North American Tungsten Corporation Limited

ISSUED FOR USE

RESPONSE TO YESAB'S ADEQUACY REVIEW REPORT FOR THE PROPOSED MACTUNG MINE, MACMILLAN PASS, YUKON (YESAB PROJECT NUMBER: 2008-0304)

ADDENDUM 1 OF THE MACTUNG PROJECT PROPOSAL

EBA FILE: W23101211.002

July 2009

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APPENDICES

1.0 INTRODUCTION

This document contains North American Tungsten Corporation's (NATC) response to the Yukon Environmental and Socio-Economic Assessment Board's (YESAB) Adequacy Review Report dated March 30, 2009 (YESAB project #2008-0304). The document should be considered an addendum to the project proposal submitted to YESAB in December 2008. Although most of the project information is contained in the project proposal, the information contained in this addendum supersedes the relevant information contained in the project proposal.

To help the reader follow the document each of NATC's responses follows the text of each of YESAB's rationales and information requests, i.e., rationale-request-response; rationale-request-response etc. Also, YESAB's rationales and information requests have a grey background to clearly separate them from the responses. The numbering of the information requests matches that in the Adequacy Review Report of March 30, 2009.

2.0 GENERAL COMMENTS

The general comments presented by YESAB in Section 2 of the Adequacy Review Report have been duly noted. One paragraph of the Adequacy Review Report states:

"There is however, a considerable amount of baseline and predictive information missing that is fundamental to developing supported and defensible assessment conclusions. An approach that compensates for this lack of data by developing a conservative, worst case scenario has been employed in previous assessments under YESAA when appropriate."

NATC has provided a considerable amount of data to support the proposed project and the associated effects assessments. Where such data are incomplete or the conclusions are unclear a worst-case scenario has been adopted and the appropriate mitigation measures have been provided. It is very important for everyone involved in the assessment of the project, or who has a personal or professional interest in the project that the science and engineering behind the proposal are understood. NATC has therefore attempted to explain, at length, some of the fundamental elements of the project to help establish a shared understanding of the Mactung project proposal.

3.0 INFRASTRUCTURE QUESTIONS

3.1 AERODROME

3.1.1 Fuel Storage at the Aerodrome

The project proposal indicates that Macmillan Pass Airstrip and surrounding area will be a hub for project activities during the life of the project. Infrastructure and project activities include a temporary construction camp for the road, a staging area and an active airstrip with regularly scheduled flights. Given that the mine site is approximately 37 km away from the aerodrome, and that it will not be accessible via the proposed access road until after the road is completed, it is expected that there will be the requirement for fuel storage at the aerodrome location.

The project proposal does not currently indicate that fuel for vehicles or aircraft will be stored at this location, nor does it state how fuel will be transported to this location. Improper fuel storage and transport can lead to leaks and spills and have adverse effects on nearby water sources, aquatic habitat, fish, wildlife, vegetation, and human safety. Therefore, as part of the assessment process, it is important to know how and where fuel for project activities and infrastructure at this location will be stored or originate from. Please provide the following information.

a) Indicate whether fuel will be stored at the aerodrome. If so, indicate the anticipated maximum amounts of fuel to be stored, what types of fuel will be stored, the kind of storage facilities to be used, and the manner in which it will be transported.

NATC will not have fuel storage at the Macmillan Pass Aerodrome for vehicles or aircrafts. NATC will store fuel for vehicles and equipment at the Macmillan Pass staging area which is separate from the aerodrome. Fuel storage at the staging area will be required during the construction phase only.

Aircraft that are used for supplying or servicing Mactung will not require refuelling at the Macmillan Pass for a return trip. The use of any fuel caches at the aerodrome may be maintained by the individual aircraft operators for the purpose of their own operational/emergency needs.

Fuel will be stored in double-walled tankers at the staging area. NATC proposes to have one 25,000 L tanker for diesel and one 10,000 L tanker for gasoline. Storage and containment of fuel will comply with terms and conditions outlined in the *Environment Act* and associated regulations. Transport of fuel to the site will travel to the Macmillan Pass staging area via the North Canol Road.

Refuelling of equipment at the staging area will occur directly from the tanker into vehicles and equipment or to tidy tanks for refuelling of equipment at construction site locations.

b) Provide details or reference standard operation procedures and mitigations that will be in place to avoid fuel leaks or spills and, should they occur, address potential fuel leaks or spills.

Fuel management practices will follow standards as established under the *Environment Act* Storage Tank Regulation and industry best management practices.

Storage tanks will be permitted under the Storage Tank Regulations and secondary containment will be installed as per the regulations. Fuel will be hauled to the site by a licensed fuel supplier.

Personnel involved in construction and later operation of the mine will be trained according to their assigned duties.

A detailed Spill Contingency Plan is contained within Appendix B of Appendix M2 of the Project Proposal; however, a summary of typical procedures that will be followed at and around the aerodrome is included within the remainder of this section.

Typical spill prevention procedures include:

- Proper storage and transfer procedures for fuel truck operators and equipment operators.
- Spill reporting.
- No refuelling will be conducted in creek beds or active drainage courses. With the exception of pumps, and equipment operating in an emergency, all equipment will be fuelled at a distance of 30 m or more from a drainage course.
- Spill kits will be located at all bulk fuel storage areas.
- Fuel will be transported on the site in a fuel truck that meets current regulatory codes and that is equipped with an appropriate spill kit. To the extent possible, fuel trucks will avoid backing near any watercourses.
- Personnel involved in refuelling will receive specific training on the use of the spill kit carried on the fuel truck.
- Fuel transfer equipment components such as pumps, hoses, and nozzles will be visually checked for leaks or damage prior to each refuelling operation.
- Fuel transfer areas for bulk fuel storage tanks will be lined to contain potential spills.
- No other activities will be allowed in the area while refuelling is underway.
- The fuel transfer will be visually and continually monitored.
- Fuel transfer nozzles will be operated manually and will not be locked in the open position.
- The fuel truck will be placed as close as possible to the equipment being refuelled. Trucks will be guided when backing close to other equipment. Where fuel transfer hoses are laid on the ground to reach equipment being refuelled, no other equipment will be allowed within 5 m of the hose or vehicles while the fuel transfer is taking place.

A spill contingency plan will be developed for the specific conditions and equipment available at the site. A basic plan is provided as an example.

Fuel or Lubricant Spill Procedure (into watercourse)

In the case of a spill, overflow, or release of hydrocarbons into a creek or watercourse, everything will be done that is practically possible to control the situation, and help will be sought.

Releases into dry watercourses should be dealt with by following procedures for releases on land; however, cleanup will proceed as rapidly as possible given the likelihood of groundwater at a shallow depth below the creek bed.

Releases into watercourses with standing water or flowing water will require immediate action. The general steps listed below will be followed as applicable to the circumstances of the release. Where possible, more than one team of responders should be used to enable multiple tasks to be completed at the same time.

The general steps below will be followed as applicable to the circumstances of the release.

a. Stop the release of contaminants. If this is not possible, removing the source of the release from the area of the watercourse will be considered.

b. Construct dykes or place barriers to prevent contaminants entering water.

c. If contaminants have entered the water use absorbent booms and pads to recover hydrocarbons from the water surface. Booms will be placed across watercourses and pads floated on the upstream side to assist in the recovery of product. Booms and absorbent pads will be used in sections of the watercourse where flow is reduced. This will usually be in areas of deeper water such as locations where sediment traps have been constructed. Multiple booms can be used to provide greater recovery of product. Where stream flow is so rapid that product is forced past booms and absorbent pads, consideration will be given to placing temporary dykes to slow the flow and assist in product recovery.

d. Remove equipment and vehicles not required for clean up.

e. Remove ignition sources.

f. Do not allow tiger torches, vehicles, smoking, or other sources of ignition near the area.

g. Keep a fire extinguisher on hand but keep it a safe distance away from any potential ignition source (if a fire starts you must be able to access the extinguisher).

h. Mark the location of the spill.

i. Notify the supervisor as soon as possible.

j. The supervisor will review the situation and determine if additional Emergency Response Services or an Environmental Consultant are required in accordance with the applicable regulations.

<u>Clean-up and Disposal</u>

The equipment available at the mine should be able to handle most spills and releases. Where necessary, the "Mine Site Supervisor" will coordinate the reallocation of equipment and resources away from the construction/mining activities for use in emergency response, clean up, and disposal. If required, Emergency Response Services will be engaged for the containment, cleanup, and disposal of contamination released into the environment.

Fuel or Lubricant Spill Procedure (On Land)

In the case of a spill, overflow, or release of fluid due to equipment or hose failure, whatever is practically and safely possible to control the situation will be done, and help will be sought. The general steps listed below will be followed as applicable to the circumstances of the release.

a. Stop the release of the contaminants at the source.

b. Shut down equipment and vehicles.

c. Remove ignition sources.

d. Do not allow tiger torches, vehicles, smoking, or other sources of ignition near the area.

e. Keep a fire extinguisher on hand but keep it a safe distance away from any potential ignition source (if a fire starts you must be able to access the extinguisher).

f. Contain the spill by using absorbent pads or constructing a temporary dike around the spill to contain the material.

g. Enlist the help of personnel on site.

h. Mark the location of the spill and notify the supervisor as soon as possible. If the supervisor is not available contact the "Mine Site Supervisor".

i. The supervisor will review the situation and determine if additional Emergency Response Services or an Environmental Consultant are required in accordance with the applicable regulations.

