). 1988. Water Quality Criteria for Aluminum Technical Appendix. Retrieved June 14, 2011 from http://www.env.gov.bc.ca/wat/wq/BCguidelines/aluminum/aluminumtech.pdf

British Columbia Ministry of Forests (BC MOF). 1995. Riparian Management Area Guidebook. Government of British Columbia, ISBN 0-7726-2748-7, 80 pp. Retrieved in 2011 from http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/riparian/rip-toc.htm.

British Columbia Research. 1986. Summary of Fishery Studies Carried Out on behalf of Iona Silver Mines Ltd. (N.P.L.) 1980-81.

British Columbia Research. 1990a. Letter to Ron Mackenzie, Ketza River Mine, Bag 2717, Whitehorse Yukon, YIA 3V5 from Derick Monteith British Columbia Research Corporation, 3650 Westbrook Mall, Vancouver BC, V6S 2L2 File Number 2-11-200-209 dated, June 28, 1990.

British Columbia Research. 1990b. Fax to Peter Campbell, Canamax Resources Inc., Vancouver BC from Derick Monteith, British Columbia Research Corporation, 3650 Westbrook Mall, Vancouver BC, V6S 2L2, File Number 2-11-165 dated, August 9, 1990.

Bear Management Team. 1997. Grizzly Bear Management Principles – July 1997. Yukon Co-operative Fish and Wildlife Management. Retrieved January, 2007 from http://www.yfwmb.yk.ca/comanagement

Bennett, B.A. 2008. List of Invasive Plants in Yukon – by Invasiveness. Retrieved July 9, 2011 from http://www.env.gov.yk.ca/wildlifebiodiversity/documents/YukonIntroducedPlantsDec08-byrank.pdf

Bernier, R. 1997. The Dimensions of Wage Inequality among Aboriginal Peoples. Statistics Canada, Catalogue No. 11F0019MPE97109, Analytical Studies Branch research paper series No. 109, December 1997.

Bond, J. 2004. Late Wisconsinan Mcconnell Glaciation of the Whitehorse Map Area (105D), Yukon. In: Emond, D.S., and Lewis, L.L. (Ed.), Yukon Exploration and Geology 2003, Yukon Geological Survey, p. 73-88. Retrieved June 10, 2011 from http://ygsftp.gov.yk.ca/publications/yeg/yeg03/07_bond.pdf

Bond, J.D., and Kennedy, K.E. 2005. Late Wisconsinan McConnell Ice-flow and Sediment Distribution Patterns in the Pelly Mountains, Yukon. In: Emond, D.S., Lewis, L.L., and Bradshaw, G.D. (Ed.), Yukon Exploration and Geology 2004, Yukon Geological Survey, p. 67-82. Retrieved June 10, 2011 from http://www.geology.gov.yk.ca/pdf/05_bond.pdf

Bowyer, R.T., and Leslie, D.M. 1992. Ovis dalli. Mammalian Species. The American Society of Mammalogists, 393: 1 – 7. Retrieved January 2007 from http://www.science.smith.edu/departments/Biology/VHAYSSEN/msi/pdf/i0076-3519-393-01-0001.pdf

Brown, R.J.E. 1978. Permafrost. In: Hydrological Atlas of Canada. Fisheries and Environment Canada, Ottawa, Ontario, Plate 32.

Burgess, M.M., Judge, A.S., and Taylor, A.E. 1982. Yukon Ground Temperature Data Collection – 1966 to August 1981. Energy, Mines and Resources Canada, Earth Physics Branch, Open File 82-1.

Cadsand, B. 2007. Thinhorn Sheep Survey in the Ketza River Area Game Management Subzones 10-1, 10-4, and 10-5. Department of Environment, Yukon Government.

Canada Revenue Agency (CRA). 2000-2010. Locality Code Statistics Tables, 1998 to 2008 Tax Years.

Canada Revenue Agency (CRA). 2007. GST Statistics by Yukon Locality Code. Retrieved from http://www.cra-arc.gc.ca/gncy/stts/lcsts-eng.html

Canadian Council of Ministers of the Environment (CCME). 2003a. Canadian Water Quality Guidelines for the Protection of Aquatic Life, Chapter 4. In: Canadian Environmental Quality Guidelines. Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 2003b. Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.

Canadian Council of Ministers of the Environment (CCME). 2011. Canadian Water Quality Guidelines for the Protection of Aquatic Life Summary Table. Retrieved May 2011 from http://st-ts.ccme.ca/

Canadian Dam Association (CDA). 2007. Dam Safety Guidelines.

Canadian Environmental Protection Agency, Working Group on Air Quality Objectives and Guidelines (CEPA). 1999. National Air Quality Objectives for Particulate Matter: Addendum to the Science Assessment Document. A Report by the CEPA/FPAC Working Group on Air Quality Objectives and Guidelines. December 1997, Revised April 1999. Minister, Public Works and Government Services, Canada.

Canadian Parks and Wilderness Society, Yukon Chapter (CPAWS). 2002. Yukon Wild: Natural Regions of the Yukon, Second Edition. CPAWS, Whitehorse, Yukon.

Canadian Wildlife Service and GNWT Environment and Natural Resources (CWS and GNWT ENR). 2008. Species at Risk in the Northwest Territories, 2008 Edition: A Guide to NWT Species Legally Listed Under the Federal Species at Risk Act and Those Under Consideration for Listing. Government of Northwest Territories, Yellowknife, NT.

Canamax Resources Inc. 1991. Ketza River Mine Project Review. April 1991.

Canamax Resources Inc. and Pacific Trans-Ocean Resources. 1987. Ketza River Project Feasibility Study, Reviewed by Wright Engineers Ltd. February 1987.

Cann, M., and Baird, C. 2008. Environmental Chemistry Fourth Edition. W.H. Freeman and Company, New York, NY.

Caribou Management Team. 1996. Woodland Caribou Management Decision Guidelines – July 1996. Yukon Co-operative Fish and Wildlife Management. Retrieved February, 2007 from http://www.yfwmb.yk.ca/comanagement.

Carlson, M.L., and Shephard, M. 2007. Is the Spread of Non-native Plants in Alaska Accelerating? Meeting the Challenge: Invasive Plants in Pacific Northwest Ecosystems. Tech. Rep. PNW-GTR-694. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 111-127, Portland, OR.

Cedarholm, C.J., Reid, L.M., Edie. B.G., and Salo, E.O. 1982. Effects of Forest Road Erosion on Salmonoid Spawning Gravel Composition and Populations of the Clearwater River, Washington. In: Hashagen, K.A., (Ed.) Habitat Disturbance and Recovery, Proceedings of a Symposium conducted January 1981, p. 1-17. California Trout Inc., San Francisco.

Chapman, R.C. 1977. The Effects of Human Disturbance on Wolves. M.Sc. Thesis. University of Alaska, Fairbanks, Alaska.

