Keno Hill Silver District
Existing State of Mine
Draft Closure Options Report
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1. Introduction

This document discusses options for the closure of the Keno Hill Mines and associated facilities within the Silver District. It is intended to provide a basis for further evaluation of closure options by communities and governments, and for selection of a preferred set of closure options.

The sections of this document present:

- An overview of the Keno Hill Mines property
- A description of the closure planning framework
- A summary of the development of alternatives, their analysis, review, and recommendation of options for further consideration; and,
- An initial evaluation of short-listed options
- A description of the risk assessment process and preliminary outcomes

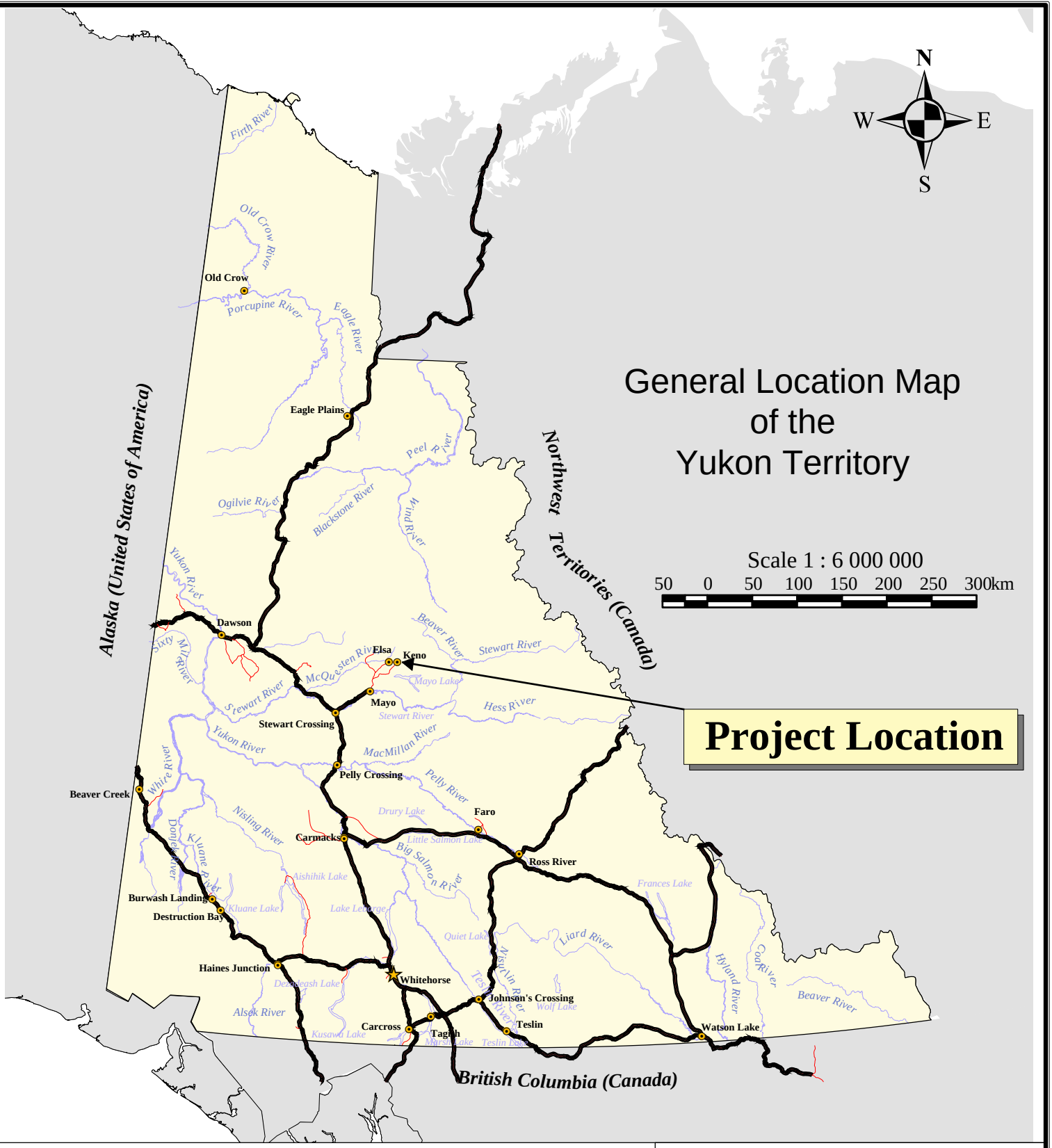
2. Site Background

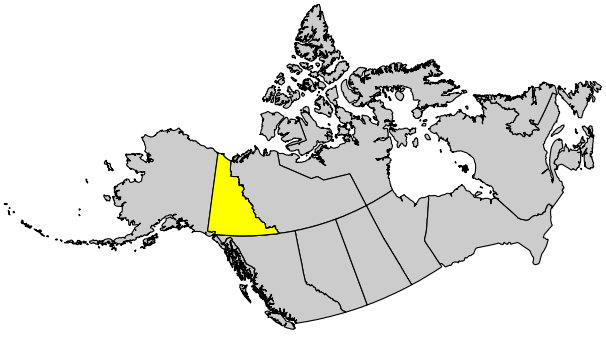
2.1 Overview

The Keno Hill Silver District is located in the central Yukon Territory, 354 km (220 miles) due north of Whitehorse in the vicinity of the villages of Elsa and Keno City. A general location map is provided in Figure 2-1.

Access to the property is by a two-lane paved road from Whitehorse to Mayo and an all weather gravel road running 45 km (28 miles) northeast from Mayo; these roads together are an effective distance of 452 km (281 miles). Whitehorse, the capital of the Yukon Territory is connected to southern Canada by the Alaska Highway.

The Keno Hill Silver District is situated on approximately 827 mineral claims, and is comprised of three adjacent mountains, Keno Hill, Galena Hill, and Sourdough Hill. The area covered by claims and leases is an elongate 15,000 ha. (37,000 acres) oriented roughly east-west with dimensions about 29 km (18 miles) long and 8 km (5 miles) at widest. Figure 2-2 illustrates the property claims. Fifteen surface leases, and several parcels of freehold property cover parts of the mineral rights.





ELSA RECLAMATION & DEVELOPMENT COMPANY LTD.

Drawn By: HD	**FIGURE 1**
Checked By: DC	Date: March 2007

Our file: D:\Project\AllProjects\ALEX-05-01\gis\mxd\UKHM\ClosurePlan2007\ExistStateMineReclPlanScopDoc\Fig1_GenLoc.mxd

464000 466000 468000 470000 472000 474000 476000 478000 480000 482000 484000 486000 488000 490000 492000 494000

7096000 7094000 7092000 7090000 7088000 7086000 7084000 7082000 7080000

N

TITAN
SHANGHAI
NORD
PADDY
WERNECKE TAILINGS
WERNECKE RAILROAD
BLACK CAP, SHEPHERD & LQ ADIT
SADIE LADUE (WERNECKE)
SADIE LADUE 600 ADIT
LUCKY QUEEN
MOON
NABOB NO. 2
NABOB
SILVER BASIN
MONUMENT & LADUE FRACTION
CARIBOU (SEGSWORTH) & ALICE
HIGHLANDER
CUB & BUNNY
LAKE
STONE
LAKE VIEW
FOX
GOLD QUEEN
AVENUE
DUNCAN
DIVIDE
FAITH
DEVON
BEMA
KLONDIKE-KENO
FORMO (YUKENO)
KIJO
GAMBLER
SHAMROCK, SHAMROCK KING
GOLD HILL NO. 2
MAIN FAULT & NABOB
KENO NO. 9 SYSTEM
KENO 700
CROESUS NO. 1
APEX
CREAM & JEAN
GALKENO 300
BLUEBIRD
TIN CAN
GALKENO 900
MACKENO
Dragon (UN) and Miller
BETTY
TOWNSITE
HECTOR CALUMET
RICO
ONEK
HOGAN
RUNER
VANGUARD
CHRISTAL (DOROTHY)
HOMESTAKE
IRONCLAD (ANKENO)
YONO
MAYBRUN
MO
BELLEKENO
FLAME & MOTH
EAGLE
BERMINGHAM
ELSA TAILINGS
NO CASH 500
NO CASH 100
DIXIE
RUBY
HUSKY
HUSKY SW
SILVER KING
GERLITSKI
ELSA AND ELSA VILLAGE
CORAL & WIGWAM
FISHER
FISHER CREEK
DUNCAN CREEK
GALENA
Sourdough Hill
Bunker Hill
CHRISTINE
MT. HINTON
Mount Hinton
KENO HILL
KENO CITY
Caribou Hill
Monument Hill
Valley Tailings
Pump House Pond
Christal Lake
Haldane Lake
Hanson Lakes
Gambler Lake
Silver Trail Highway
Galena Hill Road
No Cash Haul Road
Keno Hill Roads
Sourdough Trail
Duncan Creek Road
McQuesten Lake Road
River Road
Shanghai Creek
McQuesten River
South McQuesten River
Sandy Creek
Christal Creek
Gambler Gulch
Lightning Creek
Thunder Gulch
Silver Creek
Maisy Gulch
Monet Gulch
Faith Creek
Flat Creek
Porcupine Creek
Bluff Creek
Gaertin Creek
Thorn Creek
Corkey Creek
Williams Creek
Kelly Creek
Fourty Pup Creek
Duncan Creek
Ruby Creek
Star Creek
Mo Esash Creek
Ladue River
Ladue Creek
Keno Creek
Silver Creek
Bear Creek

1:80,000
0 1 2 4 6 8 km

Legend

Topography
- Town
- Silver Trail
- Secondary Road
- Limited-use road
- Trail
- Watercourse
- Waterbody

- 2005 Inspection (On Alexco Claim)
- 2006 Inspection (On Alexco Claim)
- 2005 Inspection (Off Alexco claim)
- 2006 Inspection (Off Alexco claim)
- Site not Inspected (off Alexco Claim)

Mine Workings
- Valley Tailings
- Adit
- Shaft (to surface - connection to underground not determined)

Quartz Claims
- UKHM Claim Package

Note:
Map does not depict all mining claims in the district.

- First Nation Settlement Land
- Crown Grant

Notes:
This map is for illustrative purposes only.
This is not a legal document.
National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced under license from © Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.
Quartz Claim boundaries are current as of October 14, 2005. Data source: http://geomaticsyukon.ca.
Crown Grants confirmed by Land Titles November 2005.
Projection: UTM Zone 8 NAD83
NTS Sheet 105M/13 and 105M/14

ALEXCO

DRAFT BASELINE ENVIRONMENTAL REPORT, UNITED KENO HILL MINES PROPERTY

UKHM Property Boundaries and Site Locations

Drawn By: HD	Date: January 2007	**FIGURE 2**
Checked by: RM	File: D:\Projects\AllProjects\ALEX-05-01\gis\mxd\UKHM8EAJan07Fig1_SiteInsp.mxd	

Many buildings of the old Elsa townsite and old mine workshop, previously owned by Unity Keno Hill Mines Ltd, remain situated on the property. The site has been under "care and maintenance" since the cessation of production in 1989. All the silver deposits are located within a 20 km radius of Elsa. Facilities in Elsa include houses, bunkhouses, mine dry offices, warehouse, transport shop, machine shop, carpentry shop and assay laboratory. A 544 ton per day concentrator and small silver refinery are also located in Elsa. The buildings and mill have deteriorated and are in varying states of disrepair. Power is supplied from a Yukon Energy Corporation 5 megawatt hydro dam located near Mayo.

2.2 Ecosystem Characterization

The Keno Hill - Galena Hill area lies within the Mayo Lake-Ross River Ecoregion. The area is characterized by widespread discontinuous permafrost. The South McQuesten River valley bounds the property to the north, while the Lightning Creek drainage confines the property to the south. The climate is characterized by hot dry summers with peak stream flows mainly occurring in spring. Increases in streamflow also occur with sudden rainfall events during the summer and fall. Temperatures range from winter extremes of -55 ^{0} C to 32 ^{0} C during summer with a mean annual precipitation of 285 mm. Treeline occurs near 1350 m to 1500 m.

Geographically, the property lies along the broad valley of the South McQuesten River, as well as over three prominent hills bordering the south side of the valley. The valley itself lies at about 700 m (2,300 feet) above sea level, while Galena Hill, Keno Hill and Sourdough Hill rise to elevations of 1,400 m (4,600 feet), 1,825 m (6,000 feet) and 1,370 m (4,500 feet), respectively. Each of these hills is incised by local linear valleys, commonly fault-controlled, with fast-flowing streams.

The area is underlain by mid Paleozoic meta-sedimentary rock overthrust by late pre-Cambrian meta-sedimentary rocks. The Mississippian Earn Group meta-sediments of the lower thrust panel are well documented for contributing to naturally elevated background metals and sulphate levels in soils and local waters. This characteristic is readily identified in the local background metals and sulphate levels in surface waters of this region.

The background water quality of the major stream drainages in the Keno Hill - Galena Hill area, South McQuesten River and Lightning Creek are slightly alkaline, with a moderately soft to hard water hardness. Some metals, for instance zinc, vary seasonally from near detection limits to above the guidelines established for the protection of freshwater aquatic life.

Historic mining within the South McQuesten River drainage has resulted in local drainages being impacted by mining activity. The Flat Creek and Christal Creek drainages have been most impacted as indicated by surface water quality and metal loading studies and by fisheries studies (Reference: Surface Water Quality Report, Minnow; Aquatic Resource Report, Minnow) . Zinc, in particular, appears to have impacted these streams. These smaller drainages which empty into the South McQuesten River have produced noticeable, but generally slight, changes in this river's water quality. These impacts are particularly pronounced during low flow periods. Water quality in the South McQuesten River downstream of all mining related activities has improved over the years as management practices have improved and now, for much of the year, meets water quality guidelines established for the protection of freshwater aquatic life.

The local ecosystem supports a wide range of biological resources. These resources have been traditionally relied upon by the Nacho Nyak Dun First Nations and area residents. Sustaining the ecosystem to ensure viability of these resources is important to local people. The South McQuesten River supports a wide variety of freshwater fish species including Chinook salmon. The area supports a variety of wildlife including, ungulates (moose, caribou), fur bearers, small mammals upland game birds and waterfowl. There are no rare or endangered species documented, although a local population of thin horn on Keno Hill was historically hunted out. The most sensitive ecosystem components considered include the aquatic resources of the South McQuesten River, particularly fisheries, the local country foods, and the local land use including aesthetics values.

No major population centres are located near the Keno Hill Silver District. Mayo, the largest community, is located 45 kilometres west of Elsa. The unincorporated community of Keno City is located 15km east of Elsa with a resident population of around 17. There are no communities or residents living below the Elsa valley tailings facilities. Seismicity of the area is ranked low.

2.3 Development and Ownership History

Prospecting for placer gold began in the Elsa area in 1885. The first discovery of silver was in July, 1903, when the Silver King Vein was found on Galena Creek. Silver vein discoveries on Galena Hill in 1919 led to a staking rush in the area. The Treadwell Yukon Company Limited initiated development on Keno Hill in September 1914, and in 1925 constructed a 110 tonne per day (125 ton per day) mill at Wernecke Camp. Most of the favourable ground had been staked by 1929 and was actively being explored. The Wernecke mill was shut down in 1931, and in 1936 a 136 tonne per day (150 ton per day) mill commenced operations in Elsa, supplied with ore by mines operating on Galena Hill. Most mining activity had ceased by 1942 due to declining silver prices.

Conwest Exploration Co. Limited and Frobisher Exploration Co. Limited formed Keno Hill Mining Company Limited in 1945 and acquired all former Treadwell Yukon Company Limited's interests. This company was reorganized as United Keno Hill Mines Limited (UKHM) in 1948.

The first UKHM production came from the Hector-Calumet vein system and from the Elsa mine in 1947. In 1949, the mill in Elsa was destroyed by fire and was replaced by a 225 tonne per day (250 ton per day) facility. The mill was expanded to 450 tonnes per day (500 tons per day) in 1951. The Hector-Calumet and Elsa Mines were the main producers in the 1950's. UKHM controlled most of the ground in the Keno Hill-Galena Hill area by 1958 with production coming from both Keno and Galena Hill.

The Keno Mine was brought into production in 1962 as reserves at the Hector-Calumet and Elsa Mines declined in the early 1960's. Falconbridge Nickel Mines Limited acquired control of UKHM in 1962. They initiated an aggressive exploration program between 1963 and 1965, with limited success and all underground diamond drilling ceased in 1966. The Hector-Calumet Mine, by far the largest producer in the camp, was abandoned in 1972. The newly discovered Husky Mine then became the major producer in the camp.

UKHM suspended commercial production due to falling silver prices, high production costs, and an inability to achieve production targets on January 9, 1989. The high production costs and inability to achieve production targets can be attributed in part to high townsite costs, high labour costs, high labour turnover and costly mining practices. Control of UKHM was acquired from Falconbridge by the current management in July, 1990.

Mining in the Keno Hill-Galena Hill area from 1914 to January 9, 1989, produced 5.342 million tons of ore grading about 1,370 g/t (40 oz/ton) Ag, 6.6% Pb and 4.1% Zn from 34 different deposits for a total of about 6.6 million kg (214 million ounces) of silver.

This ore was obtained from both open pit and underground operations. Underground production, including documented small hand cobbing operations, totals 4.420 million tonnes (4.873 million tons) grading about 1,440 g/t (42 oz/ton) Ag, 7.0% Pb and 4.4% Zn. Well over half of this production has come from the Hector-Calumet and Elsa mines, which are also two of the deepest mines in the camp.

Open pit production, which commenced in 1977 with mining from the Porcupine Pit, has totalled 425,600 tonnes (469,200 tons) grading about 580 g/t (17 oz/ton) Ag, 3.0% Pb and 0.4% Zn from 14 different deposits.

Considerable effort has been made to concisely present a great deal of information about a variety of localities. The 1996 Site Characterization report (reference) presents the history, quantities of ore production, waste type, and waste rock quantity for each component (mine). The Closure Issues Report summarizes the specific closure issues related to all of the individual sites across the district.

The following descriptions of the individual mines are organized in terms of these three “Hills”, and thence generally in alphabetical order. The development on Galena Hill comprises:

- Bermingham Mine

- Dixie Mine
- Elsa Mine
- Elsa Tailings, Mill and Infrastructure
- Galkeno Mine
- Hector-Calumet Mine
- Husky and Husky SW Mines
- Miller
- No Cash Mine
- Ruby Mine
- Silver King Mine
- Sime Open Pits
- Townsite Adit
- UN Adit

These mines are all located within the South McQuesten River watershed.

Sourdough Hill has only the Bellekeno Mine. The mine is in the Lightning Creek watershed, a tributary to Duncan Creek which drains into the Mayo River.

The mines of Keno Hill comprise four main mines:

- Keno Summit including:
    - Keno 700 - 9 Vein
    - Shamrock J - 18 Vein
    - Comstock-Keno & Porcupine
    - Lucky Queen/Black Cap
    - Onek
- Sadie Ladue (Wernecke Camp)

These properties drain to different watersheds; Sadie Ladue to the Ladue Creek watershed, Keno 700 to Lightning Creek, and Lucky Queen and Onek to the South McQuesten River watershed via Christal Creek.

2.4 Care and Maintenance History

UKHM, the previous owner of the properties located on and around Galena Hill, Keno Hill and Sourdough Hill, ceased operations in 1989. UKHM was subsequently convicted of several compliance issues with respect to Water Use Licence QZ96-001 in 1999. These issues were mainly due to the inability of UKHM to raise the necessary financial backing required to undertake engineering studies and to make necessary improvements to the environmental liabilities associated with the property. Further financial difficulties resulted in the company ceasing operating water treatment systems in late 2000.

In January 2001, The Minister of DIAND exercised his authority under the Yukon Waters Act by issuing a determination that the mine had been abandoned. Under contract to DIAND, Access Consulting Group (Access) undertook care and maintenance of the site to maintain the existing water treatment systems and tailings pond dam integrity in order to protect the environment. DIAND retained stewardship of the mine property until it was sold through Court order by the UKHM miners' lien claimants to AMT Canada Inc. (AMT) in October of 2001. Also in October 2001, the site was declared a Type II Site under the Devolution Transfer Agreement, which meant that Yukon would manage the property, but financial responsibility for environmental liabilities would remain with the Government of Canada.

AMT operated the water treatment systems while they pursued permitting, but ultimately dropped the project in 2003. Nevada Pacific Gold Inc. operated the care & maintenance systems for a few months after AMT left in 2003, until they also ultimately ceased involvement with the property. On June 26, 2003, the Yukon Government declared the properties and the works on these sites abandoned once again. Yukon Government subsequently took over care and

maintenance and water treatment activities at the site and contracted the work to Access Consulting Group (ACG).

The Court appointed PricewaterhouseCoopers Inc. as Interim Receiver and Receiver-Manager of United Keno Hill Mines Limited and UKH Minerals Limited (collectively known as "UKHM") on April 6, 2004, and through a selection process Alexco Resource Corp. (Alexco) became the preferred purchaser of the UKHM assets (June 24, 2005). As per the Court arranged sale, Alexco formed Elsa Reclamation and Development Company, as a wholly owned single purpose subsidiary of Alexco (hereinafter referred to as ERDC) to provide a project-specific legal vehicle to undertake ownership and management of the site. Water Use Licence QZ06-074 was issued on 14 Nov 2007 for care and maintenance activities on the property. As the final requirement of the negotiated terms of sale between the two governments and Alexco, it consummates final transfer of the property.

Separately, INAC have entered into a contractual arrangement with ERDC to perform ongoing environmental care and maintenance (provision of site security and operation of water treatment systems) at the site. The agreement further provides for ERDC to develop an Existing State of Mine Closure Plan for the site to address long term site liabilities and to implement the plan. Reclamation and closure-related activities and plans will be subject to an environmental assessment under YESAB and then licenced under a water use licence application.

3. Site Closure Components

The Keno Hill mine site can be broadly broken down into mine 'components' that encompass every mine-associated development, disturbance, working and remediation activity at every site. These components include the Valley Tailings Facility, mine workings (adits and pits), adit treatment areas, adit water management activities, waste rock storage areas, infrastructure, and other more minor components such as the Wernecke and MacKeno Tailings and mills.

3.1 Adits and Pits

The Keno Hill Silver District consists of open pits and underground workings. Underground workings were accessed through adits or shafts depending on mine location. In total, the mine workings comprised, 19 separate open pits, (12 open pits on Galena hill; no open pits on Sourdough Hill; and 7 on Keno Hill) and 65 underground workings, including adits and shafts (23 adits and 17 shafts on Galena Hill; 4 adits and no shafts on Sourdough Hill; and 15 adits and 6 shafts on Keno Hill). These mine workings have been worked intermittently from 1914 to 1989 when UKHM temporarily suspended operations. UKHM previously operated 34 mine workings with the focus recently (1980's) being on the Silver King, Bellekeno, and Husky mines.

The majority of mine working occurred on the Galena Hill with all of these working eventually draining directly by surface waters or indirectly via groundwater to the South McQuesten River via the Flat Creek or Christal Creek drainages.

Adit Treatment

Metals-laden water discharges continually from various mine openings throughout the Keno Hill Silver District, and seasonally from the Valley Tailings Facility. The quality of this effluent fails to comply with water licence regulations for the site, and in order to reduce metals levels, water treatment is required on an ongoing basis.

The treatment system for all sites at Keno Hill consists of the mechanical application of lime slurry ($CaO_{(s)} + H_20_{(l)}$) to the mine discharge waters. The slurry acts to raise the pH, causing zinc and other

metals to precipitate out of solution, forming a solid metal hydroxide sludge. Precipitate retention ponds are located at each treatment facility to assist metals precipitation and clarification of effluent prior to release into the receiving environment. Sludge is periodically removed from the primary settling ponds and transported to final storage in the Valley Tailings.

Discharge samples at each treatment location are taken and analyzed on a daily basis using the on-site AA machine. Review and evaluation of these results is conducted by the ERDC project manager and discussed with the treatment system operators. These results allow the project manager to provide direction regarding the treatment process, (i.e. lime addition rates and pond clean-out activities).

Adit Treatment Process General Description

Water treatment is undertaken seasonally during the freshet at the Tailings Facility and is conducted year-round at four adits. Water treatment was initiated in 1993 at three of the adits (excluding Galkeno 300) due to concerns with metal concentration in adit discharges. Treatment at these sites consists of conventional lime treatment followed by clarification in settling ponds. Sludge from the adit settling ponds are routinely removed and placed either in the tailings impoundment or the Sime Pit above the Galkeno 300 treatment facility.

In general, the treatment processes currently involves continuous lime addition to mine portal effluent water at:

- The Galkeno 900 adit;
- The Galkeno 300 adit;
- The Silver King 100 adit;
- The Bellekeno 600 adit; and
- The Valley Tailings Facility (on an as-needed basis, depending on water quality and decant situation - normally requiring treatment only during spring freshet, between May and June).

The treatment objective is to reduce zinc effluent concentrations to less than 0.50 mg/L, as required under Water Licence QZ06-074. Historic correlations between zinc concentrations and other metals (i.e. arsenic, lead and cadmium) indicate that the zinc discharge treatment objective ensures that other potential contaminants of concern are also managed.

Lime Mixing and Consumption

Lime slurry preparation, conducted within the transport garage at Elsa, involves the addition of hydrated lime (CaOH) via an auger conveyor into a slaking tank, where water is added to produce lime slurry. Water for lime slurry mixing is delivered to the transport garage via water tanker truck on a daily basis. In total, approximately 9,000 litres of slurry are mixed and delivered daily, via truck. The Bellekeno and Galkeno 900 adit requires lime delivery 2 times per week, the Silver King system once per week and the Galkeno 300 system 5-6 times per week. Slurry concentration is roughly 37.4 grams of lime per litre of water, equating to a consumption rate of 20 tonnes of lime per month (consumption rate rises during spring freshet in May and June, when treatment is required at the Valley Tailings). The Galkeno 300 treatment plant requires approximately 70% of the total lime consumed at the four treatment sites at Keno Hill, or approximately 14 tonnes per month.

Galkeno 900 Bioreactor Cell Pilot Study

The Galkeno 900 bioreactor is a pilot test of sulphate-reducing bacteria (SRB) technology for treating mine drainage. In the bioreactor, a pond was filled with streambed gravels, a baffle installed to direct flow through the gravels, and mine waters are amended with a soluble organic carbon source mixture, primarily alcohols. The first few months of operation are a growth phase for naturally-occurring SRB to colonize the surface of the gravels, in time forming a microbial coating over the gravels comprised primarily of SRB. The SRB metabolize the carbon source, leading to the reduction of sulphate and the formation of aqueous sulphide within the bioreactor. The sulphide reacts with soluble metals in the mine drainage, precipitating the metals within the bioreactor, where the metal precipitates are filtered by the gravels.

The pilot test is a demonstration that this SRB technology, which has been successfully employed at many sites in mine pools, wetlands, and bioreactors in warmer climates, can be successfully implemented year-round in a buried pond bioreactor in the cold climate at Keno Hill, where temperatures of -40 or colder are common in the winter months. To this point, there are initial signs of microbial growth within the bioreactor, and the pond as been maintained flowing through the winter, even with minimal fresh inputs of mine water (which is 3^{o}C year round). This demonstrates that the approach of utilizing burial in the ground for insulation is successful to maintain flow through the winter. In the spring and summer months, we expect the growth phase to be complete and the treatment phase to be maintained, with metal removals well over 90% for cadmium and zinc being primary success criteria expected to be achieved and maintained. Finally, next winter will complete the important phase of the demonstration, showing the metals removal will continue even through the cold temperatures associated with wintertime.

As a result of the high levels of zinc discharging from the Galkeno 300 adit, and the difficulty associated with treating these zinc levels, ERDC completed an assessment of the performance of the Galkeno 300 adit water treatment system in 2007. The result was recommendations for process improvements to both the treatment plant and the sludge management systems at the site. Improvements that were enacted are:

- A new rapid mix tank to improve lime use efficiency
- A new tube settler clarifier to improve solids removal and sludge handling
- A new sludge storage pond to improve sludge management practice and assist in densification.
- New methods for handling and disposing of sludge from the sludge storage pond.
- Storage of sludge in the Sime Open Pit.

Overall, these changes have been positive and have allowed the system to operate in compliance with water licence conditions for much of the time since the changes were implemented in late 2007.

Adit Water Management

In the fall of 1993, a hydraulic plug was installed by UKHM in the Galkeno 900 level adit, in response to concerns from Environment Canada that this adit was a major source of contaminant loading to the receiving environment. The objective of the installation was to cause flooding of the underground workings which would limit oxidation and dissolution of metals into the drainage water.

It has been recognised, given the geology of the hillside and extent of development above the 900 level, that the workings would not entirely flood and the source of soluble metals could continue. Moreover, as water accumulated behind the plug, the increasing hydraulic head would force the water to seep from the rock mass beyond the plug and surrounding grout curtain, and to daylight elsewhere in the hillside. The adit plug continues to leak and produce water at a rate of several litres per second.

Other water management facilities at the site are generally associated with treatment facilities at the adits and at the Valley Tailings. Ponds and decant structures hold and convey water to and from various sources at the site. Treated water from the Galkeno 300 system is routed down Calumet Drive via a HDPE pipeline that directs water into a ditch and eventually infiltrates into the ground.

Water Management Facilities

Freshwater supply for domestic, fire and milling purposes was obtained from a small lake connected to the South McQuesten River. A pumphouse is located near the lake and water was pumped via pipeline 5 km to the Elsa townsite and mill. There are no dams or structures located

at the pumphouse. Mine water from the Husky shaft was piped to the tailings impoundment. Tailings were piped from the Elsa mill to the valley tailings area, with no water recycle.

The only major surface water diversion is located on Porcupine Gulch. Porcupine Gulch originates on Galena Hill and flows by the Elsa mill. Surface waters are partially diverted around the tailings impoundment. Maintenance work is required on the Porcupine Diversion as the diversion was constructed within the tailings itself.

3.2 Tailings

Tailings were produced from each of the three mills (existing Elsa mill, Galkeno/MacKeno mill, and Wernecke mill).

The Wernecke tailings are difficult to locate as they have partially revegetated. Tailings were deposited on the hillside between 1925 and 1931. The quantity of tailings deposited here is unknown, although the maximum mill capacity was reported at 125 tons per day. There are no dams retaining tailings. Very little information exists on these tailings. This tailings area drains north to the Keno-Ladue River.

The Galkeno/MacKeno tailings were deposited on land near the northeast shore of Christal Lake. Mill feed was from early Bellekeno and Galkeno workings. Approximately 3,000 to 5,000 tons of tailings were deposited in this area between 1953 to approximately 1959. There are unconfirmed reports that tailings were deposited in Christal Lake. There are no dams retaining the on-land tailings. Historically the waters of Christal Lake have inundated part of these tailings. Some tailings loss to Christal Creek has occurred.

The Elsa Tailings impoundment is the single largest in the district and presents a host of issues to consider for closure, including physical stability of dams and diversions and long-term geochemical stability. The recent geochemical assessment by SRK suggests that the tailings are not likely to generate acidity in the future and that metal loads to surface and groundwater will continue to be

generated but will remain relatively small. A complex issue such as the tailings has to be approached in a series of steps in order to define the questions to be addressed in the next phase of investigation. Reprocessing of tailings, perhaps with relocation, to a more secure site has been suggested as a possible closure option. Considerable work has been done on re-vegetation of the tailings but with the exception of wet areas, little has taken hold. Wet areas, on the other hand, have developed lush growth.

The geotechnical reviews of the valley tailings over the years by regulatory authorities, site annual inspection consultants, and closure plan consultants indicates that there are three key issues related to physical stability of the Dam structures that need to be addressed for closure:

- ground thaw beneath the tailings dams resulting in settling and therefore potential for overtopping and breaching of the structure;
- presence of culverts and decant structures through the dams which may lead to piping failures around these structures; and,
- failure or slumping of the downstream face of each dam due to steep (over-steepened) slopes.

The Valley Tailings are not a significant load of metals on the property in terms of surface water pathways relative to other contaminant sources since seasonal water treatment occurs each spring. They are even less significant in terms of groundwater contaminant loading. However, the loads that *are* produced by the tailings must be mitigated to an acceptable level, with which water management issues are necessarily concerned.

The last consideration for closure of the Valley Tailings Area is the potential for airborne contribution of metals into the surrounding terrestrial environment. When the tailings are dry and significant wind events occur, dust from the tailings is easily transported. This can be mitigated by keeping the tailings moist. Where the tailings are submerged or wet, transport is unlikely to occur and there is the added benefit of revegetation. Another consideration to mitigate air borne

transportation of tailings is to cover the surface with benign overburden material that will also promote revegetation efforts.

The tailings deposited from the Elsa mill are the most recent, and by far the largest deposit. Approximately 4,128,000 tons of tailings have been deposited in this facility. Tailings were deposited from the Elsa mill during the periods 1936 to 1942, before the formation of UKHM, and 1947 to 1989, by UKHM.. The valley tailings facility is located in the Flat Creek Valley, and consists of a series of three impoundment structures. Most of the tailings are impounded behind Dam No. 1. The No. 1 and No. 2 dams failed in the early 1970's and some tailings were lost downstream to Flat Creek. The No. 3 dam was constructed shortly thereafter. The tailings dams are routinely inspected and monitored. There is no human habitation immediately downstream of the tailings.

3.3 Waste Rock

Generally, there are waste rock dumps associated with each mine working. A total of 47 separate waste rock dumps were created (28 waste rock dumps on Galena Hill; 4 on Sourdough Hill and 15 on Keno Hill). Waste rock material has been used in the construction of the Elsa tailings dam and haul roads. There has been no mass failure of any waste rock dump, although minor instabilities have been noted at some waste rock piles. The waste rock dump at Keno 700 has experienced significant erosion from water surges as a result of blown ice plugs. The rock dumps are located on hillsides away from all major roads, water courses, and human habitation.

3.4 Infrastructure

The infrastructure associated with the Keno Hill Silver District is confined to specific mine workings and the Elsa Townsite. Historically small local townsites were set-up to support major mine workings, for example Hector Calumet and Keno 700. The Hector Calumet townsite was removed while parts of the Keno 700 camp remain, but are uninhabited. The Elsa Townsite has largely been dismantled but considerable infrastructure at the site remains and consists of the mine offices, shops, warehouses, bunkhouses and a small number of houses. Power is supplied from Yukon Energy Corporation Mayo Lake Hydroelectric facility.

The majority of houses from the townsite have been removed. The Silver Trail highway runs through the Elsa townsite en route to Keno City and this road will remain at closure.

Keno City was once a thriving community housing large numbers of mine workers, but currently is a quiet hamlet with a small population. The hamlet draws its drinking water from ground water in the center of town and operates a solid waste disposal site in the headwaters of Christal Creek.

The Elsa site contains numerous remnant fuel oil and fuel storage facilities that are likely contributors to hydrocarbon contamination that will require remediation at closure.

Mills

Three mills were known to have operated within the UKHM claim boundaries. These include the existing Elsa mill which lies near the headwaters of Flat Creek, the old Galkeno or MacKeno mill near the northeast shore of Christal Lake, and the older Wernecke mill located as part of the Wernecke camp on Keno Hill. The mill building at the Galkeno mill site has been removed. Similarly, there is no visible evidence remaining of the Wernecke mill building. The MacKeno and Wernecke Mills were not UKHM operations.

3.5 Closure Issues

An extensive review of relevant materials has been conducted and led to the identification of the major closure issues at each site on the property. Table 3.1 provides a summary, broken down by component, of the various issues that the closure plan will necessarily need to address. The key issues that will drive closure planning at Keno Hill, relate to human and wildlife health and safety, contamination of the environment (including water, air and land), community concerns, and risks from extreme events that may affect the ability to effectively manage water or the structural integrity of site works.

Table 3.1 Keno Hill Property Closure Issues

Site Component	Closure Issue Category	Description of Issues	Source of Data
Valley Tailings Area	Hydrogeological/ Geochemical	Groundwater pathways presently exist beneath the Elas tailings. Based on preliminary investigations undertaken in 2006, investigators inferred that the Elsa tailings are a source of contaminant loading. Analysis results support the conclusion that arsenic, sulfate, and zinc are all mobile in the saturated interface between beneath and down gradient of the Valley Tailings, and the mass load of contaminants from the un-reclaimed Valley Tailings are a source of contaminant loading in the McQuesten River Valley. A drilling program carried out in 2007 estimates that there is a net flux of 18m^3/day leaving the VTF via groundwater flow beneath Dam #3.	
	Water Management	There are two sets of diversion ditches in place as a part of water management at the VTF. The upper diversion system is in good condition, and is inspected regularly and maintained as required. The Lower Porcupine Diversion Ditch has not received regular inspection or maintenance and is expected to be in poor condition.Uncontrolled releases of water from one or more of the ditches could result in significant increases in the water level behind Dam #3, possibly leading to a dam breach.	
	Geotechnical	The three tailings dams at the Valley Tailings Facility (VTF) are thought to be founded on permafrost rich siols. The permafrost appears to be thawing and the soils consolidating, leading to settlement of the dams. Annual inspections are undertaken to determine maintenance requirements, if any, to keep the dam crests at the desired height and thereby prevent overtopping. It is thought at the present time that the tailings retention dams do not pose any hazard.	
Adits	Geochemical	Several adits produce high levels of water-borne contaminants. Some of these adits discharge directly to watercourses, and in these cases will require long-term water treatment. The primary contaminant of concern is Zn, although other contaminants of concern are being assessed.	
	Water Management	Some adits will require long-term water treatment, and in some cases this will involve consideration of physical water management applications. This encompasses cases where physical pooling or water, or piping will be required. For example, the volume of water treated at a low-volume site may not be enough to warrant long-term treatment at that site and there is a case for conveying contaminated water to a new location.	Outcomes from 2007/08 Keno Hill Adit Closure Studies, Technical Memorandum (in: Technical Closure Studies 2007/08)
	Geotechnical	The stability of some adits is a concern as they are in an advanced state of deterioration or semi-collapse. In the case where adits will potentially be reentered, stabilization will be required. In other cases it will be necessary to adequately fill and block the adit entrance.	
	Human Health and Safety	The nature of risks/issues varies from adit to adit, thus it is necessary to identify adit-specific closure requirements in order to select appropriate closure measures. Restricting public access is a requirement for all adits. Certain adits will require long-term drainage control, and in these cases a closure measure must be identified that will restrict public access, yet allow the operational access necessary to service and maintain water control systems. Other adits are presently in a fully collapsed state and require no additional work to prevent public access.	Outcomes from 2007/08 Keno Hill Adit Closure Studies, Technical Memorandum (in: Technical Closure Studies 2007/08)
Waste Rock and Pits	Geochemical	The potential for acid rock drainange (ARD) and metals leaching (ML) is a potential concern for some of the waste rock piles. ARD is a concern for the waste material at the Dixie, Hector, Husky SW, and SK 100 waste rock dumps. Metals leaching concerns are more widespread, with the primary metal of concern being Zn. Metal loads are witnessed at the Bermingham, Calumet, Dixie, Galkeno 900, Hector, Husky SW, Ruby, Silver King and Townsite waste rock dumps. While waste rock materials in the dumps present an ARD or ML concern, pit walls are decidedly less reactive due to their decresed proximity to mineralization.	Review of Historic Keno Static Test Data to Define ARD/ML - Controlling and Correlating factors (Altrua Environmental Consulting)
	Geotechnical	The history of the waste rock piles in general indicates that, for most sites, the long-term geotechnical stability of waste rock piles is of little concern as the potential consequences of failure are likely to be minor and quite localized. For stable waste rock piles, the selection of a waste rock pile closure measure will be driven by geochemical loading, aesthetic objectives, or revegetation goals. For the Hector #1 vein waste rock pile, the ongoing erosion and recent evidence of slope movement indicate that there is a high likelihood of failure of this dump over the long term; however, consequences of failure would be very low, and limited to downslope movement of waste rock covering a limited area that is presently vegetated. For the Keno 700, No cash 500, Silver King 100 and Bellekeno 625 adit waste rock piles, permanent streams at the base of the piles may necessitate relocation of some waste rock if a closure measure other than 'Do Nothing' is selected. These waste rock piles are at risk of future undercutting during periods of high stream discharge. No Cash 500 and Keno 700 have the added risk of erosion arising from uncontrolled discharge from the respective adits.	2007 Geotechnical Closure Studies, Keno Hill, YT (in: Technical Closure Studies 2007/08)
		All of the open pit excavations will continue to unravel to some degree. Within the Bermingham, Calumet and Sime #6 Pits this instability is expected to be more significant, with some larger sections of the slope walls becoming unstable over time.	
	Human Health and Safety	Access to open pits is presently unimpeded. Public access, whether dileberate or inadvertent will have to be addressed in closure plannnig.	
Buildings/ Infrastructure	Human Health and Safety	Most transportable contaminants have been removed from buildings. However, fixed contamination such as asbestos siding and lead paint has not been removed. ACG has compiled an inventory of suspected asbestos and lead paint. The Elsa Village has by far the largest known amount of contaminated building materials, predominantly in the form of exterior cladding containing asbestos. Several buildings at the Elsa Village have also been identified as structural hazards. Buildings in service under current site operations have been inspected and are considered safe.	Baseline Environmental Report - UKHM (SRK Consulting)

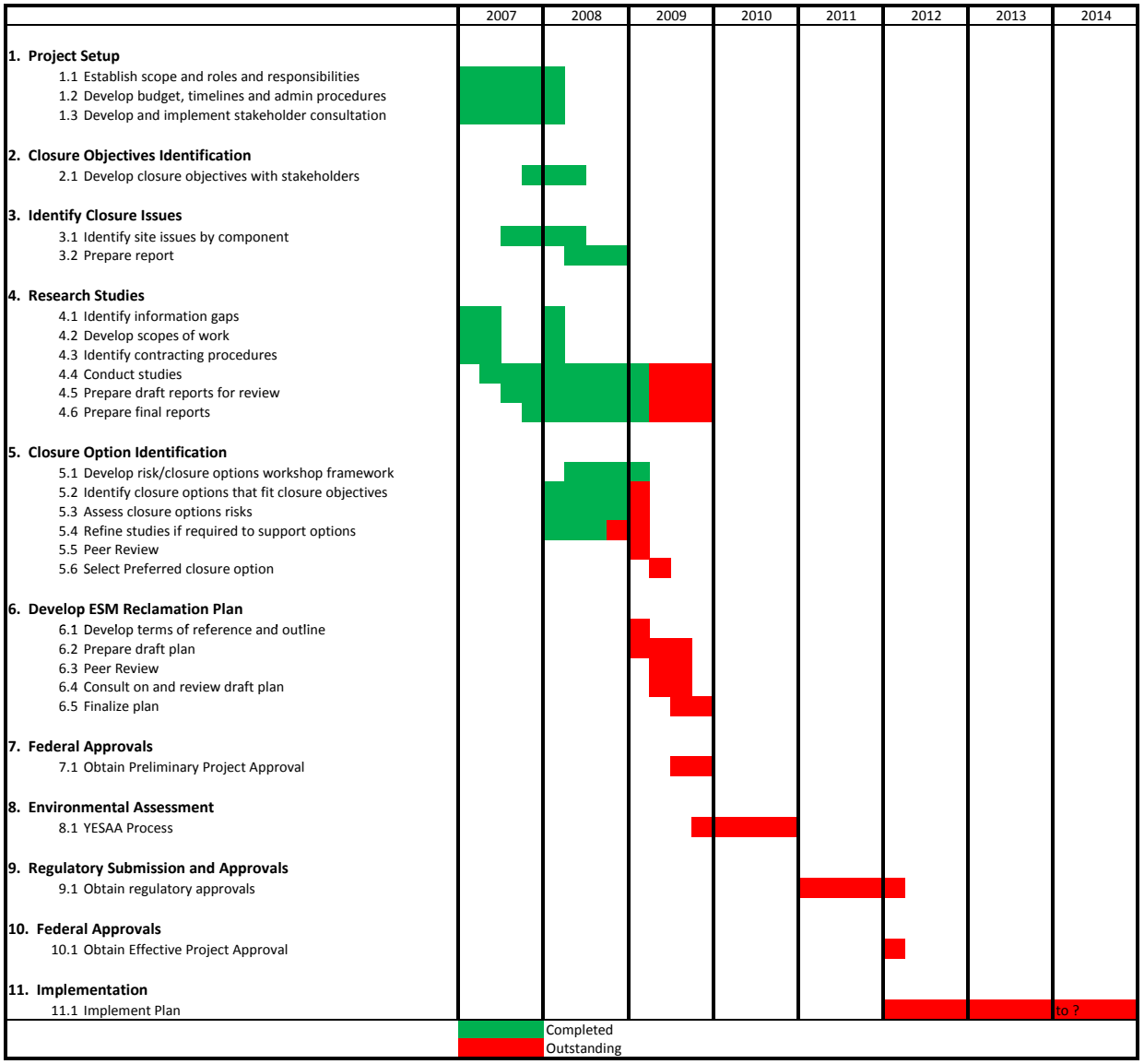
4. Closure Planning Framework

4.1 Closure Planning Process

Development of a closure plan process to address the Keno Hill Silver District historic environmental liabilities requires a tailor made approach given the fact there are several parties involved including a site owner and operator (ERDC) and 3 governments (INAC, YG and FNNND). A closure planning process has been developed that considers the unique nature of this project and the overall process and timeline associated with the plan development is shown in Table 4-1.