Clean-up and Disposal

The equipment available at the mine should be able to handle most spills and releases. Where necessary, the "Mine Site Supervisor" will coordinate the reallocation of equipment and resources away from the construction/mining activities for use in emergency response, clean up, and disposal. If required, Emergency Response Services will be engaged for the containment, cleanup, and disposal of contamination released into the environment.

3.1.2 Borrow Sites for Aerodrome

The expansion of the Macmillan Pass Airstrip will require approximately 150 000 m³ of granular resources. The proposal indicates that a borrow pit will be developed in the vicinity of the airstrip and provides details on its design and development. Appendix C2 of the proposal provides an overview of terrain, soils, and geology in the area of the proposed access road and the airstrip indicating that conditions should be favorable for the development of construction material. However, the proposal also states that no specific or suitable deposits of granular resources have been identified, and that granular resources in the region are of poor quality (p.57). An alternative source is the crushing of local bedrock, however it is known to have naturally high ARD/ML potential.

Given these conditions and the uncertainty of known resources in the area, a better understanding is required of the borrow sources that will be used for the airstrip expansion. Please provide the following information.

a) Details on the location, volume, ARD/ML potential, nature of the granular resources, and any mitigation measures proposed to minimize potential adverse effects associated with the development and use of the proposed borrow site.

The present Macmillan Pass Aerodrome is on a broad floodplain with extensive granular deposits. During its construction, numerous borrow areas were developed adjacent to the airstrip. Expanded development of these granular resources is planned to provide materials for aerodrome expansion. Potential additional sources of granular borrow have been identified where the proposed access road meets the North Canol Road about 4 km south of the aerodrome site.

The Adequacy Report references a statement in the project proposal (p.57) that states that granular resources in the region are of poor quality. This reference describes the mine production area only and does not apply to the access road or aerodrome.

Borrow pits for the planned expansion of the Macmillan Pass Aerodrome would be developed within the proposed Borrow Area A (Figure 3.4.1-1). Additional volume, if required, may be acquired from the development of borrow pits within Borrow Area 1, located about 3.5 km south on the North Canol Road.

Approximately 55,000 m^3 of granular material will be needed for aerodrome construction. Borrow areas for the aerodrome are being developed within surficial deposits that have been subject to weathering and metal leaching from interaction with oxygenated groundwater since deglaciation. There is not anticipated to be an increase in the ARD/ML as a result of the use of these uncrushed granular deposits for the expansion of the aerodrome. Should crushing be required for the surfacing of the airstrip then geochemical characterization of the aggregate source will be conducted as part of borrow development permitting. Characterization would be conducted according to the standards outlined in Price (1997).

b) If access roads or other infrastructure are required as a component of borrow site development, please provide details on their location and design, including if relevant a discussion on the ARD/ML potential associated with their development.

Short access road into borrow areas may be required within the footprint of the borrow areas. These would be temporary access roads to allow for extraction of granular resources and would be reclaimed following the end of borrowing activities. Reclamation procedures and objectives for the Mactung Project were provided in Appendix M1 of the Mactung Project proposal. There is not an ARD/ML concern associated with these temporary access roads due to their construction in shallow granular materials and that there is no need for crushing to construct the temporary roads.

3.1.3 Construction of the South-West Corner of the Aerodrome

The proponent indicates that the Macmillan Pass Airstrip will have to be expanded as part of the project, and that stabilization efforts may be required at the south-west corner of the airstrip. However, no further details are provided as to what these stabilization efforts may entail. It is important to understand the details of these efforts with respect to their design, and how they will minimize potential adverse effects on the South Macmillan River. Potential adverse effects could include increased sedimentation of the river or alteration of the channel that in turn could have effects on downstream aquatic habitats, water quality and aquatic life. Please provide the following information.

a) Describe the spatial relationship (i.e. proximity) between the areas of the airstrip proposed to be expanded, and the existing river channel. Indicate whether or not the expansion and stabilization efforts are occurring within the high water mark of the river.

The area of the airstrip that requires stabilization of existing erosion is one isolated location near the western end of the airstrip. The stabilization work will be required within the high water mark and will be addressed by a senior hydrotechnical engineer. The purpose of the works is to stop ongoing erosion at this location. The approach will be as follows:

- Survey data will be obtained including river cross sections extending up the airstrip fill slope.
- A regional hydrological study will be carried out to determine the 200-year peak flow for the South Macmillan River close to the airstrip. Environment Canada's Consolidated Frequency Analysis computer program (CFA 3.1) will be used.
- A numerical model will be developed using the MIKE-11 software to predict the South Macmillan River water levels and velocities in a 200-year flood.
- Erosion protection measures will be designed including riprap and filter layer sizes, specifications, and configuration. Design will take into account the potential for ice build-up or scouring at the site. Construction drawings will be prepared by a qualified engineer licensed to practice in the Yukon.

b) Provide details of the stabilization efforts (e.g. purpose, associated activities) and design considerations (e.g. flooding, ice build-up) that will be taken with respect to the South Macmillan River, as referenced on pages 594 and 595 of the project proposal.

The stabilization of existing erosion at the airstrip by the South Macmillan River will be addressed by a senior hydrotechnical engineer qualified to practise in the Yukon. The purpose of the works will be to stop ongoing erosion of the existing airstrip. The approach will be as follows:

- Survey data will be obtained, including river cross sections extending up the airstrip fill slope.
- A regional hydrological study will be carried out to determine the 200-year peak flow for the South Macmillan River close to the airstrip. Environment Canada's Consolidated Frequency Analysis computer program (CFA 3.1) will be used.
- A numerical model will be developed using the MIKE-11 software to predict the South Macmillan River water levels and velocities in a 200-year flood.
- Erosion protection measures will be designed including riprap and filter layer sizes, specifications, and configuration. Design will take into account the potential for ice build-up or scouring at the site. Construction drawings will be prepared by a qualified engineer licensed to practice in the Yukon.

c) Indicate what mitigation efforts and best practices will be implemented during stabilization activities occurring in or beside water.

The South MacMillan River, in the area of the proposed aerodrome upgrade, is not considered to be fish bearing or high quality aquatic habitat. Moderate aquatic resources have been recorded in the local area, and the river does support fish populations in downstream areas (likely where water quality is moderated). Consequently, mitigation measures and best practices for the aerodrome expansion are focussed on preventing downstream impacts through the prevention of input of sediment and deleterious substances into a watercourse. Mitigation measures and rationale specific to stabilization efforts are detailed below.

Timing

- In-stream works at the aerodrome will be undertaken during times of low flow to greatly reduce the risk of significant downstream sediment transport due to reduced sediment loading and transport capacity. Further, as water levels drop, the proportion of works in the active watercourse and depth of those works is reduced. Isolation of in-stream work areas at low flow is significantly easier and more effective at times of reduced flow. For these reasons, NATC will conduct the installation of pumping infrastructure during a period of low flow.

Site Control

- The right of way for access to the work zone will be minimized. The access and work zone will be clearly delineated, and disturbance to vegetation outside the delineated area will be avoided.
- Terrestrial and runoff sediments from the work site will be controlled with sediment fences, which will be placed and maintained in a manner that effectively contains any disturbed and/or exposed soil.

- Top soil removed from the construction site will be stockpiled at least 30 m away from the watercourse, kept covered, and provisions will be made to contain runoff (e.g. silt fences).
- Slopes and soils prone to erosion will be stabilized as soon as possible by revegetation and the use of erosion mats.
- Work will be discontinued in the event of storms or other weather that may significantly increase the erosion/runoff potential.
- Reclamation and stabilization of the site will be initiated as soon as practically possible. Initial stabilization will be undertaken as appropriate using temporary measures such as ground coverings until permanent vegetation has become established.
- All construction-related structures and materials will be removed from the site upon completion of the works.

Deleterious Substances

- Hydraulic and fuel systems of machinery involved with work in or around the watercourse will be leak free and in good repair.
- All equipment will arrive at the site clean (no external mud, grease, oils, and other deleterious substances).
- Servicing and washing of construction equipment will not occur within 100 m of the watercourse, and will be confined to a specially marked service area that will not drain towards the watercourse.
- Spent lubricants, oils, and other petroleum products will be disposed of in an appropriate manner.
- Risks of fuel spills will be minimized by ensuring all hoses, containers, and nozzles do not leak; using specific fuel transfer procedures during fuelling; and bleeding fuel hoses into a storage tank. Fuel storage and handling procedures are provided within the response to Section 3.1.1(b) of this Addendum.
- The crew working at the site will be trained in spill response and containment procedures. A spill kit will be present at the site. Spills will be reported as presented in response to section 3.1.1(b) of this Addendum.
- A Spill Contingency Plan (Appendix M2 of the Project Proposal) will be in effect for all works and the crews will be familiar with the plan.
- No treated wood products will be used for temporary structures during construction.

In-stream Works

- If approved, minor in-stream works (i.e. bank stabilization) will be conducted through the placement of only clean materials (i.e. riprap, gabions) into the watercourse. Any stream realignment, bank, or bed excavation below the active water level will require isolation (below).