Chatwin, S.C., Howes, D.E., Schwab, J.W., and Swanson, D.N. 1994. A Guide for Management of Landslide-prone Terrain in the Pacific Northwest. Land Management Handbook Number 18, 2nd edition. Research Branch, Ministry of Forests, Province of British Columbia, Vancouver.

Chris Stethem and Associates Ltd. 1987. Ketza River Property Initial Assessment of Snow Avalanche Hazard. Prepared for Canamax Resources Inc. April 23, 1987.

Clum, N. J., and Cade, T.J. 1994. Gyrfalcon (Falco rusticolus). In: Poole, A., and Gill, F., (Ed.) The Birds of North America, No. 114. The Birds of North America, Inc., Philadelphia, PA.

Cody, W.J. 2000. Flora of the Yukon Territory – Second Edition. NRC Research Press, Ottawa, Ontario, Canada.

Cody, W.J., Kennedy C.E., and Bennett, B. 1998. New Records of Vascular Plants in the Yukon Territory. Canadian Field-Naturalist, 112 (2): 289-328.

Cody, W.J., Kennedy C.E., and Bennett, B. 2000. New Records of Vascular Plants in the Yukon Territory II. Canadian Field-Naturalist, 114 (3): 417-443.

Cody, W.J., Kennedy C.E., and Bennett, B. 2001. New Records of Vascular Plants in the Yukon Territory III. Canadian Field-Naturalist, 115 (2): 301-322.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2003. Assessment and Update Status Report on the Wolverine Gulo gulo in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2010. Canadian Wildlife Species at Risk. Retrieved June, 2011 from http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.pdf

Department of Fisheries and Oceans, Fisheries and Oceans Canada (DFO). No Date. Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff. Version 1. Habitat Management Program, Department of Fisheries and Oceans Canada.

Department of Fisheries and Oceans, Fisheries and Oceans Canada (DFO). 1991a. Juvenile Chinook Salmon Investigations Ketza River 1991. Prepared by Department of Fisheries and Oceans, Habitat Management Unit. Whitehorse, Yukon. October, 1991.

Department of Fisheries and Oceans, Fisheries and Oceans Canada (DFO). 1991b. Letter to Joan Eamer, Environmental Protection Yukon Branch., Box 6010, Whitehorse, Yukon from A. von Finster, Fisheries and Oceans, 122 Industrial Rd, Whitehorse Yukon, Y1A 2T9, File Number 8507 dated, November 13, 1991.

Department of Fisheries and Oceans, Fisheries and Oceans Canada (DFO). 1993. Land Development Guidelines for the Protection of Aquatic Habitat.

Department of Renewable Resources and Department of Fisheries and Oceans. 1991. Cache Creek Fisheries Reassessment. October 1991.

Domenico, P.A., and Schwartz, F.W. 1998. Physical and Chemical Hydrogeology, 2nd edition. John Wiley & Sons, New York, NY.

Douglas, G.W., Argus, G.W., Dickson, H.L. and Brunton, D.F. 1981. The Rare Vascular Plants of the Yukon. Syllogeus No. 28. National Museum of Natural Sciences, Ottawa.

Dreyer, D., and Meyers, H. 2004. Impact and Benefits Agreements: Do the Ross River Dena Benefit from Mineral Projects? Final Report submitted to the Northern Land Use Institute, University of British Columbia. Retrieved June 30, 2011 from http://www.unbc.ca/nlui/publications/final_reports/ross_river_dena.pdf

Duffey, S. 1981. Cyanide and Arthropods. Cyanide and Biology. Academic Press, New York.

EBA Engineering Consultants Ltd. (EBA). 2003. Regional Ecosystem Classification and Mapping of the Yukon Southern Lakes and Pelly Mountains Ecoregion. Prepared for Government of the Yukon, Department of Environment, Whitehorse, Yukon.

EBA Engineering Consultants Ltd. (EBA) 2007. MacTung Project: 2006 Environmental Baseline Studies, Wildlife Report. Prepared for North American Tungsten Corporation Ltd. Vancouver, BC.

EBA Engineering Consultants Ltd. (EBA). 2008a. 2007 Bedrock Geology, Surficial Geology and Terrain, Terrain Hazards. 2007 Environmental Baseline Studies. Prepared for Ketza River Holdings Ltd. February 2008.

EBA Engineering Consultants Ltd. (EBA). 2008b. 2007 Environmental Baseline Studies Program, Ecosystem Land Classification and Vegetation Baseline Studies, Ketza River Mine. Prepared for Ketza River Holdings Ltd. April 2008.

EBA Engineering Consultants Ltd. (EBA). 2008c. 2008 Environmental Baseline Studies Program, Rare Plant Species and Community Survey, Ketza River Mine. Prepared for Ketza River Holdings Ltd. August 2008.

EBA Engineering Consultants Ltd. (EBA). 2008d. 2007 – 2008 Environmental Baseline Report, Wildlife Program, Ketza River Mine. Prepared for Ketza River Holdings Ltd. June 2008.

EBA Engineering Consultants, Ltd. 2008e. 2007 Environmental Baseline Studies Program, Aquatic Resources, Ketza River Mine. Prepared for Ketza River Holdings Ltd. May 2008.

EBA Engineering Consultants Ltd. (EBA). 2008f. Mactung Mine Project Proposal. YESAB – Executive Committee Submission. Prepared for North American Tungsten Ltd. December 2008.

EBA Engineering Consultants Ltd. (EBA). 2009. 2008 Geotechnical Inspection Report Ketza River Mine, Yukon. Prepared for Ketza River Holdings Ltd.

EBA Engineering Consultants Ltd. (EBA). 2010. 2010 Geotechnical Inspection Ketza River Mine, Yukon. Prepared for Ketza River Holdings Ltd.

EBA Engineering Consultants Ltd. (EBA). 2011a. 2008 Environmental Baseline Studies, Wildlife Program, Ketza River Project. Prepared for Yukon Nevada Gold Corporation. July 2011.

EBA Engineering Consultants Ltd. (EBA). 2011b. 2010 - 2011 Environmental Baseline Studies, Wildlife Program, Ketza River Project. Prepared for Yukon Nevada Gold Corporation. July 2011.

EBA Engineering Consultants Ltd. (EBA). 2011c. Grizzly Bear Cumulative Effects Assessment Models, Ketza River Mine. Prepared for Yukon Nevada Gold Corp. June 2011.

EBA Engineering Consultants Ltd. (EBA). 2011d. 2010 Environmental Baseline Assessment, Fisheries Study, Ketza River Mine. Prepared for Yukon Nevada Gold Corporation. March 2011

EBA Engineering Consultants Ltd. (EBA). 2011e. Detailed Hydrogeological Assessment, Ketza River Mine, Yukon. Prepared for Yukon Nevada Gold Corp., July 2011.

EBA Engineering Consultants Ltd. (EBA). 2011f. Ketza River Project Description Report. Prepared for Yukon Nevada Gold Corp and Ketza River Holdings. May 2011.