The process for selecting appropriate closure options for mine area components has been structured around a risk assessment process whereby closure options are risk assessed and then further refined and a final closure options selected. Given the considerable number of individual sites (40+ adits, 47 waste dumps, infrastructure, etc), conducting a risk assessment on all of the multiple closure combinations envisioned would become unworkable and not effective. The proposed risk assessment approach for Keno Hill is to assess the most important mine area components in the district and present viable closure options for these components. Based on the risks identified in this select group of components, it is reasonable that all high level risks will be identified that can then be applied to all components across the district.

Table 4.1 Timeline to Development of Existing State of the Mine Reclamation Plan



4.2 Closure Objectives

Closure objectives have been developed through a consultative process with INAC, YG and NND.

The following are closure objectives that are intended to guide the development of the Existing State of Mine Closure Plan for the Keno Hill Mines property. These objectives have been developed in conjunction with the local community and will assist with selection of preferred closure options and implementation of the final plan. Specific closure objectives were prepared by Nacho Nyak Dun First Nation as part of the closure planning process. Specific closure objectives prepared by NND are included in Appendix A.

Public health and safety

- Make sure that the site is safe for people who use the area
- Ensure workers' health and safety
- Protect peoples' health by ensuring that country and traditional food sources, including wildlife, fish and plants are safe to eat

Environment

- Protect the environment including land, air, water and wildlife health and safety
- Restore the environment from effects of past mining activities
- Protect the South McQuesten River
- Mitigate significant adverse environmental effects to community identified Valued Ecosystem Components (VEC's) using a risk based approach
- Monitor appropriate environmental conditions to ensure the effectiveness of site closure measures

Community Land Use

- Consider the relevant expectations of stakeholders for post closure land use
- Use traditional knowledge to protect the culture and traditional pursuits of the First Nation of Nacho N'yak Dunn

- Restore traditional and local land uses in the area
- Preserve heritage values where practicable
- Provide a land use that allows the mine site to continue to be productive in a manner consistent with, although not necessarily identical to local and pre-mining land use.

Socio-economic

- Maximize economic opportunities for the First Nation of Nacho N'yak Dunn residents and businesses, local residents and Yukoners in general
- Ensure that long-term and permanent site activities continue to address site needs and concerns of local people
- Minimize negative socio-economic impacts in the area

Cost Effective

- Provide a closure plan that meets industry standards of best practice
- Minimize overall risk and cost of remediation project
- Consider, and use where appropriate, technologies that reduce long-term liability and minimize requirements for long-term post-closure care and maintenance

5. Options for Closure

5.1 Mine Component Assessment Process

For the purposes of risk assessment of the short listed closure options, mine components have been selected that represent the vast majority of contaminant loading within the district as well as present the more challenging closure issues to consider. Identification of risks for these sites will provide an overall risk assessment that can be applied for final closure option selection for all mine components. The following mine components represent the major contaminant loads, risks and challenges across the district (not in order of contaminant load):

- Onek
- Keno 700
- Galkeno 900
- No Cash 500
- Galkeno 300
- Hector Calumet
- Valley Tailings Area

Closure options have been identified through the course of the closure planning process. These potential closure options have been reviewed and vetted by the closure planning group including ERDC, INAC, YG, NND and SRK Consulting.

Table 5-1 summarizes the possible closure options identified for each mine component at the Keno Hill Property. Where options have been excluded from consideration following vetting, an 'N' is denoted in the shortlisted field.

Table 5.1 Keno Hill Property Closure Options

Site Component		Option	Description of Option	Variants	Shortlisted
Valley Tailings Area	1	Do Nothing - Status Quo	Leave as is; natural revegetation and continue seasonal water treatment as necessary	No further inspection required	Y
				Inspect dams periodically	
	2	Revegetation and Dams Stabilization	Regrade and cover the surface of the tailings, and stabilize the dams to hold tailings in place	Natural revegetation	N
				Soil cover and revegetate	
				Flood tailings (either with or without seasonal lime treatment as necessary)	
				Maintain current water management plan	
				Construct Lower North Fork Flat Creek channel through borrow area	
				Construct Lower North Fork Flat Creek channel through borrow area and abandon Pocupine Creek Diversion in lieu of a stable channel over tailings	
	3	Revegetation and Flatten Dams 1, 2 and 3	Regrade and cover the surface of the tailings, and flatten the profile of the dams to integrate tailings area	Natural revegetation	Y
				Soil cover and revegetate	
				Maintain current water management plan	
				Construct Lower North Fork Flat Creek channel through borrow area	
				Construct Lower North Fork Flat Creek channel through borrow area and abandon Pocupine Creek Diversion in lieu of a stable channel over tailings	
				Re-establish Porcupine Creek and Brefalt Creek near their pre-mining alignments; direct North Fork Flat Creek flows into Porcupine Creek; and upgrade the lower portion of the Porcupine Diversion to convey upper Flat Creek flows to the original channel west of the Valley Tailings Facility	
	4	Consolidate Tailings, Revegetation and Flatten Dams 1, 2 and 3	Consolidate tailings to reduce their overall aerial extent, regrade and cover the surface to promote revegetation, and flatten the profile of the dams to integrate the tailings area.	Natural revegetation	Y
				Soil cover and revegetate	
				Maintain current water management plan	
				Construct Lower North Fork Flat Creek channel through borrow area	
				Construct Lower North Fork Flat Creek channel through borrow area and abandon Pocupine Creek Diversion in lieu of a stable channel over tailings	
	5	Consolidate and Flood Tailings	Consolidate tailings behind large, constructed dam and flood with water to stabilize tailings mobility	No treatment	N
				Seasonal lime treatment of surface water runoff as necessary	
				Capture and injection/in-situ treatment of surface water as necessary	
	6	Remove and Reprocess	Reprocess high grade tailings followed by Option 3	Reprocess for silver recovery and then consolidate and cover.	Y
				Slurry/paste backfill elsewhere	
	7	Remove Some Tailings and Reprocess	Reprocess high grade tailings	Slurry/paste backfill into Hector workings	N
				Slurry/paste backfill elsewhere	
				Options 1 through 4 for remaining tailings	
	8	Relocate	Remove and relocate all tailings	Options of where to move tailings to	N
	9	Relocate Some Tailings	Remove and relocate some tailings	Options of where to move tailings to	N
				Options 1 through 4 for remaining tailings	
Adit Treatment	1	Do Nothing	No treatment	No further inspection required	Y
				Monitor periodically	
	2	Conventional Central Treatment	Capture, build central treatment plant, multiple pipelines, long-term conventional lime treatment	In-line treatment and co-deposition	Y
				Conventional treatment plant	
				Simple sludge recycle	
				HDS process	
				Geco process	
				Staged-neutralization process	
	3	Conventional Site Treatment	Capture, build multiple treatment plants, longterm conventional lime treatment	As in Option #3	Y
	4	Simple Lime Mixing	Capture, long-term simple lime mixing with settling	Current pond treatment	Y
				Upgrade pond systems	
				Pit treatment	
	5	Natural Attenuation	Capture, redirect to natural attenuation areas	Capture and redirect all adit waters	Y
				Capture and redirect some adit waters, perform treatment at others	
				Capture and redirect some adit waters, no treatment at others	
	6	Ex-Situ Bioreactor (sulphate-reducing)	Capture, ex-situ treatment in sulphate-reducing bioreactor	Bioreactor treatment only (all adit discharge)	Y
				Bioreactor treatment only (some adit discharge), no treatment for above-capacity discharge	
				Couple bioreactor treatment with conventional lime systems	
	7	Mine Pool Bioreactor (sulphate-reducing)	In mine pool treatment biological sulphate reducing	In mine pool treatment only	Y
				In mine pool treatment coupled with any of Options 2 - 5	
	8	Trench Bioreactor (sulphate-reducing)	Capture, injection to trench or gallery w/ in-situ sulphate-reducing treatment	Trench treatment only	Y
				Trench treatment coupled with any of Options 2 - 5	
	9	Wetlands Treatment	Capture, engineered wetlands treatment		N
	10	Combinations of above		Many of the in situ alternatives can be used in combination, for example in mine pool treatment at G300 may reduce load by large percentage followed by in situ injection and treatment as polishing	Y
Adit Water Management	1	Do nothing	No action necessary for dry adits	Prevent access through rock piles	Y
	2	Hydraulic Plug	Hydraulic Plug and create mine/pit pool - constant discharge		Y
	3	Seasonal Batch Treatment	Mine pool storage, seasonal batch treatment - controlled discharge	Hydraulic plug	Y
				Mine pool dewatering	
				Seasonal batch treatment may be selected from Adit Treatment Closure Options	
	4	Underground Alkaline Sludge Recycle	Recycle sludge underground with alkalinity	With alkalinity	Y
				With carbon source	
	6	Reduce Infiltration	Water source control	Diversions	Y
	7	Water Conveyance	Water conveyance structures from adit	pipelines, rip rap channels, lined channels, settling pond, energy dissipators, erosion control and geochemical control	Y
Adit Closure	1	Do nothing	No action necessary for dry adits	No further inspection required	Y
				Inspect periodically	
	2	Collapse Adit	Collapse adit	No further inspection required	Y
				Inspect periodically	
	3	Plugs	Control water	Bulkhead	Y
				Poured massive concrete	
				Composite soil plug	
	4	Seals	Drain freely, prevent access	Masonry wall	Y
				Polyurethane membrane	
				Rock fill	
				Rock pile	
	5	Barriers	Secure adit, allow authorized access	Steel grate	Y
				Steel grate with masonry frame	
				Insulated steel doors with masonry frame	
Waste Rock Storage Areas	1	Do nothing	No action for stable dumps	No further inspection required	Y
				Monitor periodically	
	2	Reslope 2.5:1 and Revegetate	Reslope and revegetate	Natural revegetation	Y
				Growth media cover, revegetate	
				Soil cover, revegetate	
	3	Relocate	Consolidate and relocate all waste rock	Remove from sensitive areas	N
				Backfill into open pit	
	4	Reprocess	Reprocess high grade waste dumps	Reprocess at new flotation mill or tailings reprocessing facility	N
Open Pits	1	Do nothing	Leave open pits as is, signage where necessary	No further inspection required	Y
				Monitor periodically	
	2	Berms	Berms around perimeter, signage where necessary	Diversion ditches to divert surface water flow	Y
	3	Reslope	Reslope unstable highwalls, signage where necessary		Y
	4	Backfill	Backfill open pits from local waste rock storage areas	Partial backfill	N
Access Roads	1	Leave all roads		Provides continued access to local community and industry, according to road-access management plan	N
	2	Leave main roads	Scarify/seed minor roads	Provides continued access to local community and industry, according to road-access management plan	Y
	3	Scarify Roads	Scarify/seed spur roads and trails		Y
	4	Access Control	Control ongoing access w/gates		Y
Buildings/ Infrastructure	1	Do nothing		No further work required	N
				Inspect periodically	
	2	Demolish and Revegetate	Demolish buildings, compact, burn, cover, revegetate	Remove powerlines and poles	Y
				Remidiate site hydrocarbons	
				For buildings with asbestos, follow H&S plan (no burning)	
	3	Stabilize	Leave as is and stabilize for heritage value	Valuable heritage assests are perserved	Y
				Stabilize some buildings, while demolish others	
	4	Central Landfill	Central onsite landfill		Y
	5	Local Landfills	localized landfills at each site		Y

5.2 Closure Options

This section provides an overview of the closure options that have been selected for further consideration for mine area components across the district.

5.2.1 Closure Options Fact Sheets

Fact summaries of the options selected for review for each of the mine sites listed above are presented in Appendix B.

These closure options have been subject to the risk assessment process. A package of information has been presented for the purposes of the risk assessment, including the following:

1. Summary of the mine area component
2. Description of each option
3. Summary table of closure issues associated with the mine area component
4. Visual depiction of the closure options
5. Closure cost estimate comparisons for each of the options

Each of the closure options has a number of variants that could be applied to the option. For example, a closure option of long-term water treatment includes variants such as an HDS plant, simple lime mixing, centralized facility, multiple facilities, etc. Each of these variants is not presented as a separate closure option but rather a variant of a larger option.

5.2.2 Technical Fact Summaries

Technical closure studies have been completed and ongoing since 2006. The closure technical studies are designed to address information gaps and provide the necessary technical and scientific information to guide closure option selection and ultimately design. Fact sheets have been prepared that present a brief summary of the pertinent facts and conclusions of each of the closure studies completed (Appendix C). More detailed information can be found in the final reports for each of the technical studies.

5.3 Valley Tailings

5.3.1 Status Quo

Seasonal water treatment would continue as per current site conditions to prevent any surface release of water above 0.5 mg/l Zn. Ongoing annual geotechnical inspections continue for the tailings dam structures and any maintenance completed to maintain the structures in a geotechnical stable condition.

5.3.2 Cover and Flatten Dams 1, 2 and 3

Tailings will be covered in place to prevent dispersion of exposed tailings by wind and water, and to allow a vegetative cover to be established. Surface water will be managed through upgrading the Porcupine Diversion and by developing a stable channel through the cover borrow area, to be developed adjacent to the northwestern edge of the facility.

5.3.3 Consolidate Tailings, Cover and Flatten Dams 1, 2 and 3

Tailings will be consolidated into a smaller footprint and covered to prevent dispersion of exposed tailings by wind and water, and to allow a vegetative cover to be established. Surface water will be managed through: re-establishing Porcupine Creek and Brefalt Creek near their pre-mining alignments; directing North Fork Flat Creek flows into Porcupine Creek; and upgrading the lower portion of the Porcupine Diversion to convey upper Flat Creek flows to the original channel west of the Valley Tailings Facility.

5.3.4 Reprocessing and consolidation

Tailings would be reprocessed for recovery of silver. This option involves transportation of tailings to a centralized processing facility within the immediate area of the Valley Tailings Area, reprocessing and then consolidation for final covering. Once processed, the final closure would be essentially the same as above. This option provides a potentially significant offset to the costs associated with consolidation. A reprocessing study is in progress to determine the potential economics of tailings reprocessing for silver recovery.

5.4 Adit Treatment

5.4.1 Central Conventional Treatment

Adit discharge will be captured and piped to a central conventional high density solids (HDS) treatment facility where water will be treated. A network of pipelines will be constructed and maintained to convey the water to and from the treatment facility. This option could be applied to a centralized plant in Elsa where water from Galkeno 300, No Cash 500 and Hector Calumet could be combined and treated in one centralized facility.

5.4.2 Site Conventional Treatment/Simple Lime Mixing

Treatment facilities will be upgraded or constructed at adits where discharge can be treated to compliant levels on a long-term basis. The type of treatment facility will vary depending on the nature of the adit and the quality of the water discharged. At Galkeno 300 this might involve upgrading and expanding the current clarifier and sludge deposition system. There is also potential for a HDS treatment facility to replace the existing system.

At Silver King, Galkeno 900 and Bellekeno, there is simple lime mixing treatment. This site-specific method of treatment is viable long-term if contaminant loads at these sites do not increase as the simple lime treatment system at these locations has proved effective.

5.4.3 Natural Attenuation/Engineered Wetlands

The capacity for the Keno Hill site to naturally attenuate contaminants of concern is high. Adit water will be redirected (if necessary) and allowed to flow into areas with high natural attenuation properties, such as the No Cash Creek bog. The Onek adit drainage has demonstrated a strong attenuation capacity and could be used as a continued treatment and closure option.

5.4.4 Bioreactor Cell (ex-situ, in-situ)

There is currently a pilot study in place at Galkeno 900 to assess the viability of using a bioreactor cell to create a sulphate-reducing environment in which Zn and other contaminants are reduced to a stable metal sulphide. A sulphate-reducing environment can be developed in one of three

scenarios: an ex-situ bioreactor cell near the adit (i.e. Galkeno 900), a mine pool bioreactor (Hector Calumet/Galkeno 300 mine pool, Silver King), or a trench/gallery (Onek) treatment.

A sulphate-reducing bioreactor could occupy a number of environments, either ex-situ (as at the Galkeno 900 pilot study) or in-situ (in-mine pool or trench bioreactor). The appropriate biological treatment process can be initially screened based on the combination of flow and concentration from any particular adit. The following (Table 5-2) presents the screening matrix used in assessing which biological treatment process is appropriate for further consideration at each particular site.

Site	Zinc (kg/year)	Total Flow (m^3/year)	Average Concentration (mg/L)
Galkeno 300	55095	394,000	140
No Cash	2407	137,000	17.6
Onek	886	10,000	89
Galkeno 900	677	217,000	3.11
Bellekeno 600	523	71,000	7.36
LES-66 Natural Spring	395	79,000	5
Keno 700	328	266,000	1.23
Bermingham	273	62,000	4.11
Silver King	260	205,000	1.26
Husky	98	104,000	0.94
Ruby	78	48,000	1.67
UN Adit	2	22,000	0.09

High Flow (> 100,000 m^3/yr) High Concentration (>5 mg/L or >10X discharge criteria)

Table 5-2 Screening Matrix for Biological Treatment Process Selection

The high flow, high metals concentration sites such as Galkeno 300 may be most appropriately treated by an active water treatment system, at least in the interim until source control technologies or in situ mine treatment approaches can be further assessed. The types of sites where the sulphate reduction technology could find application at sites in the Keno Hill Silver District sites with somewhat lower loading, either lower flow and higher concentration (such as Onek) or higher flow and lower concentration (such as Galkeno 900, Keno 700, Silver King).

5.5 Adit Water Management

5.5.1 Hydraulic Plug

This option involves installing an engineered hydraulic plug to block water and backfill the mine or pit with water, and allowing water to drain from the adit or pit with a constant or regulated level of discharge.

5.5.2 Seasonal Batch Treatment

The Valley Tailings Facility is a good current example of season batch treatment of water. For underground workings, water would be stored in the mine pool, treated at the freshet and discharged. Discharge would be controlled in line with what is acceptable for the watershed. The mine pool can be drawn down and treated during the spring/summer/fall period and then treatment shutdown during the winter while the pool slowly fills.

5.5.3 Underground Alkaline Sludge Recycle

This option can be practiced with either a carbon or alkaline source of neutralization in the underground workings. Water treatment sludge is combined with a carbon source and pumped back into the underground workings for final storage and stabilization.

5.5.4 Reduce Infiltration

Reducing the amount of water that infiltrates the basin would theoretically reduce the amount of water seen in the workings and thus the amount of water available for contamination and discharge to the environment.

5.5.5 Water Conveyance

Water conveyance is generally associated with water treatment options. Adit waters carried from adits to a central HDS or other facility would necessarily require adequate pipelines, rip rap channels, lined channels or erosion channels. For treatment at the source, it will also be necessary to maintain settling ponds.

5.6 Adit Closure

5.6.1 Plugs

This category refers to any measure that involves a structure that completely fills a drift for some length within the underground portion of the mine with the intent of minimizing or preventing discharge. Plugs are generally intended to be permanent installations, and may require detailed rock characterization and extensive grouting of the surrounding rock to achieve acceptable performance.

Further investigations would be required before proceeding to final design. Adit plugs can be candidate closure options where any of preventing access, controlling adit drainage, or minimizing brow collapse are required.

5.6.2 Seals

The category of adit seals refers to any measure for which the sole purpose is to prevent public access. Seals are typically cheaper than plugs; however, where rehabilitation of the adit is required to ensure safe working conditions, costs can increase significantly. Adit seals are not intended for controlling adit drainage waters, but can be designed to allow free drainage.

5.6.3 Barriers

The category of adit barriers refers to any measure which prevents inadvertent access by the public, but maintains an opening for authorized persons; barriers are also used where the mine workings provide habitat for animals such as bats. Barriers are typically cheaper than seals; however, there remains a requirement for rehabilitation of the immediate portal area to provide safe working conditions for the seal construction period. Adit barriers are not intended for controlling adit drainage waters, but can be designed to allow free drainage.

5.6.4 Rock Piles

Adits that have no ongoing discharge of waters but require closure are good candidates for rock piles. Sized rock is piled into the adit entrance and pushed into the adit for several meters and then additional rock is stockpiled to form a rock slope that forms with the surrounding portal.

5.6.5 Do Nothing; Natural Collapses

There are numerous cases among the former UKHM adits where adit collapse is sufficiently complete that access is no longer possible and where little risk remains. A 'Do nothing' closure option may be appropriate in certain cases, while a 'Do nothing now and inspect periodically' option may be appropriate for other cases.

5.7 Waste Rock Storage Areas

5.7.1 Leave as is; natural revegetation

Under a 'do nothing' scenario, waste rock for specific dumps would be left as it presently is. A variant of this would involve periodic monitoring to ensure against acid rock drainage (ARD), thereby lengthening the time during which a site presence would be necessary.

5.7.2 Reslope 2.5H:1V, Revegetate

This option encompasses three different variants, which rely heavily on the characteristics of the waste rock and its ability to be revegetated. Where waste rock surfaces have sufficient fines to promote natural regrowth, and there are no acid rock drainage (ARD) concerns, revegetation may commence without application of any material. However, if the waste rock will not naturally promote vegetation, a growth media can be applied to facilitate regrowth. In the case where ARD or metal loading is a concern, soil cover may be applied to the waste rock to reduce infiltration and increase metals attenuation.

5.7.3 Reprocess high grade dumps (all or partial coupled with other option)

This option is only relevant for perhaps one or two waste dumps where there is a necessity or strong desire to remove the dump, and grades are sufficiently high to economically reprocess the waste as ore. This option could only be reasonably applied in the event a new mill has been constructed as part of new mine redevelopment of a tailings reprocessing option has been selected that can also reprocess high grade waste material.

5.8 Open Pits

5.8.1 Do Nothing

A do nothing option for closure of open pits involves no terrestrial reclamation as the pit is geotechnically and geochemically stable and public and wildlife access and risk is minimal. Appropriate signage would be posted around the pit perimeters alerting of highwalls.

5.8.2 Berm

Berms can be constructed around the perimeter of open pits to further deter inadvertent access as well as serving to divert surface water flow during spring freshet and high precipitation events from entering the pit. This option is appropriate for geotechnically and geochemically stable pits that require further human and wildlife safety considerations.

5.8.3 Recontour

Open pits with unstable highwalls and incompetent material may be candidates for recontouring a portion of the high walls. Recontouring would prevent ongoing movement of unstable highwalls and reduce human and wildlife safety concerns.

6. Risk Assessment Process

The March 18, 2009 risk assessment was completed for five of the major sites at Keno Hill, and covered the closure components discussed above, including waste rock storage areas, pits, adits and their associated water management and the valley tailings area, with the exception of site infrastructure. We expect that site infrastructure will be covered in a future assessment as discussed below. This section deals with the risk assessment process and outcomes achieved thus far.

The risk assessment was recorded in a standard risk matrix which logged both the probability and severity of a potential risk, and in turn identified the resulting risk rating. It uses a modified form of the "Risk Rating" method developed and used by the INAC Contaminated Sites Program. These risks and their ratings are provided in Appendix D. For completeness, mine site components that were not expressly addressed during the assessment, but were peripherally or implicitly discussed in the risk assessment have been added.

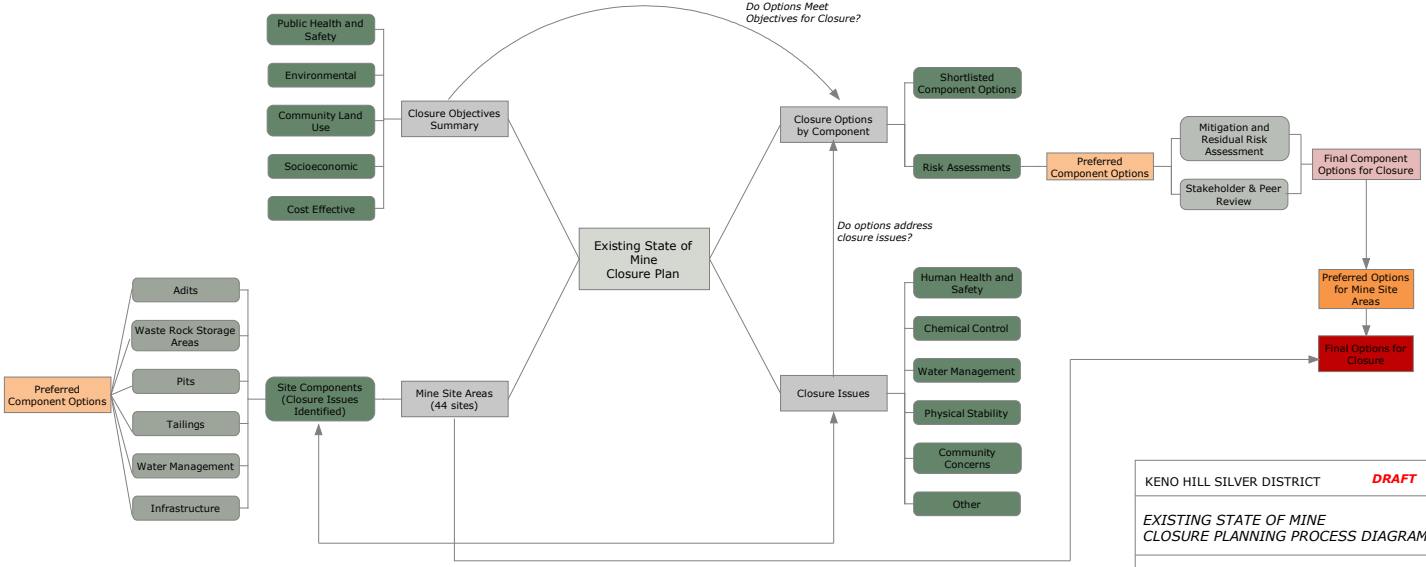
Risk identification and rating was based on the premise that each scenario was an unmitigated measure for closure. In the future, mitigative measures for each closure scenario will be identified and a residual risk assessment performed, leading to selection of a preferred closure option for each mine site component at each mine site.

Mine site areas and mine site closure components (namely, infrastructure) that were not addressed in the initial risk assessment will be addressed in a future assessment carried out by a smaller working group. Moreover, mitigation for each risk will be considered, and a residual risk assessment conducted at that time. During that process, a preferred option will be selected for each site.

Once preferred options and residual risks are determined, these options for mine site component closure will be taken to the public to undergo a stakeholder and peer review. With the feedback

from this process in mind, final options for each mine site component will be selected and used to develop a final closure option for each site.

A description of this process is illustrated in Figure 6-1. Outstanding items for closure planning include further risk assessment on sites previously not discussed, mitigation and residual risk assessment, stakeholder and peer review and selection of a preferred option for each site. These are the next immediate steps in the process to selecting final closure options and to developing the Closure Plan.



KENO HILL SILVER DISTRICT **DRAFT**

EXISTING STATE OF MINE CLOSURE PLANNING PROCESS DIAGRAM

FIGURE 6-1 DRAWN BY: TL

6.1 Risk Rating Method

The risk rating method employs a qualitative approach. Its strength is that it allows a wide range of risk types to be considered in a time- and cost-effective manner. Moreover, it allows inputs from people with a wide range of perspectives and technical backgrounds. The primary weakness of the risk rating method is that it sometimes fails to provide adequate resolution of risks that are low likelihood and high consequence.

6.2 Risk Rating Tools

The risk rating method employs the three charts on the following pages.

The Consequence-Severity Matrix (Table 6-1) lists various types of negative outcomes, and classifies their severity from “Low” to “Critical”. The matrix shown here is taken directly from the INAC-CSP guidance. We have added examples to show how consequence severities have been classified at other mine sites.

The Likelihood (Table 6-2) chart defines a series of terms used to define the likelihood that a consequence (from the previous chart) will be realized. The columns of the table give examples to guide the selection of the appropriate term.

The Risk Matrix (Table 6-3) assigns each combination of severity and likelihood to a “risk” level. The significance of the risk levels is only apparent when one considers the resulting actions. INAC CSP program has the following particular requirements for each risk level:

- Very High risks must be mitigated immediately
- For High risks, mitigation is imperative within two years or as soon as possible
- For Moderately High risks, a mitigation plan must be developed and should be implemented within two years or as soon as possible

- For Moderate risks, a mitigation plan must be in place and should be implemented within five years
- Low risks must be tracked and re-evaluated regularly.

As described on the preceding page, we propose a different set of required actions for our work.
For Very High, High and most Moderately High risks, available mitigation measures are being considered and will be added to the alternative and included in the cost estimate.
For Moderate, Low and Moderately High risks with low probabilities, contingencies will be added to the cost estimates.

All risks that still classify as Very High, High or Moderately High after mitigation measures and contingencies are added will be listed and included in subsequent presentations of the primary alternatives.

Table 6-1 Consequency Severity Matrix

Consequence Categories	Very Low	Minor	Moderate	Major	Critical
1. Environmental Impact	No impact.	Minor localized or short-term impacts.	Significant impact on valued ecosystem component.	Significant impact on valued ecosystem component and medium-term impairment of ecosystem function.	Serious long-term impairment of ecosystem function.
		UKHM: Ice plug release at Onek 400 adit	*UKHM: Tailings dam breach*	*Mt. Nansen: Failure of Main Dam leads to release of contaminated water & tailings into Victoria Creek*	
2. Special Considerations	Some disturbance but no impact to traditional land use.	Minor or perceived impact to traditional land use.	Some mitigatable impact to traditional land use.	Significant temporary impact to traditional land use.	Significant permanent impact on traditional land use.
		Clinton Creek: Ongoing erosion of tailings into creek			*Mt. Nansen: Tailings dam breach*
3. Legal Obligations	No non-compliance but lack of conformance with departmental policy requirement.	Technical/Administrative non-compliance with permit, approval or regulatory requirement.	Breach of regulations, permits, or approvals (e.g. 1 day violation of discharge limits).	Substantive breach of regulations, permits or approvals (e.g. multi-day violation of discharge limits).	Major breach of regulation – wilful violation.
	Informal advice from a regulatory agency.	Warning letter issued.	Order or direction issued.	Prosecution.	
	No land claim or other agreement.	Land claim or other agreement requires the Crown to satisfy administrative obligations (e.g. notification).	Land claim or other agreement requires the Crown to respond, but no time frame is specified.	Land claim or other agreement requires the Crown to exercise its obligations within a specified time frame (i.e. 2-5 years)	Court order issued.
					Land claim or other agreement requires the Crown to exercise its obligations within a specified short time frame (i.e. 1-2 years)
			Mt. Nansen: Hydrocarbon from historical spills seeps into receiving water	*UKHM: Tailings dam breach*	
4. Consequence Costs	<$100,000	$100,000 - $500,000	$500,000 - $2.5 Million	$2.5-$10 Million	>$10 Million
		Mt. Nansen: Erosion leads to loss of spillway		*Mt. Nansen: fire in mill leads to loss of power and treatment*	*UKHM: Tailings dam breach leading to tailings release*
5. Community/ Media/Reputation	Local concerns, but no local complaints or adverse press coverage.	Public concern restricted to local complaints or local adverse press coverage.	Heightened concern by local community, criticism by NGOs or adverse local /regional media attention.	Significant adverse national public, NGO or media attention.	Serious public outcry/demonstrations or adverse International NGO attention or media coverage.
				UKHM: Tailings dam breach	
6. Human Health and Safety	Low-level short-term subjective symptoms. No measurable physical effect. No medical treatment.	Objective but reversible disability/impairment and /or medical treatment injuries requiring hospitalization.	Moderate irreversible disability or impairment to one or more people.	Single fatality and /or severe irreversible disability or impairment to one or more people.	Multiple fatalities.
			UKHM: Public access to boneyards leads to injury	*UKHM: Snow machine accident on waste rock leads to fatality*	*UKHM: Vehicle accident on poorly maintained road leads to multiple fatalities*

Table 6-2 Likelihood Chart

Likelihood	Descriptor	Frequency Descriptor	Probability of occurrence over twenty years	Probability of occurrence in any one year
Almost Certain	Happens often	High frequency (more than once every 5 years)	98%	17.80%
Likely	Could easily happen	Event does occur, has a history, once every 15 years	75%	6.70%
Possible	Could happen and has happened elsewhere	Occurs once every 40 years	40%	2.50%
Unlikely	Hasn't happened yet but could	Occurs once every 200 years	10%	0.50%
Very Unlikely	Conceivable, but only in extreme circumstances	Occurs once every 1000 years	2%	0.10%

Table 6-3 Risk Matrix

Likelihood	Consequence Severity				
	Low	**Minor**	**Moderate**	**Major**	**Critical**
Almost Certain	Moderate	Moderately High	High	Very High	Very High
Likely	Moderate	Moderate	Moderately High	High	Very High
Possible	Low	Moderate	Moderately High	High	High
Unlikely	Low	Low	Moderate	Moderately High	Moderately High
Very Unlikely	Low	Low	Low	Moderate	Moderately High

Attachment A

Na-Cho Nyak Dun Closure Objectives

Version 1

NND OBJECTIVES
For
Clean-up and Reclamation – Keno Hill Property

April 2008

1.0 Introduction and Purpose

Citizens of the First Nation of Na-Cho Nyak Dun (NND) met on April 3, 2008 to discuss their expectations and hopes for the clean-up and reclamation of the Keno Hill mine property.

The federal and Yukon governments have recognized the need for clean-up and reclamation at the Keno Hill mine property. They have also recognized the need for participation of NND in planning and carrying out the clean-up and reclamation. Canada and Yukon agreed to work with Elsa Reclamation and Development Corporation (ERDC) to get the clean-up done.

NND wants to ensure that the expectations and hopes of its government and citizens are addressed by the mine closure project. To make sure this happens, NND needs to understand the views and interests of its citizens, and communicate these clearly to the federal government, Yukon government and ERDC. The purpose of the April 3, 2008 workshop was to seek input from NND citizens about their concerns and expectations for the mine closure project. This report summarizes the results of the discussions.

2.0 Background

2.1 Purpose of Closure Objectives

ERDC is preparing a closure plan for the Keno Hill mine property near Elsa. Mining in this area took place for about 80 years on Galena, Sourdough and Keno Hills. The closure plan will describe how ERDC plans to clean up and protect the land and water in the area by reclaiming pits, waste rock dumps, underground workings, tailings deposits, roads and other facilities.

The land affected by the Keno Hill mines is entirely within the traditional territory of the NND. Before mining began in the Keno Hill area, NND people had used the area for thousands of years. Because of their history and experience in the area, NND people have a unique understanding about the land. Direct use of the mine area has probably decreased due to mining and other activities that have occurred in the last 100 years. But, NND people continue to use the surrounding areas for traditional activities. Direct use of the mine areas may increase following clean-up and reclamation.

NND peoples' hopes and expectations for the mine clean-up are an important consideration for the closure plan. ERDC needs to understand the expectations of local people so that clean-up will return the land to a condition that people will be happy with. ERDC also needs to understand how local people expect to be involved in the clean-up. The words that describe peoples' expectations for the clean-up and reclamation are often called "Closure Objectives." These closure objectives need to specify what people want the site to be like once the clean-up is finished, and how people want to be involved.

2.2 Closure Phases

Even after clean-up of the Keno Hill mine property, people will still need to continue some activities to ensure future protection of land, water and people in the area. These activities will continue for a very long time, possibly hundreds of years. Because the long-term activities will be quite different than the activities during the actual clean-up, the mine closure has two distinct phases.

The initial phase will involve the most of the major clean-up activities. This phase will probably include construction, demolition, re-grading, re-vegetation, water treatment, monitoring and maintenance activities. The level of activity during the second phase will be much less and will certainly involve monitoring and maintenance activities. It is also likely to include some water treatment activities. Closure objectives need to consider both of the phases of the closure plan.

3.0 NND Objectives for Clean-up and Reclamation

The discussions during the workshop were focused by identifying several key areas for consideration. These included environmental protection; environmental clean-up; human health; human safety; existing, past and future land uses in the area; access to the area; benefits for NND people; and, long-term site activities. For each of these main considerations, people identified important values in the area and discussed their concerns, hopes and expectations for the mine clean-up. The outcomes of the discussions are summarized below for key areas of consideration. Some of the discussion topics have been combined for the purposes of clarity in the summary. For each key objective topic, the summary states a broad objective that is further defined by the important values, factors and considerations identified during the workshop.

3.1 Protect the Environment

Broad Objective For Clean-up and Reclamation:
To protect the environment from: (1) ongoing effects of past mining activities and (2) new effects of activities that are part of the closure plan.

- Important Values
    - Healthy Fish and Wildlife
        - Fish - Grayling, Salmon, Inconnu, Jackfish, Whitefish, Trout, etc.
        - Spawning areas are critical

        - Moose
        - Fur-bearing animals – numbers and health
        - Beaver, birds, waterfowl, porcupine, whistlers
    - Healthy Plants
        - Berries, caribou horn, wild mushrooms
    - Environment has overall value – this includes all plants and animals
        - Keep Christal and Flat Creek Clean
- Protect water quality so that it doesn't affect health of fish or people
    - Protecting the South McQuesten River is CRITICAL – it is commonly used by local people for fishing and other traditional and subsistence activities
    - Protecting the South McQuesten River requires keeping Christal and Flat Creeks clean
    - Local streams and rivers are drinking water sources (though they are sometimes affected by "Beaver Fever"). Ensure that contamination from the mine doesn't make the water unacceptable for drinking
- Understand Environmental Conditions
    - Monitoring and testing must be done to confirm the environmental conditions. NND people need to know, understand and trust the results

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3.2 Restore the Environment

Broad Objective For Clean-up and Reclamation:
To restore the environment from effects of past mining activities.