- An isolation area will be established to acceptably contain sediment from the construction activities for any works below the active water level. This isolation structure will be designed and suited to the final construction plans and to the river conditions at the time of construction. Silt-laden water from within the isolation area will be pumped as necessary or allowed to settle such that sediment concentrations downstream are maintained within acceptable levels (outlined further below).
- Any water pumped from the in-stream isolation area will be directed towards a vegetated area sufficiently far from the river, such that it infiltrates to the substrate and does not re-enter the watercourse directly.

Monitoring

- During construction of the pumping infrastructure, the effectiveness of the erosion and sediment control measures will be monitored regularly, with adjustments being made where necessary (i.e. sediment fence, ground coverings, responses following large rainfall events, etc.).
- In-stream works will be monitored by a qualified professional to ensure that downstream sediment concentrations are maintained within acceptable concentrations. The monitor will advise the work crew of the need for further isolation measures, where required and in-stream works will be suspended when necessary. Standards to be used for monitoring are the "*Ambient Water Quality Guidelines (Criteria) for Turbidity, Suspended and Benthic Sediments*", produced by the British Columbia Ministry of the Environment (2001).

Photo 1
View of South Macmillan River and Airstrip

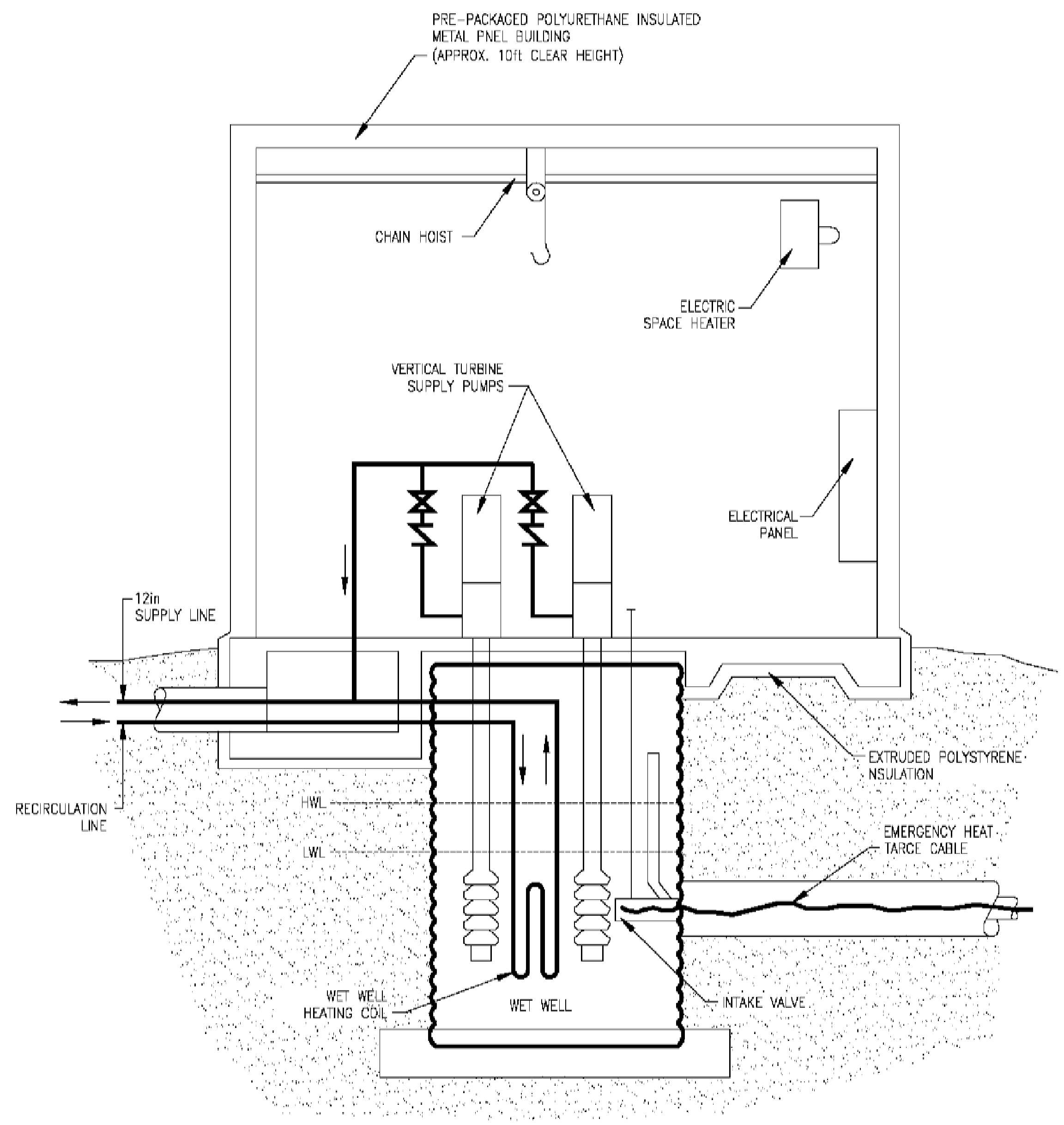
Photo 2
View showing SW area requiring stabilization

3.1.4 Water Intake and Associated Infrastructure

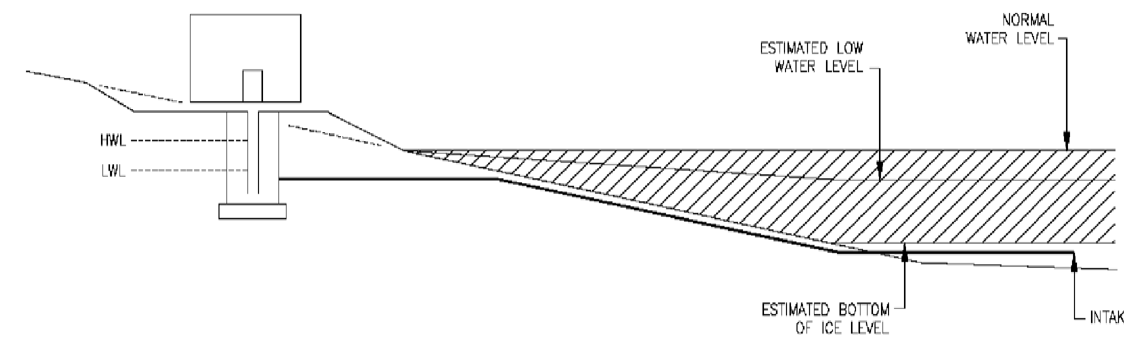
The water intake facility is to be constructed on the banks of the Hess River tributary, with a slot cut into the rock bank for the water intake pipe. Details have not been provided in the proposal to understand the manner in which the water intake pipe will be installed into the bank of the Hess River tributary. Please provide the following information.

a) Design specifics on the installation of the water intake pipe into the rock bank of the Hess River tributary (e.g. length of pipe, diameter of the pipe, depth from stream bed to pipe).

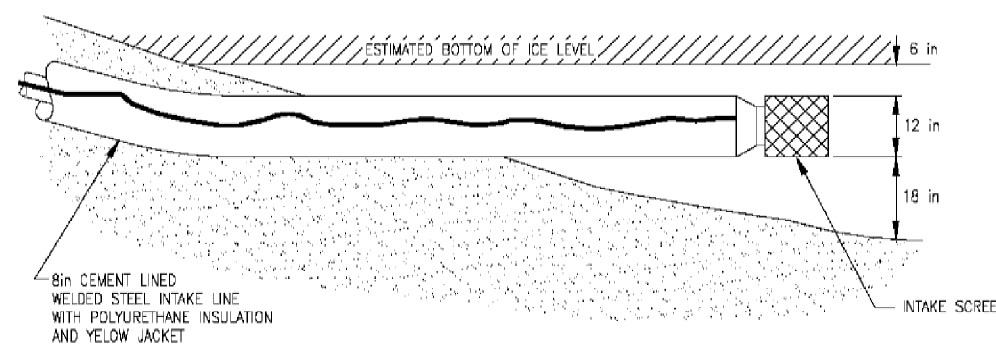
The conceptual design specifics of the water intake facility are shown in Figure 3.1.4-1.



TYPICAL INTAKE SCHEMATIC
(NOT TO SCALE)



TYPICAL INTAKE PROFILE



NOTES:

DRAWING ADAPTED FROM ORIGINAL PROVIDED BY WARDROP ENGINEERING INC.

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MACTUNG

WATER INTAKE

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Figure 3.1.4-1

b) Details as to how the water intake pipe will be installed in the rock bank. How will the slot be cut into the rock shoreline and what steps or guidelines will be followed with respect to any in-stream works that might occur?

The intake pipe wet well will be ripped and excavated into the bedrock using construction equipment, if possible. If the bedrock is too competent for ripping and excavating then it will be drilled and blasted into the bedrock.

The pipe connection into the Hess River Tributary (H. Tributary) will be installed either by the use of cut and cover techniques. Minor in-stream work will then be done to install components on the end of the pipe.

In the case of a cut and cover construction, a coffer dam will be constructed into the H. Tributary, but not entirely across it, and a slot cut through the bedrock from the wet well to the area confined by the coffer dam. The intake pipe will be installed and then the cut will be backfilled with the rock previously excavated, if approved for use. If the rock is not approved for use the cut will be backfilled with borrow material. Riprap or concrete erosion mats will be placed in the H. Tributary to provide erosion protection.