EBA Engineering Consultants Ltd. (EBA). 2011g. 2008 and 2010 Geotechnical Site Investigations and Geotechnical Pre-Feasibility Study for the Peel, Lab-Hoodoo, Penguin, and Tarn Pits, Ketza River Property, Yukon. Report prepared for Yukon Nevada Gold Corp, July 2011.

EBA Engineering Consultants Ltd. (EBA). 2011h. 2008 and 2010 Geotechnical Site Investigations and Geotechnical Pre-Feasibility Study for the QB, Gully, 3m, and Knoll Pits, Ketza River Property, Yukon. Report prepared for Yukon Nevada Gold Corp, July 2011.

Environment Canada (EC). 1992. Baseline Study of the Watershed in the Canamax-Ketza River Gold Mine Area in Yukon Territory. DRAFT. Environment Canada, Environmental Protection, Pacific and Yukon Region. April 1992.

Environment Canada (EC). 2002. MMER Guidance Document for Aquatic Environmental Effects Monitoring.

Environment Canada (EC). 2005. National Inventory Report, 1990-2005: Greenhouse Gas Sources and Sinks in Canada.

Environment Canada (EC). 2011. National Inventory Report 1990-2009. Greenhouse Gas Sources and Sinks in Canada: Executive Summary.

Environmental Dynamics Inc. (EDI). 2007. Fisheries Study of Cache Creek Watershed. Prepared for Yukon Nevada Gold Corporation. December 2007.

Farmer, A.M. 1993. The Effects of Dust on Vegetation – A Review. Environmental Pollution, 79: 63-75.

Farnell, R., and MacDonald, J. 1989. Inventory of Yukon's Wolf Lake Caribou Herd. Fish and Wildlife Branch, Yukon Department of Renewable Resources, Report No. TR-89-5. Whitehorse, Yukon.

Farnell, R., Barichello, N., Egli, K., and Kuzyk, G. 1996. Population Ecology of Two Woodland Caribou Herds in Southern Yukon. Rangifer Special Issue No. 9, 1996.

Fisheries and Environment Canada. 1978. The Hydrological Atlas of Canada. Retrieved from http://atlas.nrcan.gc.ca/site/english/maps/archives/hydrological_atlas_1978

Flynn, N., and Francis, S. 2011. The Yukon Ecosystem and Landscape Classification (ELC) Framework: Overview and Concepts. Interim Draft Report for Review.

Fonseca, A. 1998. Structural Evolution of the Ketza River Gold Deposit. In: Yukon Exploration and Geology 1997, p. 77-81. Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada.

Forbes, B.C., Ebersole, J.J., and Strandberg, B. 2001. Anthropogenic Disturbance and Patch Dynamics in Circumpolar Arctic Ecosystems. Conservation Biology, 15(4): 954-969.

Foster, M., Fell, R., and Spannagle, M. 2000. The Statistics of Embankment Dam Failures. Can. Geotech. 5., Vol. 37, p. 1000-1024.

Francis, S.R., and Steffen, N. 2003. Concepts, Rationale and Suggested Standards for the Yukon Ecosystem Classification and Mapping Framework-First Approximation. Draft, ver 1.3. Report prepared by Applied Ecosystem Management Ltd. for DIAND Environment Directorate and DIAND Lands Branch, Whitehorse, Yukon. January, 2003.

Freeze, R.A., and Cherry, J.A. 1979. Groundwater. Prentice Hall, Eaglewood Cliffs, NJ.

Gartner Lee Limited. 2002. Ketza River Mine Environmental Liability Assessment Final Report. May 2002.

George, P., and Kuhn, P. 1994. The Size and Structure of Native-White Wage Differentials in Canada. Canadian Journal of Economics, XXVII, No. 1, February 1994, 20-42.

Gill, D. 1978. Large Mammals of the Macmillan Pass Area, Northwest Territories and Yukon. AMAX Northwest Mining Company Ltd., Vancouver, British Columbia.

Gill, R.E., McCaffery, B.J., and Tomkovich, P.S. 2002. Wandering Tattler (Heteroscelus incanus). In: Poole, A., and Gill, F. (Ed.) The Birds of North America, No. 642. The Birds of North America, Inc., Philadelphia, PA.

Godin, B., and Mackenzie-Grieve, G. 1984. Baseline Study of the Watershed in the Iona Silver Area, Yukon Territory. Regional Program Report 84-04. Environment Canada, Environmental Protection Service, Pacific Region, Yukon Branch, April 1984.

Golder Associates. 1986. Geotechnical Design of Tailings Disposal Facilities, Camp Site and Mill Site, Ketza River Project, Yukon. December, 1986.

Goodman, R.E., Moye, D.G., Van Schalkwyk, A., and Javandel, I. 1965. Ground Water Inflow During Tunnel Driving. Eng. Geol., 2: 39-56.

Government of Canada, Council for Yukon Indians, and the Government of the Yukon. 1993. Umbrella Final Agreement. Retrieved June 30, 2011 from http://www.ainc-inac.gc.ca/al/ldc/ccl/fagr/ykn/umb/umb-eng.asp

Government of Yukon (YG). No Date. Unpublished Report.

Government of Yukon (YG). 2004a. Yukon Community Profile - Ross River. Retrieved June 30, 2011 from http://www.yukoncommunities.yk.ca/communities

Government of Yukon (YG). 2004b. Yukon Community Profile -Teslin. Retrieved June 30, 2011 from http://www.yukoncommunities.yk.ca/communities

Government of Yukon (YG). 2005. Wildlife Key Area Maps. Accessed though digital format.

data (shapefile) available from Geomatics Yukon.

Government of Yukon (YG). 2006. Unpublished Report.

Government of Yukon (YG). 2010. Pelly Mountain Ice Flow. Prepared by Jeffery Bond for Government of Yukon. Retrieved June 10, 2011 from http://www.geology.gov.yk.ca/pelly_mountain_ice_flow.html

Government of Yukon (YG). 2003-2011. 2002-2010 Public Accounts, 2010-2011 Financial Information. Retrieved July 8, 2011 from http://www.finance.gov.yk.ca/general/publications.html.

Government of Yukon (YG). 2011. Crime Rates per 100,000 people. Government of Yukon Socio-economic Web Portal. Retrieved on July 7, 2011 from http://www.sewp.gov.yk.ca/

Government of Yukon, Bureau of Statistics (YBS). No Date. Yukon Crime Statistics 1995-2003.

Government of Yukon, Bureau of Statistics (YBS). 2006. Business Survey December 2006.

Government of Yukon, Bureau of Statistics (YBS). 2007. Business Survey October 2007.

Government of Yukon, Bureau of Statistics (YBS). 2008. Yukon Business Survey December 2008.

Government of Yukon, Bureau of Statistics (YBS). 2010a. The Yukon Statistical Review - 2009 Annual Report. October 2010.

Government of Yukon, Bureau of Statistics (YBS). 2010b. Population Report. December 2010. Retrieved in 2011 from http://www.eco.gov.yk.ca/stats/pdf/population_dec_2010.pdf

Government of Yukon, Bureau of Statistics (YBS). 2011a. Retail Motor Fuel Prices in Yukon. Yukon Fuel Survey, May 2011. Retrieved in 2011 from http://www.eco.gov.yk.ca/stats/pdf/fuel_may11.pdf

Government of Yukon, Bureau of Statistics (YBS). 2011b. Health Care Population 1974-2010.