- Important Values are those identified for protection of the environment
- Make sure that the site will be safe for animals
- There used to be lots of ptarmigan, grouse and rabbits in this area – restore the site so that animals can return to the area.
- Clean-up waste scattered around the site – drums, old vehicles, etc.
- Restore water quality so that fish can return to creeks in the area
- Elders' stories indicate that salmon used to be present in the South McQuesten up to McQuesten Lake – but their current absence is acknowledged to be related to a log jam

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3.3 Protect Peoples' Health

Broad Objective For Clean-up and Reclamation:
To protect peoples' health from: (1) ongoing effects of past mining activities and (2) new effects of activities that are part of the closure plan.

- Protect the health of people who use the areas affected by the mine
    - Make sure that fish and wildlife are safe to eat
    - Make sure that plants for food and medicines are safe for humans
    - Make sure that contamination from the mine doesn't make water unsafe for humans.

- Protect the health of people who work at the mine during the mine closure
    - People need to understand the risks of working at the mine before they begin working
    - Provide appropriate training
- Understand Environmental and Human Health Conditions
    - Monitoring and testing must be done to confirm the environmental conditions
    - People need to know the results, and understand whether they will affect peoples' health

---

3.4 Make Sure the Site is Safe

Broad Objective For Clean-up and Reclamation:
To make sure that the site is safe for people who use the area.

- Mine shafts, adits, tunnels and pits need to be cleaned up and reclaimed so that there won't be safety hazards for people at the site
- There needs to be signs and education about any remaining safety issues at the site

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3.5 Protect Existing Land Uses

Broad Objective For Clean-up and Reclamation:
To protect existing traditional and local land uses in the area from: (1) ongoing effects of past mining activities and (2) new effects of activities that are part of the closure plan.

- Important existing land use values
    - Large cultural value for McQuesten Lake – including "first hunts" for youth
    - Traplines
    - Value of living on the land, and teaching this to youth
    - Tourism values of some historic sites and artifacts
    - NND cultural and heritage sites – none specific identified, but recognized as important value if present
- Work cooperatively among local communities to ensure coordinated planning and sharing for historic sites and artifacts
- Conducting a site tour would help people to recall past activities in the area and identify historic values

---

3.6 Restore Land Uses

Broad Objective For Clean-up and Reclamation:
To restore traditional and local land uses in the area.

- Identify appropriate land uses by considering activities that occurred in the area in the past and activities that now occur in similar nearby areas
    - In the past, people hunted and picked berries throughout this area.
- Clean-up and land tenure should support development of line cabins for trappers
- Access to the area is important and should not be restricted by locked gates
- NND and its citizens (including trappers) need to be involved in making decisions about access

---

3.7 Provide Benefits to NND and its Citizens

Broad Objective For Clean-up and Reclamation:
To maximize benefits to NND, NND businesses, local businesses and local people from the mine closure activities.

- Potential benefits need to be considered for both phases of the mine clean-up and reclamation – the short-term construction phase, and the long-term maintenance phase
- Clean-up and reclamation should provide benefits to local businesses
    - NND Development Corporation
    - Local store and restaurant
    - Other NND and local businesses
    - Training and business development will be needed
- Clean-up and reclamation should provide employment opportunities for NND citizens
    - People need jobs in the short-term and in the long-term
    - Clean-up and reclamation needs to provide opportunities for young people
    - Jobs and employment should be for skilled jobs that will provide young people with incentives to learn and stay in the community
    - Training will be needed
- Need agreements with other governments and ERDC about how to involve NND people and businesses
- Local people should benefit from salvage opportunities at the site – there are many valuable materials that will be wasted if not used by local people
- Silver Trail tourism will be an important local benefit – historic values need to be shared among communities

---

3.8 Manage Long-Term and Permanent Activities

Broad Objective For Clean-up and Reclamation:
To ensure that long-term and permanent site activities continue to address site needs and concerns of local people.

- Local people should be directly involved in long-term and permanent activities like monitoring and water treatment

- Monitoring and testing need to continue in the long-term to confirm environmental conditions and ensure that the site remains safe
- Water treatment should continue where it is necessary
- People need to have a mechanism to report issues and have them addressed

Attachment B

Closure Options Fact Sheets

Onek

Description

Onek was mined originally from underground, and subsequently from the open pit. There is one adit, located at the 400 level, in Keno City. The Fisher shaft daylights within the Onek open pit (also called the Fisher Pit); the pit bottom being about 25 feet above the 100 level. The second shaft developed at Onek is located about 650 feet SW of the Fisher shaft. There are three waste rock piles at the Onek site. There are 600,000 tonnes of ore at the pit, with an additional 7,500 tonnes at the adit.

There is clearly a hydraulic connection between the pit and the underground workings, primarily through the Fisher shaft. This hydraulic connection is of particular interest at Onek, due to the history of ice damming in the adit, and subsequent sudden release of stored water as the ice plug was displaced. This ceased to occur when the open pit was developed in the mid 1980's. However, the adit continues to drain water from the underground workings.

There are no remaining buildings or equipment remaining associated with the Onek development. The adit is open and, being located within Keno City, requires long-term control of access.

Closure Issues Martrix

Common Site Name: **Onek**

Site coordinates:	easting	northing	Datum: NAD83	Projection: UTM Zone 8N
	479577	7090692		

General Location Description	Closure Issue Categories					
	Human & Wildlife Health and Safety	Chemical Control	Water Management	Physical Stability	Community Interest	Other
Onek Pit and Waste Dumps						
Dump - north and west areas				✔		
crest of waste dumps - north of Lone Star Shaft						
Buldings - north of Lone Star Shaft	✔	✔		✔		
south waste dump				✔		
pit edge				✔		
benches				✔		
Onek 400 Portal						
400 Level portal			✔	✔		
400 Level portal - area above				✔		
site buildings	✔					

Mine Site Area: **Onek**

Mine Site Area Components and Description:

1. **Adits**
   2 shafts, 1 adit, adit discharge to ground (Christal Creek drainage)
2. **Open Pits**
   1 pit: 62,254 tonnes
3. **Waste Rock Piles**
   3 waste rock piles: 7,500 tonnes@adit; 600,000 tonnes@pit
4. **Underground Levels**
   4 for 400ft: 33,036 tonnes mined

Closure Issues:

1. Public access is currently used at the Onek pit for shooting range
2. The underground is free draining for part of the year, with very low flow but high zinc and cadmium levels. Adit drainage contains in excess of 100 mg/l Zn and elevated levels of cadmium. Drainage seeps in to the ground, attentuates metals and there is no evidence of direct contamination into groundwater or surface water. The issue of longterm stability and sustainability of the attenuation mechanisms has not been finalized
3. Catastrophic release of water behind an ice dam plug has occurred in the past. Heat trace is maintained in the adit during the winter to maintain free flowing conditions and prevent formation of ice plugs
4. In the 2007/08 SRK Geochemical Study, Onek waste rock was classified as non-ARD, and therefore the primary consideration for Onek waste rock, like most dumps on the Keno property, includes physical stabilization and reclamation
5. The geochemical load from dump seepage is minor compared to loading from the adit
6. The adit and open pit are within hundreds of meters of local Keno City residents

Options for Closure:

1. **In-Mine Pool Treatment, Hydraulic Bulkhead , WRSA Do Nothing**
   a. *Adit Treatment: In-Mine Pool Treatment*
   b. *Adit Closure: Poured Concrete Massive Plug*
   c. *WRSA: Do Nothing*
   d. *Open Pit: Leave as is, signage*
2. **Ex-situ Bioreactor, Hydraulic Plug, Reslope Dumps 2.5H:1V & Revegetate**
   a. *Adit Treatment: Ex-situ Bioreactor Treatment*
   b. *Adit Closure: Hydraulic Plug*
   c. *WRSA: Reslope 2.5H:1V and Revegetate*
   d. *Open Pit: Leave as is, signage*
3. **Natural Attenuation, Rock Pile, WRSA Scarify & Revegetate**
   a. *Adit Treatment: Natural Attenuation*
   b. *Adit Closure: Rock Pile*
   c. *WRSA: Scarify and Revegetate*
   d. *Open Pit: Leave as is, signage*

Mine Site Area:	**Onek**
Closure Option 1:	**In-Mine Pool Treatment, Poured Massive Concrete Bulkhead , WRSA Do Nothing**

Facts/Description of Option:

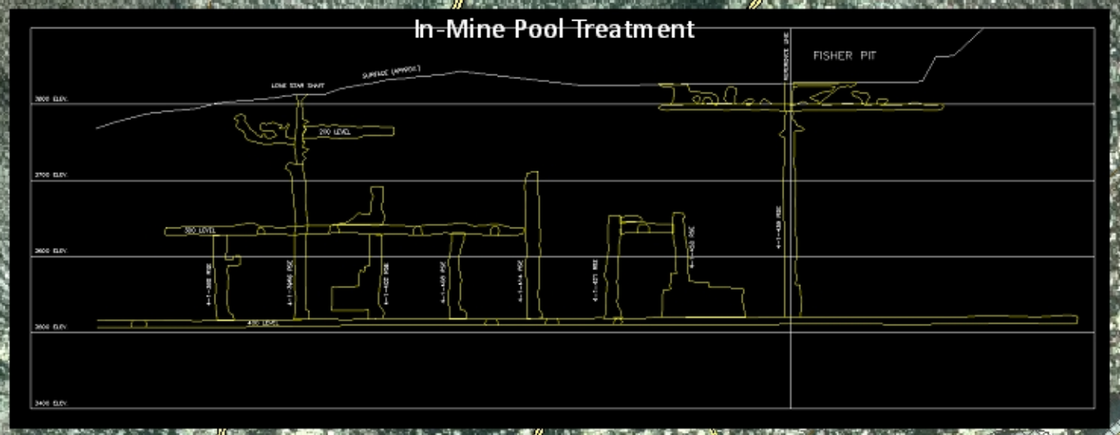
1. Install hydraulic plug in the 400 level to backup and withstand 100' of water pressure.
2. Treat the mine pool through injection of carbon sources into the Lone Star shaft to reduce the load of zinc leaving the adit
3. Allow any remaining water from the adit plug to continue to be released outside the adit and any remaining metals to be attenuated
4. Leave the waste rock storage areas as is with the exception of minor flattening of any muck piles on the top of the WRSA
5. Leave open pit as is with signage and posting of high walls

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$3,877,000

In-Mine Pool Treatment



Place a hydraulic plug to the 400 level, back up mine pool and treat through Lone Star Shaft

Fisher Shaft

Lone Star Shaft

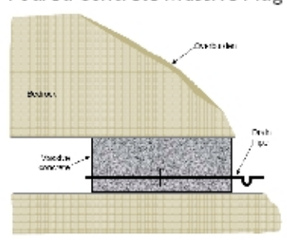
Inject mine pool treatment through Lone Star Shaft

Leave as is

WRSA: Leave as is

Onek 400

Poured Concrete Massive Plug



Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

ONEK OPTION #1

SITE PLAN

SCALE: 1:3,000

0 30 60 120 180 240 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Onek**
Closure Option 2:	**Ex-situ Bioreactor, Hydraulic Plug, Reslope Dumps 2.5H:1V & Revegetate**

Facts/Description of Option:

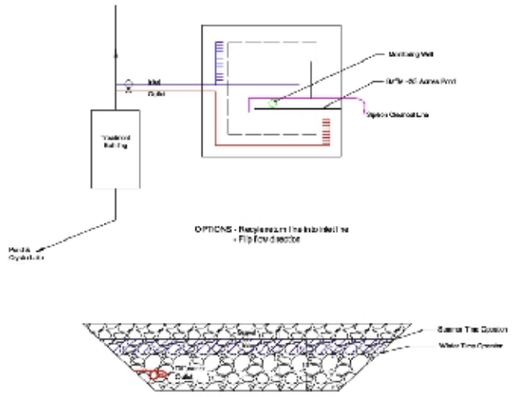
1. Construct a barrier or seal in the adit entrance to prevent access but allow continued collection and treatment of adit water
2. Contrust a bioreactor similar to the Galkneo 900 bioreactor for treatment and reduction of zinc and cadmium. Discharge of solution from the bioreactor allowed to flowdown current flowpath and infiltrate and attenutate any metals not reduced in the bioreactor
3. Reslope the Onek waste rock storage areas to a 2.5:1 contour and revegetate. No growth media applied
4. Leave open pit as is with signage and posting of high walls

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$3,530,000

Ex-situ Bioreactor Treatment



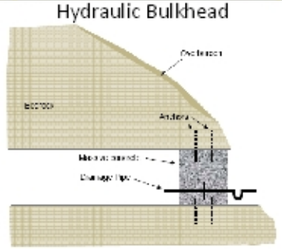
Ex-situ bioreactor

Fisher Shaft

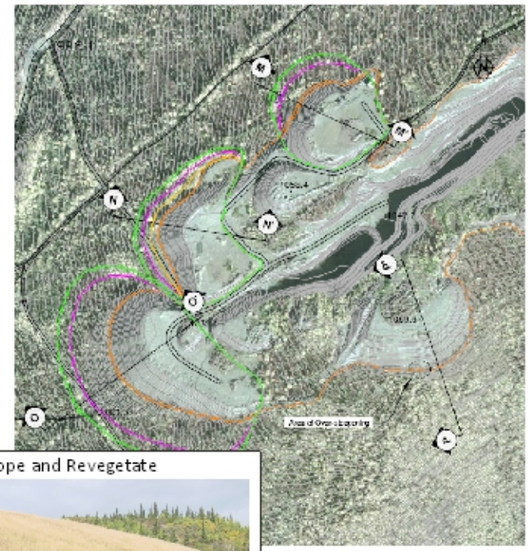
Lone Star Shaft

Onek 400

Hydraulic Bulkhead



Reslope Surface 2.5H:1V



Reslope and Revegetate

WRSA: Reslope 2.5H:1V, Revegetate

Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS CONSULTING GROUP

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

ONEK OPTION #2

SITE PLAN

SCALE: 1:3,000

0 30 60 120 180 240 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Onek**
Closure Option 3:	**Natural Attenuation, Rock Pile, WRSA Scarify & Revegetate**

Facts/Description of Option:

1. Construct a barrier or seal in the adit entrance to prevent access and allow for capture of adit waters into a ditch/channel of pipeline
2. Allow the adit water to infiltrate into the ground just outside the adit and attenuate metals (current conditions)
3. Scarify the top surface of the waste rock storage areas and revegetate, no growth media applied
4. Leave open pit as is with signage and posting of high walls

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$1,824,000

Natural Attenuation

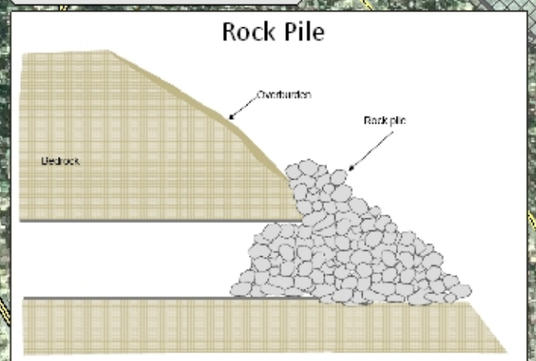
Onek 400

Fisher Shaft

Lone Star Shaft

Place rock pile at adit entrance to inhibit access and allow flow

Rock Pile



Scarify and Revegetate

WRSA: Scarify and Revegetate

Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

ONEK OPTION #3

SITE PLAN

SCALE: 1:3,000

0 30 60 120 180 240 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Keno 700

Description

The Keno 700 adit accessed an underground mine, working the No. 9 Vein. The No. 9 vein was first mined in the 1920's by Keno Hill Limited. The workings were in the upper part of the hill, with access via the 100 level adit (located in Faro Gulch) and from the shaft extending from surface to the 300 level. The 100 level adit is caved and iced in. An adit at the 200 level was also developed, in 1955, from Faro Gulch but is also caved and iced in.

UKHM worked No. 9 vein via the Keno 700 adit from 1958 to 1982. There was considerable further development, with an additional adit at the 200 level (on the south side of the hill), an incline from the 200 to 400 levels, and the No. 4 shaft developed from the 700 to 1075 levels. Overall, there are nine levels on the No. 9 vein from the 200 level to the 1075 level. Much of the ground in the No. 9 vein is frozen (to at least the 400 level).

The majority of the infrastructure was located at the 700 level and included the No. 4 shaft hoist (underground) and buildings, shops, power, offices, and housing facilities located at the portal. Most of these buildings remain in place today. Development rock from the 700 adit was used for foundations for these buildings, with the remainder deposited down slope from the Keno 700 portal. The dump has failed locally and been eroded; some of the rock has been carried into the galley below the portal.

The only remaining facilities at the Keno 200 adit are the portal, which is blocked by doors, and a section of tracks from underground.

Two other adjoining veins were also worked as part of Keno 700 Mine: the Shamrock J-18 vein (described below) and the Comstock - Keno - Porcupine . The three mines are connected by workings at the 400 and 700 levels.

The Shamrock J18 vein was developed from the 400 level of the No. 9 vein with access from Keno 700 portal. There was a raise from the 400 level to surface for ventilation and for access of men and material to stopes. The raise is covered by a building which is collapsing.

Several other small veins were worked in conjunction with the No. 9 vein over the years. These include the No. 1 vein with two adits, one from Faro Gulch; the No. 3 vein, accessed by adit from Faro Gulch; the No. 12 vein accessed by 2 adits; the No. 5 vein also accessed by 2 adits at the northeast and southwest end of the vein, respectively; the No. 4 vein with an upper and lower adit; the No. 6 vein intersected by the Keno 200 adit with an old shaft from surface; and lastly, the No. 2 vein accessed by a shaft from surface. The condition of these various adits and shafts is not fully known but most predate the 1950's and are likely to be caved.

Drainage from the underground workings, including the Keno 200 through 700, Comstock - Keno - Porcupine and Shamrock J-18, is collected at, and discharged from the 700 level to Hope Gulch, via a culvert through the waste rock. Hope Gulch reports to Lightning Creek.

Closure Issues Martrix

Common Site Name: **Keno 700**

Site coordinates:	easting	northing	Datum: NAD83	Projection: UTM Zone 8N
	489969	7089596		

General Location Description	Closure Issue Categories					
	Human & Wildlife Health and Safety	Chemical Control	Water Management	Physical Stability	Community Interest	Other
Waste dumps				✔		
Waste dump - into Hope Gulch		✔		✔		
Waste dump cribbing				✔		
Garage foundation				✔		
Underground culvert for drainage - outflow point			✔	✔		
Underground culvert for drainage - intake point			✔			
Keno 700 adit			✔			
various buildings				✔		
Blocked culvert - first gulch in Keno direction from site.			✔			

Mine Site Area: **Keno 700**
(including Shamrock "J", and Comstock-Keno-Porcupine)

Mine Site Area Components and Description:

1 **Adits**
- *Keno 700 & Shamrock "J" - 4 adits, 2 shafts, several raises*
- *Comstock-Keno-Porcupine - 3 adits, 1 raise*

2 **Open Pits**
- *Comstock-Keno-Porcupine - 1: 4,253 tonnes*

3 **Waste Rock Piles**
- *Keno 700 & Shamrock "J" - 2 waste rock piles: 42,100 tonnes total waste rock*
- *Comstock-Keno-Porcupine - 2 waste rock piles, 1@pit, 1@UG: 6,500 tonnes total waste rock*

4 **Underground Levels**
- *Keno 700 & Shamrock "J" - 8 levels: 283,517 tonnes mined*
- *Comstock-Keno-Porcupine - 3 levels: 22,663 tonnes mined*

5 **Infrastructure**
- *Keno 700 & Shamrock "J" - several buildings*
- *Comstock-Keno-Porcupine - 2 buildings at portals*

Closure Issues:

1 The Keno 700 adit produces water that flows from the adit into a culvert and then is released over the face of the waste rock storage area. Zn levels in the adit water are nominally 1 mg/l Zn and there is no direct connection to the receiving environment

2 The waste rock storage area has experienced significant erosion and destabilization from blown adit ice plugs and discharging the adit water over the face of the WRSA

3 There are a number of remnant buildings that require demolition and reclamation

Options for Closure:

1 **No Treatment, Poured Concrete Massive Plug, WRSA Leave as is**
- a. *Adit Treatment: No Treatment*
- b. *Adit Closure: Poured Concrete Massive Plug (to withstand ~500' water pressure)*
- c. *WRSA: Leave as is*

2 **Exsitu Bioreactor Treatment, Hydraulic Plug, Recontour 2.5H:1V & Revegetate**
- a. *Adit Treatment: Exsitu bioreactor*
- b. *Adit Closure: Hydraulic Plug*
- c. *WRSA: Recontour 2.5H:1V and revegetate*

3 **Natural Attenuation, Rock Pile, Scarify & Revegetate**
- a. *Adit Treatment: Capture and natural attenuation in lowlands*
- b. *Adit Closure: Rock Pile*
- c. *WRSA: Scarify surface and revegetate*

Mine Site Area:	**Keno 700**
Closure Option 1:	**No Treatment, Poured Massive Concrete Plug, WRSA Leave As Is**

Facts/Description of Option:

1 Install a concrete plug in the 700 adit to backup water ~300'. No active treatment but rely on attenuation through country rock and organics to reduce Zn from current ~1 mg/l to less than 0.5 mg/l. Reduction of Zn at Galkeno 900 after the plug was installed was several mg/lwhich would be enough to reduce Keno 700 to below 0.5 mg/l

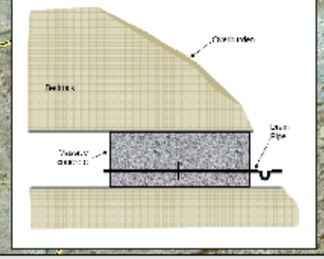
2 Leave waste rock storage areas as is

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$3,877,000

Poured Concrete Massive Plug



Install hydraulic plug in the 700 level to withstand 500' of water pressure

Keno 700

WRSA: Leave as is

Leave as is

Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

KENO 700 OPTION #1

SITE PLAN

SCALE: 1:2,500

0 25 50 100 150 200 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Keno 700**
Closure Option 2:	**Hydraulic Plug, Exsitu Bioreactor, Recontour WRSA 2.5:1 Slope**

Facts/Description of Option:

1 Install a concrete hydraulic plug in the 700 adit to capture adit water and direct to an exsitu bioreactor just outside the adit.

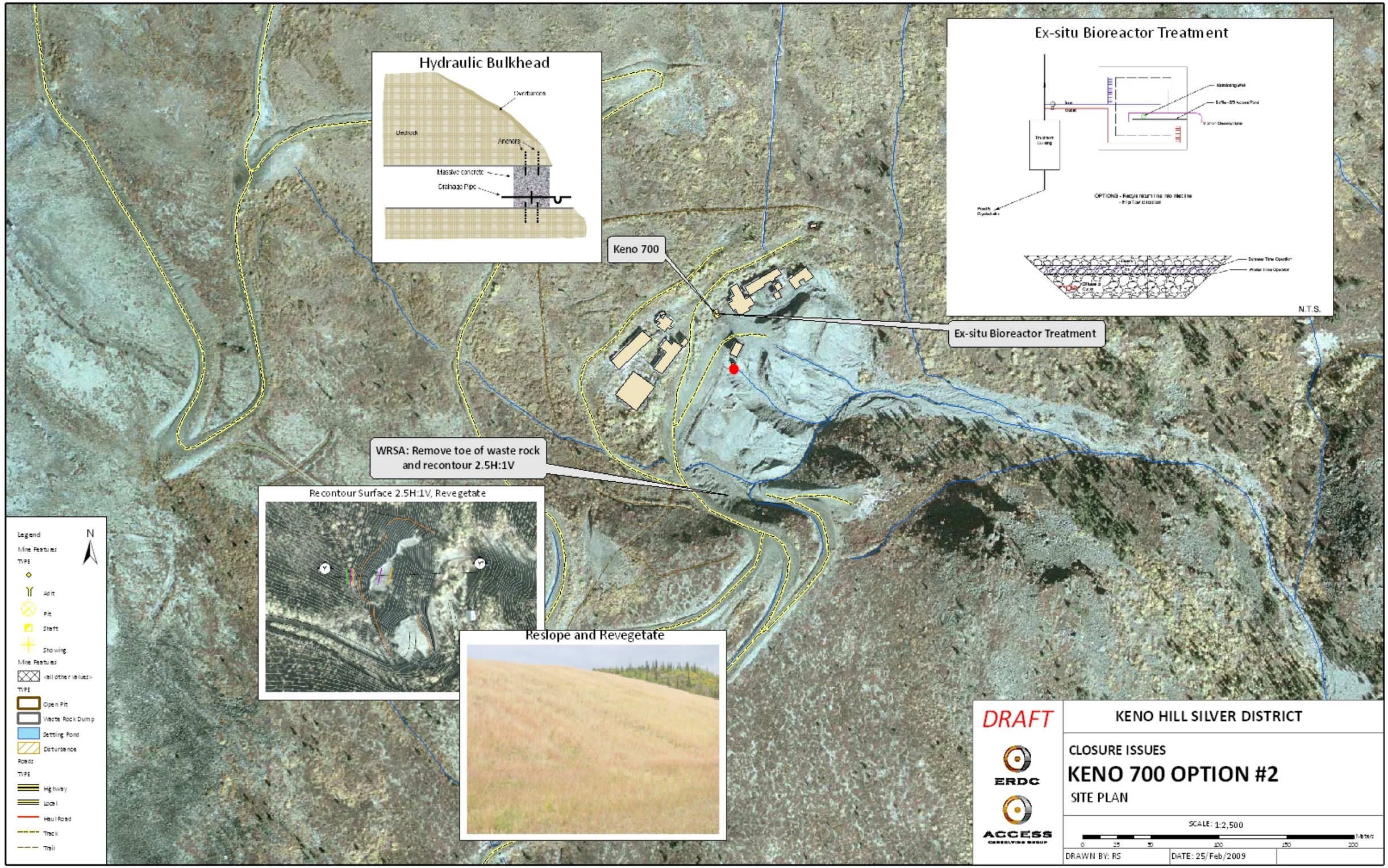
2 Construct a bioreactor similar to the Galkeno 900 pilot and treat the adit water continuously through the bioreactor to discharge less than 0.5 mg/l

3 Recontour the WRSA to a 2.5:1 slope and revegetate

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$3,530,000


Hydraulic Bulkhead
Overburden
Bedrock
Anchors
Massive concrete
Drainage Pipe
Ex-situ Bioreactor Treatment
Treatment Building
OPTIONS - Recycle return line into inlet line
- Pipe flow direction
Pond Crystal Lake
Membrane Inlet
Drill - 89 Access Point
Sensor Cluster Line
Sensor Time Operator
Water Time Operator
N.T.S.
Keno 700
Ex-situ Bioreactor Treatment
WRSA: Remove toe of waste rock and recontour 2.5H:1V
Recontour Surface 2.5H:1V, Revegetate
Reslope and Revegetate
Legend
N
Mine Features
TYPE
Adit
Pit
Shaft
Showing
Mine Features
<all other values>
TYPE
Open Pit
Waste Rock Dump
Settling Pond
Disturbance
Roads
TYPE
Highway
Local
Haul Road
Track
Trail
DRAFT
ERDC
ACCESS
KENO HILL SILVER DISTRICT
CLOSURE ISSUES
KENO 700 OPTION #2
SITE PLAN
SCALE: 1:2,500
Meters
0 25 50 100 150 200
DRAWN BY: RS
DATE: 25/Feb/2009

Mine Site Area:	**Keno 700**
Closure Option 3:	**Attenuation, Rock Pile, Scarify WRSA and Revegetate**

Facts/Description of Option:

1. Construct a rock pile in the adit to prevent inadvertant access, reduce air flow andice plug formation and allow drainage from adit to seep through and be collected on the outside of the adit

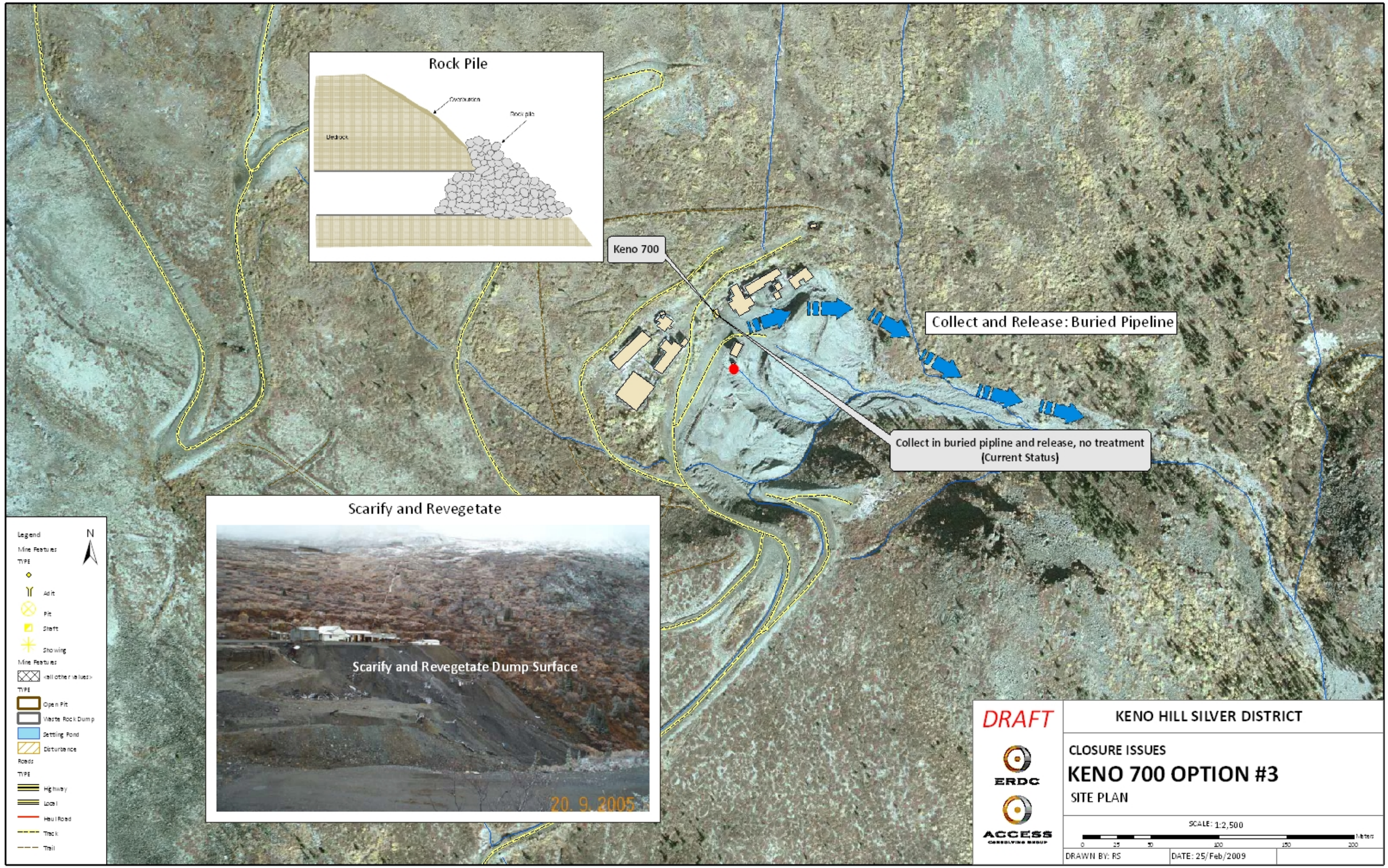
2. Collect adit water that seeps through the rock pile and collect in a buried pipe and divert around the WRSA and discharge downgradient

3. Scarify the top of the WRSA and revegetate, leave the angle of repose slopes in place

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$1,824,000


Rock Pile
Overburden
Rock pile
Bedrock
Keno 700
Collect and Release: Buried Pipeline
Collect in buried pipline and release, no treatment
(Current Status)
Scarify and Revegetate
Scarify and Revegetate Dump Surface
20. 9. 2005
Legend
N
Mine Features
TYPE
Adit
Pit
Shaft
Showing
Mine Features
<all other values>
TYPE
Open Pit
Waste Rock Dump
Settling Pond
Disturbance
Roads
TYPE
Highway
Local
Haul Road
Track
Trail
DRAFT
ERDC
ACCESS
KENO HILL SILVER DISTRICT
CLOSURE ISSUES
KENO 700 OPTION #3
SITE PLAN
SCALE: 1:2,500
Meters
0
25
50
100
150
200
DRAWN BY: RS
DATE: 25/Feb/2009

No Cash

Description

The No Cash underground mine was mined from two levels; initially from the 100 level, and then from the 500 level.

Access to the mine at the 500 level was via the 500 level adit. The portal is blocked by metal doors. The only other opening to surface from the No Cash Mine is a raise near the Brefalt shaft. There are no records of closure of this raise, and it is assumed that some reclamation will be required.

The No Cash Mine is drained at the 500 level. Water from the adit is discharged to No Cash Creek via a culvert through the waste dump at the portal. Recharge to the No Cash Mine is primarily from groundwater, enhanced by connections to other underground workings. It is understood that there is a hydraulic connection to the Calumet Mine via the Jock Fault.

Closure Issues Martrix

Common Site Name: **No Cash**

Site coordinates:	easting	northing	Datum: NAD83	Projection: UTM Zone 8N
	478748	7088234		

General Location Description	Closure Issue Categories					
	Human & Wildlife Health and Safety	Chemical Control	Water Management	Physical Stability	Community Interest	Other
500 Level Adit						
Garage	✔					
Bare waste rock area (E side)		✔	✔			
500 Adit			✔	✔		
No Cash 500 Creek square timber culvert	✔		✔	✔		
Waste rock dump			✔			
Area where No Cash 500 Creek flows past waste rock dump			✔	✔		
East side of railway tracks				✔		
Cribed log retaining wall along East side of overburden dump				✔		
500 Adit (along current and former flowpaths of adit discharge)		✔				
100 Level Adit						
Waste Rock pile (upper end of Sandy Creek Drainage)	✔	✔		✔		
100 Level adit portal	✔			✔		
Shaft (south of abandoned tramway, north of Bretall shaft dump)				✔		
Along Star Creek channel at Calumet Drive			✔			

Mine Site Area: **No Cash 500**

Mine Site Area Components and Description:

1 **Adits**
1 raise, 1 shaft, 2 adits

2 **Open Pits**
None

3 **Waste Rock Piles**
2 waste rock piles, 1@500 level, 1@100 level: 144,600 tonnes total waste rock

4 **Underground Levels**
4 @ 100, 200, 300 and 500: 166,530 tonnes mined

5 **Infrastructure**
Tram Station, H. frame, 1 building

Closure Issues:

1 No Cash discharge is the second largest metal load from underground in the district. The adit water is collected in a culvert at the adit entrance and discharged over the face of the waste rock storage area. Zinc is attenuated/sorbed downgradient eventuall entering a large bog in the valley. No large source or plume of metals has been identified from the release of water at No Cash, despite its high contaminate load.

2 The face of the waste rock storage area exhibits large areas of erosion and release of material due to the adit water flow and blown ice plugs. Ice plugs form in the adit during the winter months and no power is available to manage plugs

Options for Closure:

1 **In-Mine Pool Treatment, Poured Concrete Massive Plug, WRSA Leave as is**
a. *Adit Treatment: In-Mine Pool Treatment*
b. *Adit Closure: Poured Concrete Massive Plug (to withstand ~300' water pressure)*
c. *WRSA: Leave as is*

2 **Direct Flow to Elsa for Common HDS Treatment, Rock Pile, Recontour 2.5H:1V & Revegetate**
a. *Adit Treatment: Direct Flow to Elsa for Common HDS Treatment*
b. *Adit Closure: Hydraulic Plug*
c. *WRSA: Recontour 2.5H:1V and revegetate*

3 **Natural Attenuation, Rock Pile, Scarify & Revegetate**
a. *Adit Treatment: Capture and natural attenuation in lowlands*
b. *Adit Closure: Rock Pile*
c. *WRSA: Scarify surface and revegetate*

Mine Site Area:	**No Cash 500**
Closure Option 1:	**In-Mine Pool Treatment, Poured Concrete Massive Plug, WRSA Leave as is**

Facts/Description of Option:

1. Install hydraulic plug in the 400 level to backup and withstand 250' of water pressure.
2. Treat the mine pool through injection of carbon sources into the Brefault Shaft to reduce the load of zinc leaving the adit
3. Allow any remaining water from the adit plug to continue to be collected and diverted away from the face of the WRSA and then allowed to infiltrate and attenuate as per current site conditions.
4. Leave the waste rock storage areas as is with the exception of drainage and erosion control

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$3,877,000

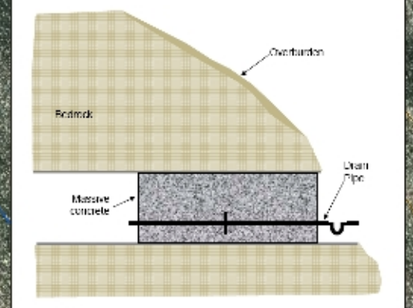
Leave as is

WRSA: Leave as is

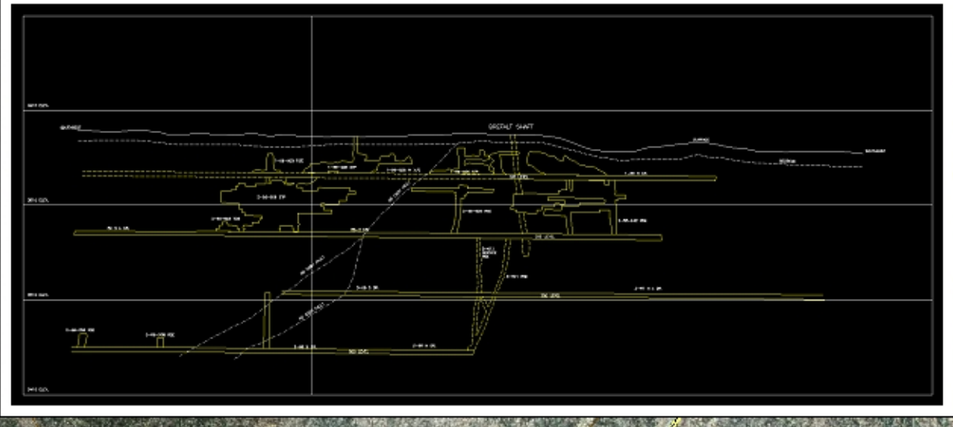
No Cash 500 Adit

Insert hydraulic plug and in-mine pool treatment

Poured Concrete Massive Plug



In-Mine Pool Treatment



No Cash 100

Tramway

Inject mine pool treatment through Brefalt

N

Legend

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

NO CASH 500 OPTION #1

SITE PLAN

SCALE: 1:4,000

0 40 80 160 240 320 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**No Cash 500**
Closure Option 2:	**Direct Flow to Elsa for Common HDS Treatment, Hydraulic Plug, Recontour 2.5H:1V & Revegetate**

Facts/Description of Option:

1 Install a barrier or seal in the 500 adit to prevent access and collect the adit water into a pipeline for diversion to Elsa

2 Construct a new and centralized HDS plant in Elsa for treatment of No Cash 500. Centralized plant to be used oin conjunction with Galkeno 300 Option for centralized treatment. Sludge from the centralized plant to be deposited into storage facility at Valley Tailings

3 Recontour the WRSA to a 2.5:1 contour and revegetate the surface, no gorwth media applied

Identified Risks and Concerns:

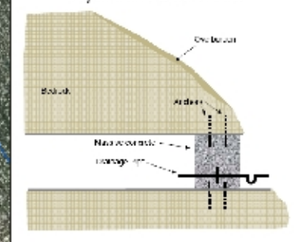
Estimated Costs:

Construction + 20 year O&M	$14,037,000

Recontour Surface 2.5H:1V

Recontour and Revegetate

Hydraulic Bulkhead



Pipeline to central Elsa treatment plant

WRSA: Reslope and Revegetate

No Cash 500 Adit

No Cash 100

Tramway

Brefalt

Legend
Mine Features
TYPE
Adit
Pit
Shaft
Showing
Roads
TYPE
Highway
Local
Haul Road
Track
Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

NO CASH 500 OPTION #2

SITE PLAN

SCALE: 1:4,000

0 40 80 160 240 320 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**No Cash 500**
Closure Option 3:	**Natural Attenuation, Rock Pile, Scarify & Revegetate**

Facts/Description of Option:

1 Contruct a rock pile or barrier/seal to prevent access and then collect the adit water in a channel or pipe for downstream release

2 Allow adit water to infiltrate and attenuate metals prior to reaching the receiving environment and rely on natural attenuation for longterm metals reduction and treatment (current site conditions)

3 Scarify the top of the WRSA and minor erosion/drainage control and revegetate the surface, no frowth media applied

Identified Risks and Concerns:

1 The capacity for the site to attenuate metals into perpetuity is not guranteed. A change in the environmental factors that enable attenutation of metals from solution before they reach the receiving environment may allow contaminants to some day enter receiving waters at appreciable levels.