The size and extent of the required coffer dam are not known at this time. It is anticipated that a geosynthetic product, such as AquaDam® provided by Layfield, would be used. Whichever type of coffer dam is selected, its construction, use, and decommissioning will be done in accordance with the best management practices detailed in the response to request 3.12g).

c) Will any fill, borrow or construction materials be used adjacent to or within the Hess River tributary for the construction of the water intake infrastructure? If yes, please indicate what mitigation efforts will be implemented to ensure that the installation of the water intake does not significantly increase sediment levels in the Hess River tributary.

The installation of the water intake infrastructure will be conducted adjacent to and within the H. Tributary. Therefore, mitigation measures will be used to minimize the release of sediment into the watercourse. A description of potential effects and mitigation measures to reduce sedimentation has been provided below.

Timing

- In-stream works will be conducted as late in the construction season as possible. EBA's baseline fisheries studies indicated that a number of fish species are absent in the area of the intake starting as early as September (including grayling, whitefish, and Dolly Varden), and conducting these works when the most sensitive species are absent is preferable. NATC will work with the Department of Fisheries and Oceans (DFO) to determine an acceptable schedule for construction. The published in-stream work window for Arctic grayling is July 1 to April 15, and April 15 to September 1 for Whitefish, making a combined window of July 1 to September 1 (DFO, Pacific Region, Yukon Timing Windows). Works occurring beyond September 1 would, however, be recommended based on baseline data presented within the Project Proposal.

- Studies on the H. Tributary have indicated that flows are reduced in the fall (e.g. beyond late August). Performing works in or adjacent to watercourses during times of low flow greatly reduces the risk of significant downstream sediment transport, as the sediment loading and transport capacity of the watercourse is reduced. Further, because water levels are reduced, the proportion of works in the active watercourse and depth of those works in reduced. Finally, isolating in-stream work areas is significantly easier and more effective at times of reduced flow. For these reasons, NATC will conduct the installation of pumping infrastructure as late in the season as possible (preferably beyond September 1).

Site Control

- The location of the pump station and intake pipe will have a low slope with bedrock outcrops and generally a thin alluvial veneer. While sedimentation issues are expected to be minor, the right of way for access to the work zone will be kept to a minimum. The access and work zone will be clearly delineated and the disturbance to vegetation outside the delineated area will be avoided.
- Sediment-laden runoff from the work site will be controlled with sediment fences that will be placed and maintained in a manner which effectively contains any disturbed and/or exposed soil.
- Topsoil removed from the construction site will be stockpiled at least 30 m away from the watercourse, kept covered, and provisions will be made to contain runoff (e.g., sediment fences).
- Slopes and soils prone to erosion, generally expected along the access route, will be stabilized as soon as possible by revegetation and the use of erosion mats.
- Work will be suspended in the event of storms or other weather that may significantly increase the erosion/runoff potential.
- Reclamation and stabilization of the site and access will be conducted as soon as practically possible. Initial stabilization will to be undertaken as appropriate using temporary measures such as ground coverings until permanent vegetation has become established.
- All construction-related structures and materials will be removed from the site upon completion of works.

Isolation

- As the installation of the pumping infrastructure will take place both adjacent to and within the watercourse, an isolation area will be established to contain sediment from the construction activities. This isolation structure will be suited to the final detailed intake structure plans, as well as to the discharge at the time of construction. Sediment-laden water from within the isolation area will be pumped as necessary or allowed to settle such that sediment concentrations downstream are maintained within acceptable levels (outlined further below).

- Any water pumped from the in-stream isolation area will be directed towards a vegetated area sufficiently far from the river so that it infiltrates the substrate and does not re-enter the watercourse directly.

Monitoring

- During construction of the pumping infrastructure, the effectiveness of the erosion, and sediment control measures will be monitored regularly, with adjustments being made where necessary (e.g. sediment fence, ground coverings, responses following large rainfall events, etc.).
- In-stream works will be monitored by a qualified professional to ensure that downstream sediment concentrations are maintained within acceptable concentrations. This monitor will advise the work crew of the need for further isolation measures and suspension of in-stream works where necessary. Standards to be used for monitoring are the "*Ambient Water Quality Guidelines (Criteria) for Turbidity, Suspended and Benthic Sediments*", produced by the British Columbia Ministry of the Environment (2001).

d) Provide an understanding of the footprint and dimensions for the water intake facility buildings.

The approximate footprint of the water intake facility is expected to be 6 m x 8 m. It is expected that a granular pad of approximately 10 m x 12 m will be required for the building.

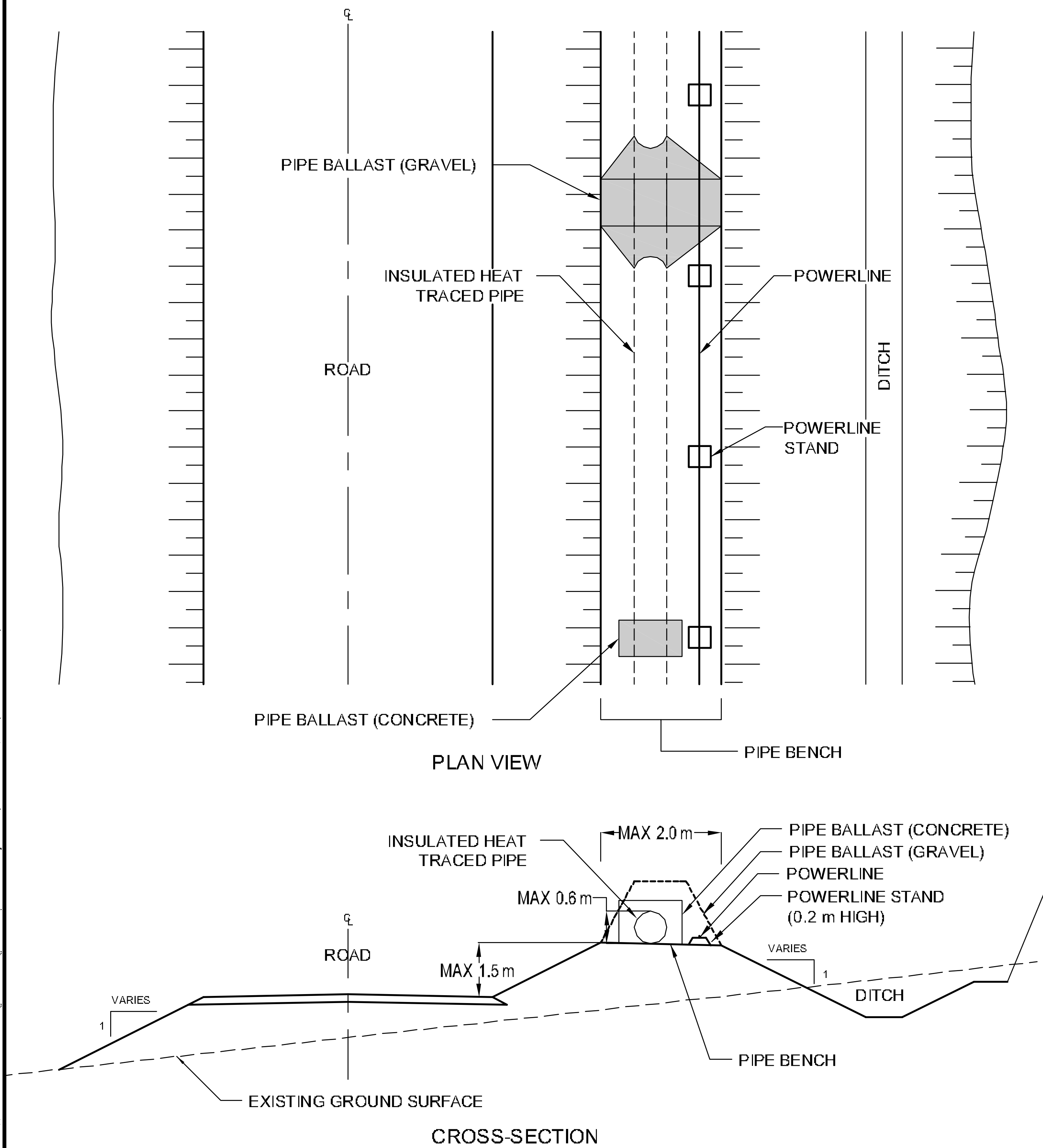
3.2 BENCH AND POWER LINE INFRASTRUCTURE

The project proposal states that water for domestic and industrial uses will come from the Hess River tributary via a 13 km pipeline. Although the proposal provides a general understanding of how the pipeline will lie adjacent to the road, few details are provided on the layout of the pipeline or the development and construction of the pipeline bench. Further to this point, the proposal also indicates the power for the water intake facility will come from the mine site power plant, and that a power line will run adjacent to the pipeline on the bench. However, no information is provided about the transmission line or how it will be installed. These project activities are considered to form part of the project scope, and therefore a complete understanding of their design is required in order for their potential effects to be appropriately considered.

Linear features such as the pipeline, the bench, and the road could potentially present barriers to the migration and movement of wildlife through the area, particularly with respect to the mineral lick that has been identified in the valley. In light of these potential effects, it is important to be able to understand how the pipeline infrastructure will alter the landscape. Please provide the following information.

a) Details on the design and construction of the pipeline bench (e.g. distance from road, height, width).