Government of Yukon, Bureau of Statistics (YBS). 2011c. Yukon Economic Accounts. Information sheet 69-14 January 2011.

Government of Yukon, Bureau of Statistics (YBS). 2011d. Yukon Employment, April 2011. Retrieved in 2011 from http://www.eco.gov.yk.ca/stats/pdf/employment_apr11.pdf

Government of Yukon, Bureau of Statistics (YBS). 2011e. Public School Enrolment 2010. Information sheet 27-14, March 2011.

Government of Yukon, Bureau of Statistics (YBS). 2011f. Yukon Business Survey 2010. March 2011.

Government of Yukon, Department of Energy, Mines, and Resources (YG EMR). 2010. Robert E. Leckie Award for Outstanding Mining Reclamation Practices. Retrieved in 2011 from http://www.emr.gov.yk.ca/mining/leckie.html

Government of Yukon, Department of Energy, Mines, and Resources (YG EMR). 2011. Yukon Government Lots for Sale. Retrieved June 7, 2011 from http://www.emr.gov.yk.ca/lands/lotsale_yukon.html

Government of Yukon, Department of Environment (YG Environment). 2001. Unpublished Report.

Government of Yukon, Department of Environment (YG Environment). 2002. Special Waste Regulations – Dust Suppressants SW#10. Environmental Programs Branch, Department of Environment. Retrieved on July 10, 2011 from http://www.env.gov.yk.ca/monitoringenvironment/EnvironmentActandRegulations/documents/sw10_dust_suppressants.pdf

Government of Yukon, Department of Environment (YG Environment). 2003. A Birder's Checklist of the Faro & Ross River Region. Wildlife Viewing Program, Whitehorse, YT.

Government of Yukon, Department of Environment (YG Environment). 2005. Yukon Amphibians. Wildlife Viewing Program, Whitehorse, YT.

Government of Yukon, Department of Environment (YG Environment). 2007a. Mammals. Prepared by the Fish and Wildlife Branch. Retrieved January, 2007 from http://www.enviromentyukon.gov.yk.ca/mammals.html

Government of Yukon, Department of Environment (YG Environment). 2007b. Unpublished Report. Prepared by the Fish and Wildlife Branch.

Government of Yukon, Department of Environment (YG Environment). 2010a. Wildlife Key Area. Wildlife Key Area Inventory Program, NatureServe Yukon and Department of Environment Geomatics Yukon. Retrieved June, 2011 from http://www.env.gov.yk.ca/wildlifebiodiversity/wildlife_key_areas.php

Government of Yukon, Department of Environment (YG Environment). 2010b. Yukon Species at Risk. Retrieved June 15, 2011 from www.env.gov.yk.ca/wildlifebiodiversity/speciesrisk.php

Government of Yukon, Department of Environment (YG Environment). 2010c. Thinhorn Sheep. Retrieved June 15, 2011 from http://www.env.gov.yk.ca/wildlifebiodiversity/mammals/sheep.php

Government of Yukon, Department of Environment (YG Environment). 2011a. Yukon Invasive Plants. Retrieved June 20, 2011 from: http://www.env.gov.yk.ca/wildlifebiodiversity/invasiveplants.php

Government of Yukon, Department of Environment (YG Environment). 2011b. Black Bear. Retrieved June 15, 2011 from http://www.env.gov.yk.ca/wildlifebiodiversity/mammals/blackbear.php

Government of Yukon, Department of Environment (YG Environment). 2011c. Wolf. Retrieved June 15, 2011 from http://www.env.gov.yk.ca/wildlifebiodiversity/mammals/wolf.php

Government of Yukon, Department of Environment (YG Environment). 2011d. Yukon Government Campgrounds and Yukon and Federal Protected Areas Map. Retrieved on July 26, 2011 from http://www.env.gov.yk.ca/camping/documents/campgroundmap11_12.pdf

Government of Yukon, Department of Environment (Yukon Environment). 2011e. Yukon Big Game Harvest - 2001 to 2010 in GMA's 10.01, 10.02, 10.03, 10.04, and 10.05.

Government of Yukon, Department of Highways and Public Works. 2010. 2009 Yukon Traffic Count Summary. Transportation Engineering Branch.

Government of Yukon, Department of Highways and Public Works. 2011. Yukon Government Airports/Aerodromes. Aviation Branch. Retrieved July 6, 2011 from http://www.hpw.gov.yk.ca/airports/1266.html and http://www.hpw.gov.yk.ca/pdf/Aerodrome_Listings_2011.pdf

Government of Yukon, Department of Tourism and Culture (YG TC). 2005. Handbook for the Identification of Heritage Sites and Features. Retrieved July 4, 2010 from http://www.tc.gov.yk.ca/pdf/heritagehandbook.pdf

Government of Yukon, Department of Tourism and Culture (YG TC). 2010a. Yukon Mineral Exploration Best Management Practices for Heritage Resources. Retrieved June 30, 2011 from http://www.tc.gov.yk.ca/pdf/Mineral_Exploration_BMP_for_Heritage_Resources.pdf

Government of Yukon, Department of Tourism and Culture (YG TC). 2010b. Operational Policy for Heritage Resources Management on Yukon Lands. Retrieved July 4, 2011 from http://www.tc.gov.yk.ca/pdf/Heritage_Resources_Operational_Policy.pdf

Government of Yukon, Department of Tourism and Culture (YG TC). 2010c. Tourism Indicators. Retrieved in 2011 from http://www.tc.gov.yk.ca/stats.html

Government of Yukon, Department of Tourism and Culture (YG TC). 2011. Yukon Archaeological Sites Regulation Permits. Retrieved July 4, 2011 from http://www.tc.gov.yk.ca/868.html

Government of Yukon, Department of Tourism, Heritage Branch (YG THB). 1999. Guidelines Respecting the Discovery of Human Remains and First Nation Burial Sites in the Yukon. Retrieved July 4, 2011 from http://www.tc.gov.yk.ca/pdf/respecting_guidelines.pdf

Gray, P., and Panegyuk, P. 1989. Woodland Caribou. In: Hall, E. (Ed.) People and Caribou in the Northwest Territories. Government of the Northwest Territories, Department of Renewable Resources.

Gullickson, D.K., and Mansequ, M. 2000. South Nahanni Woodland Caribou Herd Seasonal Range Use and Demographics. Parks Canada Agency.

Fisheries and Environment Canada. 1978. The Hydrological Atlas of Canada.

Haber, E. 1997. Guide to Monitoring Exotic and Invasive Plants. Prepared for Ecological Monitoring and Assessment Network, Environment Canada. National Botanical Services, Ontario, Canada.