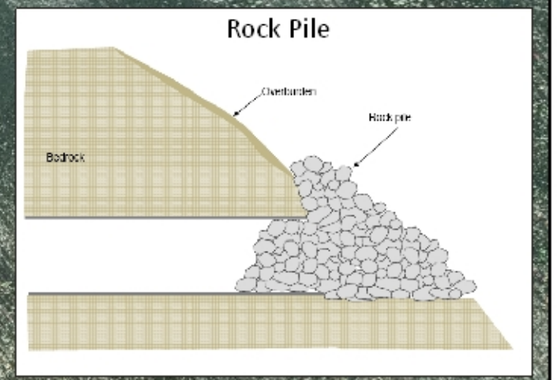
Estimated Costs:

Construction + 20 year O&M	$1,627,000

Natural Attenuation into Lowlands

Natural Attenuation into Lowlands

Rock Pile



Scarify and Revegetate

Rock Pile allowing drainage

No Cash 500 Adit

Scarify and Revegetate

Legend

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

NO CASH 500 OPTION #3

SITE PLAN

SCALE: 1:4,000

Meters

0 40 80 160 240 320

DRAWN BY: RS

DATE: 25/Feb/2009

Galkeno (Galkeno 900 and Galkeno 300)

Description

Galkeno mine is primarily an underground mining area, mining two veins; the McLeod Vein and the Sime Vein. The area was mined in the 1950's and 60's. UKHM did not mine from any of the McLeod workings, but did development work on the Sime 400 and 500 levels.

The McLeod Vein was mined from underground, with workings from the 100 to 500 levels, and an adit at the 900 level. The 900 level adit was driven to dewater the McLeod Vein workings below the 500 level, but apparently was not used for production.

The adits at the 100 and 200 levels have both caved, preventing access to the underground.

The adit at the 300 level is open, blocked by a wooden door but not locked. The 300 level adit connects the McLeod and Sime workings. There was also a shaft on the McLeod vein connecting surface with the 100 level. It is reported that this shaft has caved, which will be confirmed.

In the fall of 1993, a hydraulic plug was installed by UKHM in the Galkeno 900 level adit, in response to concerns from Environment Canada that this adit was a major source of contaminant loading to the receiving environment. The objective of the installation was to cause flooding of the underground workings which would limit oxidation and dissolution of metals into the drainage water.

It has been recognised, given the geology of the hillside and extent of development above the 900 level, that:

- The workings would not entirely flood and the source of soluble metals could continue; and,
- As water accumulated behind the plug, the increasing hydraulic head would force the water to seep from the rock mass beyond the plug and surrounding grout curtain, and to daylight elsewhere in the hillside.

Therefore, a temporary active water treatment system has been established at the Galkeno 900 adit, comprising lime addition and two settling ponds. Investigations into passive treatment systems are in progress, based on observations of in-situ sulphate reduction downstream of the Galkeno 900 adit drainage.

The Sime Vein was mined both from a series of three open pits, and from underground. Access to underground was through two adits at the 200 and 300 levels, with an internal shaft connecting the 300 level to the 400 and 500 levels. The 300 level is partly caved, and connects to the Hector-Calumet 775 level. The status of the 200 level adit must be checked. It is assumed that some closure measures will be required.

The Sime open pits have some waste rock associated with them, but appear to have been mined in sequence, with waste deposited in and around the open pits. While no shafts are located within the pits, it appears that some stopes broke through to the pit floor, keeping the pits drained. The floors and lower benches of the upper two pits, called Sime 6 and Sime 4, are covered with broken rock.

The McLeod and Sime underground workings are also connected by a cross-cut at the 500 level. Prior to the development of this cross-cut, there was no hydraulic connection between the workings below the 400 level, as evidenced by the water level recorded in March 1965.

Also associated with the Galkeno area is the former Galkeno mill and tailings. This mill was operated by Mackeno Mines in the 1950's, with some custom milling. UKHM did not use this mill, or the tailings facilities. All of the buildings were removed from the area, and some contouring done. While anecdotal evidence indicates that the tailings were deposited in the lake, at least during winter months, old air photos show what appears to be a tailings impoundment adjacent to the mill and upstream of the mouth of Christal Lake. It is likely that the custom milling operations resulted in tailings deposition in different areas, that is, both on-land and underwater disposal.

Closure Issues Martrix

Common Site Name: **Galkeno 900**

Site coordinates:	easting	northing	Datum: NAD83	Projection: UTM Zone 8N
	483407	7087890		

General Location Description	Closure Issue Categories					
	Human & Wildlife Health and Safety	Chemical Control	Water Management	Physical Stability	Community Interest	Other
Discharge point from pipe - corrugated sections				✔		
Discharge area - after corrugated section		✔	✔	✔		
Settling pond - southeast corner			✔	✔		

Mine Site Area: **Galkeno 900**

Mine Site Area Components and Description:

1 **Adits**
1 adit

2 **Open Pits**
na

3 **Waste Rock Piles**
1 WRSA

4 **Underground Levels**
1 level - 900

5 **Infrastructure**
Treatment building plus ponds

Closure Issues:

1 The most significant closure issue for the Galkeno area is drainage from the workings out the Galkeno 900 level adits. A hydraulic plug was installed into the Galkeno 900 level adit to stop/reduce flow from the adit. Approximately 5 lps continues to drain from the adit around the concrete bulkhead.

Options for Closure:

1 **Ex-situ Bioreactor with Lime Treatment Contingency, Hydraulic Bulkhead (current), WRSA Leave as is**
a. *Adit Treatment: Ex-situ Bioreactor*
b. *Adit Closure: (Current) Hydraulic Bulkhead; Barrier/Seal*
c. *WRSA: Leave as is*

2 **Upgrade Current Treatment System, Hydraulic Bulkhead (current), WRSA Leave as is**
a. *Adit Treatment: Upgrade current system*
b. *Adit Closure: (Current) Hydraulic Bulkhead; Barrier/Seal*
c. *WRSA: Leave as is*

3 **Batch In-Mine Pool Bioreactor Treatment, Hydraulic Bulkhead (current), WRSA Leave as is**
a. *Adit Treatment: Treat combined GK900 and GK300 waters w/ chemical/bioreactor combination*
b. *Adit Closure: Second Hydraulic Bulkhead (together with existing); Barrier/Seal*
c. *WRSA: Leave as is*

Mine Site Area:	**Galkeno 900**
Closure Option 1:	**Bioreactor Treatment, Current Bulkhead**

Facts/Description of Option:

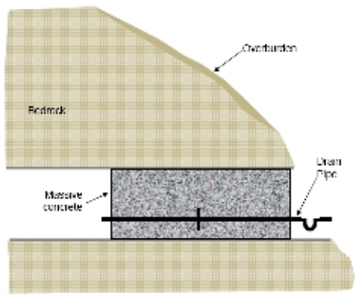
1. Convert the current pilot test bioreactor to a full-scale treatment facility to handle full adit flow
2. The bulkhead in the Galkeno 900 adit remains with no further maintenance or upgrade
3. The existing chemical treatment system in operation would remain as a contingency measure until it has been demonstrated that the bioreactor is operating in compliance for the longterm
4. Install barrier or seal at Galkeno 900 adit entrance to prevent access but allow for inspection and water conveyance

Identified Risks and Concerns:

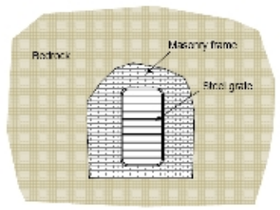
Estimated Costs:

Construction + 20 year O&M	$3,084,000

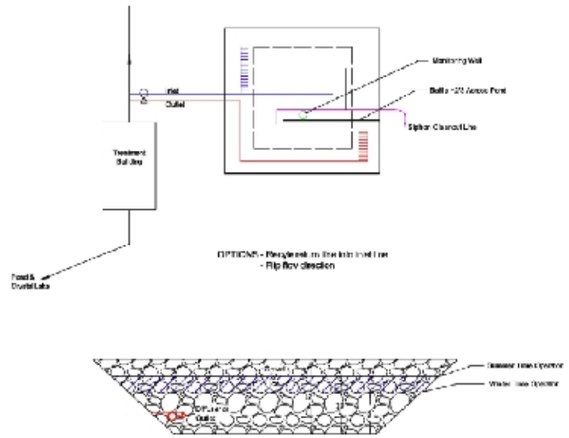
Poured Concrete Massive Plug



Steel Barrier



Ex-situ Bioreactor Treatment



Existing Adit Plug

Galkeno 900

Test Pilot Bioreactor

Treatment Plant

Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

GALKENO 900 OPTION #1

SITE PLAN

SCALE: 1:1,500

0 15 30 60 90 120 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Galkeno 900**
Closure Option 2:	**Chemical Treatment, Current Bulkhead**

Facts/Description of Option:

1 Upgrade as necesssary current chemical treatment system for longterm sustainability and continue with collection and treatment of adit water

2 Install barrier or seal at Galkeno 900 adit entrance to prevent access but allow for inspection and water conveyance

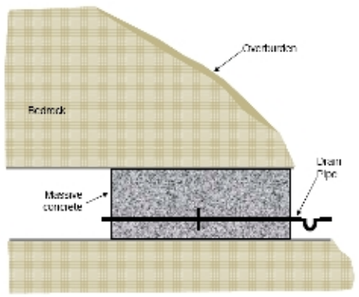
3 The bulkhead in the Galkeno 900 adit remains with no further maintenance or upgrade

Identified Risks and Concerns:

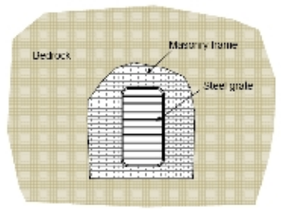
Estimated Costs:

Construction + 20 year O&M	$6,459,000

Poured Concrete Massive Plug



Steel Barrier



Existing Adit Plug

Test Pilot Bioreactor

Galkeno 900

Treatment Plant

Upgrade Current Chemical Treatment System

Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS CONSULTING GROUP

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

GALKENO 900 OPTION #2

SITE PLAN

SCALE: 1:1,500

0 15 30 60 90 120 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Galkeno 900**
Closure Option 3:	**Combined G300 and G900 Flows, Bioreactor with Chemical Backup, Current Bulkhead**

Facts/Description of Option:

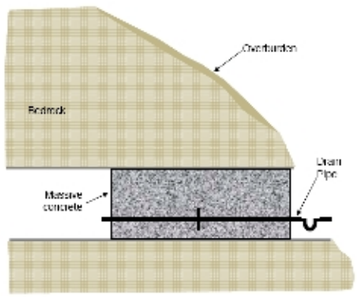
1. In combination with Galkeno 300 closure option, additional flow is redirected to Galkeno 900 and combined flows and zinc loads are treated at the current facilities at Galkeno 900.
2. Expand bioreactor to treat higher loads from combined G900 and G300 flows and use bioreactor as primary treatment system
3. Upgrade current chemical treatment system as required to handle additional loads and to serve as a backup and contingency treatment system. Flow is not expected to increase substantially due to existing bulkhead
4. The bulkhead in the Galkeno 900 adit remains with no further maintenance or upgrade
5. Install barrier or seal at Galkeno 900 adit entrance to prevent access but allow for inspection and water conveyance

Identified Risks and Concerns:

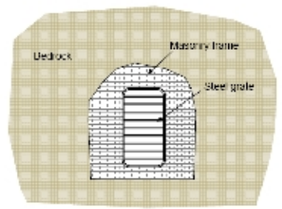
Estimated Costs:

Construction + 20 year O&M	$3,877,000

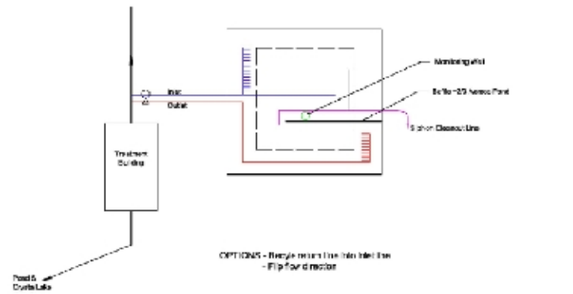
Poured Concrete Massive Plug



Steel Barrier



Ex-situ Bioreactor Treatment



Existing Adit Plug

Galkeno 900

Treatment Plant

Batch In-Mine Pool Bioreactor Treatment

Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

GALKENO 900 OPTION #3

SITE PLAN

SCALE: 1:1,500

0 15 30 60 90 120 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Closure Issues Martrix

Common Site Name: **Galkeno 300**

Site coordinates:	easting	northing	Datum:	Projection:
	482545	7088755	NAD83	UTM Zone 8N

General Location Description	Closure Issue Categories					
	Human & Wildlife Health and Safety	Chemical Control	Water Management	Physical Stability	Community Interest	Other
Sinkhole - south Bench, #35 Vein Pit	✔			✔		
Dumps 1 - 7	✔					
Dump - east of unnamed adit (minor issue)			✔			
Sime #6 pit				✔		
Sime #4 pit - NE side				✔		
11-1 Adit dump			✔			
100 Level	✔					
Effluent pipe discharge point - riprap area				✔		
Galkeno 300 Adit southeast corner of pond			✔	✔		

Mine Site Area: **Galkeno 300**

Mine Site Area Components and Description:

1 **Adits**
5 adits, 2 internal shafts, 1 external shaft

2 **Open Pits**
3 open pits

3 **Waste Rock Piles**
4 waste rock piles: 171,400 tonnes total waste rock

4 **Underground Levels**
6 levels @ 100, 200, 300, 400, 500, 900

5 **Infrastructure**
Treatment building plus ponds

Closure Issues:

1 The most significant closure issue for the Galkeno area is drainage from the workings out the Galkeno 300 . Galkeno 300 flows and loads are the highest at the site, and though they do not presently report to any waterways, they pose a significant environmental risk.

2 The Sime open pit serves as a sludge storage location for the Galkeno 300 treatment system

Options for Closure:

1 **Current Treatment System**
a. *Adit Treatment: Existing clarifier*
b. *Adit Closure: Barrier or seal*
c. *WRSA: Leave as is*

2 **Centralized HDS Plant in Elsa**
a. *Adit Treatment: Centralized HDS plant in Elsa combined with No Cash*
b. *Adit Closure: Barrier or seal*
c. *WRSA: Reslope 2.5:1 and Revegetate*

3 **Isolate Hector Mine Pool, redirect to Galkeno 900**
a. *Adit Treatment: Breast high dam and redirect to G900 treatment system*
b. *Adit Closure: Rock Pile*
c. *WRSA: Reslope 2.5:1 and Revegetate*

4 **Isolate Hector Mine Pool, use current treatment system**
a. *Adit Treatment: Isolate Hector Mine pool and treat remaining flow with clarifier*
b. *Adit Closure: Barrier or seal*
c. *WRSA: Scarify and revegetate*

Mine Site Area:	**Galkeno 300**
Closure Option 1:	**Current Treatment System, Barrier or Seal, WRSA Do Nothing**

Facts/Description of Option:

1 The current clarifier treatment system remains in place and Galkeno 300 water continues to be captured and treated as per current site conditions. Additional modifications to the treatment system would likely be required to provide a sustainable and reliable treatment plant for a 20-30 year time horizon

2 A barrier or seal would be installed to prevent inadvertant access and still provide for water collection and routing to the clarifier treatment system

3 The waste rock storage areas would remain as is with the exception of diversion and erosion control measures as necessary

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$18,052,000

WRSA: Leave as is

200 Level

100 Level

Calumet Drive

Current Treatment System

Floc Shed

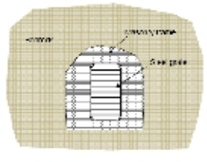
Sludge Pumphouse

Clarifier Shed

300 Level

Install barrier to allow authorized access to mine workings

Steel Barrier



Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS CONSULTING GROUP

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

GALKENO 300 OPTION #1

SITE PLAN

SCALE: 1:4,000

0 40 80 160 240 320 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Galkeno 300**
Closure Option 2:	**Direct Flow to Elsa in Central HDS Plant, Adit Barrier or Seal, Reslope WRSA 2.5:1 and Revegetate**

Facts/Description of Option:

1 Adit water from Galkeno 300 would be captured and routed in a pipeline to a centralized treatment plant in Elsa. This option would be in combination with the same closure option for No Cash treatment in a centralized plant

2 A barrier or seal would be installed to prevent inadvertant access and still provide for water collection and routing to the clarifier treatment system

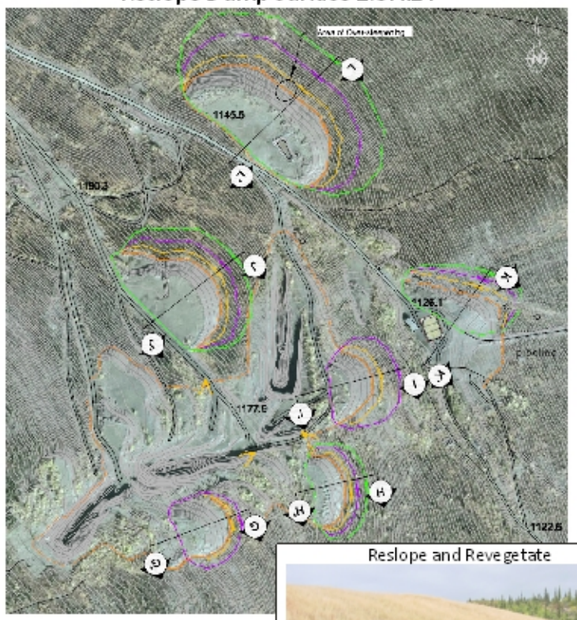
3 Reslope the waste rock storage areas to a 2.5:1 contour and revegetate. No growth media applied

Identified Risks and Concerns:

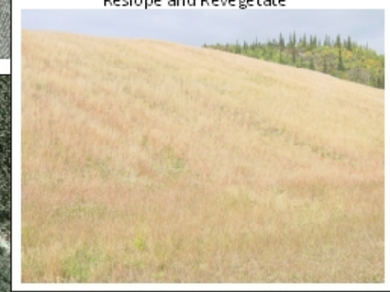
Estimated Costs:

Construction + 20 year O&M	$18,596,000

Reslope Dump Surface 2.5H:1V



Reslope and Revegetate



WRSA: Reslope surface 2.5H:1V and Revegetate

Reslope and Revegetate

Surface Pipeline to Elsa HDS Treatment Plant

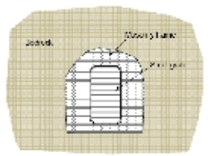
Calumet Drive

200 Level

300 Level

Install barrier to allow authorized access to mine workings

Steel Barrier



Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS CONSULTING GROUP

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

GALKENO 300 OPTION #2

SITE PLAN

SCALE: 1:4,000

0 40 80 160 240 320 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Galkeno 300**
Closure Option 3:	**Isolate from Hector Mine Pool, redirect to G900, Rock Pile, Reslope WRSA 2.5:1 and Revegetate**

Facts/Description of Option:

1 Construct a bulkhead at the connection between the Hector Calumet working and the Galkeno 300, effectively isolating the load of contaminants currently draining out the Galkeno 300 adit

2 With the flow isolated from the Hector Workings, the majority of flow and load exiting the Galkeno 300 adit is effectively cutoff. A breast high dam is installed in the Galkeno 300 adit to divert the flow to the Sime cross cut and into the Galkeno 900 adit. This option would allow active treatment at Galkeno 300 to cease

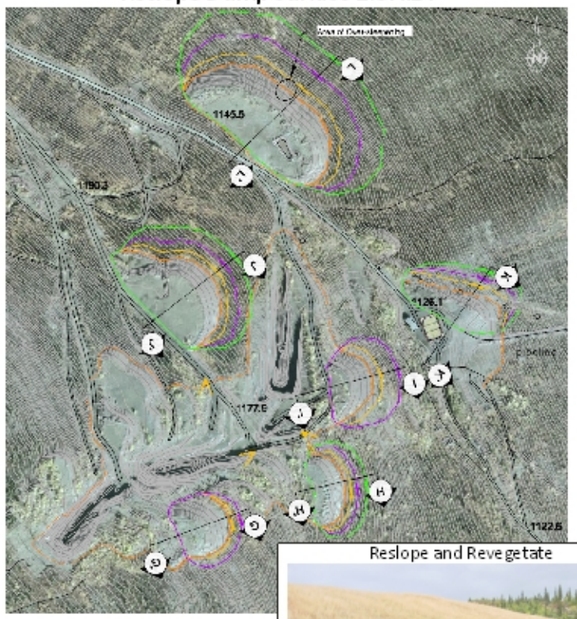
3 Reslope the waste rock storage areas to a 2.5:1 contour and revegetate. No growth media applied

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$12,521,000

Reslope Dump Surface 2.5H:1V



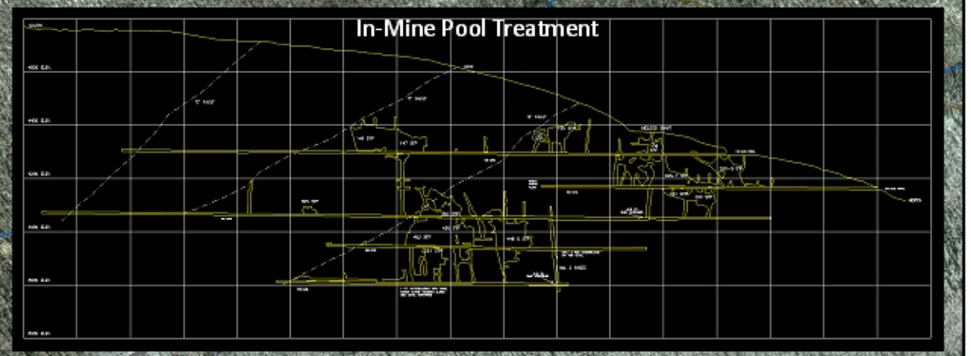
Reslope and Revegetate

WRSA: Reslope surface 2.5H:1V and Revegetate

Calumet Drive

200 Level

In-Mine Pool Treatment



Isolate Galkeno 300 from Hector mine pool, direct to GK900 for bioreactor treatment or other GK900 treatment options

Floc Shed

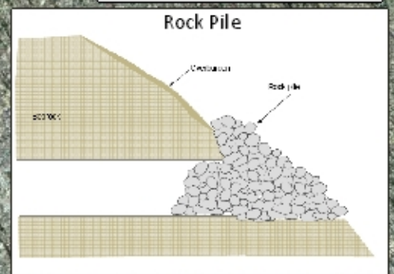
Sludge Pumphouse

300 Level

Clarifier Shed

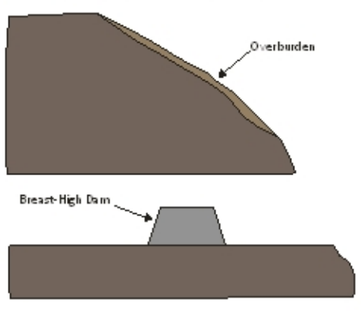
Place rock pile at adit entrance to inhibit access and allow flow

Rock Pile



Breast-high dam to redirect low flow to GK900 for treatment in existing bioreactor

Breast-High Dam



Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS CONSULTING GROUP

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

GALKENO 300 OPTION #3

SITE PLAN

SCALE: 1:4,000

0 40 80 160 240 320 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Galkeno 300**
Closure Option 4:	**Isolate from Hector Mine Pool, Treat with clarifier, Concrete Plug, Scarify and Revegetate**

Facts/Description of Option:

1 Construct a bulkhead at the connection between the Hector Calumet working and the Galkeno 300, effectively isolating the load of contaminants currently draining out the Galkeno 300 adit

2 Continue chemical treatment with the existing clarifier at the Galkeno 300 adit. The flow and load will be substantially reduced through isolating the majority of the load coming from the Hector Calumet workings.

3 Scarify the top surface of the waste rock storage areas and revegetate, no growth media applied

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$14,496,000

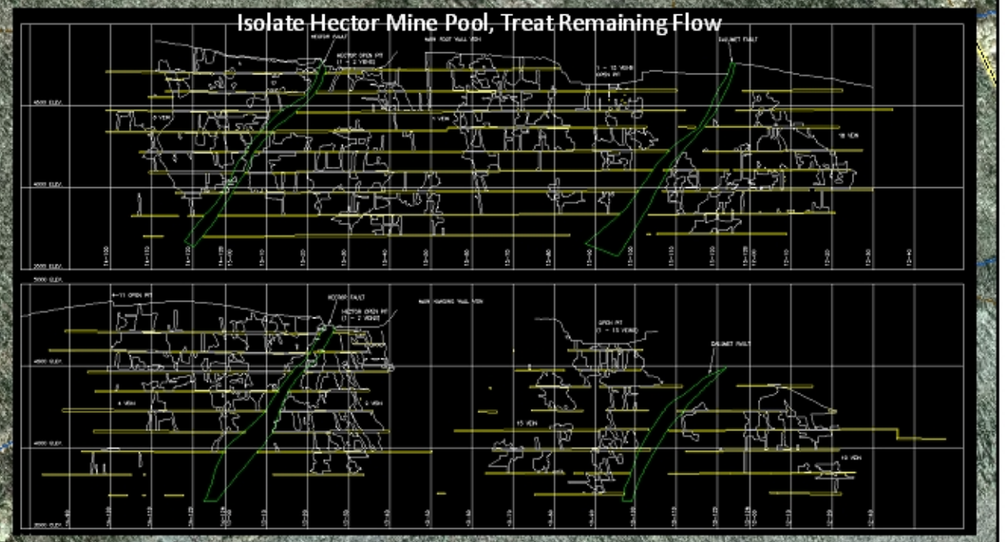
WRSA: Scarify and Revegetate

Calumet Drive

200 Level

100 Level

Isolate Hector Mine Pool, Treat Remaining Flow



Isolate Hector mine pool and treat remaining flow with existing clarifier

Floc Shed

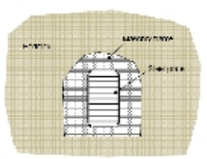
Sludge Pumphouse

300 Level

Clarifier Shed

Install barrier to allow authorized access to mine workings

Steel Barrier



Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

GALKENO 300 OPTION #4

SITE PLAN

SCALE: 1:4,000

0 40 80 160 240 320 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Hector Calumet

Description

The Hector-Calumet mine workings are probably the most extensive workings on Galena Hill, and include three open pits mined in the mid 1980's and the older Hector-Calumet underground workings. Just over half of the Company's total silver production has come from the Hector-Calumet mine.

The Hector Calumet workings are clearly very extensive and close to surface, it is reported that there was considerable backfilling, using waste rock generated underground, and thus subsidence at the surface is not a concern.

There is one portal, at the 400 level, which remains open. The portal is supported by timber and concrete and appears stable. Access is limited by doors at the portal.

There is a significant amount of waste rock at the 400 portal; estimated at about 200,000 tons. Some of this was used as fill and road construction around Calumet, and for foundations for the aerial tramway terminus. The remainder is deposited at the portal. The tramway was used to transport ore from Hector-Calumet to the mill. Most of the Calumet tramway station has been demolished or burned, although some wood and debris remains, as does the cribbing for the foundations.

There are two shafts at the Calumet workings. Both are reported collapsed, but this must be confirmed. It appears from old drawings and plans that there may be additional shafts and raises to surface associated with the older workings, which will be investigated.

The Calumet 1-15 is the second largest pit mined by UKHM, and was mined to recover the crown pillars of the No.1 and No.15 veins. There are two waste dumps associated with the open pit, comprising about 1,000,000 tons of waste rock. The Hector Pit (also called the No. 1 Vein pit) and the 4-11 pit are smaller, with the 4-11 "pit" being a large stripped area and a series of trenches adjacent to the Hector pit, about 600 feet to the west south-west. The 4-11 area was stripped to sample veins, and then a backhoe was used to mine a short, narrow section of ore material. The open pits are connected to the underground workings through either old raises or fault structures and thus are not expected to flood.

The composite plan also shows the very small Calumet "C" pit which was mined in 1981. The pit is, in fact, a small shallow slot which is filled with water.

There was a significant amount of infrastructure at the Hector-Calumet during the peak years of operation, that is, from 1948 through to 1972. A town site was built, although all of the buildings and structures have since been removed. There was also a steam power plant operating at the 400 level, which explains the residual coal and ash evident in the lower section of the waste dump.

During operation, the mine was dewatered from the 400 level adit. The water discharged on to the hillside down slope from the adit, flooding the area with water and silt, and resulting in the dead trees that are still evident today. There has been no drainage from the Hector 400 adit since mining ceased in October of 1972. It is understood that the underground water reports to the Galkeno workings. Review of the operations reports from the shaft development period (1953/54) shows that the Hector shaft was essentially dry with the exception of two areas:

- At about 940 ft. depth, the Hector fault was encountered resulting in ". . . water problems";
- Between the 1165 and 1300 levels heavy water inflows were encountered (Aug. 2, 1954), with recorded flows of up to 100 gallons per minute.

Development was finished in October of 1954 and it was reported that ". . . water flow continues undiminished." It is expected that, after the mining of the Hector underground was finished in 1972, the drainage from underground may have reported ultimately to the Galkeno 900 Adit.

Closure Issues Martrix

Common Site Name: **Hector Calumet**

Site coordinates:	easting	northing	Datum: NAD83	Projection: UTM Zone 8N
	480900	7088300		

General Location Description	Closure Issue Categories					
	Human & Wildlife Health and Safety	Chemical Control	Water Management	Physical Stability	Community Interest	Other
Calumet Pit (intersection of footwall and vent)				✔		
Calumet South Pit				✔		
South of Calumet South Pit				✔		
Hector Pit (upper sides - N end)				✔		
Hector Pit (upper sides - S end)	✔			✔		
<100m E of Jock Shaft	✔		✔	✔		
Hector Pit dump site			✔	✔		
Hill S of Hector Pit dump site			✔	✔		
General site Issue - rain water influence		✔	✔			

Mine Site Area: **Hector - Calumet**

Mine Site Area Components and Description:

1 **Adits**

1 shaft, 1 adit, discharge through Galkeno 300 connection

2 **Open Pits**

3 pits: 108,547 tonnes mined

3 **Waste Rock Piles**

4 waste rock piles: 3@pits = 1,110,000tonnes; 1 @adit = 198,000tonnes

4 **Underground Levels**

1300 ft depth, extensive underground

5 **Infrastructure**

head of tramway still exists; town removed

Closure Issues:

1 The underground does not discharge to surface and the major chemical issue is the rock dump at the portal.

2 There is some vein material in the waste rock, albeit a small percentage of the total mass, which could be a contaminant source. However, there are no surface waters immediately downstream of the dump which show an adverse impact.

3 SRK concluded in their 2007/08 Geochemical Study that,

"Given the large size of the [Hector Adit] dump and the high metal content, onset of acid weathering conditions within the Hector Adit dump could lead to significant metal loadings to the adjacent environment. If advance knowledge of the development of acid weathering conditions and increased metal leaching would cause a different closure plan to be selected when compared to a closure option selected for current conditions, a limited program of XRD testing and additional ABA analysis should be undertaken to determine sphalerite, galena, anglesite, and carbonate content of the Hector Adit waste rock. However, this additional testing is unnecessary if the same closure option is preferred for scenarios where the current conditions persist and where onset of ARD occurs in the future."

4 The Hector Mine pool is the primary load for the Galkeno 300 adit and represents the largest source of contaminant in the district

Options for Closure:

1 **Mine Pool Drain, Centralized HDS plant in Elsa**

a. *Adit Treatment: Isolate pool from G300 by draining pool to below 775' connection to Galkeno*
b. *Direct flow into pipeline with No Cash drainage to HDS plant in Elsa*
c. *Adit Closure: Rock Pile*
d. *WRSA: Leave as is*

2 **Isolate from Galkeno 300 by Hydraulic Plug, Centralized HDS plant in Elsa**

a. *Adit Treatment: Isolate pool from G300 by installing hydraulic plug between HC 775 and G300*
b. *Fill mine pool to Hector 400 adit: flood 775, 650, 500 and 400 level workings*
c. *Direct flow from Hector 400 adit into pipeline with No Cash drainage to HDS plant in Elsa*
d. *Adit Closure: Water retention at Hector 400 to equalize flows from adit year-round*
e. *WRSA: Reslope 2.5:1 and Revegetate*

3 **Isolate from Galkeno 300, In-Mine Pool Treatment and Attenuation in McQuesten Valley Bogs**

a. *Adit Treatment: Isolate pool from G300 by installing hydraulic plug between HC 775 and G300*
b. *Fill mine pool to Hector 400 adit, flood 775, 650, 500 and 400 level workings*
c. *In-mine pool treatment by organic carbon addition into shaft, recirculation from H400 adit*
d. *Direct treated flow from Hector 400 down to McQuesten valley bogs for attenuation*
e. *Adit Closure: Hydraulic Plug*
f. *WRSA: Scarify and revegetate*

Mine Site Area:	**Hector - Calumet**
Closure Option 1:	**Mine Pool Drain, Centralized HDS plant in Elsa, WRSA** **Leave as is**

Facts/Description of Option:

1 The Hector-Calumet workings are assumed to be the largest loading of metals from underground workings in the district. These workings are isolated from the Galkeno 300 adit by lowering the water level in the existing pool either by pumping from the shaft or by installing a cased hole into lower level workings, and pumping or gravity draining from the mine pool. Water from the drainage point is directed into a pipeline (which may also collect No Cash drainage) and carried to Elsa where a new HDS plant is constructed

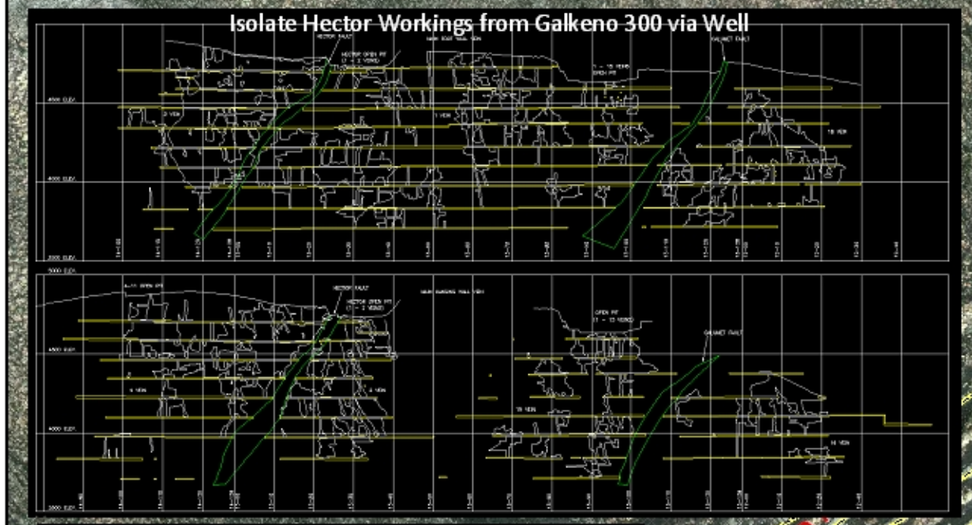
2 A barrier or seal is constructed at the adit entrance to eliminate any inadvertent access and reduce air flow into the workings. The concrete portal structure is maintained as a heritage artifact given the significant impact the Hector mine played in the success of the Keno Hill Silver District

3 The waste rock storage areas would remain as is with the exception of diversion and erosion control measures as necessary

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$14,759,000



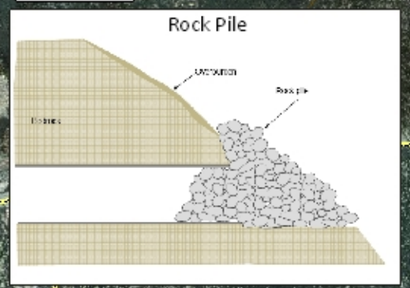
Isolate Hector workings from Galkeno 300 via a well, drain workings, capture water, and direct to central Elsa HDS Treatment Facility

Hector Adit

WRSA: Do Nothing

Calumet D...

Rock Pile



Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

HECTOR & CALUMET OPTION #1

SITE PLAN

SCALE: 1:4,500

0 45 90 180 270 360 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Hector - Calumet**
Closure Option 2:	**Isolate from Hector Mine Pool, Redirect to Central HDS plant in Elsa, Rock Pile, Reslope WRSA 2.5:1 and Revegetate**

Facts/Description of Option:

1 Construct a bulkhead at the connection between the Hector Calumet working and the Galkeno 300, effectively isolating the load of contaminants currently draining out the Galkeno 300 adit

2 The water elevation in the Hector Calumet pool will rise to the point of exiting the Hector Calumet adit. Collect the contaminated water and route in a pipeline to a central HDS treatment plant in Elsa. This option is done in combination with a central treatment plant for the No Cash 500 adit water

3 A hydraulic plug is also constructed in Hector 400 adit to allow flow equalization from the mine workings, and eliminate access. The concrete portal structure is maintained as a heritage artifact given the significant impact the Hector mine played in the success of the Keno Hill Silver District

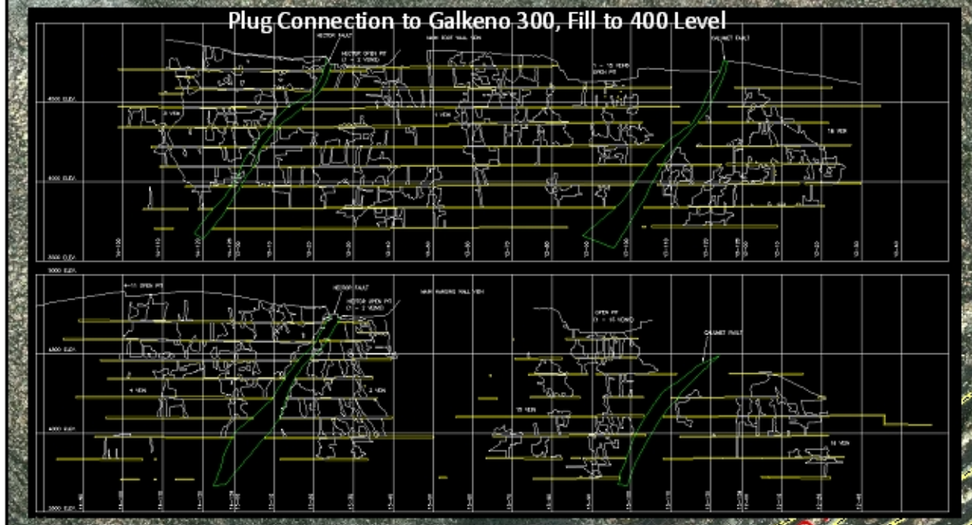
4 Reslope the waste rock storage areas to a 2.5:1 contour and revegetate. Growth media is applied to promote a more effective cover and reduce infiltration and thereby reducing potential contaminant release from the Hector Dumps

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$13,815,000

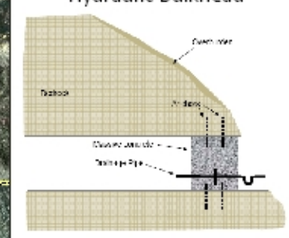
Plug Connection to Galkeno 300, Fill to 400 Level



Plug at the connection between Hector mine and Galkeno 300 workings, gravity flow to central Elsa HDS Treatment Facility

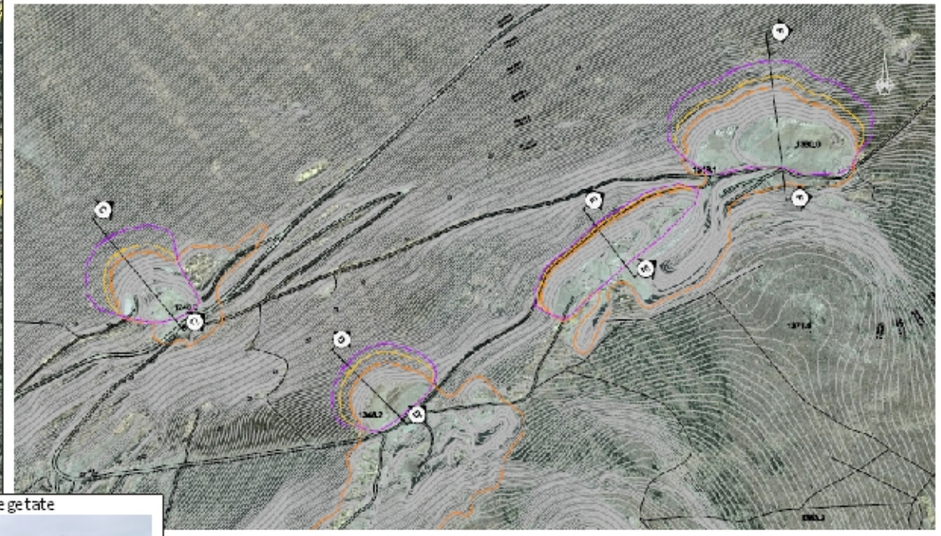
Hector Adit

Hydraulic Bulkhead



WRSA: Reslope and Revegetate

Reslope Surface 2.5H:1V



Reslope and Revegetate

Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

HECTOR & CALUMET OPTION #2

SITE PLAN

SCALE: 1:4,500

0 45 90 180 270 360 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Hector - Calumet**
Closure Option 3:	**Isolate from Galkeno 300, In-Mine Pool Treatment and Attenuation in McQuesten Valley Bogs**

Facts/Description of Option:

1 Construct a bulkhead at the connection between the Hector Calumet working and the Galkeno 300, effectively isolating the load of contaminants currently draining out the Galkeno 300 adit

2 The water elevation in the Hector Calumet pool will rise to the point of exiting the Hector 400 adit. In mine pool treatment is initated to reduce the overall load of contaminants that will drain out the Hector Calumet adit once it is flooded, with flow from the adit amended and recirculated into the mine workings with additional reagents.

3 Treated water from the H-C pool will be drained into the McQueston Valley bogs for attenuation of any residual metals and diffusion of the water into the bog.