Updated plan and profile drawings of the pipe bench are included in Figure 3.2-1.



ISSUED FOR USE

Not To Scale

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MACTUNG

Pipe Bench - Plan and Cross-Section

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Figure 3.2-1

b) Specific details on layout of the water pipeline (e.g. height of pipeline ballasts, height of pipeline from the ground, distance between pipeline ballasts).

The details of the pipeline are shown in Figure 3.2-1. The pipeline rests directly on the pipe bench and ranges in diameter from 100 to 250 mm (could be up to 600 mm OD with insulation). Details on the size and number of pipe ballasts will be determined during detailed design; however, it is expected to be in the range of one ballast for every 10 to 30 m along the pipeline. The ballast will be designed based on the diameter and pressure of the pipeline, and will be constructed from either gravel fill or concrete covered in gravel fill. If gravel fill is used the ballast is expected to be approximately 1.5 m high from the pipe bench and 2 m long. The gravel will be contoured to allow wildlife to cross the pipe bench, even though the pipeline is not considered to be a barrier to wildlife. It is anticipated that one gravel ballast will be contoured for each kilometre of the pipeline.

c) Details on the type and source of construction materials that will be used for the development of the pipeline bench.

Construction of the pipeline and powerline bench will use primarily shallow surficial materials excavated during the construction of the access road and ditch. It is not expected that there will be a need to develop borrow areas to construct this bench, outside of any borrows that may be required for the access road construction.

Where rock is encountered near surface the disturbance will be limited to the upper weathered portion of the bedrock as the access road does not require deep cuts and a level grade. There will be no ARD/ML concern associated with the materials used to construct the bench as there will be no need to construct the bench through areas of un-weathered bedrock. Should blasting be identified during detailed design then appropriate testing to characterize the ARD/ML potential of the blasted materials will be conducted prior to blasting operations and any PAG material will either be encapsulated or relocated to the mine site for underground disposal (see Section 4.1.4(b) of this document and page 434 of the project proposal. Crushing is not required for construction of the pipeline and powerline bench.

d) Details on how and where the power line will be installed in relation to the water pipeline.

The power line will rest on a small stands or wooden blocks, approximately 0.2 m high. The location of the power line is shown in Figure 3.2-1.

e) Identify the potential adverse effects on wildlife movement resulting from the development of the pipeline infrastructure/bench and the road. Provide details on design aspects or considerations that will mitigate these effects.

Linear features such as the proposed road and pipeline infrastructure have the potential to affect local wildlife movements through an area, depending on the right-of-way size and associated human activities. Much of the literature on effects to wildlife from roads and pipelines relate to roads with higher traffic volumes and larger diameter pipelines than that proposed for the Mactung mine project. Potential adverse affects to wildlife movement from these larger infrastructure features include altering movement patterns and crossing avoidance due to the direct presence of the development, traffic and human activity, and steeply banked snow after winter ploughing activities. The degree of avoidance varies with the level of disturbance activity and with seasons. Anderson *et al.*[1](2002) have reported traffic levels of 15 vehicles per hour (much higher than that expected at the Mactung project) have been known to cause behavioural changes in woodland caribou, a species considered sensitive to human disturbances. Animals with young may avoid crossing or alter their movement patterns in response to a proposed road or pipeline.

The Mactung road and pipeline infrastructure is proposed predominantly in low elevation habitats, outside preferred caribou habitat. Caribou movements may be adversely affected by a small portion (3.5 km) of the road that lies above 1,300 m elevation, an elevation above which will likely be used during spring (late May to early June) and fall (late September to October) migrations. The low profile of approximately 0.6 m, of the proposed pipeline and gravel ballast sections spaced along the pipeline route, will provide crossing points for ungulates. Woodland caribou are thought to maintain a general avoidance buffer of 500 m from a road (traffic volume undefined) and 100 m from a pipeline (Anderson *et al* 2002). Therefore, no adverse effects to caribou movement at a population-level are anticipated from the construction, operation, and/or decommissioning of the road and pipeline infrastructure. A large portion of migrating caribou are expected to migrate along larger valleys, outside the direct influence of the road and pipeline infrastructure. Adverse effects of the road and pipeline infrastructure to caribou migrations is therefore considered low.

The movements of other local wildlife, including moose, Dall's sheep, small mammals, grizzly bears, and birds, may be potentially affected by the proposed road and pipeline infrastructure. The potential to affect moose is associated with the location of a mineral lick in the project area. Moose use the neighbouring mineral lick throughout the year.

Based on 12 aerial ungulate surveys and multiple other supplementary Dall's sheep and winter habitat surveys from 2005 – 2009, only a single Dall's sheep ram was repeatedly observed in the local area. With an existing resident population of a single Dall's sheep, potential effects to Dall's sheep are considered very low. Therefore, with the proposed mitigation measures in place (noted below), potential adverse effects on moose and Dall's sheep movements to and from the mineral lick are considered low.

Small mammal (*e.g.* mice, voles, shrews, and lemmings) movements may be directly obstructed by the pipeline. The proposed 100 mm to 250 mm diameter insulated heat traced pipeline will rest directly on the pipe bench, and gravel filled pipe ballasts will be constructed every 1.0 km along the pipeline to allow additional small mammal and ungulate

[1] Anderson, R.B., S.J. Dyer, S.R. Francis, and E.M. Anderson. 2002. Development of a Threshold Approach for Assessing Industrial Impacts on Woodland Caribou in Yukon, Draft Report Version 2.1. Prepared for the Environment Directorate, Northern Affairs Program. 64 pp.

crossing structures, as noted previously. The road may also act as a barrier to small mammal movements. Although small mammal movements across the pipeline and road may be adversely affected, the effects would be local in scale and not considered of a large enough magnitude to affect the area's small mammal population.

Other wildlife species, for example grizzly bears and birds, may alter their movements across the road and pipeline infrastructure due to traffic and human activities. These potential effects are considered low and infrequent due to the low traffic levels anticipated along the proposed road and implementation of mitigation measures.

Design Considerations to Mitigate Potential Effects to Wildlife Movement

To minimize potential adverse effects to wildlife movement, the road and pipeline infrastructure are proposed within a single right-of-way, which has been kept to a minimum width (approximately 20 m). Although the proposed activity level along the road and pipeline route will be heavy during construction (a time period not to exceed 27 months), the activity levels along the 2.7 km of road from the junction to the H. Tributary during operation will be negligible, and will be restricted predominantly to maintenance activities. Traffic during maintenance activities may cause short-term infrequent adverse effects on small mammal, bird, moose, Dall's sheep, and grizzly bear movements. Traffic volumes along the remaining section of road from the junction to the mine site will include approximately four haul trucks a day (plus return travel) and minimal traffic from smaller trucks. These low traffic volumes have the potential to cause small, short-term, and infrequent adverse effects to wildlife movements.

Upon decommissioning, the pipeline will be removed and the bench and road will be scarified to prevent people from continuing to use it as a recreational road, particularly to prevent access to the mineral lick. See Section 4.5.3 (p.34) of the Decommissioning Plan in Appendix M1 of the project proposal regarding road decommissioning.

As outlined in the project proposal, the following mitigation measures are proposed to avoid or minimize adverse effects to wildlife movements in response to the road and pipeline infrastructure:

- Post and enforce a speed limit, particularly in the vicinity of the mineral lick;
- Implement a wildlife right-of-way policy to apply to all mine related traffic. As part of this right-of-way policy, motorized vehicles are required to stop when wildlife are encountered on the road, and will not proceed until the animals have moved off the road;
- Prohibit recreational use of ATVs;
- Install an access gate at approximately km 17.5 from the North Canol Road; and,
- During winter months, maintain sloped and shallow snow banks along the road edge during ploughing.

3.3 STAGING AREAS

The proposal includes the development of three staging areas; two in the vicinity of Ross River and one temporary area at the Macmillan Pass Airstrip. These staging areas are indicated to be up to 20 ha in size, cleared of all vegetation, surfaced with approximately two inches of gravel, and will be active and integral components of the project. Even though the proposal indicates how and generally where these staging areas will be constructed, there is no information provided on the surrounding terrain or the specific location of the borrow sources that will be used to construct them. Of particular concern is the fact that the development, use or decommissioning of the staging areas have not been considered in the effects assessment analysis.

Because each staging area is of a notable size, will be cleared of existing vegetation, and covered in crushed gravel, there is the potential for significant adverse effects on valued components such as terrain, wildlife, vegetation, soil stability, and heritage/archaeological resources. Also, cleared trees from these staging areas may be wasted if appropriate timber salvage is not considered.

More specific details and information are required for the assessment process with respect to these staging areas. This information will aid the Executive Committee in determining if there are potentially significant socio-economic and environmental effects associated with the staging areas, and if the proposed mitigation measures are adequate.

Please provide the following information with respect to the staging areas.

a) Detailed heritage assessments for the two staging areas located on the North Canol Road. Of particular concern is the staging area adjacent to the old town site of Ross River, given its proximity to areas of high historical usage.