Halchuk, S., and Adams, J. 2008. Fourth Generation Seismic Hazard Maps of Canada: Maps and Grid Values to be used with the 2005 National Building Code of Canada. Geological Survey of Canada Open File 5813.

Harper, J. 1991. Letter to Lois Craig, Indian and Northern Affairs, 200 Range Road, Whitehorse, Yukon, from James Harper, Barrister and Solicitor, General Delivery, Pelly Crossing, Yukon, Y0B 1P0, on behalf of Ross River Dena Council dated January 24, 1991.

Hashagen, K.A. (Ed.). 1981. Habitat Disturbance and Recovery, Proceedings of a Symposium conducted January 1981. California Trout Inc., San Francisco.

Hengeveld, H. 1997. The Science of Climate Change. In: Taylor, E., and Taylor, B. (Ed.) Responding to Global Climate Change in British Columbia and Yukon, Volume I of the Canada Country Study: Climate Impacts and Adaptation. Aquatic and Atmospheric Sciences Division, Pacific and Yukon Region, and the Air Resources Branch, British Columbia Ministry of Environment, Lands and Parks, Vancouver, BC.

Hyndman, R.D., Cassidy, J.F., Adams, J., Rogers, G.C., Mazzoti, S. 2005. Earthquakes and Seismic Hazard in the Yukon –Beaufort-Mackenzie. Geological Survey of Canada. CSE Recorder. May 2005.

International Commission on Large Dams (ICOLD). 1995. Tailings Dams and Seismicity: Review and Recommendations. Bulletin 98.

Irwin, R.J., VanMouwerik, M., Stevens, L., Seese, M.D., and Basham, W. 1997. Environmental Contaminants Encyclopedia. National Park Service, Water Resources Division, Fort Collins, Colorado.

Jackson Jr., L.E. 1986. Terrain Inventory, Finlayson Lake, Yukon Territory. Geological Survey of Canada, Open file 1379, scale 1:125,000.

Jackson Jr., L. E., and Harrington, C.R. 1991. Middle Wisconsian Mammals, Stratigraphy, and Sedimentology at the Ketza River Site, Yukon Territory. Geographie Physique et Quaternaire, 45(1): 69-77.

Jackson Jr., L.E., and Mackay, T.D. 1991. Glacial Limits and Ice-Flow Directions of the Last Cordilleran Ice Sheet in Yukon Territory Between 60 and 63 Degrees North. Geological Survey of Canada, Open File 2329.

Kaska Dena Council. 2011. Kaska Dena Traditional Territory. Retrieved June 30, 2011 from http://kaskadenacouncil.com/kaska-dena-nation/our-history

Ketza River Holdings Ltd. No Date. Ketza River Mine Geology and Geochemistry.

Klinkenberg, B. 2011. Invasive Plant Species. In: Klinkenberg, B., (Ed.) E-Flora BC: Electronic Atlas of the Plants of British Columbia. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. Retrieved July 7, 2011 from http://www.eflora.bc.ca

Knowles, C. 1976. Micro-organisms and Cyanide. Biological Reviews, Volume 40: 652-680.

Kochert, M. N., Steenhof, K., McIntyre, C. L., and Craig, E. H. 2002. Golden Eagle (Aquila chrysaetos). In: Poole, A. and Gill, F., (Ed.) The Birds of North America, No. 684. The Birds of North America Inc., Philadelphia, PA.

Lamprecht, R., and Graber, W. 1996. Modeling Dry Deposition of Dust along the Dalton Highway. In: Reynolds, J.F., and Tenhunen, J.D., (Ed.) Landscape Function and Disturbance in Arctic Tundra, p. 325-346. Ecological Studies Volume 120. Springer-Verlag Publishers, New York, NY.

Larsen, D.G., and Ward, R.M.P. 1995. Moose Population Characteristics in the Frances Lake and North Canol Areas – 1991. Yukon Fish and Wildlife Branch PR-95-1. Yukon Renewable Resources, Fish and Wildlife Branch. 49 pp.

Laviviere, S. 2001. Ursus americanus. In: Haysson, V., (Ed.) Mammalian Species. The American Society of Mammalogists 647: 1- 11. Retrieved in 2011 from http://www.science.smith.edu/departments/Biology/VHAYSSEN/msi/msi_intro.html

Line, J., Brunner, G., Rosie, R., and Russell, K. 2008. Result of 2007 Invasive Plants Roadside Inventory in Yukon. NatureServe Yukon and Government of Yukon, Department of Environment. Retrieved June 20, 2011 from http://www.yukoninvasives.com/resources1.html

Lloyd, D.S., Koenings, J.P., and LaPerriere, J.D. 1987. Effects of Turbidity in Fresh Waters of Alaska. N. Amer J. Fish Mgmt., 7:18-33.

MacKenzie, H.2005. Snow Avalanche Re-assessment, Ketza River Mine, Ross River, Yukon. December 19 & 20, 2005.

Marinelli, F., and Niccoli, W.L. 2000. Simple Analytical Equations for Estimating Ground Water Inflow to a Mine Pit. Ground Water, 38(2): 311-314.

Markert, B (Ed.). 1993. Plants as Biomonitors: Indicators For Heavy Metals in the Terrestrial Environment. VCH Publishers Inc. and VCH Verlagsgesellschaft, New York, USA and Weinheim, Germany.

Matrix Research Ltd. (Matrix). 2008. A Heritage Resources Impact Assessment Conducted Under Permit 08—5ASR on the Proposed Ketza River Mine Footprint Expansion 2008, on Behalf of Ketza River Holdings Limited. Report prepared for Ketza River Holdings Limited. Quesnel, British Columbia.

McClellan, C. 1975. My Old People Say: An Ethnographic Survey of Southern Yukon Territory, Parts 1 & 2. Mercury Series Publications in Ethnology, Paper No. 137.

Mercalli XII Inc. 2010. Richter Magnitude, PGA, and Duration. Retrieved in 2011 from http://www.tilt-upretrofit.com/information/15-the-richter-scale.html

Miller, S.J., Barichello, N., and Tait, D. 1982. The Grizzly Bears of the Mackenzie Mountains, Northwest Territories. Completion Report No. 3. NWT Wildlife Service, Yellowknife, NT. 118 pp.

Mining Environment Research Group (MERG). 2002. Flying in Sheep Country: How to Minimize Disturbance from Aircraft. MERG Report 2002-6.

Moose Management Team. 1996. Moose Management Guidelines – July 1996. Yukon Co-operative Fish and Wildlife Management. Retrieved January, 2007 from http://www.yfwmb.yk.ca/comanagement

Mudd, G.M. 2008. Gold Mining and Sustainability: A Critical Reflection. In: Cutler J. (Ed.) Cleveland Encyclopedia of Earth. Revised September 12, 2008.

Myers-Smith, I.H., Arnesen, B.K., Thompson, R.M., and Chapin III, F.S. 2006. Cumulative Impacts on Alaskan Arctic Tundra of a Quarter Century of Road Dust. Ecoscience, 13(4): 503-510.