4 A barrier or seal is constructed at the adit entrance to eliminate any inadvertent access and reduce air flow into the workings. The concrete portal structure is maintained as a heritage artifact given the significant impact the Hector mine played in the success of the Keno Hill Silver District

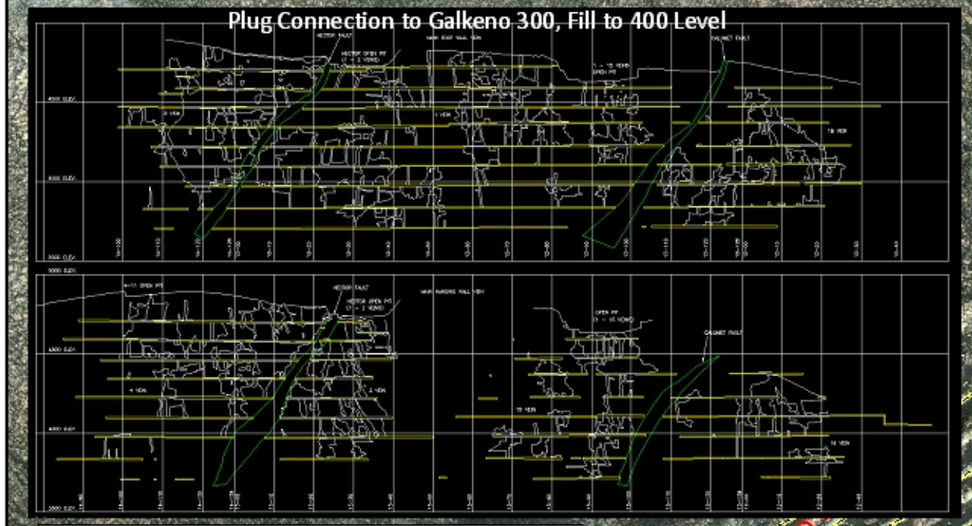
5 The surface of the waste rock storage areas are scarified and revegetated. The side slopes are left at an angle of repose

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$5,315,000

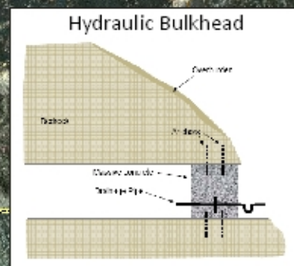
Plug Connection to Galkeno 300, Fill to 400 Level



Plug at the connection between Hector mine and Galkeno 300 workings, gravity flow discharge to lowlands bog

Hector Adit

Hydraulic Bulkhead



WRSA: Scarify and Revegetate

Scarify and Revegetate Dump Surface

Legend

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

N

DRAFT

ERDC

ACCESS CONSULTING GROUP

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

HECTOR & CALUMET OPTION #3

SITE PLAN

SCALE: 1:4,500

0 45 90 180 270 360 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Valley Tailings

Description

In 1932, the old Sadie Ladue Mill from Wernecke Camp was moved to Elsa and used here until 1942. Tailings from this mill reported to the hillside adjacent to Porcupine reek.

The new Elsa Mill was commissioned in 1949, and ran, with some modifications and temporary shut downs, until the mine's cessation in 1988. During this period, over four million tons of tailings were deposited in the valley.

Dam No. 1 was originally constructed in 1968, and fortified after a failure in 1972. Dam No. 2 was also constructed in 1972. Dam No. 3 was constructed from local sand and gravel till in 1979. Porcupine Creek was diverted from the valley tailings area via the Porcupine Diversion ditch.

The EIsa tailings are located in the Flat Creek valley bottom below the Elsa mill site. The major accumulation of tailings is upstream from the main stem of Flat Creek in a swampy area draining into Flat Creek. Porcupine Creek passes through the tailings area. An additional area of older tailings is perched on the hillside above the valley bottom south of Porcupine Creek and just below the highway to Keno City. The areal extent of tailings is relatively well known from recent air photography. The total surface area of the impoundment is approximately 185 acres (75 ha). However, the depth of the material is uncertain.

Considerable drilling was done in the tailings area by UKHM in a number of campaigns.

The tailings form in two lobes, the northern one, behind the #1 dam, is more recent than the other, more southerly one near Porcupine Creek, which expands down to the #3 pond. An isolated area of old tailings occurs just below the highway near Porcupine Creek. A capsule history of tailings deposition can be found in the 1990 plan. Some tailings were from cyanide leach operations whereas other years no cyanidation was carried out. It appears that the tailings from open pit operations are largely behind the #1 dam and uphill from there.

Porcupine Creek appears to have jumped its banks occasionally and eroded tailings from the old deposit. These events may have carried tailings into the area of the #3 pond and/or beyond.

The dams have been reviewed by EBA Engineering in a 1983 report "Geotechnical Evaluation of Existing Tailings Dams." Most of the dams are of unzoned construction and were built on frozen peat-rich soils overlying fill. The soils have since thawed causing subsidence of the dams. An engineering investigation of the dams is in progress the evaluate the current stability, and requirements for both future operation and for closure to ensure long-term stability.

UKHM has kept up with the subsidence by adding mine rock to the low points every few years. Results of inspections of the dams can be found in a series of reports by EBA Engineering, the most recent of which is dated 1994. These inspection reports note ongoing subsidence of the structures. The difficult foundation conditions of the dam sites have been a complicating factor for the closure plan.

The incomplete diversion of Porcupine Creek around the tailings is another complicating factor for closure. The central 400 m of the creek appears to pass over the south edge of the tailings. Most times of the year Porcupine Creek is dry, but as noted above, occasional floods (before 1984) appear to have entered the tailings area and may have eroded nearly a meter of tailings. Sand and gravel locally deposited on the tailings (by the floods) has developed good vegetative, zinc enriched, seepage emerges from the tailings and flows down lower Porcupine diversion to enter Flat Creek below #3 Pond.

Unquantified seepage passes beneath the dams. During 1994-95, Dam #1 was commonly observed to decant approximately 5 l/s whereas dam #2 did not decant at all.

At the same time Dam #3 decanted 1-2 l/s.

The tailings behind Dam #1, where wet, have developed lush vegetation but the dry, sandy, upper part of the tailings deposit is barren. The dry tailings are subject to wind erosion from time to time.

The tonnage of tailings indicated by these drill results apparently reconciled well with the milled tonnage. However, recent backhoe excavations in the tailings area have thrown some doubt on the thickness indicated by previous drilling, since it was possible to excavate through the tails to the original ground surface. Only a third of the expected thickness was found to be present in some of those areas.

Closure Issues Martrix

Common Site Name: **Elsa Tailings**

Site coordinates:	easting	northing	Datum: NAD83	Projection: UTM Zone 8N
	475100	7088500		

General Location Description	Closure Issue Categories					
	Human & Wildlife Health and Safety	Chemical Control	Water Management	Physical Stability	Community Interest	Other
Porcupine creek flowing through tailings			✔			
Slude disposal cells				✔		
Dam 1 - upstream crest				✔		
Dam 1 - downstream crest				✔		
Dam 1 - toe berm				✔		
Dam 2 - upstream face				✔		
Dam 2 - decant			✔			
Dam 3 - Upstream crest				✔		

Mine Site Area: **Valley Tailings Area**

Mine Site Area Components and Description:

1 **Ponds**
3 ponds

2 **Tailings**
4,128,000 tons of tailings

3 **Diversion**
Porcupine Diversion Ditch

Closure Issues:

1 The Elsa tailings impoundment is the largest in the district and presents a host of issues to consider for closure. Three key issues related to physical stability need to be addressed:

1. Ground thaw beneath the tailings dams resulting in settling and therefore potential for overtopping and breaching of the structure
2. Presence of culverts and decant structures through the dams which may lead to piping failures around these structures
3. Failure or slumping of the downstream face of each dam due to steep (oversteepened) slopes

2 Zn loads are required to be treated for several weeks each spring during the freshet to prevent discharge of waters higher than 0.5 mg/l Zn into the receiving environment (Flat Creek)

3 The Porcupine Diversion ditch is partially constructed in tailings and is a source of tailings release and metals mobilization during the spring freshet

Options for Closure:

1 **Status Quo**

2 **Cover in Place and Reveg**

3 **Consolidate, Cover and Reveg**

Mine Site Area:	**Valley Tailings Facility**
Closure Option 1:	**Status Quo**

Facts/Description of Option:

1 Continue lime treatment during the spring freshet period (May-June) to ensure discharge solution to the receiving environment is less than 0.5 mg/l.

2 Continue annual geotechnical inspections of valley tailings dams and maintain structures as necessary to maintain stability

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$2,850,000

Valley Tailings Borrow Pit

Valley Tailings Borrow Pit

#2 Dam

#1 Dam

#3 Dam

Contact Mill Sludge Storage

Legend

N

Mine Features

TYPE

Adit

Pit

Shaft

Showing

Mine Features

<all other values>

TYPE

Open Pit

Waste Rock Dump

Settling Pond

Disturbance

Roads

TYPE

Highway

Local

Haul Road

Track

Trail

DRAFT

ERDC

ACCESS

KENO HILL SILVER DISTRICT

CLOSURE ISSUES

VALLEY TAILINGS OPTION #1

SITE PLAN

SCALE: 1:5,500

0 55 110 220 330 440 Meters

DRAWN BY: RS

DATE: 25/Feb/2009

Mine Site Area:	**Valley Tailings Area**
Closure Option 2:	**Cover Tailings and Revegetation**

Facts/Description of Option:

1 Cover the tailings in place with local borrow material. Flatten dam profiles and upgrade the Porcupine Diversion

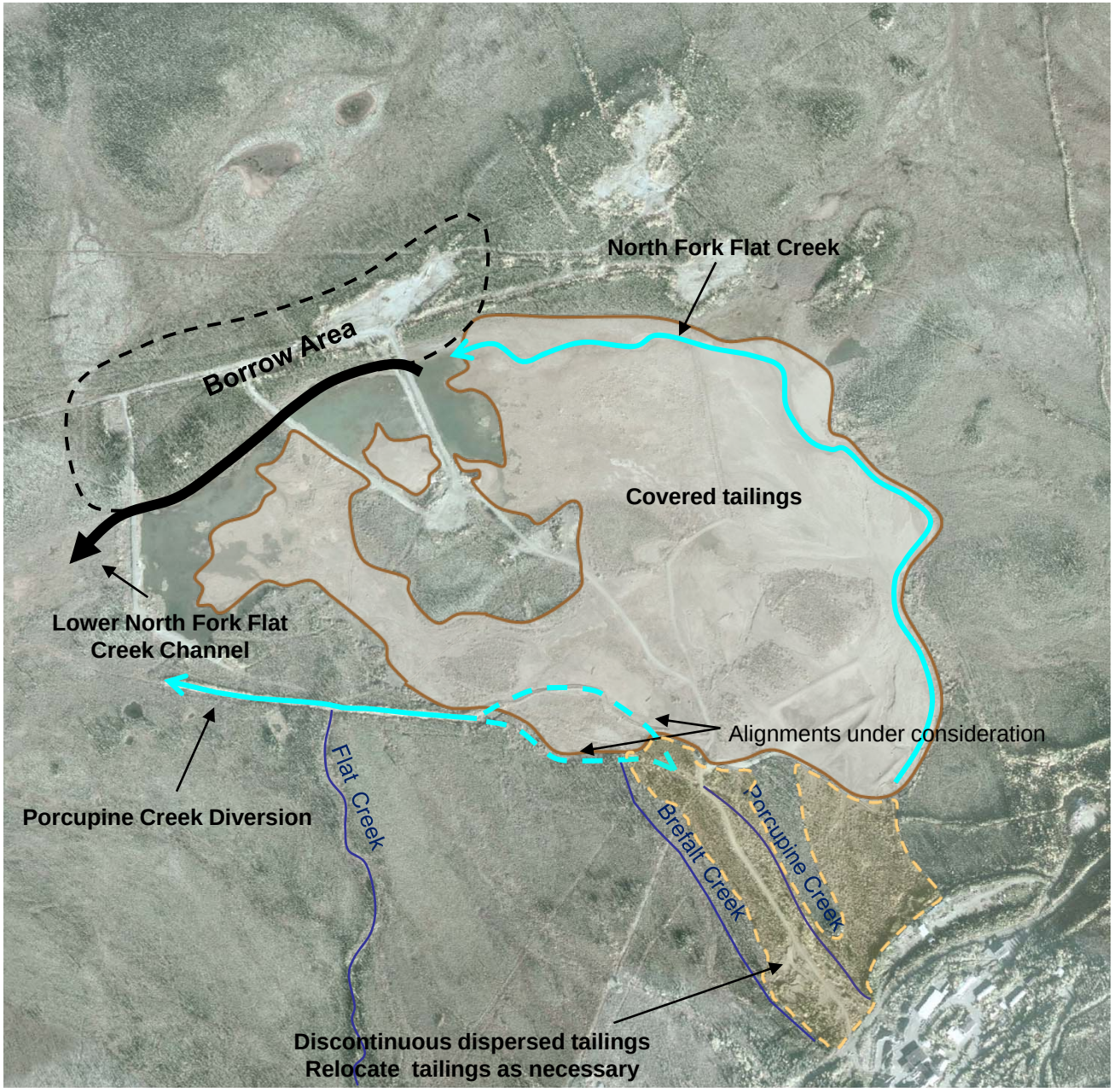
2 Construct lower North Fork Flat Creek Channels and continue water treatment for interim period until stabilized

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$8,000,000

Option 2A: Cover In Place



Key Features

- Cover tailings in-place.
- Flatten profile of Dams #1, 2, 3.
- Maintain current water management.

North Fork Flat Creek

- Establish stable channel to pass design flows:
  - Line as necessary;
  - Armour as necessary;
  - Stabilize slopes and contour to promote drainage towards channel;
  - Channel to follow edge of VTF to encourage natural revegetation.

Porcupine Creek Diversion

- Remove tailings from streambed.
- Select final alignment.
- Upgrade channel to pass design flows:
  - Line as necessary;
  - Armour as necessary;
  - Recontour and stabilize channel side slopes.

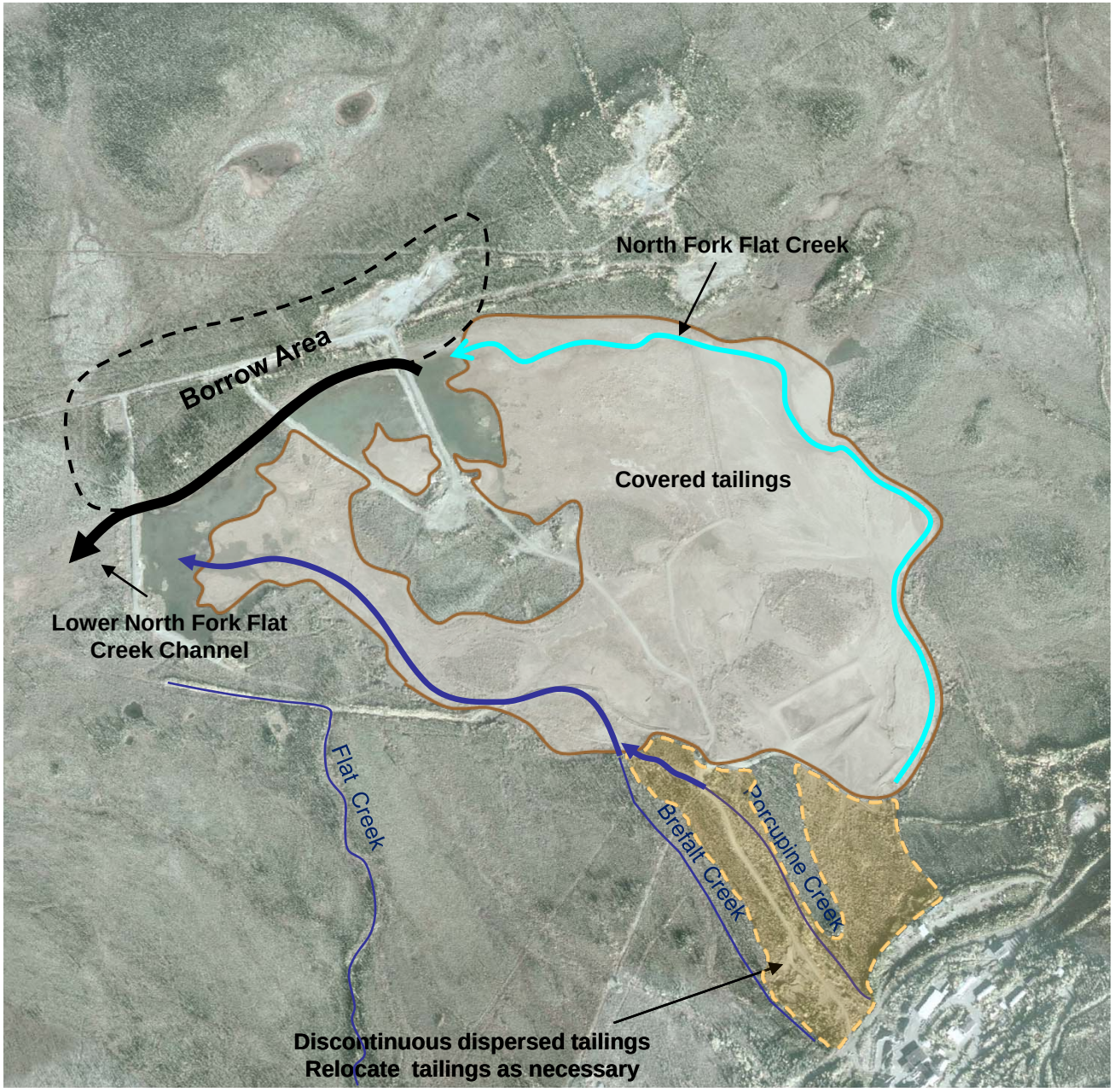
Cover

- Tailings surface preparation to be uniform as necessary
- Cover placement to isolate tailings and acid generating dam fill from the environment and provide a medium for vegetative growth.

Lower North Fork Flat Creek Channel

- Construct channel through borrow area.

Option 2B: Cover In Place with Spillway



Key Features

- Cover tailings in-place.
- Flatten profile of Dams #1, 2, 3.
- Construct Lower North Fork Flat Creek Channel.
- Abandon Porcupine Creek Diversion and develop stable channel over tailings cover.

North Fork Flat Creek

- Establish stable channel to pass design flows:
  - Line as necessary;
  - Armour as necessary;
  - Stabilize slopes and contour to promote drainage towards channel;
  - Channel to follow edge of VTF to encourage natural revegetation.

Flat Creek, Brefalt Creek and Porcupine Creek

- Establish stable channel:
  - Line as necessary;
  - Armour as necessary;
  - Stabilize slopes and contour to promote drainage towards channel.

Cover

- Tailings surface preparation to be uniform as necessary
- Cover placement to isolate tailings and acid generating dam fill from the environment and provide a medium for vegetative growth.

Lower North Fork Flat Creek Channel

- Construct channel through borrow area.

Mine Site Area:	**Valley Tailings Area**
Closure Option 3:	**Consolidate Tailings, Revegetation, and Flatten Dams 1, 2 and 3**

Facts/Description of Option:

1 Tailings will be consolidated and covered to prevent dispersion of exposed tailings by wind and water, and to allow a vegetative cover to be established.

2 Surface water will be managed through:

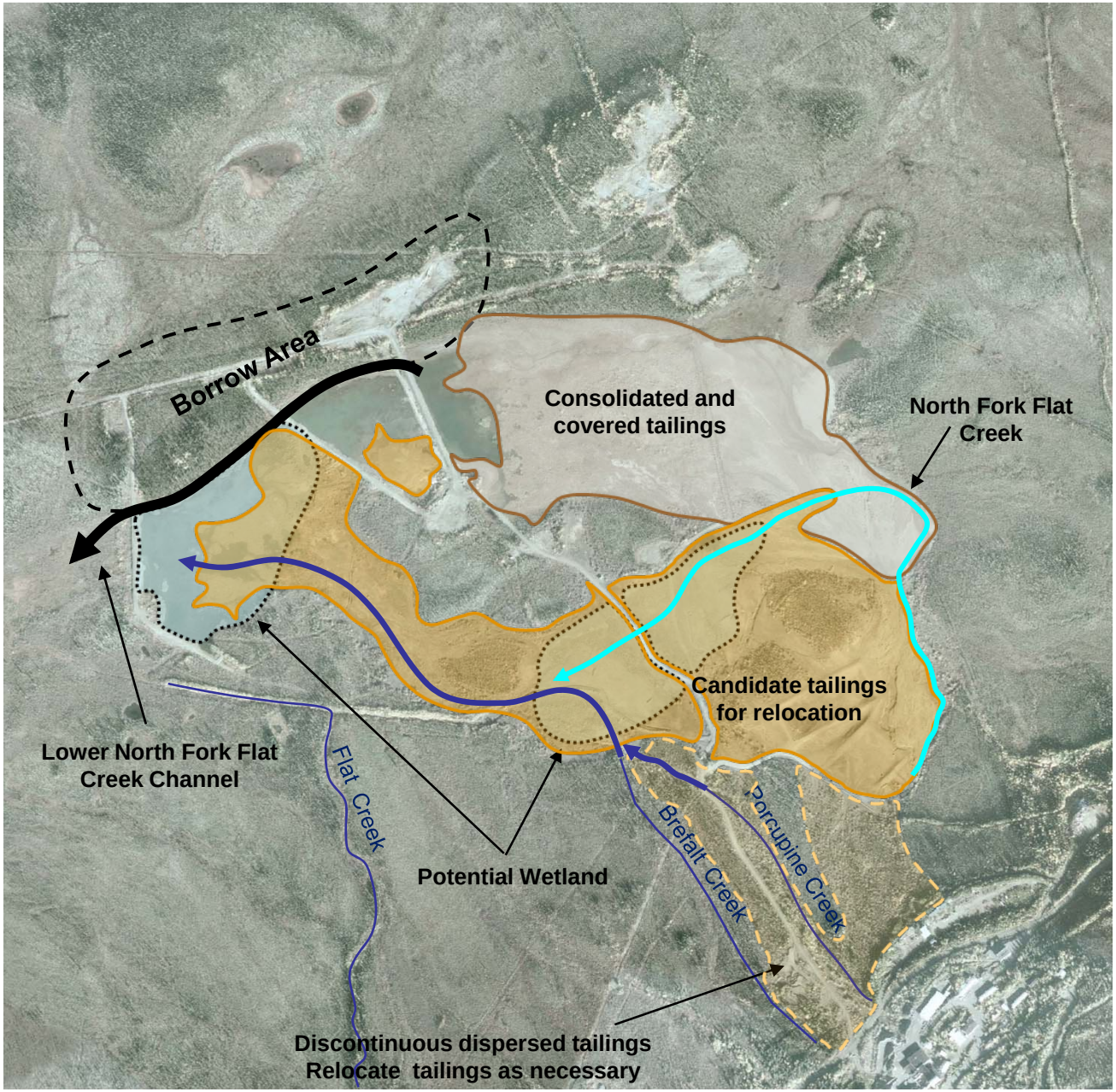
1. Re-establishing Porcupine Creek and Brefalt Creek near their pre-mining alignments
2. Directing North Fork Flat Creek flows into Porcupine Creek
3. Upgrading the lower portion of the Porcupine Diversion to convey upper Flat Creek flows to the original channel west of the Valley Tailings Facility

Identified Risks and Concerns:

Estimated Costs:

Construction + 20 year O&M	$25,300,000	Closure Costs
	$9,900,000	Lime Addition
	$35,200,000	Total Costs

Option 3: Partial Relocation with Spillway



Key Features

- Relocate tailings to NE quadrant and cover.
- Flatten profile of Dams #1, 2, 3.
- Construct Lower North Fork Flat Creek Channel.
- Abandon Porcupine Creek Diversion and develop stable channel over original ground.

North Fork Flat Creek

- Establish stable channel to pass design flows:
  - Line as necessary;
  - Armour as necessary;
  - Stabilize slopes and contour to promote drainage towards channel;
  - Channel to follow edge of VTF to encourage natural revegetation.

Brefalt Creek and Porcupine Creek

- Establish stable channel:
  - Line as necessary;
  - Armour as necessary;
  - Stabilize slopes and contour to promote drainage towards channel.

Original Ground Exposed by Tailings Relocation

- Establish vegetation in exposed soil.
- Leave exposed soil.
- Establish stable water features:
  - Ponds,
  - Wetlands,
  - Channels.

Cover

- Tailings surface preparation to be uniform as necessary
- Cover placement to isolate tailings and acid generating dam fill from the environment and provide a medium for vegetative growth.

Relocated Tailings Area

- Consolidate tailings and place appropriate cover.

Lower North Fork Flat Creek Channel

- Construct channel through borrow area.

Attachment C

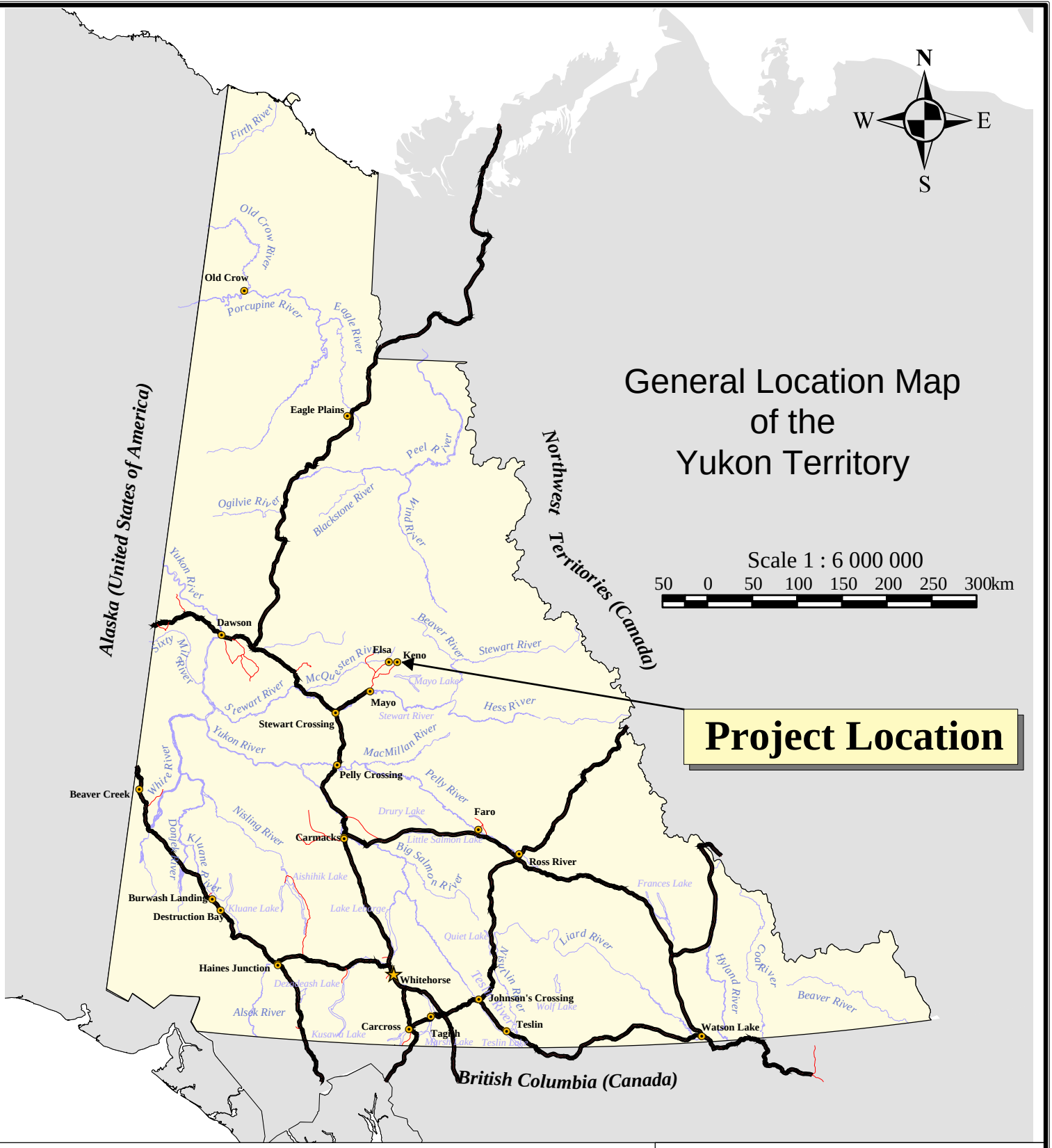
Technical Fact Summary Sheets

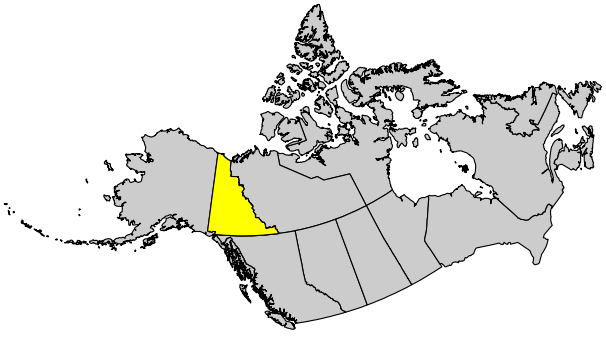
EXISTING STATE OF MINE RECLAMATION PLANNING TECHNICAL STUDIES – KENO HILL, YUKON

TECHNICAL FACT SUMMARY SHEETS

As part of the reclamation and closure of the Keno Hills Silver District (for location see Figure 1), a comprehensive closure plan for the existing state of the mine (ESM Reclamation Plan) will be developed and undergo environmental assessment and licensing processes. In order to support, the selection of reclamation options for sites, and allow for environmental assessment and water, significant technical backup and studies are required to support the assumptions and strategies developed for the ultimate reclamation and closure option selected.

This compilation provides a brief summary of the main points of each technical study completed to-date and serves to inform interested parties and the public at large of the main technical points that will assist in selecting appropriate closure options and eventually, final options for the ESM Reclamation Plan.





ELSA RECLAMATION & DEVELOPMENT COMPANY LTD.

Drawn By: HD	**FIGURE 1**
Checked By: DC	Date: March 2007

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UNITED KENO HILL MINE

TECHNICAL FACT SUMMARY SHEETS

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UNITED KENO HILL MINE

TECHNICAL FACT SUMMARY SHEETS

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Technical Study:

WATER QUALITY DATA REVIEW

Date: July 2008 – present

Performed By:

ACG

Objectives:

Comprehensively review the water quality database and add any additional information from others; and using this as source data,

Maintain the site-wide database and loading balance

Facts\Description of Study:

- Past sampling programs at Keno Hill have provided a depth of information sufficient for assessing water quality impacts and trends
- The Keno Hill water quality database was updated to include all available known water quality results, and all historic stations were renamed under a common set of KV numbers. A table of concordance exists for all stations
- Water quality data was vetted to ensure the inclusion of only the most reliable, trustworthy results for future analysis, including mass balance updating. This was based on data filters applied by Minnow Environmental
- The database was migrated to a newer, more efficient system for streamlined data input/output
- The database continues to be updated on a regular basis, as new results are obtained
- The data contained in the current, vetted database is the source for inputs to the site-wide loading balance

Information Gaps:

Flow and groundwater monitoring data, although not presently a part of the dataset, is a necessary addition to supplement the overall site loading balance inputs

Results/Conclusions:

- The current Keno Hill Mines water quality database is now an excellent data repository containing reliable data back to 1994 and will serve to provide good input data for models in the future.

Technical Study:

ADIT CLOSURE STUDIES

Date: Summer 2007

Performed By:

SRK Consulting

Objective:

Build on existing risk rankings for adits and move towards a specific closure measure for each adit, in consideration of the broad range of adit conditions that exists at the site.

Facts\Description of Study:

- Each of the 70 adits at Keno Hill will require a site-specific closure measure
- Restricting public access is a requirement for all adits. Certain adits will require long-term drainage control with restricted public access, yet allow operational access. Other adits are fully collapsed and require no additional work.
- For adits which produce water, water control issues must be addressed. Where water is acceptable for direct discharge, the closure measure must allow free drainage while preventing public access. Where water requires treatment, an additional consideration of how to collect and treat the water is necessary.
- Adit closure designs fall into four categories: plugs, seals, barriers and natural collapses
- Adit plugs fill a portion of the mine shaft and are designed as permanent structures. They can be used where preventing access, controlling adit discharge, or minimizing brow collapse is necessary.
- Adit seals are any closure measure where the sole purpose is to prevent access. If rehabilitation of the adit is required later, costs can become expensive. They are not intended to control drainage, but allow free drainage.
- Adit barriers are a closure method which prevents inadvertent access by the public (such as grates or gates). They are not intended to control drainage, but allow free drainage.
- Natural collapses are where sufficient adit collapse has already produced a situation where little safety risk remains. These can be grouped into ‘do nothing’ closures, and ‘do nothing now and inspect later’ closures.

Information Gaps:

Once adit closure measures have been considered and selected, further modifications will need to be made on a site-by-site basis for the design to be implemented under different conditions.

Water treatment sites are in the process of being assessed to determine water management closure options, at which point an appropriate closure option will be selected.

Results/Conclusions:

- SRK has developed an adit closure matrix for the 70 adits at Keno Hill. Closure requirements for each adit in this study are outlined in this matrix, presented in Table 1, alongside the recommended closure option for that site.

Table 1 Decision Matrix For Selection Of Adit Closure Measures
Keno Hill Closure Planning
Rev. 00, March 31 2008

				Adit Closure Requirements						**Considerations for implementation**					**Adit Closure Options**									
				Adit closure requirements capture the specific closure objectives for each adit. 'Control public access' is the default minimum requirement identified for all sites, including those where public access is prevented at present by the fully collapsed condition of the adit.						*Considerations for implementation are intended to record specific site features or elements that need to be incorporated into the selection of a closure option for each adit.*					**1. Plugs (control water)**			**2. Seals (drain freely, prevent access)**				**3. Barriers (secure adit, allow authorized access)**			**4. Do nothing**	
Mine	**Adit**	**EASTING (UTM NAD 83)**	**NORTHING (UTM NAD 83)**	Prevent public access	Allow free drainage	Control contaminated water	Control ice plugging	Control air flow	Historical considerations	Removal of Structures	Upgrade/ development of access required for equipment	2008 Inspection Required	Water management decision required	Requirement for long term supply of electricity	1a. Bulkhead	1b. Poured massive concrete plug	1c. Composite Soil Plug (aka Millenium Plug)	2a. Masonry Wall	2b. Polyurethane membrane	2c. Rock fill	2d. Rock pile	3a. Steel grate	3b. Steel grate with masonry frame	3c. Insulated steel doors with masonry frame	4a. No further inspection required	4b. Inspect periodically
Silver King	50 East	471913	7085390	X						?	X	X														Recommended
	50 West	471930	7085397	X						?	X	X														Recommended
	75	471902	7085448	X					X		X								Alternate				Alternate			Recommended
	100	471894	7085683	X		X				X			X	X	Subject to water management decision											
Elsa	+50	476462	7087122	X																					Recommended	
	50	476295	7087026	X																					Recommended	
	Gravel	476361	7087088	X																					Recommended	
	100	476302	7087070	X																					Recommended	
	200	476207	7087107	X						X	X									Alternate	Recommended					
	400	475940	7087109	X	?	?	X			X				?						Alternate	Recommended					
No Cash	100	478735	7088249	X						X	X									Alternate	Recommended					
	500	477766	7088469	X		X				X	X		X	?	Subject to water management decision											
Dixie	200	476921	7087409	X	?		X			X										Alternate	Recommended					
Ruby	400	478522	7087681	X	X	?	X			X										Alternate	Recommended					
Bermingham	200	478682	7087211	X	X	?	?			?										Alternate	Recommended					
Townsite	500	479535	7087969	X																	Recommended					
Hector	400	480069	7088176	X					X													Barrier recommended subject to historical considerations				
UN		481538	7089358	X	?		?														Recommended					
Galkeno	Unnamed	482019	7088898	X																	Alternate				Recommended	
	100	482022	7088988	X																	Recommended					Alternate
	200	482164	7089062	X																	Recommended					Alternate
	300	482593	7088740	X		X				X			X	X	Subject to water management decision											
	900	483420	7087919	X		X				X			X	X	Subject to water management decision											
Viola		482506	7088134	X						?	?	X													Recommended	
Rico		483171	7088044	X																					Recommended	
Bellekeno	100- 48 Vein	486969	7086702	X						?	X	X									Recommended					
	100- 50 Vein	487064	7086679	X						?	X	X									Recommended					
	200	487017	7086770	X						X											Recommended					
	625	487350	7086990	X		X				X			X	X	Subject to water management decision											
	Mayo Mines	487125	7086914	X																	Alternate				Recommended	
	Eureka	487191	7086212	X																	Alternate					Recommended
Onek	400	485207	7087326	X		?	X			X	X		X	?	Subject to water management decision											
Sadie Ladue	600	485996	7092671	X		?					X		X		Subject to water management decision											
Lake		487302	7092905	X							X														Recommended	
Stone	Upper adit	488718	7092560	X							X														Recommended	
	Middle adit	488825	7092633	X						X	X														Recommended	Alternate
	Lower adit	488929	7092724	X							X														Recommended	
Highlander	Main Adit	487937	7092203	X	X				X	X	X														Recommended	Alternate
	Upper Adit 1	487844	7092105	X							X														Recommended	
	Upper Adit 2	487844	7092105	X							X														Recommended	
	Upper Adit 3	487830	7092119	X							X														Recommended	
Klondike Keno	Lower adit	485597	7090841	X	X					X	X										Alternate				Recommended	
	Upper adit	485599	7090854	X							X														Recommended	
Lucky Queen	500	486646	7090562	X	X					X											Recommended					
Black Cap		486884	7090560	X	X																Recommended				Alternate	
Brewis Red Lake (aka Shepherd Adit)		486731	7090393	X																					Recommended	
Croesus	Adit #1	486614	7089660	X							X														Recommended	
	Adit #2	486611	7089617	X							X														Recommended	
	Adit #3	486602	7089570	X							X														Recommended	
	Adit #4	486602	7089539	X							X														Recommended	
Kijo	Upper adit	486103	7089785	X							X														Recommended	
	Middle adit	486100	7086775	X							X														Recommended	
	Lower adit	486093	7089758	X							X														Recommended	
Shamrock	60	488110	7090690	X						?	X														Recommended	
	200	488132	7090646	X						X	X										Recommended					Alternate
	Lower (Adit B)	487920	7090577	X						?	X														Recommended	
Monument and Ladue Fraction		491064	7091110	X							X														Recommended	Alternate
Keno #9	Faro Gulch 100 (aka N	489572	7090659	X						?	X	X													Recommended	
	Faro Gulch Portal (200 level)	489728	7090744	X						?	X	X														Recommended
	Keno 200	489491	7089993	X						X											Recommended					
	Keno 700	489977	7089610	X	X	?	X		X	X			X		Subject to water management decision											
	12 Vein Adit	489877	7090733	X						?	X														Recommended	Alternate
	Lower No. 4 Vein Adit	489253	7090254	X							X														Recommended	
	Upper No. 4 Vein Adit	489266	7090290	X							X														Recommended	
	5-2 Vein Adit	489167	7090202	X							X														Recommended	
	No. 1 Vein Adit	489508	7090665	X						?	X	X													Recommended	Alternate
	No. 3 Vein Adit	489538	7090710	X						?	X	X													Recommended	Alternate
Comstock Keno	150	490014	7090123	X						X											Recommended					
	275	489939	7090056	X						X											Recommended					
	Porcupine 50	489705	7089944	X						X											Recommended				Alternate	

Technical Study:

ADIT DISCHARGE SURVEY

Date: Summer 2007

Performed By:

ACG

Objective

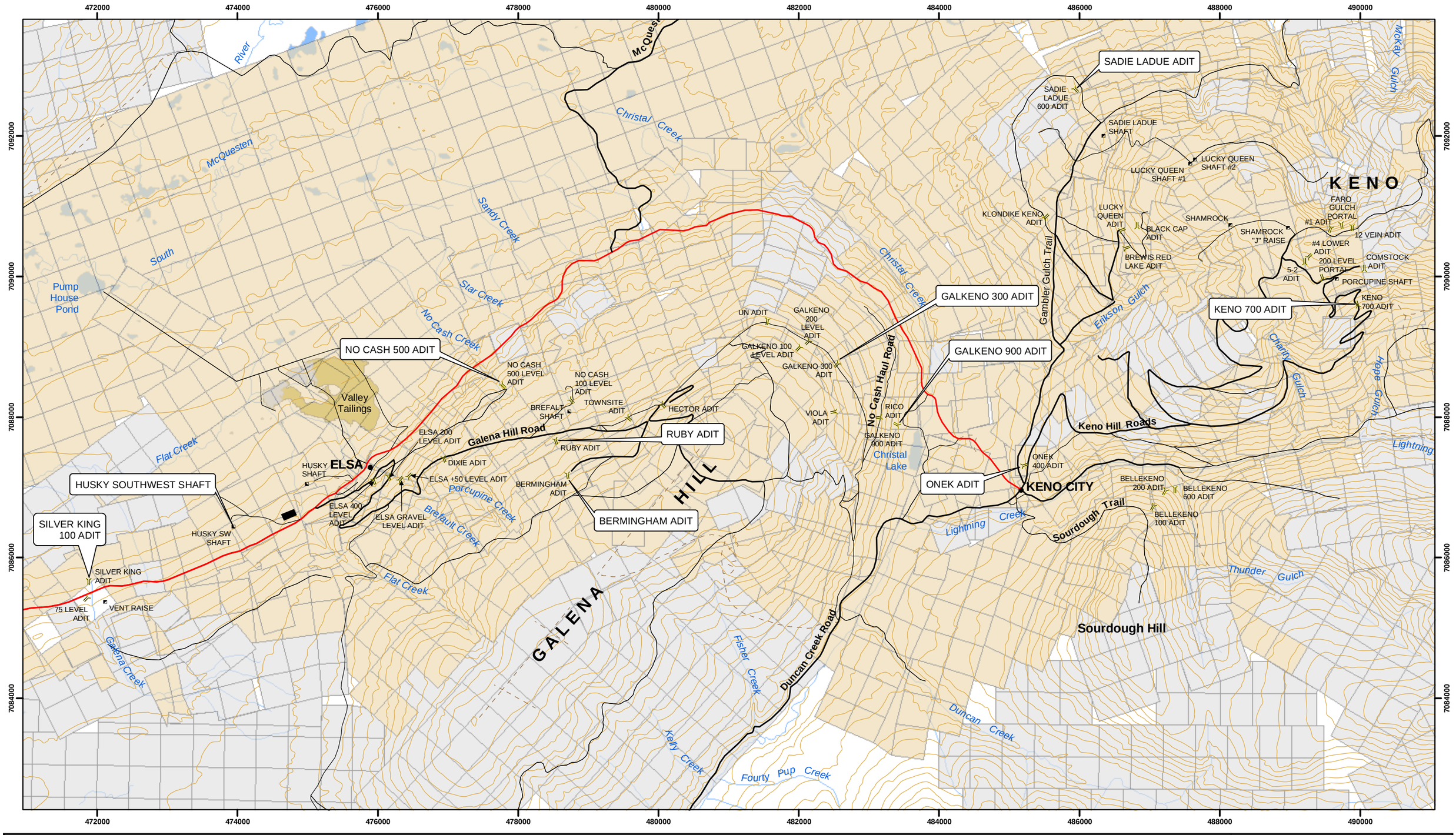
To reaffirm the understanding of adit flow paths and down gradient water quality.