For the staging area adjacent to the Macmillan Pass Aerodrome, Archaeology Yukon, Government of Yukon, has stated that the area is considered to have low potential for heritage value, largely because the area has been heavily disturbed and developed by previous activities, e.g., by the aerodrome, road and exploration activity. Archaeology Yukon stated that "Further archaeological research at this staging area is not required by our office." Also, the regulations and laws regarding the actions to be taken in the event that archaeological artefacts are found are very clear and NATC will fully abide by those laws. This information has already been discussed with the Executive Committee at YESAB through email correspondence. On June 23, 2009 the Executive Committee provided the following statement to NATC's consultant (EBA):

"The Executive Committee was able to resolve the issue related to the requested heritage assessment for the MacPass [sic] staging area based upon information you provided, as well as through contact with staff at YTG. There will be no requirement to conduct a heritage assessment of that staging area prior to proceeding into the assessment stage."

b) Details/rationale as to how the interim protected land was considered in selecting the location for the staging area on the north side of the Pelly River. Was this element of the proposed project discussed with the Ross River Dena Council? Will the interim protected status of this land impact the ability of YTG to grant permission to develop this area?

The proposed staging area location along the North Canol Road on the north side of the Pelly River close to the old village site is no longer being considered for a staging area. A new proposed staging area site has been chosen. The new site is approximately 5.3 km along the North Canol Road from Ross River (Figure 3.3-1 and Figure 3.3-2). The proposed new site is approximately 20 hectares in size. A heritage assessment will be completed for this proposed staging before construction begins. Ross River Dena Council (RRDC) has been advised of the proposed new staging area location and NATC continues to have positive and open dialogue with RRDC regarding the proposed Mactung mine and its associated infrastructure.

NOTE: Background imagery provided courtesy of Google Earth and is shown for illustration only.

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0 — 500 000

Scale: 1: 1 000 000 (metres)

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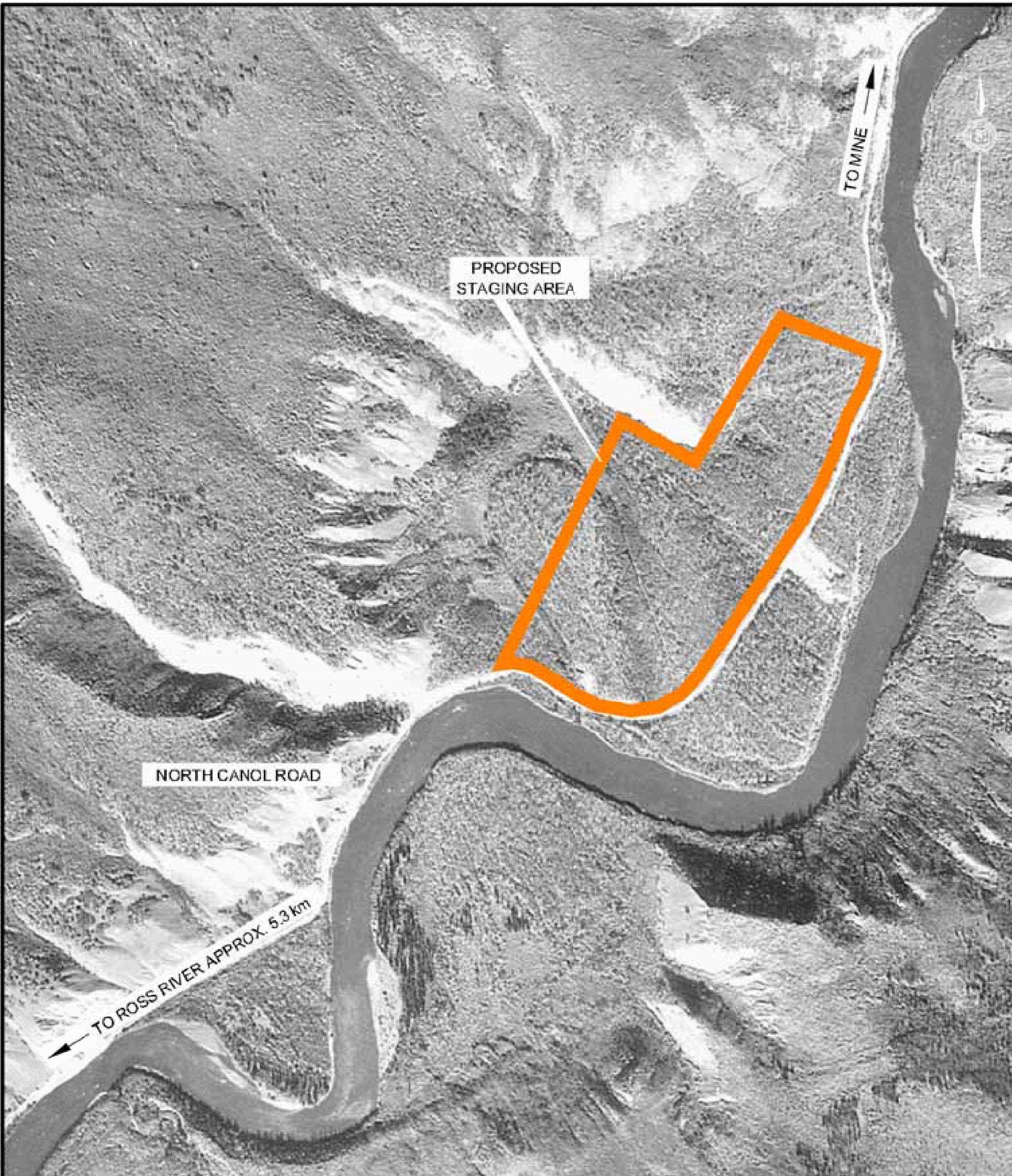
MACTUNG

Staging Area Locations

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	GMR	0
OFFICE: EBA-WHSE	DATE: JUNE 2009		

Figure 3.3-1



ISSUED FOR USE

500

Scale: 1: 10 000 (metres)

NORTH AMERICAN TUNGSTEN CORPORATION LTD

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MACTUNG

Staging Area
Approximately 5.3 km from Ross River

W23101211.002	KJT	GMR	0
EBA-WHSE	JUNE 2009		

Figure 3.3-2

c) Details/rationale as to how the existing active airport reserve was considered in selecting the location for the staging area near the south end of Ross River, and how this proposed use may interfere with current users.

NATC has commenced discussions with Government of Yukon, Aviation Branch to determine whether the existing Airport Reserve could potentially be used by NATC as a staging area for the duration of the proposed project. These discussions and the development of an agreement will need to continue and cannot be finalized until the project is approved to proceed within the regulatory process.

Should NATC be unable to obtain permission to use this area for the staging of equipment and supplies moving to and from the mine site, the company will seek to rent private property at an existing facility.

Logistically, the staging area could be located close to the Pelly River or outside of the community core.

d) Given the proximity of the staging area across the Pelly River (near the old town site) to the Village of Ross River, please provide details on how timber will be salvaged during clearing activities.

A Timber Salvage Plan will be developed in conjunction with Government of Yukon's Department of Energy, Mines and Resources Forestry Branch as part of any tender package. Tree felling will be conducted in accordance with the plan.

3.4 ACCESS ROAD TO THE MINE

3.4.1 Design

For an environmental and socio-economic assessment to be comprehensive in nature, the standard for design has to be more than conceptual. The design should demonstrate that the project component or infrastructure is technically and economically feasible at the specific site selected and under the specific conditions at those sites. The Executive Committee requires a clear presentation of how infrastructure relates to the surrounding environment in order to understand potential adverse effects, potential hazards and to determine the adequacy and effectiveness of proposed mitigation measures.

The proposed access road design is presented in a very generic manner. Although the proposed route for the road has been identified, and the road appears on many of the figures within the proposal, sufficient detail on the types of terrain and the habitat types that the road will cross, the type of rock and permafrost likely to be encountered, and the location, volumes and types of borrow sources are absent in the project proposal. The proposal discusses bedrock geology, the surficial geology, soils, permafrost, terrain hazards, and potential borrow sources that do exist along the proposed route, but these are discussed in general terms and only speak in terms of generic valleys, slopes, and stream channels. For example, the proposal identifies that slope stability studies have yet to be completed, and recognizes that these studies may influence road design (p.421). The descriptions and figures provided in the project proposal do not provide the required level of detail or description for an appropriate assessment to take place. Please provide the following information.

a) Detailed terrain mapping that shows the location and path of the proposed access road. Maps or figures should show the road in sufficient detail so that the Executive Committee can understand the road in the context of the surrounding terrain features and topography. An example of appropriate terrain mapping for linear developments can be found in the proposal for project 2006-0286 (Yukon Energy Corporation Carmacks-Stewart/Minto Spur Transmission Project). This will not only facilitate the assessment of effects associated with the road, but will also aid in determining risks to human safety, since as noted in the proposal (p.65) rock falls are the most common terrain hazard in the area.

Terrain mapping of the proposed road corridor will be completed as part of detailed design following assessment. However, preliminary assessments including ground-truthing were completed in 2008. The proposed road alignment was determined based on preliminary terrain stability and snow avalanche assessments. There is expected to be little change to the proposed road alignment based on additional stability assessments. Ground-truthing of terrain completed in July 2008 found that suitable granular materials exist along much of the proposed access road.

Rock falls were noted in the proposal as the most common terrain hazard in the area. Rock fall is an ongoing erosion process where small quantities of rock separate from exposed bedrock and accumulate as talus. Preliminary studies indicate that most of the proposed alignment is located within a broad valley floor or lower valley slopes and there is a low probability that the alignment would be impacted by rockfall hazard. Ground-truthing of terrain completed in July 2008 did not identify rock fall hazards that would have a consequence within the proposed road corridor.