Norecol Environmental Consultants Ltd. 1986. Canamax Ketza River Project Fisheries Assessment of Cache Creek. File: 88-1A. August, 1986.

North American Tungsten Ltd. 2009. Mactung Project submission to YESAB. October 2009

Northern Natural Resource Services Ltd. 1977. A Collection of Fisheries Information from Water Bodies Associated with Pipeline Routes in the Yukon Territory from Dawson to Watson Lake. September 1, 1977. Prepared by Northern Natural Resource Services Ltd for Fisheries and Marine Service.

NWT Status of Women Council. 1999. Review of Diavik Diamonds Project Socio-Economic Environmental Effects Report: Impacts on Women and Families. March 1999

Osborne, C. 1991. An Investigation of the Fisheries Resources of Cache Creek Tributary to Ketza River, Yukon Territory. Government of Yukon, Renewable Resources, Fisheries Branch, September 1991.

PAEHolmes. 2009. Air Quality Assessment, Appendix G. In: Cowal Gold Mine (CGM) Modified Request Project. October 15, 2009. Retrieved in 2011 from http://www.barrick.com/Theme/Barrick/files/cowal-E42-modified-request/Appendix-G-Air-Quality-Assessment.pdf

Pasitschniak-Art, M. 1993. Ursus arctos. Mammalian Species. The American Society of Mammalogists 439: 1 – 10. Retrieved January, 2007 from http://www.science.smith.edu/departments/Biology/VHAYSSEN/msi/pdf/i0076-3519-439-01-0001.pdf

Pasitschniak-Arts, M., and S. Larivière. 1995. Gulo gulo. Mammalian Species. The American Society of Mammalogists 499: 1 – 10. Retrieved in 2011 from http://www.science.smith.edu/departments/Biology/VHAYSSEN/msi/pdf/i0076-3519-499-01-0001.pdf

Pendakur, K., and Pendakur, R. 1998. The Colour of Money: Earnings Differentials Among Ethnic Groups in Canada. Canadian Journal of Economics, XXXI, No. 3, August 1998, 518-548.

Pinard, J.P., Benoit, R., and Wilson, J. D. 2009. Mesoscale Wind Climate Modelling in Steep Mountains. Department of Earth and Atmospheric Sciences University of Alberta & Recherche en Prevision Numerique (RPN), Environment Canada. Atmosphere-Ocean 47 (1): 63-78. Canadian Meteorological and Oceanographic Society.

Polster, D.F. 2005. The Role of Invasive Plant Species Management in Mined Land Reclamation. Canadian Reclamation, Summer/Fall 2005: 24-32.

Pomeroy, J.W. 1985. An Identification of Environmental Disturbances from Road Developments in Subarctic Muskeg. Arctic, 38 (2): 104-111.

Price, W.A. 2009. Prediction Manual of Drainage Chemistry for Sulphidic Geologic Materials. CANMET – Mining and Mineral Sciences Laboratories. Smithers, British Columbia.

Pyatt, F.B., and Haywood, W.J. 1989. Airborne Particulate Distribution and their Accumulation in Tree Canopies. Environmentalist, 9: 291-298.

Radle, A.L. 2007. The Effect of Noise on Wildlife: A Literature Review.

Rand, A.L. 1946. List of Yukon Birds and Those of the Canol Road. National Museum of Canada Bulletin No. 105; Biological Series No. 33. Department of Mines and Resources, Mines and Geology Branch, Ottawa, ON. 76 pp.

Reid, B.J., and McGreer, E.R. 1983. Bioaccumulation of Heavy Metals by Sculpin (Cottus asper) Exposed to Mine Tailings. In: Proceedings of the Eighth Annual Aquatic Toxicity Workshop Nov. 2-4, 1981, Guelph, Ontario. Canadian Technical Report of Fisheries and Aquatic Sciences, No. 1151 (1983).

Resource Inventory Standards Committee (RISC). 1998. Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures.

Ross River Dena Council Economic Development Program and Ross River Mining Committee (RRDCEDP and RRMC). 2004. The Snow that Eats the Snow (A Mining Strategy for Ross River, Yukon Territory). Assisted by Bruce McKnight Minerals Advisor Services.

Salix Heritage Consulting (Salix). 2007. Heritage Assessment: Ketza River Mine. Final Report. Prepared for EBA Engineering Consultants Ltd. and Ketza River Holdings Ltd. Whitehorse, Yukon.

Santelmann, M.V., and Gorham, E. 1988. The Influence of Airborne Road Dust on the Chemistry of Sphagnum Mosses. Journal of Ecology, 76: 1219-1231.

Sheep Management Team. 1996. Sheep Management Guidelines – July 1996. Yukon Co-operative Fish and Wildlife Management. Retrieved January, 2007 from http://www.yfwmb.yk.ca/comanagement

Sinclair, P.H., Nixon, W.A., Eckert, C.D., and Hughes, N.L. 2003. Birds of the Yukon Territory. UBC Press, Vancouver, BC. 595 pp.

Smith, C.A.S., Meikle, J.C., and Roots, C.F. 2004. Ecoregions of the Yukon Territory, Biophysical Properties of The Yukon Landscapes. Agriculture and Agri-Food Canada, PARC Technical Bulletin 04-01, Summerland, British Columbia.

Spatt, P.D., and Miller, M.C. 1981. Growth Conditions and Vitality of Sphagnum in a Tundra Community along the Alaska Pipeline Haul Road. Arctic, 34(1): 48-54.

Spellerberg, I.F., and Morrison, T. 1998. The Ecological Effects of New Roads – A Literature Review. Department of Conservation, Wellington, NZ.

SRK Consulting Engineers and Scientists (SRK). 1990. Debris Flow Potential and Permanent Spillway Design, Ketza River Tailings Impoundment. July 13, 1990.

Stanley Associates Ltd. 1986. Groundwater Supply Investigation, Ross River, Yukon. Report to Department of Community and Transportation Services, Yukon Territorial Government, Whitehorse, Yukon. 9 pp.

Statistics Canada. 2003. Canada E-Book. Catalogue no. 11-404-XIE.

Statistics Canada. 2004-2009. Special Tabulations of Community Data, Based On 1971, 1976, 1981, 1986, 1991, 2001 and 2006 Census of Population.

Statistics Canada. 2005. Canada E-Book. No. 11-404-XIE. Retrieved in 2011 from http://dsp-psd.pwgsc.gc.ca/Collection/Statcan/11-404-XIB/11-404-XIB-e.html

Statistics Canada. 2006. Census 2006, Community Profiles, Yukon Territory, Ross River, Watson Lake, Teslin, Faro. Retrieved in 2011 from http://www12.statcan.gc.ca/

Statistics Canada. 2010. Provincial and Territorial Economic Accounts: Data Tables. Catalogue No. 13-018-X.

Statistics Canada. 2011a. Cansim Table 003-0013 Number and Value of Pelts Produced, Annual.

Statistics Canada. 2011b. Health Trends. Catalogue no. 82-213-XWE. Released June 21 2011.