Facts\Description of Study:

- The following survey components were outlined to achieve the aforementioned objective:
    a. Determine the discharge path from adit to a surface water source if possible;
    b. GPS the discharge path;
    c. Establish sample locations;
    d. Obtain water samples at locations along the path;
    e. Collect in-situ water quality;
    f. Receive lab results of water's analysis;
    g. Collect a photo library; and
    h. Report on the results of the survey.
- The adits included in the study were: Silver King 100, Husky South West, Bermingham, Ruby, No Cash 500, Galkeno 300, Galkeno 900, Keno 700, Onek, and Sadie Ladue (Figure 2)
- Results were compared with CCME Fresh Water Aquatic Life Guidelines and Effluent Standards as Part E of the Water Use Licence (QZ06-074)

Results/Conclusions:

- The survey was able to successfully identify and confirm the receiving waters drainage for the adit network
- Site locations for AMP monitoring were successfully identified
- Hydraulic catchment areas for the mass loading model were verified (Table 2)



N

1:50,000
(when plotted on 11x17 inch sheet)

0 1 2 4 km

Legend

Topography
- Town
- Silver Trail
- Secondary Road
- Limited-use road
- Trail
- Watercourse
- Waterbody

Mine Workings
- Valley Tailings
- Adit
- Shaft (to surface - connection to underground not determined)

Quartz Claims
- Elsa Reclamation and Development Corp. and Related Companies Quartz Claims
- Other Quartz Claim

First Nation Settlement Land
- First Nation Settlement Land

Notes:
This map is for illustrative purposes only.
This is not a legal document.
National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced under license from © Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.
Quartz claim boundaries are current as of December 7, 2007.
Data source: http://geomaticsyukon.ca.
Ownership is current as of Dec. 11, 2007. Digital claim status report obtained from the Mining Recorder website at http://www.yukonminingrecorder.ca/
Projection: UTM Zone 8 NAD83
NTS Sheet 105M/13 and 105M/14

ERDC
ACCESS

Keno Hill Silver District
Adit Discharge Survey

Adit Discharge Survey Locations

Drawn By: HD	Date: March 2008	**FIGURE 2**
Checked by: DC	Our File: D:\Project\AlProjects\ALEX-05-01\gis\mxd\UKHM\AditDischargeSurvey_Summer07\Rpt_OV.mxd	

Table 2 Adit Discharge Survey Matrix

Adit	Receiving Water Drainage	AMP Monitoring Station	1996 Mass Balance Catchment	2008 Mass Balance Catchment
Silver King 100	Flat Creek via ground	SK100-7, SK100-8, SK100-9	Galena Creek above the mouth	Galena Creek above the mouth
Husky South West	Flat Creek via ground	HSW-6	Flat Creek above station KV-9 and below Porcupine Creek diversion channel	Flat Creek above station KV-9 and below Porcupine Creek diversion channel
Bermingham	No Cash Creek via ground	Berm-4	No Cash Creek above Highway 2 which drains to South McQuesten River between station KV-2 and KV-1	No Cash Creek above Highway 2, which drains to South McQuesten River between station KV-2 and KV-1
Ruby	Star Creek via ground	Ruby-5	No Cash Creek above Highway 2, which drains to South McQuesten River between station KV-2 and KV-1	No Cash Creek above Highway 2, which drains to South McQuesten River between station KV-2 and KV-1
No Cash 500	No Cash Creek	No Cash-500-4	No Cash Creek above Highway 2	No Cash Creek above Highway 2
Galkeno 300	Christal Creek	GK300-4	Christal Creek between station KV-7 and KV-6	Christal Creek between station KV-7 and KV-6
Galkeno 900	Christal Lake	GK900-3	Christal Creek above station KV-6	Christal Creek above station KV-6
Keno 700	Lightning Creek	Keno 700-4	Hope Gulch above KV-39	Hope Gulch above KV-39
Onek	Christal Creek via ground	MDP7	Christal Creek above station KV-6	Christal Creek above station KV-6
Sadie Ladue	Ladue Creek via unnamed Watercourse	Sadie-3	Ladue Creek via unnamed watercourse northeast of KV-35 and southwest of KV-73	Ladue Creek via unnamed watercourse northeast of KV-35 and southwest of KV-73

Technical Study:

HYDROLOGICAL UPDATE AND ASSESSMENT

Date: 2007

Performed By:

Clearwater Consultants Ltd.

Objective

To refine the understanding of the UKHM hydrology that was originally developed in 1996 and to provide guidance on developing hydrological inputs to the site-wide water balance.

Facts\Description of Study:

- The following three steps were outlined to achieve the aforementioned objective:
    a. Process historical records of water level, direct discharge measurements and survey data collected at the mine's three streamflow gauging stations (KV-7, KV-9 and KV-41)
    b. Use streamflow records developed in (step a) to assess accuracy of flow-estimation techniques documented in the 1996 climate and hydrology study; and,
    c. Outline a proposed method for estimating flows around the Keno Hill property based on the original hydrology study and the streamflow records for the three mine site gauging stations
- Processing of the gauging station data (Step a) was used to produce a mean annual runoff (MAR) for each of the sites which could in turn be used to validate the method developed in the 1996 Hydrological Study (step b)
- The 1996 Hydrology Study developed an empirical relationship between MAR and catchment mean elevation

Information Gaps:

2006 freshet data for Station KV-9 could not be located by the time the memorandum from CCL was issued. The mean annual runoff for KV-9 was thus estimated through a correlation analysis with regional Water Survey of Canada stations.

Water level data collected at mine adits was not processed as the data appears to be of dubious quality

Results/Conclusions:

- Table 3 presents specific catchment areas, MAR, and runoff depth for the three gauging stations

- It was found that the streamflow data collected at the three gauging stations offers an excellent basis for validating the adopted relationship between MAR and catchment median elevation; moreover,
- The hydrological inputs for the new water balance could be estimated using the original techniques presented in the 1996 Hydrology Study; however,
- The availability of the streamflow record at KV-7, KV-9 and KV-41 may offer a more accurate method of assessing chemical loads
- The most complete and accurate data available are for Water Years 2005 and 2006 (i.e. the period from October 1, 2004 to September 31, 2006) and should be used for the next set of water and load balances
- The conditions on the McQuesten River would be expected to best represent seasonal flow conditions at Christal Ck, while those on the North Klondike River provide a reasonable estimation of the seasonal flow distribution for Lightning Ck

Table 3 Results of the Hydrological Survey at Christal, Lightning and Flat Creeks

Site	Site Description	Catchment Area	MAR	Average Runoff Depth
		km^2	m^3/s	mm
KV-7	Christal Creek @ Hansen Road	43.5	0.304	221
KV-9	Flat Creek u/s South McQuesten River	56.5	0.304 - 0.352	170 - 197
KV-41	Lightning Creek u/s bridge @ Keno City	59.1	0.645	344

Technical Study:

SURFACE WATER QUALITY ASSESSMENT FOR UNITED KENO HILL MINE COMPLEX

Date: 2007

Performed By:

Minnow Environmental Inc.

Objective

To identify parameters and locations of concern within the downstream waters relative to established guidelines and background. This data, together with toxicity data and receiving watershed use objectives will be combined to develop an approach for considering the development of a Site Specific Water Quality Objectives (SSWQO) or water quality goals for various parameters and locations.

Facts\Description of Study:

- The following steps were outlined to achieve the aforementioned objective:

    a. The data were screened to identify where data should be removed from analysis due to errors.

    b. Background concentration for each parameter were established based on the upper limit of background data distribution for the combined data from KV-1 and KV-37

    c. Background concentrations which exceed the Canadian Water Quality Guidelines (CWQG) were identified

    d. Locations that exceed background and/or CWQG at measurable and sustainable frequencies were identified

    e. Parameters and locations where concentrations are highest were identified

    f. An assessment of trends over time was conducted to anticipate if concentrations are increasing or decreasing relative to CWQG and/or background

    g. Modifying factors and toxicity literature were considered to assess the opportunity for SSWQO development following the guidelines

Results/Conclusions:

- Background concentrations of several parameters exceed the CWQG, suggesting that concentrations of these parameters are naturally elevated. Contaminants of concern were identified as **total Zn** and **Cd**, while potential contaminants of concern were identified as: **total Al, As, Cr, Mn, Nitrite, P, Se, and Ag**

- Many stations were found to have concentrations for numerous parameters that exceeded CWQG in more than 10% of samples
- Significantly fewer stations were found to have concentrations for numerous parameters that exceeded CWQG in more than 50% of samples. The stations that exhibited this were concentrated at Christal Creek, No Cash Creek, and the upper portion of Lightning Creek and Flat Creek watersheds.
- Only a few locations exhibited parameters with median values 5X or more the CWQG; however, it was not uncommon for parameter maximum values to exceed 5X the CWQG
- The key locations of concern are KV-39, KV-29, KV-21 and KV-47
- While background concentrations are elevated for some parameters, even these high background values are exceeded in some cases (notably at Christal Creek, No Cash Creek, and the upper portion of Lightning Creek and Flat Creek watersheds); thus, a two-tiered approach to SSWQO is suggested which could permit higher concentrations in some near-field areas and higher protection in downstream areas

Technical Study:

AQUATIC RESOURCE ASSESSMENT FOR UNITED KENO HILL MINES

Date: April 2008 – March 2009

Performed By:

Minnow Environmental Inc.

Objective

To provide an integrated assessment of the available biotic (fish and benthic invertebrate community) and abiotic (water and sediment) data such that current conditions within the headwaters tributaries down gradient of the mine and further downstream in the South McQuesten River are characterized.

This report, along with the Water Quality Assessment Report for United Keno Hill Mines will serve as key supporting documents for other ERDC initiatives, such as preparation of the Closure Plan, determination of water quality goals and objectives, and the development of a long-term monitoring program

Facts\Description of Study:

- The following steps were outlined to achieve the aforementioned objectives:
    a. The watershed characteristics for each watershed were assessed and an overview of mine influences and habitat characteristics were determined
    b. The water quality assessment for UKHM was considered in view of the aquatic characteristics of the site
    c. Current and historical sediment quality at the Keno Hill mine was evaluated
    d. Benthic invertebrate community health was evaluated
    e. Current and historical fisheries data including community composition, fish condition and metal concentrations in tissues was considered and evaluated
    f. Data was integrated to provide an exhaustive assessment of the current aquatic conditions at Keno Hill

Results/Conclusions:

- Analysis of water quality identified cadmium and zinc as key contaminants of concern in waters downstream of the Keno Hill property. Concentrations of these substances are at levels that are potentially toxic to aquatic biota in portions of the tributaries receiving mine drainage (particularly Christal Creek). However, contaminant levels in the South McQuesten River are currently below levels of concern

- Sediment guidelines are based on concentrations measured in whole sediment samples (not just the fine fraction), so potential risks to benthic biota cannot be ascertained from the available sediment data

- Benthic invertebrate communities in lower Christal and Flat Creeks were characterized by relatively low abundance and number of taxa compared to reference and other, mine exposed areas. Correlation analysis suggested that reduced number of taxa may be related to elevated water concentrations of mine-related variables such as major ions (e.g., sulphate, hardness, conductivity), cadmium, and zinc

- The presence of both adult and juvenile Arctic grayling in most watercourses indicates availability of suitable spawning and rearing habitats. Portions of Christal Creek showed limited fish diversity and densities, particularly at KV-7 where no fish were found in 2006. No large and consistent patterns were evident in mine-exposed areas that would suggest that conditions had either improved or degraded over time

- Whole body analysis of slimy sculpin showed levels of arsenic in excess of reference sediment concentrations and wildlife consumption benchmarks at most areas downstream of UKHM, particularly in Christal and Flat Creeks. Metal concentrations in Arctic grayling muscle were less than human or wildlife consumption benchmarks in almost all samples from all areas. No consistent increases or decreases were evident over time based on comparison of data from 2006 to data from 1994-95

- Modifications and guidance for developing a long-term monitoring program for Keno Hill were recommended based on the findings of the water quality and aquatic resources assessment, in particular ensuring that monitoring programs retrieve all necessary data and that redundancies are eliminated.

Technical Study:

BENTHIC INVERTEBRATE MONITORING PROGRAMS

Date: Summer 207 – March 2008

Performed By:

Laberge Environmental Services

Objective:

To determine the population size and diversity of benthic invertebrate communities within the Keno Hill watersheds, and explain these variables through metal concentration levels.

Facts\Description of Study:

- Water quality, stream sediment and substrate samples for benthic invertebrate sampling were collected for laboratory analysis
- Stream sediment samples were collected from areas of deposition along the stream banks
- Substrate samples for benthic invertebrate sampling were collected from riffle areas at each sample location

Information Gaps

Historical benthic and sediment data was recently acquired and will be incorporated into future assessment of Keno Hill benthic data, including a report on Environmental Conditions at the property.

Results/Conclusions:

- CCME guidelines were exceeded for Cd and Zn in waters of all drainages, including the background drainage
- Concentrations of As, Cd, Pb and Zn were high in stream sediments at most sites, including at the background site, KV-1
- Highest sediment metals concentrations were documented at KV-9, Flat Creek
- Over time, metal concentrations have been greater in the sediments at Flat and Christal Creeks than the South McQuesten and Lightning drainages
- Benthic invertebrate populations were robust and healthy in the South McQuesten river and Lightning Creek drainages; good representation of chemically-sensitive insects indicates a healthy aquatic environment
- KV-6, Christal Creek at Keno Highway, was the least diverse of the site studied

- Populations at the other two sites on Christal Creek and KV-9 at Flat Creek, were depressed
- High concentrations of metals at Flat and Christal Creeks appear to be negatively impacting benthos community health

Technical Study:

2007 GEOTECHNICAL CLOSURE STUDIES

Date: October 2007

Performed By:

SRK Consulting

Objectives

To develop an understanding of the foundation conditions under VTF Dams #1, #2 and #3 for use in determining the long-term dam stability. Monitor physical hydrogeology, geochemistry and temperature at a number of common locations along the dams.

To develop an understanding of the current conditions at selected waste rock piles so that closure measures can be developed on a pile-by-pile basis. Assess the geotechnical suitability and realistic reclamation outcomes for the re-sloped footprint of select piles.

Facts\Description of Study:

- A field study was conducted at the VTA to help assess the first objective:
    a. Six boreholes were drilled at the crests of Dams #1, #2 and #3 to log soil stratigraphy, depth to bedrock, geotechnical conditions and permafrost extent and monitor groundwater flow and thermal regime
    b. Boreholes were drilled within the tailings impoundments behind Dams #1 and #3 to determine the extent of tailings, overburden, permafrost, bedrock depth and lithology, to collect soils for soils characterization, and to monitor water levels and groundwater chemistry
    c. Other boreholes were completed to monitor water chemistry and levels, background characteristics, and groundwater down gradient of the VTF
- Additional information on dam performance was gathered from the following information repositories:
    a. 2007 seismic hazard calculation
    b. 2007 VTA dam classification
    c. Review of historical records
    d. 1996 flood frequency analysis
    e. Review of the stability analysis completed by EBA in 1982

- Waste rock sites were inspected and assessed via the following:
    a. A review of the historical stability of the waste rock piles
    b. Water management considerations, including assessment of running surface waters that could pose a risk of future undercutting and instability
    c. An assessment of the state of deterioration of wooden support structures
    d. Resloping considerations

Information Gaps:

A desktop study to evaluate the stability of selected crown pillars was to be conducted based on a review of operational records of the shallow stopes at the major mines. However, the records consist of a digital library of tens of thousands of unsorted data files which through considerable effort was not able to produce more information on crown pillar stability.

Results/Conclusions:

Valley Tailings Foundation Conditions

- The VTF dams are currently under static loading conditions, but it is unclear whether their respective safety factors meet appropriate values for closure
- The parameters used in the stability analysis completed for static loading conditions in 1982 are believed to be reasonable and can be used in future analysis to assess their current and post-closure stability
- These same parameters, coupled with the recent seismic hazard information, can be used for pseudo-static analyses to evaluate the stability of the dams under seismic loading assuming that the foundation layers will not liquefy
- At some point prior to final closure design, the assumption that the foundation stratum immediately below the peat at each of the permanently installed dams will not liquefy in response to the design earthquake should be checked with a geotechnical drilling program that will obtain suitable relative density data using Standard Percussion Tests or other suitable methods

Waste Rock Pile Closure Options

- A decision matrix has been developed for Keno Hill waste rock piles to provide a framework for stakeholders to assess the requirements for closure (Table 4)
- Waste rock closure options are currently in the process of being established; for most waste rock dumps this will mean resloping either with or without vegetative cover

- Also included in the example decision matrix are a number of considerations for implementation of a closure measure for a given waste rock pile. For example, one closure option might be to reslope the waste rock 2.5H:1V. A consideration in this case might be the additional land that would be covered during the resloping exercise. Stakeholders may wish to consider weighing the benefits of resloping against covering the additional footprint area with waste rock

Table 4 Example decision matrix to be used for review of conceptual closure options for waste rock piles
Keno Hill Closure Planning
Rev. 00, March 2008

			Waste Rock Dump Closure Requirements				Considerations for implementation									Waste Rock Dump Closure Options					
																1. Reslope 2.5:1, revegetate	2. Reslope 2.5:1, growth media, revegetate	3. Reslope 2.5:1, soil cover, revegetate	4. Relocate	5. Reprocess high grade waste dumps	6. Do nothing
Waste Rock Dump	Size Category[1]	Tonnage[2]	Ensure geotechnical stability	Reduce chemical loading	Revegetate	Esthetic improvement	Water course near toe	Adit discharging	Steep dump face angle	Can dump be used for borrow source?	Steep slopes below dump (<3H:1V)	Status of adjacent vegetation	Adjacent surface materials similar to coarse waste rock	Value of area to be covered by resloping	Increase in load due to disturbance, or to increased surface area	Suitable for dumps without ARD concerns and sufficient fines to promote revegetation without additional growth media	Suitable for dumps with no compelling ARD concerns	Suitable for dumps that have ARD concern that require reduction or mitigation of metals load		Potential option that can be incorporated into remaining scenario, very specific to only 1 or 2 dumps, may not carry forward into options analysis	
Bermingham pit dumps	A	1,500,000																			
Calumet 1-15 pit (2 dumps)	A	1,000,000							X		X		X								
Onek	A	600,000							X		X (SE only)										
Sime dumps	A	450,000									X		X								
Black Cap	A	390,000	X						X		X		X								
Hector 400 adit dump	A	198,000	X						X		X		X		X						
Galkeno 100/200/300	A	150,000	X					X													
No Cash 500	A	138,100	X				X	X	X					Creek							
Silver King pit dump	A	120,000																			
Hector #1 Vein Pit	A	100,000	X						X		X		X								
Stone (3 piles)	B	84,540																			
Coral & Wigwam	B	75,000											X								
Miller	B	63,000											X								
Lucky Queen 500 adit dump	B	61,900																			
Bellekeno 625	B	48,000	X (erosion)				X	X						Creek							
Elsa 400	B	44,100																			
Silver King 100 adit	B	43,000	X (erosion)				X	X						Creek							
Ruby	B	28,900						X													
Keno 700	B	27,500	X (erosion)				X	X	X					Creek							
Calumet C-Structure	B	25,000																			
Sadie Ladue (Wernecke)	B	24,500																			
Galkeno 900	B	20,800						X													
Dixie	B	19,800																			
Husky SW	B	17,000																			
Shamrock King	B	16,200											X								
Highlander	B	15,000					X	X													
Keno 200	B	14,600											X								
Townsite	B	14,300											X								
Bellekeno 200	B	13,000																			
Gerlitski	B	10,281																			
Hector 4-11 pits	B	10,000											X								
Sadie Ladue 600	C	9,500	X (erosion)					X													
Shamrock	C	9,000	X (erosion)						X				X								
Onek 400 adit dump	C	7,500	X (erosion)					X													
Bermingham adit dump	C	7,000						X	X												
No Cash 100	C	6,500																			
Elsa 200	C	6,000																			
Lucky Queen shaft area	C	5,000											X								
Husky	C	4,600																			
Porcupine Pit Dump	C	3,400											X								
UN adit dump	C	3,200																			
Comstock 150	C	3,100											X								
Comstock 275	C	3,100											X								
Lake	C	2,550																			
Bellekeno 100 (48 Vein)	C	2,450																			
Klondike Keno	C	2,000						X													
Elsa +50	C	1,550																			
Cub & Bunny (pit dump)	C	1,350																			
Flame & Moth	C	small- est. >1000 t																			
Bellekeno 100 (50 Vein)	D	500																			
Monument & Ladue Fraction adit	D	500											X								
Nabob No. 2	D	480											X								
Gold Hill No. 2	D	100 t + trenching											X								
Keno No. 9 System	D	Many small piles											X								
Apex	D	trenching																			
Divide	D	trenching																			
Fox	D	trenching																			
Lake View	D	trenching											X								
Nabob	D	trenching											X								
Silver Basin	D	trenching											X								
Betty	D	none											X								
Christal (Dorothy)	D	minimal																			
Duncan Creek	D	none																			
Blue Bird	D	minimal																			
Croesus No. 1	D	minimal																			
Kijo	D	minimal																			
Rico	D	minimal																			
Shepherd	D	minimal																			
Tin Can	D	minimal																			

Notes
1. Size Category: A= >100,000 tonnes; B= 10,000 to 100,000 tonnes; C= 1,000 to 10,000 tonnes; D= <1000 tonnes
2. Tonnage- short tons (Source: Primary 1996 SCR, secondary PWGSC 2000 and estimates from SRK inspections)

Technical Study:

TERRESTRIAL EFFECTS ASSESSMENT

Date: September 2007 – March 2008

Performed By:

EDI Environmental Dynamics Inc.

Objective

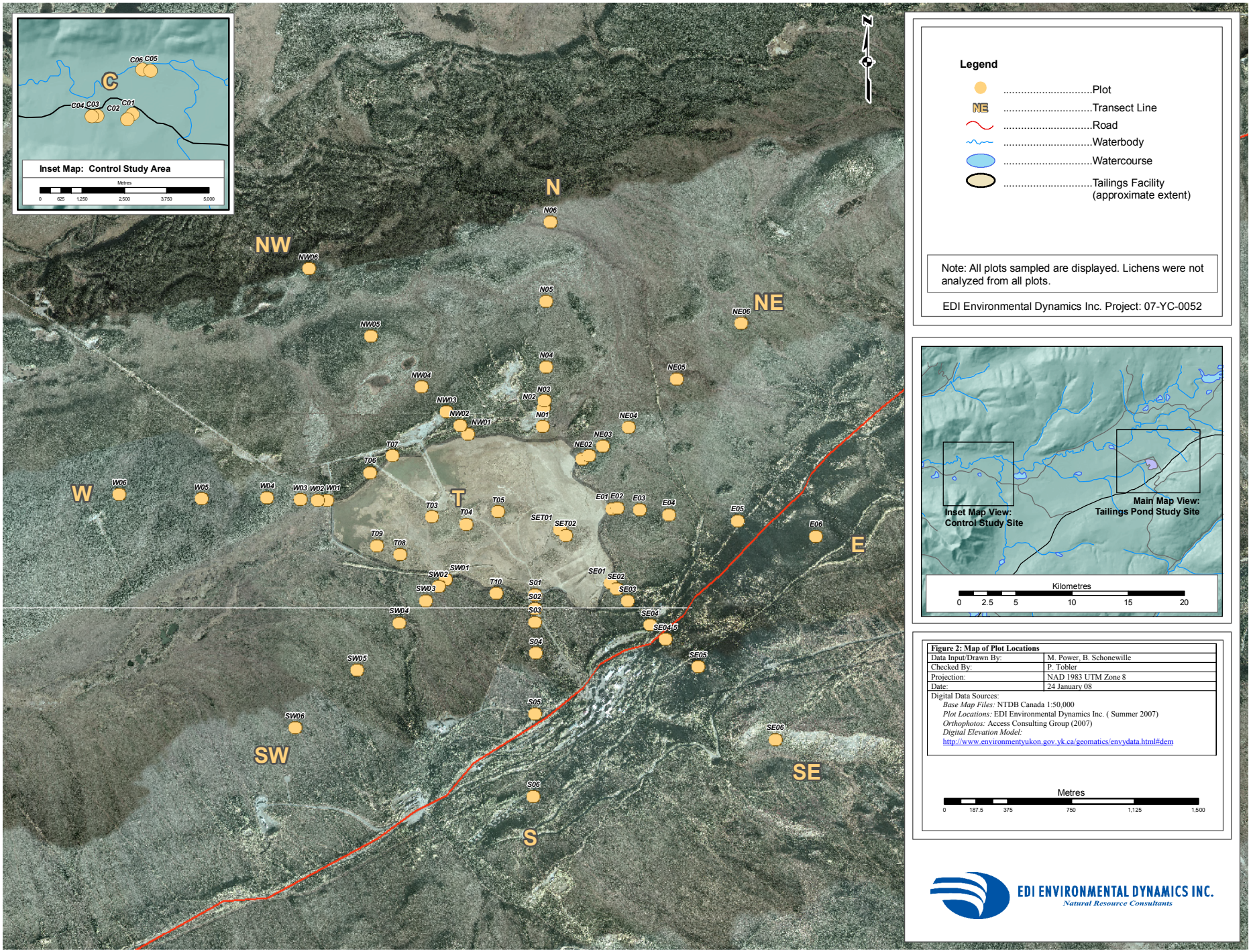
To determine if aerial dispersion of metals has occurred and, if so, determine the extent of such dispersion into the natural terrestrial ecosystem surrounding the Valley Tailings Facilities.

Facts\Description of Study:

- The study focused on lichen as they receive most of their nutrients from air and rainfall, and thus are excellent indicators of airborne contamination
- Samples were collected along 8 transects radiating outwards in cardinal directions from the centre of the Valley Tailings. Plots were established along the transects for sampling at increasing distances from the first plot (Figure 3)
- Results were analyzed to determine if metals levels were elevated compared to Yukon background data and to control site data, and if so, the magnitude and spatial extent of the contamination
- Analysis also included a review of the comparability of the two lichen species collected

Results/Conclusions:

- There is indication of contamination of metals (As, Cd, Ag, Zn) immediately around the eastern 'dry' portion of the tailings facility (e.g. Figure 4), although to limited spatial extent, especially when compared to other Yukon sites
- The Valley Tailings may have the potential to continue to contribute metals to the surrounding terrestrial environment. To assess if this is the case, deployment of moss bags is recommended
- There may be a need to assess other components of the terrestrial ecosystem in the future



Legend

- Plot
- NE — Transect Line
- Road
- Waterbody
- Watercourse
- Tailings Facility (approximate extent)

Note: All plots sampled are displayed. Lichens were not analyzed from all plots.

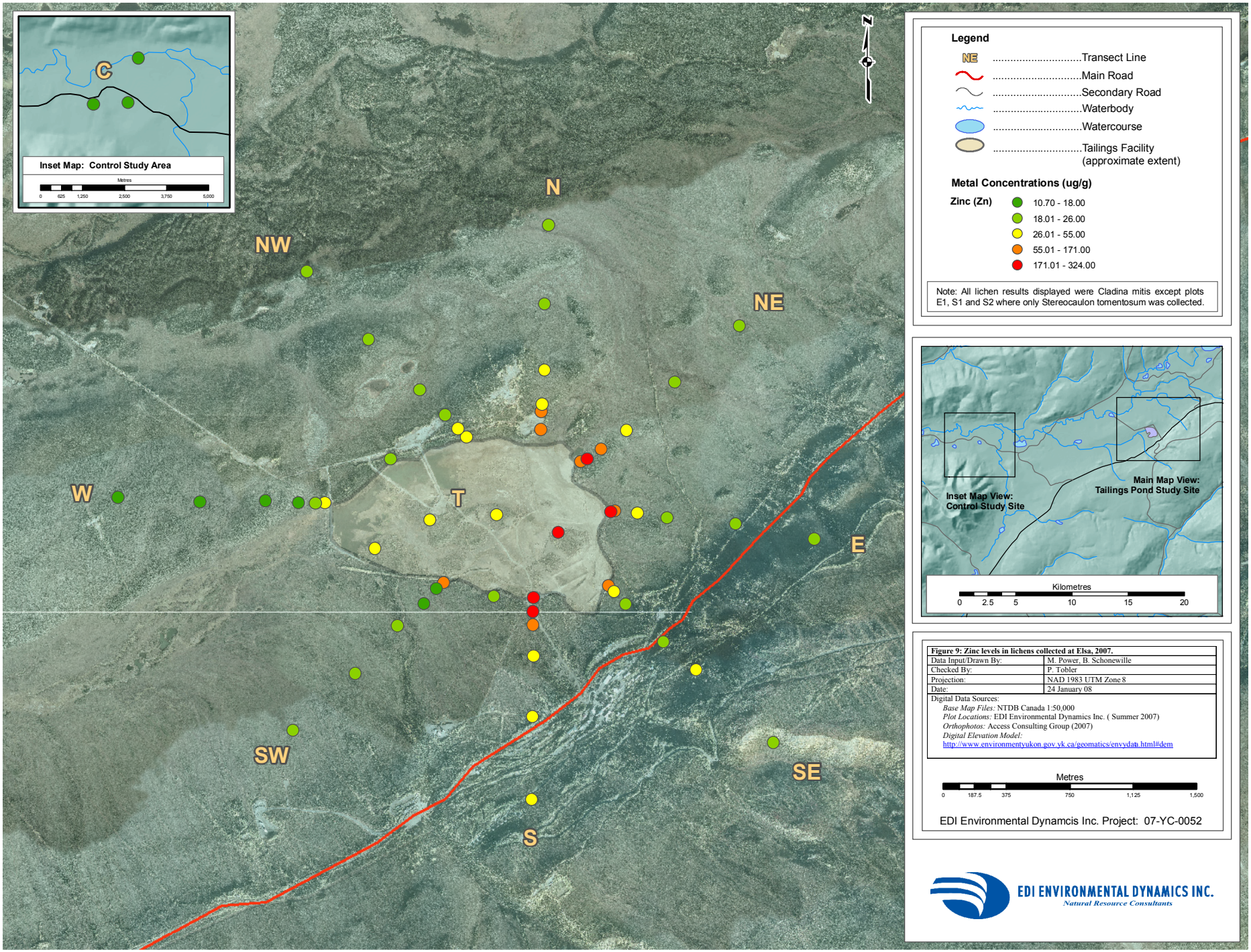
EDI Environmental Dynamics Inc. Project: 07-YC-0052

Figure 2: Map of Plot Locations	
Data Input/Drawn By:	M. Power, B. Schonewille
Checked By:	P. Tobler
Projection:	NAD 1983 UTM Zone 8
Date:	24 January 08

Digital Data Sources:
Base Map Files: NTDB Canada 1:50,000
Plot Locations: EDI Environmental Dynamics Inc. (Summer 2007)
Orthophotos: Access Consulting Group (2007)
Digital Elevation Model:
http://www.environmentyukon.gov.yk.ca/geomatics/envydata.html#dem

Metres
0 187.5 375 750 1,125 1,500

EDI ENVIRONMENTAL DYNAMICS INC.
Natural Resource Consultants


C
Inset Map: Control Study Area
Metres
0 625 1,250 2,500 3,750 5,000
N
NW
NE
W
T
E
SW
SE
S
Legend
NE .....Transect Line
.....Main Road
.....Secondary Road
.....Waterbody
.....Watercourse
.....Tailings Facility (approximate extent)
Metal Concentrations (ug/g)
Zinc (Zn)
10.70 - 18.00
18.01 - 26.00
26.01 - 55.00
55.01 - 171.00
171.01 - 324.00
Note: All lichen results displayed were Cladina mitis except plots E1, S1 and S2 where only Stereocaulon tomentosum was collected.
Inset Map View: Control Study Site
Main Map View: Tailings Pond Study Site
Kilometres
0 2.5 5 10 15 20
Figure 9: Zinc levels in lichens collected at Elsa, 2007.
Data Input/Drawn By: M. Power, B. Schonewille
Checked By: P. Tobler
Projection: NAD 1983 UTM Zone 8
Date: 24 January 08
Digital Data Sources:
Base Map Files: NTDB Canada 1:50,000
Plot Locations: EDI Environmental Dynamics Inc. (Summer 2007)
Orthophotos: Access Consulting Group (2007)
Digital Elevation Model:
http://www.environmentyukon.gov.yk.ca/geomatics/envydata.html#dem
Metres
0 187.5 375 750 1,125 1,500
EDI Environmental Dynamcis Inc. Project: 07-YC-0052
EDI ENVIRONMENTAL DYNAMICS INC.
Natural Resource Consultants

Technical Study:

VALLEY TAILINGS REVEGETATION ASSESSMENT

Date: August 2007 – January 2008

Performed By:

S.P. Withers

Objective

To facilitate future revegetation efforts at the Valley Tailings Area of the former Keno Hill mine site

Facts\Description of Study:

- Archived reports on earlier tailings revegetation trials were reviewed
- An inventory of the state of natural revegetation occurring on the mill tailings was carried out and the vegetation types were delineated on a current aerial photograph

Results/Conclusions:

- Some notable conclusions were reached during revegetation tests carried out between 1976 and 1984
    a. The principal contributor to the inhibition of long-term plant growth on much of the tailings is the impenetrable surface that occurs when salts, primarily zinc sulphate, migrate upward through the tailings slimes
    b. The slightly acidic nature of the tailings (pH 6 – 7) produces a top layer of soil with pH between 6.7 – 6.8, which is near enough to neutral to not significantly impede plant growth
    c. Phytotoxic concentrations of Cd, Pb, Zn, Cu and Mn are found in the rooting zones of most soils on the unvegetated portion of the tailings impoundment; the high levels of extractable ions appear to be a significant impediment to the establishment of vegetation on these areas
    d. Plant development on the metalliferous tailings is restricted by very low levels of macronutrients (nitrogen, phosphorous and potassium) and high concentrations of phytotoxic metals; as such, repetitive application of nitrogen fertilizers and phosphorous is required for plant growth
- The vegetation types observed in the valley tailings during the 2007 assessment are primarily locally occurring indigenous species that have naturally colonized the tailings. Their type and extent is illustrated in Figure 5

- There are large sections of barren ground in the tailings area; to resume efforts to vegetate these areas, the following are recommended:

    a. Soil samples were collected from nine test pits on the valley tailings impoundment in 2007, and in order to help characterize the current state of the impounded tailings, should be analyzed for texture, total metals, extractable ions, organic content, available nutrients, cation exchange capacity, carbon-nitrogen ratio and pH

    b. A field survey of the unvegetated area of the tailings should include a series of transects with in-situ measurements of soil pH and moisture content and an examination of soil permeability

    c. Experimentation with soil caps should be conducted

*2006 aerial photograph obtained from Geodesy Remote Sensing Inc., Calgary Alberta. Flown 13,14 September 2006.

Projection - UTM Zone 8 NAD83
NTS 105M/13
Vegetation identified by Stu Withers, S.P.Withers Consulting, Whitehorse, Yukon.

N

DRAFT

0 50 100 200 300 m

Legend

- Test Pit Est 1995
- Test Pit Est 2007
- Public Road
- Exploration Roads
- Trails
- Cutlines
- Contours
- Water Course (actual and potential)
- Swampy area
- Pipe

Valley Tailings Vegetation Type

- A - Willow Regeneration
- B - Bluejoint Meadow
- C - Undisturbed Closed Black Spruce
- D - Barren
- E - Water Sedge
- F - Balsam Poplar Regeneration
- G - Undisturbed Open Black Spruce
- H - Water Horsetail
- I - Water

ALEXCO RESOURCE CORP.

VALLEY TAILINGS VEGETATION STUDY

VALLEY TAILINGS VEGETATION TYPES

Drawn By: HD	Date: December 2007	**FIGURE**
Checked by: DC/SW	File: D:\Projects\AllProjects\ALEX-05-01\gis\mxd\UKHM\VegetationStudies\ValleyTailingsVeg2007\ValleyTailingsVeg.mxd	

Technical Study:

REVEGETATION TRIALS – GALENA HILL WASTE ROCK DUMPS

Date: July 2007 – January 2008

Performed By:

S.P. Withers

Objective

To establish effective measures for revegetating the discontinued waste rock dumps in the Elsa area

Facts\Description of Study:

- Three revegetation test sites were established on Galena Hill including two waste rock dumps and one control site
- The sites' physical characteristics were assessed prior to the test plots
- The sites were recontoured and seed and fertilizer were added

Results/Conclusions:

- The level of available nitrogen and potassium was low at the waste rock dump sites
- Available phosphorous was moderate at the Simes dump and low at the Hector dump
- A visual examination of the test plots should take place in mid-summer 2008, including an assessment of soil erosion
- Soil and vegetation samples should be taken from the test plots and analyzed for metal concentrations; soil should be texture classified and analyzed for available nutrients, pH, cation exchange capacity, carbon-nitrogen ratio and the percent of organic matter
- More fertilizer should be added in the fall 2008

Technical Study:

PHYSICAL HAZARDS REDUCTION PROGRAM

Date: September 2005 – February 2008

Performed By:

Access Consulting Group

Objective

To identify, mitigate, and rank the risks associated with each site observed in 2005 – 2007

Facts\Description of Study:

- Review of previously documented physical hazard information on the Keno Hill Property, including the PWGSC Environmental Baseline Assessment, the SRK Preliminary Baseline Assessment Report, the 2006 ERDC Physical Hazards Report and discussions with site caretakers and historic operators possessing historical knowledge of site operations;
- Comprehensive physical hazard site investigation and documentation of hazards not currently identified on the Keno Hill Property (2005-2006);
- Updating the physical hazard risk register including all risks at all locations showing location, description of hazard, accessibility, and priority for risk reduction;
- Consultation with local Yukon Government offices to review the risk registry and hazard ratings;
- Consultation in 2007 with Yukon Government Heritage to review heritage potential of site;
- Review 2006: recommendations to either eliminate or limit access to the hazards, including but not limited to signage, fences, locked gates, and public education;
- Additional field investigation as necessary to develop design;
- Develop construction designs and cost estimates for elimination of the hazards;
- Implement the recommended actions; and
- Prepare a final project report.