Avalanche assessment works conducted during 2008 examined the run out behaviour of avalanches along the proposed alignment in order to determine the areas with the highest avalanche hazard. The majority of the proposed road alignment was located to avoid avalanche terrain based on the avalanche assessment information. There are several sections of road where avoidance of avalanche prone terrain may not be feasible given local terrain. An avalanche hazard management plan for the access road is described in the response to Section 8.5.

b) Identify the location of all related borrow sources as well as design details and the location of any other infrastructure (e.g. access roads) associated with these borrow sources.

Probable borrow source areas are located based on the results of the terrain ground truthing completed in July 2008. Interpretation of high level air photographs provided some guidance for location of the potential borrow areas (Figures 3.4.1-1 and 3.4.1-2). The location and size of borrow pits will be determined during detailed road design as the volume of materials required for construction will then be known. All selected borrow areas are located within or adjacent to the alignment corridor and should not require development of extensive access roads. Borrow pits will be developed on areas with less than 30% slopes and at a distance greater than 30 m from streams. Borrow pit drainage management will be determined during detailed road design once an idea of the size of each borrow is available. Drainage management features will include infrastructure components like perimeter ditching and settling/exfiltration ponds.

The material texture and terrain expected within the borrow areas is summarized in Table 3.4.1-1.

TABLE 3.4.1-1: BORROW PIT SUMMARY FOR MACTUNG ACCESS ROAD.		
Borrow No.	Expected Material Texture	Terrain
1	sand and gravel, glaciofluvial	hummocky, well drained
2	sand and gravel, glaciofluvial	gentle slope, well drained
3	sand and gravel till	gentle slope, well drained
4	thin veneer of till or colluvium	ridged area, well drained
5	veneer of till or colluvium (?)	terrace, well drained
6	sand, gravel and trace silt, till blanket	terraced, moderately well drained
7	gravelly sand, some silt and boulders	varying terrain with areas of terrace and gentle slope, moderately well drained
8	gravel and sand, till blanket	terrace with slope below, well drained
9	gravelly sand with trace silt, till blanket	irregular mound in valley bottom, well drained
10	gravel and sand, till	flat, hummocky, well drained
11	gravel and sand, ridged hummocky till	flat, terraced area, well drained
12	gravelly sand, hummocky ridged till	flat, bottom of valley, well drained
13	gravelly sand, till blanket	gentle slope, well drained
14	gravelly sand, till	terraced, well drained
15	sand with some gravel and trace silt, hummocky till blanket	flat, well drained
16	sand and gravel, colluvial (?)	terraced to gently sloping, well drained
A	sand and gravel, glaciofluvial	flat, floodplain

c) Present a detailed understanding of slopes, unique features, location, and extent of permafrost zones of potential flooding, and any erosion and drainage issues.

Ground temperature data collected by EBA in the valley near the mine (elevation 1500 m) indicates that the ground in this area is not permanently frozen as shown in Figure 3.4.1-1. However, data at the mill site (elevation 1830 m) indicate that discontinuous permafrost begins to become present as elevation increases. The proposed mine in on the south facing slope of the valley and it is expected that discontinuous permafrost exists at that location and continuous permafrost exists at the mine elevation on the north facing slope.

The environmental lapse rate (ELR) is the reduction of temperature with altitude of the stationary atmosphere at a specific time and specific location. The ELR at a given place varies from day to day and even during each day. As an average the International Civil Aviation Organization (ICAO) defines an international standard atmosphere with a temperature lapse rate of -6.5°C/1000 m from sea level to 11 km. Using this information and a conservative average valley ground temperature of +1ºC we can expect the road alignment to begin to encounter discontinuous permafrost if the road is more than 150 m higher than the valley.

The proposed access road alignment follows three valleys with elevations ranging from 1100 to 1500 m. The maximum elevation difference between the road and the valley bottom at any point along its alignment is 120 m, except for the last 3 km of the road, near the mine site. Therefore, it is expected that the road alignment will encounter discontinuous permafrost for the last 3 km of road, near the mine site and possibly at isolated sections along the alignment.

Several areas of potential steep slopes, increased erosion, and flooding have been identified using conservative means and 20 m contour information provided from NTS maps. These areas will be reviewed during detailed design when air photos and detailed contours are available. The road is expected to be constructed from and on well drained soils thus drainage should not be a concern. To aid in erosion protection and help reduce the distance in which the runoff water will travel the road side ditches, cross drains will be installed beneath the roadway. These drains will be installed in the same manner as culverts and proposed for installation at a frequency of up to 4 per km. The diameter of the cross drains will be determined during detailed design, but are expected to range between 300 and 900 mm.

The areas of potential steep slopes are:

- km 1.0 – 1.6
- km 4.3 – 4.8
- km 18.3 – 18.6
- km 20.5 – 21.7
- km 28.5 – 32.0
- km 37 – 37.5
- km 38.9 – 39.5
- km 41.0 – 45.0

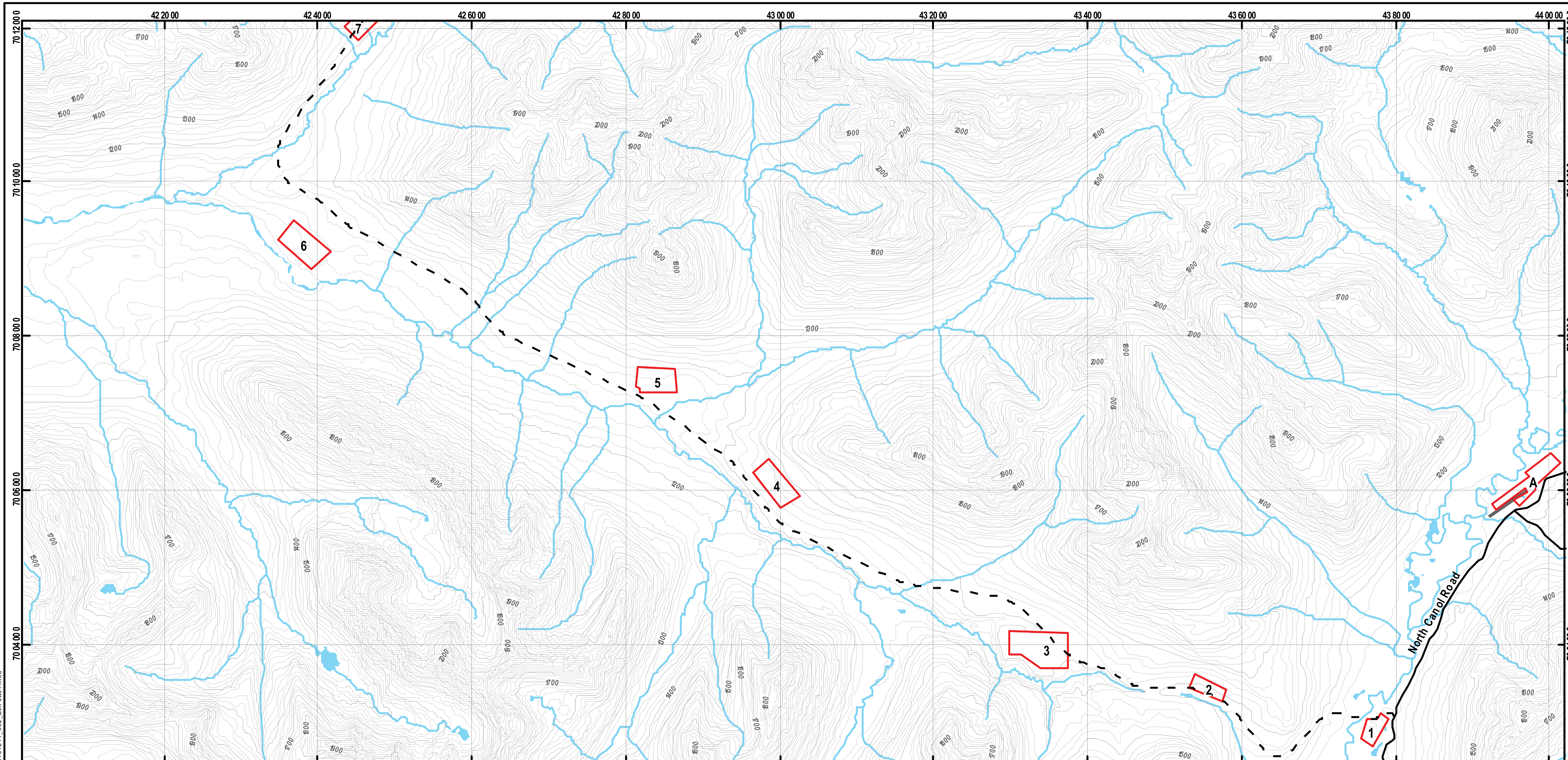
The areas of potential increased erosion (stream crossings) are:

- km 7.2
- km 11.25
- km 13
- km 13.9 – 14.2
- km 15.4
- km 19.2
- km 22.5

- km 24.0
- km 24.7 – 25.2
- km 25.9
- km 27.1
- km 37.7
- km 38.4
- km 39.0
- km 39.9
- km 40.1

The areas of potential flooding are:

- km 0.4 to 0.7 (MacMillan River)
- km 2.3 – 4.3
- km 17.3 – 17.7 (Trib E)
- km 21.7 – 22.0
- km 23.0 – 24.0
- km 27.5 – 28.5
- km 35 – 35.6 (Trib A)



LEGEND

- Potential Borrow Areas
- Proposed Access Road
- Existing Roads
- Macmillan Pass Aerodrome
- Contours (20 m)
- Contours (100 m)
- Watercourse
- Waterbody

ISSUED FOR USE

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

MACTUNG

Potential Borrow Site Locations
Mactung Access Road

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:50,000
1 0.5 0 1
Kilometers

FILE NO.: W23101211_002_Borrow01.mxd

PROJECT NO.	DWN	CKD	REV
W23101211.002	MEZ	JD	0

OFFICE	DATE
EBA-VANC	June 29, 2009

EBA Engineering Consultants Ltd.