Statistics Canada. 2011c. Sales of Alcoholic Beverages by Volume, Value and Per Capita 15 Years and Over, Fiscal Years Ended March 31, Annual. CANSIM Table 183-0006.

Statistics Canada. 2011d. Health Trends. Catalogue no. 82-213-XWE.

Statistics Canada. 2011e. 2006 Census of Population. Statistics Canada Catalogue No. 97-563-XCB2006008. Income Statistics (4) in Constant (2005) Dollars, Age Groups (5A), Aboriginal Identity, Registered Indian Status and Aboriginal Ancestry (21), Highest Certificate, Diploma or Degree (5) and Sex (3) for the Population 15 Years and Over With Income of Canada, Provinces, Territories, 2000 and 2005 - 20% Sample Data. Retrieved in 2011 from http://www12.statcan.gc.ca/census-recensement/index-eng.cfm

Statistics Canada. 2011f. 2006 Census of Population. Statistics Canada Catalogue No. 97-558-XCB2006015. Selected Language Characteristics (165), Aboriginal Identity (8), Age Groups (7), Sex (3) and Area of Residence (6) for the Population of Canada, Provinces and Territories, 2006 Census - 20% Sample Data". Retrieved in 2011 from http://www12.statcan.gc.ca/census-recensement/index-eng.cfm

TD Economics. 2011. Commodity Price Forecast Update. Retrieved July 21, 2011 from http://www.td.com/economics/index.jsp.

Teslin Tlingit Council (TTC). 2008. Teslin Tlingit Mining Policy. Draft 9. March 2008.

Teslin Tlingit Council (TTC). 2009. Government of the Teslin Tlingit Council: Teslin Tlingit Traditional Territory. Retrieved June 30, 2010 from http://www.ttc-teslin.com/heritage.html

Teslin Tlingit Council (TTC). 2011. Government of the Teslin Tlingit Council: A Brief History of the Teslin Tlingit. Retrieved June 30, 2010 from http://www.ttc-teslin.com/heritage.html

Thompson, J.R., Mueller, P.W., Fluckiger, W., and Rutter, A.J. 1984. The Effect of Dust on Photosynthesis and its Significance for Roadside Plants. Environmental Pollution, Ser. A (34): 171-190.Town of Faro. 2004. History of Faro. Retrieved in 2011 from http://www.faroyukon.ca/index.asp?Type=B_BASIC&SEC={3DE5A112-1FC6-4341-92DA-D91CEBAEB287}

Town of Faro. 2004. Current Real Estate Listings. Retrieved June 7, 2011 from http://www.faroyukon.ca/index.asp?Type=B_BASIC&SEC=%7BE9B8E9D2-04BF-4789-9B20-3D4AF76F4AE5%7D

Town of Faro. 2007. Faro Forward: Integrated Sustainability Plan.

Town of Faro. 2010. Financial Statements for the Year Ended December 31, 2009.

Town of Faro. 2011. Financial Statements for the Year Ended December 31, 2010.

Trombulak, S.C., and Frissell, C.A. 2000. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology, 14 (1): 18-30.

Tyler, G. 1989. Effects of Heavy Metals in Forest Ecosystems. Uptake, Retention and Toxicity of Heavy Metals in Lichens, a Brief Review. Water, Air and Soil Pollution, 47(3-4): 321-333. Kluwer Academic Publishers B.V.

United States Department of Agriculture (USDA). 2011. National Invasive Species Information Center Website. Retrieved July 10, 2011, from http://www.invasivespeciesinfo.gov/plants/main.shtml

United States Environmental Protection Agency (US EPA). 1995. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources.

United States Environmental Protection Agency (US EPA). 2004. Aquatic Life Criteria for Selenium – Draft Criteria. Retrieved June 14, 2011 from http://water.epa.giv/scitech/swguidance/standards/criteria/aqlife/pollutants/selenium/upload/complete.pdf

United States Environmental Protection Agency (US EPA). 2005. Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel. Office of Transportation and Air Quality. February 2005.

United States Environmental Protection Agency (US EPA). 2009. Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater – Draft Update. Retrieved June 14, 2011 from http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/pollutants/ammonia/upload/2009_12_23_criteria_ammonia_2009update.pdf

US Army Corps of Engineers. 1993. Engineering and Design – Seepage Analysis and Control for Dams with CH 1. Publication Number: EM 1110-2-1901. Retrieved March 2011 from http://publications.usace.army.mil/publications/eng-manuals/em1110-2-1901/basdoc.pdf

US Army Corps of Engineers. 2004. Engineering and Design – General Design and Construction Considerations For Earth and Rock-Fill Dams. Publication Number: EM 1110-2-2300 . Retrieved March 2011 from http://140.194.76.129/publications/eng-manuals/em1110-2-2300/basdoc.pdf

US Fish and Wildlife Service. 1991. Cyanide Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Biol. Rep. 85 (1.23), Contaminant Hazard reviews report 23. US Department of the Interior, December, 1991.

Wahl, H.E., Fraser D.B., Harvey, R.D., and Maxwell, J.B. 1987. Climate of the Yukon. Climatological Studies No. 40, Atmospheric Environmental Service. Environment Canada, Downsview, ON.

Walker, D.A., and Everett, K.R. 1987. Road Dust and its Environmental Impact on Alaskan Taiga and Tundra. Arctic and Alpine Research 19(4): 479-489.

Walker, D.A., and Everett, K.R. 1991. Loess Ecosystems of Northern Alaska: Regional Gradient and Toposequence at Prudhoe Bay. Ecological Monographs, 61(4): 437-464.

Weaver, J.L. 2001. The Transboundary Flathead: A Critical Landscape for Carnivores in the Rocky Mountains. Working Paper No. 18. Wildlife Conservation Society. 62 pp.

Weaver, J.L., Paquet, P.C., and Ruggiero, L.F. 1996. Resilience and Conservation of Large Carnivores in the Rocky Mountains. Conservation Biology (10): 964-976.

Wiggins, D.A., Holt, D.W., and Leasure, S.M. 2006. Short-eared Owl (Asio flammeus). In: Poole, A., (Ed.) The Birds of North America. Cornell Laboratory of Ornithology, Ithaca, NY. Retrieved from http://bna.birds.cornell.edu/BNA/account/Short-eared_Owl/

Wilson, D.E., and Ruff, S. (Ed). 1999. The Smithsonian Book of North American Mammals. UBC Press, Vancouver and Toronto. 750 pp.

WorksafeBC. 2010. WorksafeBC Statistics 2009. Retrieved in 2011 from http://www.worksafebc.com/publications/reports/statistics_reports/assets/pdf/stats2009.pdf accessed 22/10/2011

Wright, D.G., and Hopky, E.G. 1998. Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters. Prepared for the Department of Fisheries and Oceans Canada (DFO).

Wulder, M., Cranny, M., Dechka, J., and White, J. 2004. An Illustrated Methodology for Land Cover Mapping of Forests with Landsat-7 ETM+ Data: Methods in Support of EOSD Land Cover, Version 3. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC, Canada. 35 pp.