Results/Conclusions:

- The risk registry is included as Table 1. Mitigated and partially mitigated risks are noted in the table

Keno Hill Physical Hazard Risk Registery

Assigned Site No.	Site Name	Location Description	UTM Coordinates	Description of Existing Physical Hazards	Hazard Identified By	Consequence	Likelihood	Likelihood	Risk Rating		Mitigation Measures	Actions Complete
						Severity	Exposure	Probability	Numerical	Descriptive		
1	Silver King	Straddles the Silver Trail Highway at Galena Creek, approximately 4km southwest of Elsa town site	473050E, 7085275N	Open Pit has no barriers to prevent access; temporary barriers have fallen down.	SRK 2005 Site Inspection	Moderate	Remote	Unlikely	0.3	Moderate	The site is gated and locked, and is actively treated by Alexco employees.	✓
				Compressor building accessible to the public.	SRK 2005 Site Inspection	Low	Remote	Unlikely	0.03	Low		✓
2	Husky & Husky SW	12km west of Keno City on Silver Trail Highway, past the first turnoff for the Elsa townsite, downhill via an access road for 0.5km.	474740E, 708677N	Power pole and power line west of headframe.	SRK 2005 Site Inspection	Low	Remote	Unlikely	0.03	Low	Site is actively treated and thereby, continually monitored be Alexco employees.	✓
				Boiler House accessible.	PWGSC Baseline Assessment	Low	Remote	Unlikely	0.03	Low		✓
				Storage Shed accessible.	PWGSC Baseline Assessment	Low	Remote	Unlikely	0.03	Low		✓
				Workshop accessible.	PWGSC Baseline Assessment	Low	Remote	Unlikely	0.03	Low		✓
				Shaft House and Headframe were accessible at Husky SW.	PWGSC Baseline Assessment	Low	Remote	Unlikely	0.03	Low		✓
				Hoist House accessible.	PWGSC Baseline Assessment	Low	Remote	Unlikely	0.03	Low		✓
				ATCO Trailer accessible.	PWGSC Baseline Assessment	Low	Remote	Unlikely	0.03	Low		✓
3	Elsa	Located within the Elsa townsite on the north-facing slope of Galena Hill.	476000E, 7087000N	Powderhouse corner vent raise appears to be subsiding with a linear depression crossing Calumet Drive.	PWGSC Baseline Assessment	Moderate	Occasional	Possible	10	Moderate	The site is gated, and is continually monitored and used by Alexco employees.	✓
				Adit has an ice plug	ACG Site Characterization	Low	Remote	Unlikely	0.03	Low		✓
				Several buildings in various stages of repair may need to be either dismantled or entry adequately blocked to prevent entry.	PWGSC Baseline Assessment	Low	Remote	Unlikely	0.03	Low		✓
4	Dixie	3.6km along Calumet Drive from the junction with Wernecke Road.	477000E, 7087200N	Ditch running along side of Garage/Office building could be subject to erosion during peak flows, which could result in the structure collapsing; accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
				Shaft is partially collapsed and filled with water to a depth of approximately 3m below ground level.	PWGSC Baseline Assessment	Critical	Occasional	Possible	100	Extreme	Upon investigation, the remedial work necessary was too extensive for the 2007 season. Site will be planned in propective action.	✓
				Two collapsed raises show evidence of subsidence.	PWGSC Baseline Assessment	Critical	Occasional	Possible	100	Extreme	Investigated and deemed stable. However, a revisit in the summer of 2008 is suggested.	✓
				200 Level Adit is blocked with timber cribbing.	PWGSC Baseline Assessment	Low	Remote	Rare	0.01	Low	The entrance to this adit was sealed off with 25 cm wire mesh.	✓
5	Coral & Wigwam	Follow the Bermingham Road for 2.8km from the Hector Portal to a cat trail that leads northwest for 100m to site.	477900E, 7086250N	Two shafts present that are open and accessible.	PWGSC Baseline Assessment	Critical	Unusual	Possible	30	Extreme	Excavated all timber and debris from shafts and backfilled both sites.	✓

note:

cell pattern indicates site has been mitigated or partially mitigated.

Keno Hill Physical Hazard Risk Registery

Assigned Site No.	Site Name	Location Description	UTM Coordinates	Description of Existing Physical Hazards	Hazard Identified By	Consequence	Likelihood	Likelihood	Risk Rating		Mitigation Measures	Actions Complete
						Severity	Exposure	Probability	Numerical	Descriptive		
6	Bermingham & Ruby (Arctic & Mastiff)	Near the summit of Galena Hill, approximately 1.5km southwest of Calumet town site via the gravel road from Calumet.	474740E, 708677N	Ruby shaft area has collapsed on skip; area in front of shaft has failed also; shaft house accessible.	PWGSC Baseline Assessment	Critical	Occasional	Possible	100	Extreme	Excavated both shafts clean of timber, debris and backfilled with material from adjoining waste dump. Part of the shaft house was torn down and burned to access larger shaft. Note: larger shaft may need additional work as sinking may occur	✓
				One of the dumps is open without any berming.	SRK 2005 Site Inspection	Moderate	Occasional	Possible	10	Moderate		
				Ruby 400 Level adit accessible	ACG Site Characterization	Moderate	Occasional	Possible	10	Moderate		
				Bermingham 200 level Adit has collapsed somewhat but is still accessible.	PWGSC Baseline Assessment	Critical	Occasional	Possible	100	Extreme	Excavated duff, topsoil, timbers, and debris. Backfilled with large rock and topsoil and duff laid atop as cover.	✓
				Explosives magazine and Detonator House accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
				Water Shack accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
				Two residential buildings were considered unsafe, yet accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
7	No Cash	Located on the mid-northwest slope of Galena Hill via a road leading from the Elsa-Calumet road.	477230E, 7088058N	No Cash 100 Level Adit partially collapsed.	PWGSC Baseline Assessment	Critical	Occasional	Possible	100	Extreme	Excavated duff and topsoil and adit cleaned of timer and debris. It was backfilled with large rock then topsoil and duff was put on the disturbed area. Wire was cut and removed	✓
				No Cash 500 adit inaccessible	ACG Site Characterization	Low	Occasional	Possible	1	Low	Doors are locked.	✓
				Brefalt shafthouse is accessible	PWGSC Baseline Assessment	Critical	Occasional	Possible	100	Extreme	Secured doors and windows with 10 cm wire mesh.	✓
				Garage accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
				Lunch Room accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
8	Betty	Old trailheads extend northeast from the No Cash mine towards the Betty mine site.	479251E, 7088632N	One shaft collapsed due to permafrost; retaining approximately 1ft of water.	ACG 2006 Site Inspection	Low	Remote	Rare	0.01	Low		
9	Hector Calumet	Located on the northwest slope of Galena Hill, on the Calumet Road.	480900E, 7088300N	Underground opening present in west corner.	SRK 2005 Site Inspection	Critical	Occasional	Possible	100	Extreme	excavated and backfilled	✓
				Other concern would be berming the open pits and wall failure in some areas.	SRK 2005 Site Inspection	Critical	Occasional	Possible	100	Extreme	Investigated and deemed stable. However, a revisit in the summer of 2008 is suggested.	✓
				Sinkholes present in pit floor.	SRK 2005 Site Inspection	Critical	Occasional	Possible	100	Extreme	a 1m berm was put at the pit entrance to prevent access.	✓
				Shacks, bunk house, and water storage building all accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
10	Dragon & Miller (UN Adit; Miller separate workings)	Located on the north slope of Galena Hill along the Calumet Back Road.	481500E, 7088800E	UN Adit open but blocked by ice year round.	PWGSC Baseline Assessment	Moderate	Occasional	Possible	10	Moderate		

note:

cell pattern indicates site has been mitigated or partially mitigated.

Keno Hill Physical Hazard Risk Registery

Assigned Site No.	Site Name	Location Description	UTM Coordinates	Description of Existing Physical Hazards	Hazard Identified By	Consequence	Likelihood	Likelihood	Risk Rating		Mitigation Measures	Actions Complete
						Severity	Exposure	Probability	Numerical	Descriptive		
11	Galkeno 200	Located on the northeast slope of Galena Hill via the Calumet Back road, approximately 3.9km from the Duncan Creek road.	482600E, 7088600N	100 Level Adit timbers have collapsed making access difficult, but still possible.	SRK 2005 Site Inspection	Moderate	Occasional	Possible	10	Moderate		
				200 Level Adit is open and unsafe.	PWGSC Baseline Assessment	Critical	Occasional	Possible	100	Extreme	Upon investigation, site was isolated enough for remdial work to be continued into the 2008 season.	✓
				Unnamed Adit has collapsed.	ACG Site Characterization	Moderate	Occasional	Possible	10	Moderate		
				Unnamed shaft is in accessible.	PWGSC Baseline Assessment	Moderate	Occasional	Possible	10	Moderate		
				Macleod shaft is partially collapsed and inaccessible.	PWGSC Baseline Assessment	Moderate	Occasional	Possible	10	Moderate		
				Subsidence/sinkhole uphill of the 300 adit.	SRK 2005 Site Inspection	Moderate	Remote	Rare	0.1	Low		
14	Bluebird	Northeast slope of Galena Hill, approximately 4km northwest from Keno City; 70m upslope from Silver Trail	482750E, 7089825N	Three shafts were located east of cabin, two with ladders. Shafts filled in but still relatively deep (approx. 1-2m) One small shaft located north of other shafts only 0.5m deep.	ACG 2006 Site Inspection	Moderate	Remote	Unlikely	0.3	Moderate		
				Log cabin accessible; in poor condition.	ACG 2006 Site Inspection	Low	Remote	Unlikely	0.03	Low		
15	Tin Can	250m uphill of Silver Trail Highway.	483743E, 7088748N	One partially caved shaft found further down slope; still somewhat accessible however, not too deep (approx 2.5m)	ACG 2006 Site Inspection	Moderate	Remote	Unlikely	0.3	Moderate		
16	Rico	Northwest slope of Galena Hill, 450m upslope of Galkeno 900 site via old dirt road that branches off Calumet Back road roughly 2.2km north of junction with Duncan Creek Road.	483300E, 7087700N	One open shaft above adit, collapsed inward approximately 4m in depth; water retained in bottom.	ACG 2006 Site Inspection	Moderate	Remote	Unlikely	0.3	Moderate		
19	Onek	Located on the south slope of Keno Hill immediately northeast of Keno City.	487406E, 7087196N	Open pits in the south end have no berms on them (location is vehicle accessible).	SRK 2005 Site Inspection	Moderate	Continuous	Likely	300	Moderate		
				Collapsed rock above 400 Level Adit; timbers of 400 Level in poor shape.	SRK 2005 Site Inspection	Major	Continuous	Likely	900	Extreme	Investigated and deemed stable. However, a revisit in the summer of 2008 is suggested.	✓
				Lone Star shaft inaccessible except for 5m deep hole within open pit.	PWGSC Baseline Assessment	Major	Continuous	Likely	900	Extreme	Excavated of timbers and backfilled	✓
20	Klondike-Keno	Northwest slope of Keno Hill, approximately 1.5km southwest of Wernecke town site.	484700E, 7090700N	Subsidence has occurred behind collapsed adit.	ACG 2006 Site Inspection	Low	Occasional	Unlikely	0.3	Low		
				Drillers shack located north of adit roof structure on it's way to collapsing	ACG 2006 Site Inspection	Low	Occasional	Unlikely	0.3	Low		
21	Sadie Ladue	Located on the northwest slope of Keno Hill at the Wernecke Camp.	486400E, 7092000N	Collapsed stope located between Shaft #2 and Pit #1; loose slabs in roof a hazard.	PWGSC Baseline Assessment	Major	Frequent	Likely	270	Extreme	Stope was mound filled with material; now inaccessible.	✓
				A number of buildings in various states of repair are present on the site.	PWGSC Baseline Assessment	Low	Frequent	Possible	3	Low		
22	Bellekeno	South side of Sourdough Hill Road at the 100 level adit site	487126E, 7086385N	Open shaft along right side of road partially covered by collapsing frame	SRK 2005 Site Inspection	Major	Continuous	Almost certain	3000	Extreme	Shaft was filled and recontoured with backhoe.	✓
				Further up road along right side, another open log-lined vent about 3m deep	SRK 2005 Site Inspection	Major	Continuous	Almost certain	3000	Extreme	Shaft was filled and recontoured with backhoe.	✓
				Minor tension cracks along edge of pond and along crest of waste rock slope.	SRK 2005 Site Inspection	Low	Frequent	Unlikely	0.9	Low		
		80m along a trail leading off of Sourdough Hill Road.		Eureka: 2 open shafts located west of cabin; one overgrown and one is fairly deep 1 large stope failure in the middle of road 1 large open vent raise	SRK 2005 Site Inspection	Critical	Occasional	Possible	100	Extreme	Workings were filled and recontoured with backhoe.	✓
				Powder mag is in poor condition and accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
				Wash house is in poor condition and accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		

note:

cell pattern indicates site has been mitigated or partially mitigated.

Keno Hill Physical Hazard Risk Registery

Assigned Site No.	Site Name	Location Description	UTM Coordinates	Description of Existing Physical Hazards	Hazard Identified By	Consequence	Likelihood	Likelihood	Risk Rating		Mitigation Measures	Actions Complete
						Severity	Exposure	Probability	Numerical	Descriptive		
23	Kijo	Located on the mid-southwest slope of Keno Hill, roughly 500m north of Erickson Gulch via Blackcap Road which branches off Wernecke Road, 80m down the slope.	486200E, 7089600N	One collapsed portal south of the collapsed adit; entrance to small for accessibility.	ACG 2006 Site Inspection	Low	Remote	Unlikely	0.03	Low		
24	Croesus No. 1	Midway up the western slope of Keno Hill, extending roughly 350m along an azimuth of 5 degrees up the north side of Erickson Gulch from the creek via the Blackcap Road which branches off of Wernecke Road, 1.3km to the northwest.	486655E, 7089425N	One shallow caved in shaft found up the hill from the adits.	ACG 2006 Site Inspection	Low	Occasional	Unlikely	0.3	Low		
25	Black Cap, Shepherd & LQ Adit	Three sites located on the western slope of Keno Hill, roughly a kilometre north of Erickson Gulch, all within 450m of each other.	486950E, 7091675N	Black Cap Adit accessible.	SRK 2005 Site Inspection	Major	Occasional	Likely	90	Extreme	Excavated of timber and debris and backfilled and sloped.	✓
				Lucky Queen Adit accessible through broken timbers.	ACG 2006 Site Inspection	Major	Frequent	Likely	270	Extreme	Excavated snow shed and adit of timber, pipe, debris and backfilled, resloped and recontoured. All old mining equipment and metal was removed. Burnable material was burned on-site.	✓
				Sheperd (Brewis Red Lake) Adit bulldozed, inaccessible	PWGSC Baseline Assessment	Low	Occasional	Rare	0.1	Low	Excavated timber and debris and backfilled and sloped.	✓
				Two shafts present that are open and accessible.	ACG Site Characterization	Major	Occasional	Likely	90	Extreme	Upon investigation, site was isolated enough for remdial work to be continued into the 2008 season.	✓
				Open pits with no berming present.	SRK 2005 Site Inspection	Moderate	Occasional	Possible	10	Moderate		
				Workshop accessible.	PWGSC Baseline Assessment	Low	Occasional	Possible	1	Low		
26	Lucky Queen	Located on the northwest slope of Keno Hill, roughly 1.25km east and uphill of the Wernecke Camp.	487700E, 7092700N	Doors unlocked on Shaft #1 headframe.	ACG 2006 Site Inspection	Major	Occasional	Almost certain	300	Extreme	Secured open shaft with timber, barricaded the double door and secured all windows and openings with 24 cm wire mesh.	✓
27	Lake	250m west of Gambler Gulch, midway down the north-western slope of Keno Hill, via the Lower Faro Gulch Trail.	490150E, 7090640N	Large headframe present above shaft, access to descent ladder nailed shut, however, access can be gained from side of shaft as ground has collapsed . Shaft may be approximately 5m deep.	ACG 2006 Site Inspection	Critical	Remote	Possible	10	Extreme	Searched extensively for this site. To perform sufficient physical hazard reduction at this site too much damage would nee d to be done to surrounding vegetation and area.	✓
28	Shamrock	Near the summit on the southwest side of Keno Hill; can be seen from Keno City	488018E, 7090536N	Shamrock J headframe is collapsing into the shaft and ground subsidence is occurring on the east side of the shaft.	ACG 2006 Site Inspection	Critical	Continuous	Almost certain	10000	Extreme	Material was removed and burned, and shaft was filled and recontoured with backhoe.	✓
				Main Site Building accessible.	PWGSC Baseline Assessment	Low	Frequent	Possible	3	Low		
				Generator Shed accessible.	PWGSC Baseline Assessment	Low	Frequent	Possible	3	Low		
29	Highlander	2km northwest of Keno Hill Summit on the south side of Gambler Gulch.	487900E, 7092100N	One caved in adit with a small opening that still allows accessibility.	ACG 2006 Site Inspection	Critical	Occasional	Possible	100	Extreme	Site was actively explored and confirmed inaccessible.	✓
				Ore processing building accessible.	ACG 2006 Site Inspection	Low	Occasional	Possible	1	Low		
				Bunkhouse accessible.	ACG 2006 Site Inspection	Low	Occasional	Possible	1	Low		
				Cabin accessible.	ACG 2006 Site Inspection	Low	Occasional	Possible	1	Low		
31	Stone	2.3km north of Keno Summit in Faro Gulch; south of Faro Gulch Trail.	488800E, 7092500N	One adit partially caved and difficult to access.	ACG 2006 Site Inspection	Low	Unusual	Unlikely	0.09	Low		
				Dry Building accessible.	ACG 2006 Site Inspection	Low	Remote	Unlikely	0.03	Low		

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Keno Hill Physical Hazard Risk Registery

Assigned Site No.	Site Name	Location Description	UTM Coordinates	Description of Existing Physical Hazards	Hazard Identified By	Consequence	Likelihood	Likelihood	Risk Rating		Mitigation Measures	Actions Complete
						Severity	Exposure	Probability	Numerical	Descriptive		
32	Keno Mine	Sites occur across a broad, relatively gentle slope above Hope Gulch southeast of the Keno Summit on Keno Hill via the Keno 700 Road.	490250E, 7089350N	Keno 200 Adit collapsed some approx. 3m deep; accessible from door at front.	PWGSC Baseline Assessment	Major	Continuous	Almost certain	3000	Extreme	secured the adit with 25 cm wire mesh on all openings. The sinkhole above the adit was excavated of duff, vegetation and timber and backfilled with local material and resloped. Duff and vegetation was replaced as cover.	✓
				Comstock 150 Adit door sealed but has some damage.	PWGSC Baseline Assessment	Major	Continuous	Almost certain	3000	Extreme	secured with 25 cm wire mesh	✓
				Comstock 200 Adit door sealed but accessible from smaller door on west side.	PWGSC Baseline Assessment	Major	Continuous	Almost certain	3000	Extreme	secured with 25 cm wire mesh	✓
				Porcupine Pit Portal is blocked by wood planks and has collapsed along a majority of its length.	PWGSC Baseline Assessment	Minor	Continuous	Unlikely	9	Low		
				Garage building subjected to erosion at base from being positioned on waste rock pile.	PWGSC Baseline Assessment	Low	Continuous	Possible	10	Low		
				Drill equipment shop was unstable, slipping into the erosion channel.	PWGSC Baseline Assessment	Low	Continuous	Possible	10	Low		
				The mining/geologist office was unstable and slipping into the erosion channel.	PWGSC Baseline Assessment	Low	Continuous	Possible	10	Low		
				All building on the site were accessible.	PWGSC Baseline Assessment	Low	Continuous	Possible	10	Low		
33	Main Fault & Nabob	North face of Keno Hill, approximately 0.75km northwest of Monument Hill, adjacent to the Keno No.9 System via the Silver Basin Gulch Trail.	490150E, 7090640N	Old house & old outhouse accessible.	ACG 2006 Site Inspection	Low	Continuous	Possible	10	Low		
36	Keno No. 9 System	Located on the Keno Hill summit via the Keno Signpost road.	48?300E, 7090200N	Faro Gulch Portal not inspected. Unsure of condition.		Critical	Frequent	Possible	300	Extreme	This site was located and confirmed to be beyond property borders.	✓
				Open pits on top of Keno Hill summit.	SRK 2006 Site Inspection	Major	Continuous	Likely	900	Extreme	Excavated and backfilled with local material	✓
				Two open holes are present just east of the Signpost.	SRK 2006 Site Inspection	Critical	Continuous	Almost certain	10000	Extreme	Excavated and backfilled with local material	✓
47	Monument & Ladue Fraction	Northwest facing slope of Monument Hill summit, approximately 1.5km past the signpost via the Silver Basin Gulch Trail.	490900E, 7090900N	One collapsed adit located on east facing slope of Silver Basin Gulch just below summit of Monument Hill; not accessible. Trenching present on top of cirque.	ACG 2006 Site Inspection	Low	Occasional	Possible	1	Low		
48	Apex	Located approximately 250m south of 4th switchback past the intersection of Signpost Road and Keno 700 Road.	488640E, 7088920N	One lined shaft located in Trench #3, a couple of meters deep. Possible subsidence immediately west of the hole.	ACG 2006 Site Inspection	Low	Unusual	Possible	0.3	Low		
				Wood cabin accessible.	ACG 2006 Site Inspection	Low	Occasional	Possible	1	Low		
71	Christal (Dorothy)	Located on the western slope of Keno Hill south of Erickson Gulch via a foot trail departing Keno Road about 2.5km out of Keno City.	486780E, 7088540N	One timber lined shaft approximately 2.5m deep with approximately 6" of water.	ACG 2006 Site Inspection	Moderate	Remote	Possible	1	Moderate		
				One shaft located north of first shaft, approx. 1m deep with approx. 0.5ft of water in it.	ACG 2006 Site Inspection	Moderate	Remote	Possible	1	Moderate		
76	Townsite Mine	6.2km along Calumet Drive from the junction of Wernecke Road .	479500E, 7087800N	Rock overhang has caved in at adit entrance and is considered a safety hazard.	PWGSC Baseline Assessment	Critical	Frequent	Possible	300	Extreme	Excavated of timber and debris and backfilled, sloped and contoured.	✓
77	Sadie Ladue 600 Adit	6km north of Keno City via a 1km trail leading north from Wernecke Camp.	485950E, 7092700N	One adit present; still accessible.	PWGSC Baseline Assessment	Critical	Occasional	Possible	100	Extreme	Investigated and deemed stable. However, a revisit in the summer of 2008 is suggested.	✓

note:

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Keno Hill Physical Hazard Risk Registery

Assigned Site No.	Site Name	Location Description	UTM Coordinates	Description of Existing Physical Hazards	Hazard Identified By	Consequence	Likelihood	Likelihood	Risk Rating		Mitigation Measures	Actions Complete
						Severity	Exposure	Probability	Numerical	Descriptive		
78	Elsa Village	Located on the south side of Silver Trail Highway, 11.5km west of Keno City.	476000E, 7087000N	Green shack accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Shack #1 & 2 beside sawmill accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Carpentry shop accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				No. 5 bunkhouse accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Union shop building accessible; in poor condition.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Snack bar accessible through a back door.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Dining hall accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Wooden walkways are in poor condition at Mill site.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Access available to the grizzly bay at Mill site.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Utilildor collapsing at mill site.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Retaining wall failing on south side of Mill site.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Light vehicle shop accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Rescue building accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Swimming pool building accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Medical building accessible; contains medical equipment and personal medical files.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low	Although this is not a physical hazard, contents of the building can subject the company to large privacy exposure.	
				Heavy Equipment Warehouse accessible through unlocked door on the north side.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Mens staffhouse accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Apartment building accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Single car garage building accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Church building in poor condition; accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Elsa School was accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		
				Flat Creek residences #1 & 2 accessible.	PWGSC Baseline Assessment	Low	Unusual	Possible	0.3	Low		

note:

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Technical Study:

Aerial Photography and Orthophoto Development

Date: 2006

Performed By:

Aero Geometrics Ltd.

Objective

To create new colour airphotos of the UKHM properties and prepare orthorectified images for closure planning and baseline environmental assessment purposes

Facts\Description of Study:

- Fly new 1:10 000 colour aerial photographs of the UKHM district
- Produce orthophotos from aerial stereopairs

Results/Conclusions:

- Site wide orthophotos were produced at 1: 10 000 scale. These form the base for site mapping of baseline environmental data.

Technical Study:

METEOROLOGICAL STATION PLANNING AND INSTALLATION

Date: Spring 2007 –

Performed By:

ACG

Objective

To install an automated meteorological station (measuring temperature, precipitation, solar radiation, wind speed and direction) and accompanying data logger on Galena Hill and tie station with existing YG snow course

Facts\Description of Study:

- ERDC purchased and installed an Onset HOBO Datalogging Weather Station on Galena Hill above the Hector Adit
- The station is equipped with the following sensors:
    a. Air temperature
    b. Relative humidity
    c. Barometric pressure
    d. Rainfall
    e. Wind speed and direction
    f. Solar radiation and,
    g. Soil temperature
- Sensors relay 15-minute average values to the logger, which records and stores readings every 15 minutes continuously
- Data is downloaded from the station monthly and is integrated into the Site Environmental Database for closure planning purposes

Results/Conclusions:

- Data is being collected on an ongoing basis for future assessment

Technical Study:

VALLEY TAILINGS GROUNDWATER SAMPLING PROGRAM

Date: Summer 2006

Performed By:

ACG

Objective

To intersect and sample groundwater flowing through the Valley Tailings

Facts\Description of Study:

- Two piezometers were placed upstream and two downstream of the observed linear vegetation feature west of Valley Tailings Pond #1
- Potential Sampling locations were surveyed by walking the entire length of the vegetation feature. Low-lying areas and indications of water neat the surface were surveyed.
- Potential install locations were selected by driving a piezometer to test for the presence of water.
- Where water was found, it was tested to determine whether it was flowing or stagnant. If found to be flowing, a piezometer was installed

Results/Conclusions:

- Groundwater samples are successfully retrieved from the installed piezometers and are stored in a groundwater quality database. These data contribute to the understanding of groundwater chemistry influenced by the valley tailings area.

Technical Study:

ASSESSMENT OF GROUNDWATER REGIME AT THE VALLEY TAILINGS FACILITY

Date: Summer 2007 – February 2008

Performed By:

SRK Consulting

Objective

To develop an understanding of the physical hydrogeology of the Valley Tailings Facility to enable an estimation of groundwater flux through the facility to be derived. This flux will be used to estimate current contaminant loadings from the VTA into the receiving environment.

Facts\Description of Study:

- To achieve the above objectives, the following broad measures were taken:
    a. Review all available data
    b. Conduct a geotechnical percussion drilling program to provide information on the unconsolidated materials at the site (Figure 6)
    c. Develop a conceptual hydrogeological model for the site
    d. Calculate groundwater flux
- Available data reviewed for the study included previous reports, memos and drill logs, grain size analysis data from boreholes, aerial photography and EBA reports
- Results of the drill program and conceptual model were used to estimate the hydraulic characteristics of the unconsolidated materials beneath the tailings and the dams

Information Gaps:

Percussion drilling creates a grain size bias towards coarse soil fractions as a result of fines being flushed with water or circulating air. This can impact on the interpretation of grain size analysis results which are used to estimate hydraulic conductivity. Thus, hydraulic conductivity was derived using low estimations of grain size.

Results/Conclusions:

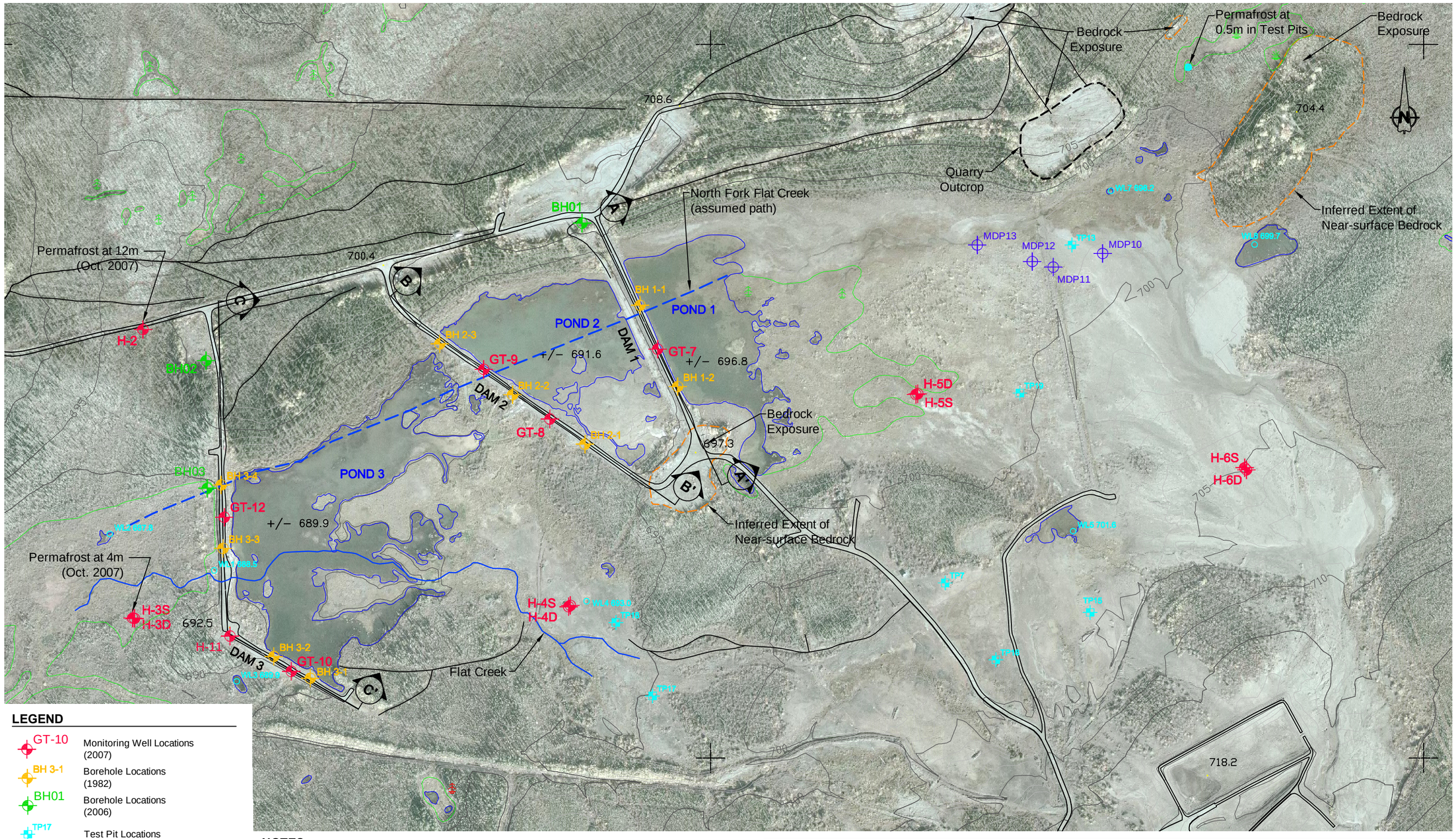
- A net flux of 18m^3/day was estimated to leave the VTF via groundwater flow beneath Dam 3

- The flux was estimated using data not collected under ideal conditions. Because the flux is sensitive to changes in hydraulic conductivity, further information should be gathered to increase the hydrogeological understanding, including:

    a. Refinement of the site water balance to allow better estimates of the seepage loss from the Porcupine Diversion

    b. Slug testing in the existing well to attempt to derive a better estimate of hydraulic conductivity in the overburden beneath the VTF

- There is little evidence to support the idea that Zn is being carried into deep seated water beneath the tailings (see 2007/08 Geochemical Studies: Tailings Geochemical Assessment)



LEGEND

- GT-10 — Monitoring Well Locations (2007)
- BH 3-1 — Borehole Locations (1982)
- BH01 — Borehole Locations (2006)
- TP17 — Test Pit Locations
- MDP10 — Manual Drive Points

Note:
GT-* locations also contain Thermistor Strings
H-* locations are Monitoring Wells only

NOTES

1. Base drawing and orthophoto provided by ERDC. Orthophoto prepared by AeroGeometric, from photos flown September 2006 by Geodesy Remote Sensing Inc, Calgary, Ab.
2. Coordinate projection is NAD83, UTM projection.
3. Contour interval is 1 metre.

0 50 100 150 200 250
Scale in Metres

SRK Consulting
Engineers and Scientists
Vancouver B.C.

SRK JOB NO.: 1CE12.000.GT2
FILE NAME: 1CE012_000-GT2-7.dwg

ERDC

Keno Hill Project

Assessment of Groundwater Regime at the Valley Tailings Facility

Drillhole Locations

DATE:	APPROVED:	FIGURE:
Feb. 2008	BG	2.1

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Technical Study:

2007/08 GEOCHEMICAL STUDIES: TAILINGS GEOCHEMICAL ASSESSMENT

Date: Summer 2007 – February 2009

Performed By:

SRK

Objective

To better understand in-situ tailings weathering conditions at the Valley Tailings Facility (VTF).

Facts\Description of Study:

- To support the evaluation of closure options, a work plan was developed to answer the following questions:
    - What is the current metal loading from the VTF?
    - What is the widespread potential for order-of-magnitude increases in metal loading rates due to widespread and significant decreases in tailings pH?
- To tackle the questions listed above, test pits were excavated in May 2007, from which tailings horizons were logged and water chemistry was obtained. Water chemistry in the pits was considered an approximation of tailings pore water chemistry immediately adjacent.
- Shallow drive points were installed to measure water quality in July and August of 2007
- Paired sets of test wells were installed in October 2007. Samples continue to be collected and tested for water quality.

Results/Conclusions:

- Current contaminant loading exiting the VTF occurs through both surface water and groundwater pathways. These pathways report to the west of Dam #3 and to the Porcupine Diversion
- Portions of Porcupine Creek, Brefault Creek, and the Porcupine Diversion traverse exposed tailings, and contribute most of the chemical load to the Porcupine Diversion and Flat Creek

  Current Contaminant Loading

    - The average contained zinc mass of 21kg/m2 is in the range of attenuation capacity of 2 to 3 metres of peat by sorption processes alone (this is equal to the amount of peat observed in borehole profiles)

- Complete leaching of all contained zinc from the tailings is highly unlikely, in part due to the fact that much of the tailings is saturated and thus not available for oxidation
- There appears to be sufficient capacity within the underlying peat to attenuate all the zinc contained within the tailings (should it be released) by sorption alone. It is however, unlikely, that 100% of the zinc will be leached out of all the tailings

Potential for Increased Metal Loading due to Acid Generation

- The implications of the mineralogical findings for future contaminant loadings from the VTF as a whole are that widespread, highly acidic (pH<4) conditions are not expected to develop, and no significant remobilization of sorbed zinc is anticipated
- Current contaminant loadings can be considered to provide a good indication of the magnitude of future loadings

Technical Study:

2007/08 GEOCHEMICAL STUDIES: WASTE ROCK GEOCHEMICAL ASSESSMENT

Date: October 2007 – February 2009

Performed By:

ERDC/SRK

Objective:

To characterize and assess long term geochemical stability of various waste rock piles.

Facts\Description of Study:

- Samples were collected as part of the baseline environmental assessment conducted in 1996; however, the samples were not analyzed at that time due to financial difficulties. The samples were revisited in 2007 and those deemed intact and uncompromised were sent to the lab for analytical testing
- To identify and site considerations that required consideration for each dump, a matrix was developed that consisted of the categorized dumps (by size), a suite of closure considerations, and various candidate closure options
- Acid Base Accounting (ABA) testing (total sulphur, sulphate sulphur, by both NaCL and NaCO3 leach, inorganic carbon, and Sobek NP) and elemental analysis (four acid digestion with ICP-AES finish) were carried out on the samples
- A toe seep survey was carried out
- Results from the extraction tests were used to develop reasonable worst-case estimates of current chemical loading from individual waste rock piles. Worst-case loading estimates were then compared to known load sources to evaluate whether loading from waste rock piles is likely to be significant at district scale

Results/Conclusions:

- All leach extraction tests demonstrated that the various dumps contained a store of soluble oxidation products. Any dump disturbance (e.g. for resloping or relocation purposes) will lead to a short-term increase in loading from the disturbed material. Column test results from 1996 showed and initial zinc release exceeding steady-state release by 14 to 300 times – these results provide an indication of the increases in short term loads that might be expected immediately following disturbance of waste rock
- Results from the shake flask extraction work indicated that the largest waste rock load is likely to be generated by the Hector Adit dump. Scoping calculations carried out to provide an

indication of porewater chemistry indicated that zinc concentrations could be on the order of a few hundred mg/L. For comparison, the porewater zinc concentrations suggested by the scoping calculations are of the same magnitude as concentrations observed in the Galkeno 300 adit discharge.

- The Hector Adit dump is several kilometers from the nearest downgradient receiving water (as is the case for most other dumps in the district). Based on the modest chemical loadings from the waste rock dumps relative to other sources in the district, and based on the length and attenuating nature of the downgradient flowpath to the receiving environment, it is unlikely that contaminants from the waste rock dumps pose a significant risk to water quality in the receiving streams that are the focus of reclamation across the former UKHM site.

Technical Study:

MINE HYDROGEOLOGICAL MODEL

Date: 2007 –

Performed By:

ERDC

Objective:

To prepare a hydrogeological model for the mine site in an effort to better understand the potential future changes in mine water discharge points, quantities and quality, such as occurred at the Galkeno 300 adit in 1997. It will aim to understand the interconnectedness of the mine workings including underground workings, veins, faults, surface topography and likely flow pathways.

To prepare a geometric model of the mine workings to cover areas of environmental interest.

Facts\Description of Study:

- Models of the Silver King, Husky, Galkeno and Bellekeno mine workings with partial surfaces were produced.
- The 3-dimensional surfaces of the models were created using the 2-metre digital elevation model generated from aerial photography flown in 2006.
- These models are initial and intended for demonstrative purposes only.
- Updating of the models is ongoing. Engineering plans and sections are being digitized along with survey data to increase the accuracy of the models.

Results/Conclusions:

- Although the models are preliminary in nature, they are illustrative in terms of the relationship between various underground mine components

Technical Study:

SITE WIDE WATER BALANCE/MASS LOADING BALANCE UPDATE

Performed By:

ACG

Objective

To update the site wide loading and water balance based on new information including the update water quality database and the UKHM Hydrological Update and Assessment.

Facts\Description of Study:

- In 1996, as part of the Site Characterization, a mass balance for the site was constructed based on sub-watershed catchment basins. The water balance, which forms the basis for calculating site loading, was developed based on regional hydrological and weather data
- In 2007, Clearwater Consultants Ltd. confirmed the hydrological input parameters that were used to determine the water balance
- Hydrological and water balance data serve as a frame for loading model development. The network of water quality monitoring stations contribute necessary contaminant node inputs
- Together, hydrological data and contaminant information are used to calculate loads at critical points along watershed pathways and at outlet points for each of the three site watersheds (Christal, Flat, and Lightning Creeks)
- In 2008, the contaminant loads were updated to reflect more recent conditions. Data from 2006 – 2008 was used to determine year by year loads from adit discharges and in receiving waters
- Adit discharges have similarly been updated with more recent flow volumes exiting from the adits

Information Gaps:

Clearwater Consultants have recommended that the hydrology for the model be updated based on flow data gathered at the site, coupled with regional hydrology data where appropriate.

Because the model is based on observed loads at output nodes, it is difficult to predict what those loads would look like under different loading scenarios without making assumptions about the site attenuation capacity. The attenuating properties of the site will be under investigation in summer 2009 so that more concrete statements can be made about contaminant dissipation.

Results/Conclusions:

- The highest loads originate from the Galkeno 300 and Onek adits. Galkeno represents the highest treated load (on the order of 40kg Zn/year after treatment), while Onek produces the highest untreated load (at between 575 – 975kg Zn/year). Both discharges report to ground
- The mass balance model has served to produce an estimation of the degree of attenuation at the site. When loading is at its highest (i.e. in years where there is little or no treatment at any of the adits) the attenuation capacity has been shown to be roughly 90% of the load entering the watersheds

Output

An excel spreadsheet has been developed and refined which accepts inputs from a master water quality database and calculated loads at eleven basin output points, including Lightning Creek, Christal Creek immediately before discharge to the South McQuesten, and the final discharge point on the South McQuesten River for all site drainage.

A written report is in progress.

Attachment D

Closure Options Risk Assessment

Summary and Results

Groupings for summary presentation of risk results

1 Risks associated with WRSA closure options
Risk of waste rock contamination

2 Risks associated with adit closure options
Risk of adit failure/collapse

3 Risks specific to each alternative, including cost risks
Risks of engineering and system design failures
Risks of non-catastrophic maintenance failure
Risks that biological treatment or in-mine treatment systems do not perform adequately
Risks of structural failure of diversions, pipelines, slopes, etc.
Risks of implementation costs being higher than estimated
Risks of operating, maintenance and repair costs being higher than estimated
Quality assurance/quality control risks

WRSA Closure Option - Reslope 2.5:1 & Revegetate

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible		1E, 2E, 3E	4R		
Unlikely					
Very Unlikely					

Risks of waste rock contamination

1E	Resloping WRSA will cause short-term, one-time only increases in load over steady state conditions. Impacts on water quality
2E	Resloping WRSA will cause short-term, one-time only increases in load over steady state conditions. Impacts produces contaminated dust
3E	Resloping WRSA will cause short-term, one-time only increases in load over steady state conditions. Impacts on natural footprint
4R	The physical look of the waste rock piles reflects the heritage and mining past of the region and is preferable to some inhabitants of the area. Inhabitants may oppose altering the physical character of the WRSA, leading to

Pit Closure Option - Berm and Sign

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible			1H		
Unlikely					
Very Unlikely					

1H Access to the pits is not effectively prohibited, leading to inadvertant access and injury.

Adit Closure Options - Adit Bulkhead, Plug, or Rock Pile

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			2E		
Possible		1C			
Unlikely					
Very Unlikely					

1C	Risk of adit failure Collapse of the adit/workings leads to an inability to manage the water discharging from it, obscuring or hindering the performance of the plug
2E	Risk of plug/engineering failure Catastrophic failure via strength loss and plug fails, leading to a significant flux of water into the receiving environment

Valley Tailings Area Option 1 - Stabilize in Place - Status Quo

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain			1R		
Likely					
Possible		3C	4E, 5R	2E	
Unlikely		7C			
Very Unlikely				6E	

Risks of tailings dispersion

1R	Windblown tailings are dispersed beyond tailings impoundment leading to an impact on community land use

Risks of failure of Porcupine Diversion system

2E	Breach or failure of the Porcupine Diversion leading to contamination of the Flat Creek drainage
3C	Breach or failure of the Porcupine Diversion leading to need for upgrade/repair/maintenance of the diversion infrastructure

Risks of tailings dam breach

4E	Interruption of active care and maintenance for a period of time as a result of a lack of funding, absence of site presence, etc. leading to untreated, raw effluent discharging into the Flat Creek drainage (1-2mg/L Zn discharge for 1 or 2 years)
5R	Interruption of active care and maintenance for a period of time as a result of a lack of funding, absence of site presence, etc. leading to untreated, raw effluent discharging into the Flat Creek drainage (1-2mg/L Zn discharge for 1 or 2 years)
6E	Major breach of tailings impoundment dams (all 3 dams) leading to large-scale release of tailings downstream into Flat Creek watershed and bog beneath dams.