Yukon Chamber of Mines (YCOM). 2010. Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide.

Yukon Environmental and Socio-economic Assessment Board (YESAB). 2005. Proponent's Guide to Information Requirements for Executive Committee Project Proposal Submissions v 2005.11.

Yukon Environmental and Socio-economic Assessment Board (YESAB). 2006a. Guide to Socio-economic Effects Assessments. June 2006. 33 pp.

Yukon Environmental and Socio-economic Assessment Board (YESAB). 2006b. Assessor's Guide to the Assessment of Cumulative Effects. V. 2006.01. 25 pp.

Yukon Environmental and Socio-economic Assessment Board (YESAB). 2007. Integration and Implementation of Wildlife Baseline and Monitoring Programs in the Yukon: A Proponents Guide.

Yukon First Nations. 2011a. Community Spotlight, Ross River Dena Council. Retrieved June 30, 2011 from http://www.yfn2010.org/explore/community-spotlights/ross-river/

Yukon First Nations. 2011b. Community Spotlight, Teslin Tlingit Council. Retrieved June 30, 2011 from http://www.yfn2010.org/explore/community-spotlights/teslin/

Yukon Invasive Species Council (YISC). 2010. Why Should I Care about Invasive Species? Publication of the Yukon Invasive Species Council. Retrieved July 10, 2011 from http://www.yukoninvasives.com/

Yukon Invasive Species Council (YISC). 2011. Yukon Invasive Species Council. Retrieved June 22, 2011 from http://www.yukoninvasives.com/

Yukon Land Use Planning Council. 2011. Planning Regions. Retrieved July 18, 2011 from http://www.planyukon.ca/index.php/planning-regions.html/

Yukon Liquor Corporation. 2010. 2010 Annual Report.

Yukon Mine Training Association (YMTA). 2010. Annual Report 2009-10.

Yukon Nevada Gold Corp (YNG). 2011. Focused on Gold. Retrieved April 15, 2011 from http://www.yukon-nevadagold.com/s/Home.asp/

Yukon Placer Secretariat (YPS). 2008. Guidebook of Mitigation Measures for Placer Mining in the Yukon.

Zanasi, L., and Taggart, M. 2006. Building on Strength, an Economic Development Strategy for Ross River. Prepared for the Ross River Dena Council. Retrieved in 2011 from http://www.yukonomics.ca/reports/Economic_Development_Strategy_for_Ross_River.pdf

Zanasi, L., and Taggart, M. 2006. Integrated Community Sustainability Plan. Appendix 6. In: Building on Strength, An Economic Development Strategy for Ross River. Prepared for the Ross River Dena Council. Retrieved in 2011 from http://www.yukonomics.ca/reports/Economic_Development_Strategy_for_Ross_River.pdf

Zoladeski, C.A., Cowell, D.W., and Ecosystem Classification Advisory Committee. 1996. Ecosystem Classification for the Southeast Yukon: Field Guide, First Approximation. Yukon Renewable Resources, Canadian Forest Service, Department of Indian Affairs and Northern Development, Whitehorse, Yukon.

Legislation and Regulations Cited in Text

Archaeological Sites Regulation, YOIC 2003/73 (*Historic Resources Act*)

Air Emissions Regulations, YOIC 1998/207 (*Environmental Act*)

Assessable Activities, Exceptions and Executive Committee Project Regulations, SOR/2005-379, (*Yukon Environmental and Socio-economic Assessment Act*)

Blasting Regulations, Part 14 Occupational Health and Safety Regulations, YOIC 2006/178 (*Occupational Health and Safety Act*)

Building Standards Act, RSY 2002, c 19

Bulk Commodity Haul Regulations, YOIC 1994/175, (*Highways Act*)

Canada Wildlife Act, RSC 1985, c W-9

Canadian Environmental Protection Act (CEPA), 1999, S.C. 1999, c.33

Contaminated Sites Regulations, YOIC 2002/171 (*Environment Act*)

Dangerous Goods Transportation Act, RSY 2002, c 50

Drinking Water Regulation, YOIC 2007/139, (*Public Health and Safety Act*)

Eating and Drinking Places Regulation, YCO 1961/1, (*Public Health and Safety Act*)

Electrical Protection Act, RSY 2002, c65

Environment Act, RSY 2002, c 76

Explosives Act, RSC 1985, c E-17

Fisheries Act, RSC 1985, c F-14

Gas Burning Devices Act, RSY 2002, c 101

Highways Act, RSY 2002, c 108

Highways Regulations, YOIC 2002/174, (*Highways Act*)

Historic Resources Act, RSY 2002, c 109

Indian Act, RSC 1985, c I-5

Land Use Regulation, YOIC 2003/51, (*Territorial Lands (Yukon) Act*)

Lands Act, RSY 2002, c 132

Lands Regulation, YOIC 1983/192, (*Lands Act*)

Metal Mine Effluent Regulations, SOR/2002-222, (*Fisheries Act*)

Migratory Birds Convention Act, 1994, SC 1994, c 22

Municipal Act, RSY 2002, c 154

Navigable Waters Protection Act, RSC 1985, c N-22

Occupational Health and Safety Act, RSY 2002, c 159

Occupational Health and Safety Regulations, YOIC 2006/178, (*Occupational Health and Safety Act*)

Public Health and Safety Act, RSY 2002, c 176

Quartz Mining Act, SY 2003, c 19

Quartz Mining Land Use Regulation, YOIC 2003/64 (*Quartz Mining Act*)

Sewage Disposal Systems Regulation, YOIC 1999/82, (*Public Health and Safety Act*)

Solid Waste Regulations, YOIC 2000/11, (*Environment Act*)

Special Waste Regulations, YOIC 1995/47 (*Environment Act*)

Species at Risk Act (SARA), SC 2002, c 29

Spills Regulations, YOIC 1996/193, (*Environment Act*)

Storage Tank Regulations, YOIC 1996/194, (*Environment Act*)

Territorial Lands Act, RSC 1985, c T-7

Territorial Lands (Yukon) Act, YOIC 2010/92, (*Territorial Lands (Yukon) Act*)

Territorial Lands (Yukon) Act, SY 2003, c 17

Territorial Lands Regulation, YOIC 2003/50, (*Territorial Lands (Yukon) Act*)

Territorial Lands Regulations, CRC, c 1525, (*Territorial Lands Act*)

Territorial Land Use Regulations, CRC, c 1524, (*Territorial Lands Act*)

Territorial Quarrying Regulations, CRC, c 1527, (*Territorial Lands Act*)

Transportation of Dangerous Goods Act, 1992, SC 1992, c 34

Waters Act, SY 2003, c 19

Waters Regulation, YOIC 2003/58, (*Waters Act*)

Wildlife Act, RSY 2002, c 229

Wildlife Regulations, YOIC 1982/89, (*Wildlife Act*)

Yukon Environmental and Socio-economic Assessment Act, SC 2003, c 7

Yukon First Nations Land Claims Settlement Act, SC 1994, c 34