Risks of contamination of receiving enviroment via tailings porewater

7C	Deterioration of porewater water quality by an order of magnitude, leading to a 3-4x increase in treatment costs.

Valley Tailings Area Option 2 - Cover in Place and Revegetate

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain			1R		
Likely					
Possible		7E	4E, 6E		
Unlikely		3C	5E, 8E	2E	
Very Unlikely					

Risk of tailings dispersion

1R	Windblown tailings are dispersed beyond tailings impoundment leading to an impact on community land use
7E	Failure/erosion of the borrow area leads to release of suspended solids to the immediate natural environment

Risks of failure of Porcupine Diversion system

2E	Breach or failure of the Porcupine Diversion leading to contamination of the Flat Creek drainage
3C	Breach or failure of the Porcupine Diversion leading to need for upgrade/repair/maintenance of the diversion infrastructure

Risks of contamination of receiving enviroment via tailings porewater

4E	Drain-down of tailings porewater, leading to contamination of the receiving environment
5E	Deterioration of porewater water quality by an order of magnitude, leading to contamination of the receiving environment

Risks associated with tailings cover

6E	The cover is not thick enough, leading deep-rooted trees to take up contaminants from the tailings below the cover, or, due to wicking action (net evaporation) contaminants are brought up to the cover from the tailings

Risk of lack of QA/QC

8E	Lack of QA/QC during implementation of this option leads to inadequacies in the final product of the work

Valley Tailings Area Option 3 - Consolidate, Cover, and Revegetate

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain			1R		
Likely					
Possible		7E, 11C	4E, 6E, 9C, 10E, 12C, 13E, 15C		
Unlikely		3C	5E, 8E	2E, 14E	
Very Unlikely					

Risk of tailings dispersion

1R	Windblown tailings are dispersed beyond tailings impoundment leading to an impact on community land use
7E	Failure/erosion of the borrow area leads to release of suspended solids to the immediate natural environment

Risks of failure of Porcupine Diversion system

2E	Breach or failure of the Porcupine Diversion leading to contamination of the Flat Creek drainage
3C	Breach or failure of the Porcupine Diversion leading to need for upgrade/repair/maintenance of the diversion infrastructure

Risks of contamination of receiving enviroment via tailings porewater

4E	Drain-down of tailings porewater, leading to contamination of the receiving environment
5E	Deterioration of porewater water quality by an order of magnitude, leading to contamination of the receiving environment

Risks associated with tailings cover

6E	The cover is not thick enough, leading deep-rooted trees to take up contaminants from the tailings below the

Risks of tailings removal/relocation

9C	Wet tailings are not easily handled, leading to increased costs for tailings consolidation.
10E	Tailings berm failures (failure of the pile) during tailings consolidation leading to contamination/destruction of new creek beds and discharge of contaminants into Flat Creek drainage.
11C	Tailings berm failures (failure of the pile) during tailings consolidation leading to contamination/destruction of new creek beds and increased costs of construction and remediation.
12C	Low estimate of the amount of material the needs to be moved results in higher-than-expected costs.
13E	Residual contamination left behind after removal of the tailings leads to adverse effects on the surface water quality of the new creek beds.
14E	Risk of suspended solids loads from the rehabilitated tailings area before the area is established.
15C	Consolidation time on the relocated tailings is longer than estimated, leading to an increase in the overall cost of the operation (wait time, different contractors may have to be acquired over a number of years).

Risk of lack of QA/QC

8E	Lack of QA/QC during implementation of this option leads to inadequacies in the final product of the work

Galkeno 900 Option 1 - Ex-situ Bioreactor with Lime Treatment Contingency

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			4R		
Possible			3E		
Unlikely			6H	5H, 7H	
Very Unlikely			1E, 2E	8H	

Risks of bioreactor system failure/design flaws

1E	Wholescale failure of bioreactor treatment facility at a slow rate, leading to release of contaminants into the environment.

Risks of the natural environment

2E	Increase in the levels of zinc from the linked workings of Hector-Calumet, leading to exposure of the receiving environment to additional contaminants.
3E	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.
4R	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public perceptions about the quality of water in the Christal Creek watershed, and ultimately, the

External health and safety risks of reagents/chemicals

5H	Release of H_2S from the bioreactor with human exposure leading to serious illness or a fatality.
6H	Line leak (as a result of vandalism) leading to expulsion of methanol/ethanol to environment and exposure causing blindness/bodily harm/toxicity effects.
7H	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a day frequency), leading to a fatal accident.
8H	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a year frequency), leading to a fatal accident.

Galkeno 900 Option 2 - Upgrade Current Treatment System

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			2R		
Possible			1E, 3C		
Unlikely				4H	
Very Unlikely				5H	

Risks of the natural environment

1E	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.
2R	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public conceptions about the quality of water in the Christal Creek watershed, and ultimately, the
3C	Significant deterioration in water quality leading to need for capital inprovements for a new treatment system.

External health and safety risks of reagents/chemicals

4H	Human health and safety risk associated with the ability to deliver lime safely on rough roads (once a day frequency)
5H	Human health and safety risk associated with the ability to deliver lime safely on rough roads (once a year frequency)

Galkeno 900 Option 3 - Batch In-Mine Pool Bioreactor Treatment

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			5R		
Possible			4E		
Unlikely				6H	
Very Unlikely	1E			2H, 3H, 7H	

Risks of bioreactor system failure/design flaws

1E Wholescale failure of bioreactor in-mine pool treatment at a slow rate, leading to release of contaminants into the environment.

Risks of the natural environment

4E Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.

5R Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public conceptions about the quality of water in the Christal Creek watershed, and ultimately, the

External health and safety risks of reagents/chemicals

2H Release of H_2S from the bioreactor with human exposure leading to serious illness or fatality.

3H Creation of toxic gaseous conditions behind the hydraulic bulkhead as a result of both the creation of a low-oxygen atmosphere and H_2S gas leading to human exposure and death.

6H Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a day frequency), leading to a fatal accident.

7H Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a year frequency), leading to a fatal accident.

Onek Option 1 - In-Mine Pool Treatment

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			1E, 2E, 6R		
Possible		3E	4H, 5E		
Unlikely				7H	
Very Unlikely				8H	

Risks of system failure/design flaws

1E	Incomplete blocking of flow leads to less effective treatment. The result is poor water quality, leading to degradation of aquatic resources.
2E	Incomplete blocking of flow leads to less effective treatment. The result is soil contamination, leading to degradation of plant species.
3E	Water is backed up in the mine pool above the adit leading to seepage along the hillside.

Risks of the natural environment

5E	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.
6R	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public conceptions about the quality of water in the Christal Creek watershed, and ultimately, the

External health and safety risks of reagents/chemicals

4H	Creation of toxic gaseous conditions behind the hydraulic bulkhead as a result of both the creation of a low-oxygen atmosphere and H_2S gas leading to human exposure and death.
7H	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a day frequency), leading to a fatal accident.
8H	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a year frequency), leading to a fatal accident.

Onek Option 2 - Ex-situ Bioreactor

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible					
Unlikely			3H	2H, 4H	
Very Unlikely			1E	5H	

Risks of bioreactor system failure/design flaws

1E	Wholescale failure of bioreactor treatment facility at a slow rate, leading to release of contaminants into the environment.

External health and safety risks of reagents/chemicals

2H	Release of H_2S from the bioreactor with human exposure leading to serious illness or a fatality.
3H	Line leak (as a result of vandalism) leading to expulsion of methanol/ethanol to environment and exposure causing blindness/bodily harm/toxicity effects.
4H	Inability to deliver ethanol/methanol safely to treatment facility at Onek (once a day frequency), leading to a fatal accident.
5H	Inability to deliver ethanol/methanol safely to treatment facility at Onek (once a year frequency), leading to a fatal accident.

Onek Option 3 - Natural Attenuation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible			1E, 2E		
Unlikely					
Very Unlikely					

1E	Onek discharge is too high for site capacity for attenuation. Result is increase in concentrations of contaminants of concern in water drainages downstream.
2E	Onek discharge is too high for site capacity for attenuation. Result is increase in concentration of contaminants in soils, affecting the ability to vegetation to naturally flourish.

Hector Calumet Option 1 - Mine Pool Drain, Centralized HDS Plant in Elsa

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible			1C, 2E, 4C		
Unlikely			3E		
Very Unlikely				5H	

Risks of mine pool water quality

1C	Draining the mine results in a variation in the mine pool water level. This leads to exposure of the walls of the workings to oxidation during periods of low water levels, and in turn results in metals flushing and treatment
2E	Water quality worsens over the long term, leading to increased metals leaching in the mine pool.

Physical Hazards

3E	Failure of the pipeline, leading to discharge of very high contaminant concentration water leaking into the receiving environment.
4C	Slope hazard associated with the pipeline occurs, leading to the need for potential mitigative measures to be undertaken on the hillslope and higher construction and/or operation costs.

External health and safety risks of reagents/chemicals

5H	Inability to deliver lime safely to treatment facility in Elsa (once a day frequency), leading to a fatal accident.

Hector Calumet Option 2 - Isolate from GK300 by Hydraulic Plug, Centralized HDS plant in Elsa

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible					
Unlikely					
Very Unlikely					

	Risks of mine pool water quality
1E	Draining the mine results in a variation in the mine pool water level. This leads to exposure of the walls of the workings to oxidation during periods of lower water levels, and in turn results in metals flushing and treatment higher costs. However, because the pool is already filled to the 400' level, there is going to be less oxidation than there would be if the mine pool were drained because there is less exposed surface.
2E	Water quality worsens over the long term, leading to increased metals leaching in the mine pool.
	Physical Hazards
3E	Failure of the pipeline, leading to discharge of very high contaminant concentration water leaking into the receiving environment.
4C	Slope hazard associated with the pipeline occurs, leading to the need for potential mitigative measures to be undertaken on the hillslope and higher construction and/or operation costs.
	External health and safety risks of reagents/chemicals
5H	Inability to deliver lime safely to treatment facility in Elsa (once a day frequency), leading to a fatal accident.

Hector Calumet Option 3 - Isolate from GK300, In-Mine Pool Treatment and Attenuation

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			1E, 2E. 6R		
Possible		3E	4E, 5E		9E
Unlikely				7H	
Very Unlikely				8H	

Risks of system failure/design flaws

1E	Incomplete blocking of flow leads to less effective treatment. The result is poor water quality, leading to degradation of aquatic resources.
2E	Incomplete blocking of flow leads to less effective treatment. The result is soil contamination, leading to degradation of plant species.
3E	Water is backed up in the mine pool above the adit leading to seepage along the hillside.

Risks of the natural environment

5E	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.
6R	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public conceptions about the quality of water in the Christal Creek watershed, and ultimately, the South McQuesten River.
9E	The attenuation capacity of the site is overwhelmed through release of contaminants in the waters, leading to high levels of zinc and other contaminants in the soils and plants of the highly sensitive permafrost environment.

External health and safety risks of reagents/chemicals

4E	Creation of toxic gaseous conditions behind the hydraulic bulkhead as a result of both the creation of a low-oxygen atmosphere and H2S gas leading to human exposure and death.
7H	Inability to deliver ethanol/methanol safely to treatment facility at Hector-Calumet (once a day frequency), leading to a fatal accident.
8H	Inability to deliver ethanol/methanol safely to treatment facility at Hector-Calumet (once a year frequency), leading to a fatal accident.

Galkeno 300 Option 1 - Current Treatment System

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain			4C		
Likely					
Possible			2E, 5E	3C, 6H	
Unlikely			1E		
Very Unlikely					

Risks of the natural environment

1E	Increased flows to ≈20-30L/s making their way all the way down to Christal Creek, leading to an impact on the receiving environment (influx of large volume of water of poor quality negatively impacts on aquatic resources in Christal Creek).
2E	Discharge route changes over time, leading to waters directly reaching the receiving environment.
3C	Increased base flows leading to increased costs (2x)
4C	Increased sludge production leads to significant increase in sludge handling costs.

Physical Hazards

5E	Collapse of the adit leads to an inability to manage the water discharging from it.

External health and safety risks of reagents/chemicals

6H	Inability to deliver lime safely on rough roads (once a day frequency), leading to a fatal accident.

Galkeno 300 Option 2 - Centralized HDS Plant in Elsa

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely			1C		
Possible			3C		
Unlikely			2E		
Very Unlikely				4H	

Risks of the natural environment

1C	Increased base flows to ≈20-30L/s leading to a need for increased treatment capacity and higher capital costs.

Physical Hazards

2E	Failure of the pipeline, leading to discharge of very high contaminant concentration water leaking into the receiving environment.
3C	Slope hazard associated with the pipeline occurs, leading to the need for potential mitigative measures to be undertaken on the hillslope and higher construction and/or operation costs.

External health and safety risks of reagents/chemicals

4H	Inability to deliver lime safely to treatment facility in Elsa (once a day frequency), leading to a fatal accident.

Galkeno 300 Option 3 - Isolate Hector Mine Pool

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain			3C		
Likely			1C		
Possible		7C	5E, 10C, 11C	8C	
Unlikely		9C	4E		
Very Unlikely			2C	6H	

Risks of the natural environment

1C	Increased flows to ≈20-30L/s leading to a need for increased treatment capacity and higher capital costs.
2C	Increased base flows (2x) leading to increased costs
3C	Increased sludge production leads to significant increase in sludge handling costs.

Physical Hazards

4E	Failure of the pipeline, leading to discharge of very high contaminant concentration water leaking into the receiving environment.
5E	Collapse of the adit leads to an inability to manage the water discharging from it.

External health and safety risks of reagents/chemicals

6H	Inability to deliver lime safely to treatment facility at Galkeno 900 (once a day frequency), leading to a fatal accident.

Risks of system failure/design flaws

7C	Water does not report to Galkeno 900 after installation of the breast-high dam, with an inability even to redirect a small flow down the hillside to GK900 leading to increased costs.
8C	Drain-down is not effective, leading to the need for a bulkhead in the workings and increased costs.
9C	Further changes to the underground flows leads to changes in plans and associated costs (e.g. seeps develop on the hillside).
10C	Pumping requirements at Hector require significant additional expenditures.
11C	Additional treatment requirements at GK900 required if the bulkhead cannot adequately isolate water.

Galkeno 300 Option 4 - Isolate Hector Mine Pool, Centralized HDS Plant in Elsa*

Likelihood	Consequence Severity				
	Very Low	Minor	Moderate	Major	Critical
Almost Certain					
Likely					
Possible					
Unlikely					
Very Unlikely					

**See Galkeno 300 Options 2 and 3 for Option 4 identified risks*

Waste Rock Storage Areas - Option #2 - Reslope 2.5:1 and Revegetate

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Resloping WRSA will cause short-term, one-time only increases in load over steady state conditions. Impacts on water quality.	Env. Imp.	Minor	Possible	Moderate		
2	Resloping WRSA will cause short-term, one-time only increases in load over steady state conditions. Impacts produces contaminated dust.	Env. Imp.	Minor	Possible	Moderate		
3	Resloping WRSA will cause short-term, one-time only increases in load over steady state conditions. Impacts on natural footprint.	Env. Imp.	Minor	Possible	Moderate		
4	The physical look of the waste rock piles reflects the heritage and mining past of the region and is preferable to some inhabitants of the area. Inhabitants may oppose altering the physical character of the WRSA, leading to public concern and unrest.	Comm/Media/Rep	Moderate	Possible	Moderately High		

Pits - Option #1 - Berm and Sign

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Access to the pits is not effectively prohibited, leading to inadvertant access and injury.	Human H&S	Moderate	Possible	Moderately High		

Adit Closure - Option #1 - Adit Rock Pile

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Collapse of the adit leads to an inability to manage the water discharging from it, obscuring or hindering the performance of the plug.	Conseq. Costs	Minor	Possible	Moderate		Would increase the costs associated with stabilizing the adit.

Adit Closure - Option #2 - Hydraulic Plug

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Collapse of the adit leads to an inability to manage the water discharging from it, obscuring or hindering the performance of the plug.	Conseq. Costs	Minor	Possible	Moderate	Install another bulkhead and engineer other mitigative measures, or potentially collect the water from the collapsed adit.	Would increase the costs associated with stabilizing the adit.
2	Catastrophic failure via strength loss and plug fails.	Env. Imp.	Moderate	Likely	Moderately High		

Adit Closure - Option #3 - Hydraulic Bulkhead

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Collapse of the adit leads to an inability to manage the water discharging from it, obscuring or hindering the performance of the plug.	Conseq. Costs	Minor	Possible	Moderate	Install another bulkhead and engineer other mitigative measures, or potentially collect the water from the collapsed adit.	Would increase the costs associated with stabilizing the adit.
2	Catastrophic failure via strength loss and plug fails.	Env. Imp.	Moderate	Likely	Moderately High		

Hector Calumet - Option #1 - Mine Pool Drain, Centralized HDS Plant in Elsa							
	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Draining the mine results in a variation in the mine pool water level. This leads to exposure of the walls of the workings to oxidation during periods of low water levels, and in turn results in metals flushing and treatment higher costs.	Conseq. Costs	Moderate	Possible	Moderately High		There is potential to see a worsening of the water quality at the bottom of the Hector mine pool, with water quality conditions below that at Galkeno 300 (see risk #2).
2	Water quality worsens over the long term, leading to increased metals leaching in the mine pool.	Env. Imp.	Moderate	Possible	Moderately High		
3	Failure of the pipeline, leading to discharge of very high contaminant concentration water leaking into the receiving environment.	Env. Imp.	Moderate	Unlikely	Moderate	Put it in secondary containment, such as a ditch, or second pipeline	Recently, there was a great deal of water discharging from the adit, uncontrolled into the environment. Impacts to the local environment during that time and in the period following were not measurable. Therefore a week's discharge from the pipeline **may not** have a great impact.
4	Slope hazard associated with the pipeline occurs, leading to the need for potential mitigative measures to be undertaken on the hillslope and higher construction and/or operation costs.	Conseq. Costs	Moderate	Possible	Moderately High	For servicing, build pipeline along the road.	
5	Inability to deliver lime safely to treatment facility in Elsa (once a day frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		The roads at Elsa are very well maintained and travelled.

Hector Calumet - Option #2 - Isolate from GK300 by Hydraulic Plug, Centralized HDS plant in Elsa							
	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Draining the mine results in a variation in the mine pool water level. This leads to exposure of the walls of the workings to oxidation during periods of lower water levels, and in turn results in metals flushing and treatment higher costs. However, because the pool is already filled to the 400' level, there is going to be less oxidation than there would be if the mine pool were drained because there is less exposed surface.	Env. Imp.	Moderate	Almost Certain	High		
2	Water quality worsens over the long term, leading to increased metals leaching.	Env. Imp.	Moderate	Unlikely	Moderate		
3	Inability to deliver lime safely to treatment facility in Elsa (once a day frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		The roads at Elsa are very well maintained and travelled.
4	Failure of the pipeline, leading to discharge of very high contaminant concentration water leaking into the receiving environment.	Env. Imp.	Moderate	Unlikely	Moderate	Put it in secondary containment, such as a ditch, or second pipeline	Recently, there was a great deal of water discharging from the adit, uncontrolled into the environment. Impacts to the local environment during that time and in the period following were not measurable. Therefore a week's discharge from the pipeline **may not** have a great impact.
5	Slope hazard associated with the pipeline occurs, leading to the need for potential mitigative measures to be undertaken on the hillslope and higher construction and/or operation costs.	Conseq. Costs	Moderate	Possible	Moderately High	For servicing, build pipeline along the road.	

Hector Calumet - Option #3 - Isolate from GK300, In-Mine Pool Treatment and Attenuation							
	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Incomplete blocking of flow leads to less effective treatment. The result is poor water quality, leading to degradation of aquatic resources.	Env. Imp.	Moderate	Likely	Moderately High		Pertains primarily to the effectiveness of the bulkhead to act as a blockage for the water exiting the mine - if there were other exits, the water would find a way to escape.
2	Incomplete blocking of flow leads to less effective treatment. The result is soil contamination, leading to degradation of plant species.	Env. Imp.	Moderate	Likely	Moderately High		Pertains primarily to the effectiveness of the bulkhead to act as a blockage for the water exiting the mine - if there were other exits, the water would find a way to escape.
3	Water is backed up in the mine pool above the adit leading to seepage along the hillside.	Env. Imp.	Minor	Possible	Moderate		This differs from GK900 in the sense that the waters have a higher concentration, lower flow, and greater distance from the receiving environment. Therefore, this risk is rated somewhat lower than that which we identified for GK900.
4	Creation of toxic gaseous conditions behind the hydraulic bulkhead as a result of both the creation of a low-oxygen atmosphere and H_2S gas leading to human exposure and death.	Env. Imp.	Moderate	Possible	Moderately High	Inhibit pit access.	Gases would exit through the pit, so it's not an adit risk per se.
5	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.	Env. Imp.	Moderate	Possible	Moderately High		
6	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public conceptions about the quality of water in the Christal Creek watershed, and ultimately, the South McQuesten River.	omm/Media/Re	Moderate	Likely	Moderately High		
7	Inability to deliver ethanol/methanol safely to treatment facility at Hector-Calumet (once a day frequency), leading to a fatal accident.	Human H&S	Major	Unlikely	Moderately High		The road into Hector Calumet is not as dangerous as the road around the hillside into Galkeno 300, therefore there is less chance of an accident here.
8	Inability to deliver ethanol/methanol safely to treatment facility at Hector-Calumet (once a year frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		The road into Hector Calumet is not as dangerous as the road around the hillside into Galkeno 300, therefore there is less chance of an accident here.
9	The attenuation capacity of the site is overwhelmed through release of contaminants in the waters, leading to high levels of zinc and other contaminants in the soils and plants of the highly sensitive permafrost environment.	Env. Imp.	Critical	Possible	High		

Galkeno 300 - Option #1 - Current Treatment System

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Increased flows to ≈20-30L/s **making their way all the way down to Christal Creek**, leading to an impact on the receiving environment (influx of large volume of water of poor quality negatively impacts on aquatic resources in Christal Creek).	Env. Imp.	Moderate	Unlikely	Moderate		
2	Discharge route changes over time, leading to waters directly reaching the receiving environment.	Env. Imp.	Moderate	Possible	Moderately High		
3	Increased base flows leading to increased costs (2x)	Conseq. Costs	Major	Possible	High		
4	Increased sludge production leads to significant increase in sludge handling costs.	Conseq. Costs	Moderate	Almost Certain	High		The sime pit will eventually run out of capacity, and a new sludge location will have to be identified for GK300 waste.
5	Collapse of the adit leads to an inability to manage the water discharging from it.	Env. Imp.	Moderate	Possible	Moderately High		Waters could be captured with little effort from collapsed adits. This scenario differs somewhat from Galkeno 900 because there are increased environmental concerns.
6	Inability to deliver lime safely on rough roads (once a day frequency), leading to a fatal accident.	Human H&S	Major	Possible	High		This is a much more dangerous road than the one to GK900 or Hector Calumet, making this a more likely risk than the risk of travelling into other sites.

Galkeno 300 - Option #2 - Centralized HDS Plant in Elsa

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Increased base flows to ≈20-30L/s leading to a need for increased treatment capacity and higher capital costs.	Conseq. Costs	Moderate	Likely	Moderately High	The pipeline to the HDS plant at Elsa can easily be sized to accommodate flows of up to 2x or more the normal flow rate.	
2	Failure of the pipeline, leading to discharge of very high contaminant concentration water leaking into the receiving environment.	Env. Imp.	Moderate	Unlikely	Moderate	Put it in secondary containment, such as a ditch, or second pipeline	Recently, there was a great deal of water discharging from the adit, uncontrolled into the environment. Impacts to the local environment during that time and in the period following were not measurable. Therefore a week's discharge from the pipeline **may not** have a great impact.
3	Slope hazard associated with the pipeline occurs, leading to the need for potential mitigative measures to be undertaken on the hillslope and higher construction and/or operation costs.	Conseq. Costs	Moderate	Possible	Moderately High	For servicing, build pipeline along the road.	
4	Inability to deliver lime safely to treatment facility in Elsa (once a day frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		

Galkeno 300 - Option #3 - Isolate Hector Mine Pool, Redirect to Galkeno 900

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Increased flows to ≈20-30L/s leading to a need for increased treatment capacity and higher capital costs.	Conseq. Costs	Moderate	Likely	Moderately High		
2	Increased base flows (2x) leading to increased costs	Conseq. Costs	Moderate	Very Unlikely	Low		
3	Increased sludge production leads to significant increase in sludge handling costs.	Conseq. Costs	Moderate	Almost Certain	High		
4	Failure of the pipeline, leading to discharge of very high contaminant concentration water leaking into the receiving environment.	Env. Imp.	Moderate	Unlikely	Moderate		
5	Collapse of the adit leads to an inability to manage the water discharging from it.	Env. Imp.	Moderate	Possible	Moderately High		Waters could be captured with little effort from collapsed adits. This scenario differs somewhat from Galkeno 900 because there are increased environmental concerns.
6	Inability to deliver lime safely to treatment facility at Galkeno 900 (once a day frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		This road is not as dangerous as the road to Galkeno 300.
7	Water does not report to Galkeno 900 after installation of the breast-high dam, with an inability even to redirect a small flow down the hillside to GK900 leading to increased costs.	Conseq. Costs	Minor	Possible	Moderate	Water could be directed to GK900 some other way (pipeline)	
8	Drain-down is not effective, leading to the need for a bulkhead in the workings and increased costs.	Conseq. Costs	Major	Possible	High		A bulkhead would need to be installed 2500m into the workings (very high risk/costs assoc. with this).
9	Further changes to the underground flows leads to changes in plans and associated costs (e.g. seeps develop on the hillside).	Conseq. Costs	Minor	Unlikely	Low		
10	Pumping requirements at Hector require significant additional expenditures.	Conseq. Costs	Moderate	Possible	Moderately High		
11	Additional treatment requirements at GK900 required if the bulkhead cannot adequately isolate water.	Conseq. Costs	Moderate	Possible	Moderately High		

Galkeno 300 - Option #4 - Isolate Hector Mine Pool, Redirect Elsa HDS*

Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments

**See Galkeno 300 Options 2 and 3 for Option 4 risks*

Onek - Option #1 - In-Mine Pool Treatment

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Incomplete blocking of flow leads to less effective treatment. The result is poor water quality, leading to degradation of aquatic resources.	Env. Imp.	Moderate	Likely	Moderately High		Pertains primarily to the effectiveness of the bulkhead to act as a blockage for the water exiting the mine - if there were other exits, the water would find a way to escape.
2	Incomplete blocking of flow leads to less effective treatment. The result is soil contamination, leading to degradation of plant species.	Env. Imp.	Moderate	Likely	Moderately High		Pertains primarily to the effectiveness of the bulkhead to act as a blockage for the water exiting the mine - if there were other exits, the water would find a way to escape.
3	Water is backed up in the mine pool above the adit leading to seepage along the hillside.	Env. Imp.	Minor	Possible	Moderate		This differs from GK900 in the sense that the waters have a higher concentration, lower flow, and greater distance from the receiving environment. Therefore, this risk is rated somewhat lower than that which we identified for GK900.
4	Creation of low-oxygen atmospheric conditions behind the hydraulic bulkhead leading to human exposure and death.	Human H&S	Moderate	Possible	Moderately High	Inhibit pit access.	Gases would exit through the pit, so it's not an adit risk per se.
5	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.	Env. Imp.	Moderate	Possible	Moderately High		
6	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public conceptions about the quality of water in the Christal Creek watershed, and ultimately, the South McQuesten River.	Comm/Media/Re	Moderate	Likely	Moderately High		
7	Inability to deliver ethanol/methanol safely to treatment facility at Onek (once a day frequency), leading to a fatal accident.	Human H&S	Major	Unlikely	Moderately High		
8	Inability to deliver ethanol/methanol safely to treatment facility at Onek (once a year frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		

Onek - Option #2 - Ex-situ Bioreactor

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Wholescale failure of bioreactor treatment facility at a slow rate, leading to release of contaminants into the environment.	Env. Imp.	Moderate	Very Unlikely	Low		Because of the sulphate-reducing environment developed over time, catastrophic failure is not possible as long as the waters come into contact with the sulphate-reducing zone.
2	Release of H_2S from the bioreactor with human exposure leading to serious illness or a fatality.	Human H&S	Major	Unlikely	Moderately High		This situation can be thought of as similar to a natural bog scenario, where there might be a fast die-off of a great deal of organic matter.
3	Line leak (as a result of vandalism) leading to expulsion of methanol/ethanol to environment and exposure causing blindness/bodily harm/toxicity effects.	Human H&S	Moderate	Unlikely	Moderate		
4	Inability to deliver ethanol/methanol safely to treatment facility at Onek (once a day frequency), leading to a fatal accident.	Human H&S	Major	Unlikely	Moderately High		
5	Inability to deliver ethanol/methanol safely to treatment facility at Onek (once a year frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		

Onek - Option #3 - Natural Attenuation

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Ice plug is created and there is a sudden failure.	Env. Imp.	Moderate	Possible	Moderately High		There is the potential for days of flow considering size of workings. However, Onek is several kilometres from discharging into receiving waters - there is a ponding region at the bottom of the bog where Onek water might sit if given the opportunity to free-flow following a breach in the ice plug. Nearer to the adit entrance, a release like this runs the risk of large-scale erosion there.
2	Onek discharge is too high for site capacity for attenuation. Result is increase in concentrations of contaminants of concern in water drainages downstream.	Env. Imp.	Moderate	Possible	Moderately High		
3	Onek discharge is too high for site capacity for attenuation. Result is increase in concentration of contaminants in soils, affecting the ability to vegetation to naturally flourish.	Comm/Media/Re	Moderate	Possible	Moderately High		The reason we've selected this as a community concern is that a contamination would result in health/activity warnings that change the perceptions of persons who might use the area for food. Signs would be posted.
4	WRSA is left at angle of repose, resulting in a potentially objectionable aesthetic to persons in Yukon.	Comm/Media/Re	Moderate	Likely	Moderately High		This may not necessarily be considered a community risk among all communities (i.e. Mayo residents are contented to leave the dumps as they are to give the impression of the mining heritage).
5	Pit is left unbermed (as is) and causes a person to fall in, resulting in a fatality.	Human H&S	Major	Unlikely	Moderately High		The thinking is that on a frequency of once every 200 years, a person will fall into the pit, with the ultimate consequence of a fatality.

Galkeno 900 - Option #1 - Ex-situ Bioreactor with Lime Treatment Contingency

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Wholescale failure of bioreactor treatment facility at a slow rate, leading to release of contaminants into the environment.	Env. Imp.	Moderate	Very Unlikely	Low		Because of the sulphate-reducing environment developed over time, catastrophic failure is not possible as long as the waters come into contact with the sulphate-reducing zone.
2	Increase in the levels of zinc from the linked workings of Hector-Calumet, leading to exposure of the receiving environment to additional contaminants.	Env. Imp.	Moderate	Very Unlikely	Low		
3	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.	Env. Imp.	Moderate	Possible	Moderately High		This water may or may not discharge to a body that shows impacts (i.e. Christal Lake). Water is estimated to discharge @ ≈1.0L/s from seeps to ground, ultimately reporting to Christal Lake and quality is thought to be at a maximum the same as that at @ Galkeno 900 adit.
4	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public perceptions about the quality of water in the Christal Creek watershed, and ultimately, the South McQuesten River.	Comm/Media/Re	Moderate	Likely	Moderately High		Perceptions of the quality of fish stocks in the S. McQuesten River may inhibit the propensity of First Nations to fish at the S. McQuesten ridge. Ling cod/Arctic greyling are the specices fished for and those that groups would be most concerned about.
5	Release of H_2S from the bioreactor with human exposure leading to serious illness or a fatality.	Human H&S	Major	Unlikely	Moderately High		
6	Line leak (as a result of vandalism) leading to expulsion of methanol/ethanol to environment and exposure causing blindness/bodily harm/toxicity effects.	Human H&S	Moderate	Unlikely	Moderate		
7	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a day frequency), leading to a fatal accident.	Human H&S	Major	Unlikely	Moderately High		
8	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a year frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		

Galkeno 900 - Option #2 - Upgrade Current Treatment System

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.	Env. Imp.	Moderate	Possible	Moderately High		This water may or may not discharge to a body that shows impacts (i.e. Christal Lake). Water is estimated to discharge @ ≈1.0L/s from seeps to ground, ultimately reporting to Christal Lake and quality is thought to be at a maximum the same as that at @ Galkeno 900 adit.
2	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public conceptions about the quality of water in the Christal Creek watershed, and ultimately, the South McQuesten River.	Comm/Media/Re	Moderate	Likely	Moderately High		Perceptions of the quality of fish stocks in the S. McQuesten River may inhibit the propensity of First Nations to fish at the S. McQuesten ridge. Ling cod/Arctic greyling are the specices fished for and those that groups would be most concerned about.
3	Significant deterioration in water quality leading to need for capital inprovements for a new treatment system.	Conseq. Costs	Moderate	Possible	Moderately High		
4	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a day frequency), leading to a fatal accident.	Human H&S	Major	Unlikely	Moderately High		
5	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a year frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		

Galkeno 900 - Option #3 - Batch In-Mine Pool Bioreactor Treatment

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Wholescale failure of bioreactor in-mine pool treatment at a slow rate, leading to release of contaminants into the environment.	Env. Imp.	Very Low	Very Unlikely	Low		
2	Release of H_2S from the bioreactor with human exposure leading to serious illness or fatality.	Human H&S	Major	Very Unlikely	Moderate		
3	Creation of toxic gaseous conditions behind the hydraulic bulkhead as a result of both the creation of a low-oxygen atmosphere and H_2S gas. These toxic conditions lead to human exposure and death.	Human H&S	Major	Very Unlikely	Moderate		
4	Uncontrolled seepage from the seeps in the hillside leading to contamination of the hillside, and ultimately the receiving environment.	Env. Imp.	Moderate	Possible	Moderately High		
5	Uncontrolled seepage from the seeps in the hillside enter the Christal Creek receiving environment, leading to negative public conceptions about the quality of water in the Christal Creek watershed, and ultimately, the South McQuesten River.	Comm/Media/Re	Moderate	Likely	Moderately High		
6	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a day frequency), leading to a fatal accident.	Human H&S	Major	Unlikely	Moderately High		
7	Inability to deliver ethanol/methanol safely to treatment facility at GK900 (once a year frequency), leading to a fatal accident.	Human H&S	Major	Very Unlikely	Moderate		

VTA - Option #1 - Status Quo

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Windblown tailings are dispersed beyond tailings impoundment leading to an impact on community land use.	Comm/Media/Rep	Moderate	Almost Certain	High		This risk has already impacted on traditional land uses (i.e. Persons are less likely to use the land for any variety of uses that other, nearby lands are used for)
2	Breach or failure of the Porcupine Diversion leading to contamination of the Flat Creek drainage	Env. Imp.	Major	Possible	High		Tailings solids would wash from behind the dam where they are contained to beyond the dam.
3	Breach or failure of the Porcupine Diversion leading to need for upgrade/repair/maintenance of the diversion infrastructure	Conseq. Costs	Minor	Possible	Moderate		
4	Interruption of active care and maintenance for a period of time as a result of a lack of funding, absence of site presence, etc. leading to untreated, raw effluent discharging into the Flat Creek drainage (1-2mg/L Zn discharge for 1 or 2 years).	Env. Imp.	Moderate	Possible	Moderately High		Assume 20% of the flow comes from the tailings facility, with the other 80% from Pocupine Diversion. This risk refers to a single event where there is a large-scale release of water (such as at the freshet).
5	Interruption of active care and maintenance for a period of time as a result of a lack of funding, absence of site presence, etc. leading to untreated, raw effluent discharging into the Flat Creek drainage (1-2mg/L Zn discharge for 1 or 2 years).	Comm/Media/Rep	Moderate	Possible	Moderately High		
6	Major breach of tailings impoundment dams (all 3 dams) leading to large-scale release of tailings downstream into Flat Creek watershed and bog beneath dams.	Env. Imp.	Major	Very Unlikely	Moderate		
7	Deterioration of porewater water quality by an order of magnitude, leading to a 3-4x increase in treatment costs.	Conseq. Costs	Minor	Unlikely	Low		

VTA - Option #2 - Cover in Place and Revegetate

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Windblown tailings are dispersed beyond tailings impoundment leading to an impact on community land use.	Comm/Media/Rep	Moderate	Almost Certain	High		This risk has already impacted on traditional land uses (i.e. Persons are less likely to use the land for any variety of uses that other, nearby lands are used for)
2	Breach or failure of the Porcupine Diversion leading to contamination of the Flat Creek drainage.	Env. Imp.	Major	Unlikely	Moderately High		This risk is reduced from Option #1 as a result of the better engineered Porcupine Diversion.
3	Breach or failure of the Porcupine Diversion leading to need for upgrade/repair/maintenance of the diversion infrastructure.	Conseq. Costs	Minor	Unlikely	Low		This risk is reduced from Option #1 as a result of the better engineered Porcupine Diversion.
4	Drain-down of tailings porewater, leading to contamination of the receiving environment.	Env. Imp.	Moderate	Possible	Moderately High		Would flow as seepage into North Fork Flat Creek
5	Deterioration of porewater water quality by an order of magnitude, leading to contamination of the receiving environment.	Env. Imp.	Moderate	Unlikely	Moderate		
6	The cover is not thick enough, leading deep-rooted trees to take up contaminants from the tailings below the cover, or, due to wicking action (net evaporation) contaminants are brought up to the cover from the tailings below.	Env. Imp.	Moderate	Possible	Moderately High		There will be some settlement associated with covering the tailings due to the additional load.
7	Failure/erosion of the borrow area leads to release of suspended solids to the immediate natural environment.	Env. Imp.	Minor	Possible	Moderate		Not sure of the overall impact this could have.
8	Lack of QA/QC during implementation of this option leads to inadequacies in the final product of the work.	Env. Imp.	Moderate	Unlikely	Moderate		

VTA - Option #3 - Consolidate, Cover, and Revegetate

	Scenario	Consequence Type	Consequence Severity	Likelihood Probability	Risk Rating Descriptive	Mitigation Measures	Comments
1	Windblown tailings are dispersed beyond tailings impoundment leading to an impact on community land use.	Comm/Media/Rep	Moderate	Almost Certain	High		This risk has already impacted on traditional land uses (i.e. Persons are less likely to use the land for any variety of uses that other, nearby lands are used for)
2	Breach or failure of the Porcupine Diversion leading to contamination of the Flat Creek drainage.	Env. Imp.	Major	Unlikely	Moderately High		This risk is reduced from Option #1 as a result of the better engineered Porcupine Diversion.
3	Breach or failure of the Porcupine Diversion leading to need for upgrade/repair/maintenance of the diversion infrastructure.	Conseq. Costs	Minor	Unlikely	Low		This risk is reduced from Option #1 as a result of the better engineered Porcupine Diversion.
4	Drain-down of tailings porewater, leading to contamination of the receiving environment.	Env. Imp.	Moderate	Possible	Moderately High		Would flow as seepage into North Fork Flat Creek
5	Deterioration of porewater water quality by an order of magnitude, leading to contamination of the receiving environment.	Env. Imp.	Moderate	Unlikely	Moderate		
6	The cover is not thick enough, leading deep-rooted trees to take up contaminants from the tailings below the cover, or, due to wicking action (net evaporation) contaminants are brought up to the cover from the tailings below.	Env. Imp.	Moderate	Possible	Moderately High		There will be some settlement associated with covering the tailings due to the additional load.
7	Failure/erosion of the borrow area leads to release of suspended solids to the immediate natural environment.	Env. Imp.	Minor	Possible	Moderate		Not sure of the overall impact this could have.
8	Lack of QA/QC during implementation of this option leads to inadequacies in the final product of the work.	Env. Imp.	Moderate	Unlikely	Moderate		
9	Wet tailings are not easily handled, leading to increased costs for tailings consolidation.	Conseq. Costs	Moderate	Possible	Moderately High		
10	Tailings berm failures (failure of the pile) during tailings consolidation leading to contamination/destruction of new creek beds and discharge of contaminants into Flat Creek drainage.	Env. Imp.	Moderate	Possible	Moderately High		
11	Tailings berm failures (failure of the pile) during tailings consolidation leading to contamination/destruction of new creek beds and increased costs of construction and remediation.	Conseq. Costs	Minor	Possible	Moderate		
12	Low estimate of the amount of material the needs to be moved results in higher-than-expected costs.	Conseq. Costs	Moderate	Possible	Moderately High		Cost would likely not be underestimated by more than 25%
13	Residual contamination left behind after removal of the tailings leads to adverse effects on the surface water quality of the new creek beds.	Env. Imp.	Moderate	Possible	Moderately High		The tailings being moved are old tailings and therefore of greater chemical concern than the other, newer, stationary tailings.
14	Risk of suspended solids loads from the rehabilitated tailings area before the area is established.	Env. Imp.	Major	Unlikely	Moderately High		There is no certainty regarding the extent dispersion of the solids, although it would not be far as they are particulate matter.
15	Consolidation time on the relocated tailings is longer than estimated, leading to an increase in the overall cost of the operation (wait time, different contractors may have to be acquired over a number of years).	Conseq. Costs	Moderate	Possible	Moderately High		Differential settling poses an added complication.