Figure 3.4.1-1

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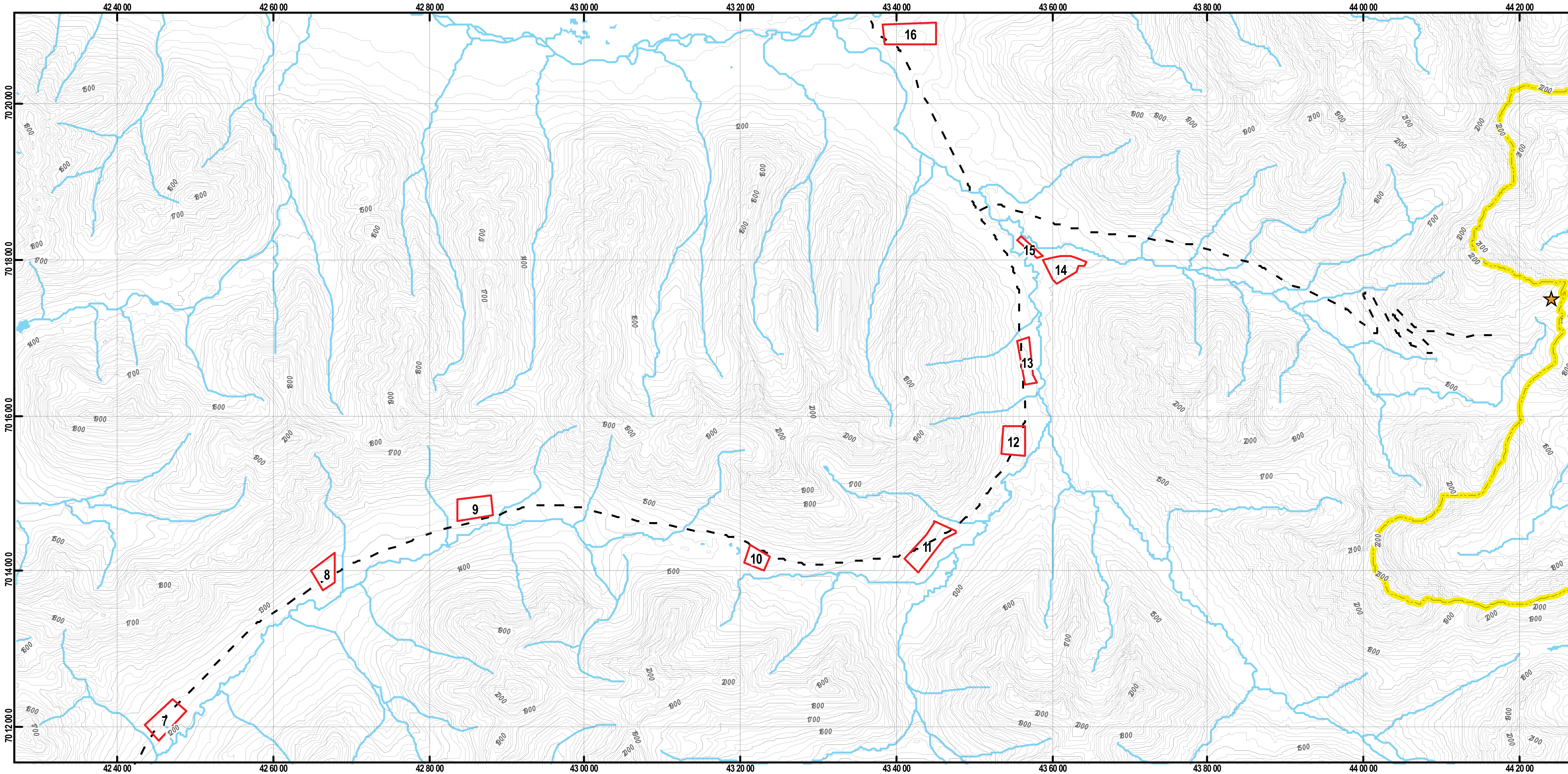

LEGEND

- Potential Borrow Areas
- Proposed Access Road
- Existing Roads
- Macmillan Pass Aerodrome
- Contours (20 m)
- Contours (100 m)
- Watercourse
- Waterbody

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ISSUED FOR USE

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

MACTUNG

Potential Borrow Site Locations
Mactung Access Road

PROJECTION	DATUM
UTM Zone 9	NAD83

Scale: 1:50,000
1 0.5 0 1
Kilometers

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FILE NO.			
W23101211_002_Borrow02.mxd			
PROJECT NO.	DWN	CKD	REV
W23101211.002	MEZ	JD	0
OFFICE	DATE		
EBA-VANC	June 29, 2009		

Figure 3.4.1-2

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d) Include details and location of any pullouts, turnarounds, or precautionary measures that are part of the road design.

For the 8.0 m wide road there will be no pullouts, and for the 5.0 m wide road there will be no less than 4 pullouts per km. All pullouts will be within the overall footprint of the road. The precise location of the pullouts will not be determined until the detailed engineering stage of the project. Check dams will be used for erosion control when ditch slopes are steeper than 5%. Seeding of the exposed surfaces of side slopes, back slopes, and ditches will be carried out where grades are less than 5%. Guardrails might be required for locations where the road drop-off is greater than 5.0 m in height. The width of the road shall be increased where guardrails are required.

Erosion/Sedimentation Control

- A water management plan to control erosion and sedimentation will be compiled in order to prevent the loss of soil and reduce the possibility of slope failure as well as to maintain water quality and aquatic habitat in downstream water bodies and riparian areas.
- Runoff control may be achieved by texturing or reconstruction of the slopes and by topsoil and seed placement.
- Sedimentation control may be achieved by installing silt fences or traps and, rock check dams.
- Bench cuts could be used for road sections traversing steep or unstable terrain.
- Groundwater seepage areas will be identified and covered with free-draining granular material, as appropriate.

Stormwater Management/Drainage

The design of the road drainage system for the mine access road was based on assumptions about the rainfall and drainage characteristics of the various sub-basins through which the road crosses. Rainfall data from the Atmospheric Environment Service (AES) of Environment Canada were used to estimate the design rainfall event. Local ground cover and flow conditions were assessed to evaluate the runoff potential during this event. When designing the drainage system, the BC Forest Road Engineering Guidebook was used as a reference in conjunction with accepted engineering principles and economic considerations to determine the locations and sizes of the culverts.

e) Provide detail regarding the gate that will be installed at km 17.5. What measures will be in place to ensure that it will achieve its goals (e.g., preventing the public from circumventing the gate). Indicate how this access control will be monitored throughout the life of the project.

The gate will be installed at approximately 17.5 km from the North Canol Road in an area where circumvention by any form of vehicle is very difficult. Possible areas include water crossings in combination with areas with steep slopes on either side. The lock for the swing gate will be card or code operated with any required power being generated by solar panels. The operation and maintenance of the gate will be monitored by designated personnel (e.g., Environmental Officer), who will also check that the gate is achieving its objective of preventing unauthorized persons from travelling further along the road towards the mine site. Any required corrective actions will depend entirely on the nature of the equipment malfunction or circumvention of the gate.

3.4.2 Consideration of Alternatives

The proposal indicates that there is an existing seasonal access road to the mine site. Even though a bulk sample was removed previously from the mine site using this existing access road (Appendix D1) the proponent briefly explains that this route is not a viable alternative for mine site access. It is important to note in the consideration of alternatives, that even though the proponent considers there to be regulatory challenges with respect to the permitting and development of sections of this road in the Northwest Territories, this does not factor in as an appropriate argument for not fully considering it as an alternative in the project proposal. It is important to the assessment process for the Executive Committee to fully understand how the proponent has considered alternatives to different aspects of the project, and the reasons why the proponent has proposed the design put forth for consideration.

Pursuant to subsection 50(2)(a) of YESAA the proponent is required to consider alternative ways of undertaking or operating the project that would avoid or minimize any significant adverse environmental or socio-economic effects. In consideration of this requirement, please provide the following information.

a) A report by a qualified engineer that:
   i. describes the current condition of the existing road;
   ii. provides detailed information on any upgrades, new construction and associated activities (e.g. borrow pit development, temporary camps, fuel storage, personnel and equipment) required to use the existing road for the purposes of the project; and,
   iii. provides an assessment of the road to confirm whether in its current condition or upgraded as described above, the road can safely support the anticipated traffic volumes and frequency.

b) A comparison of the existing and proposed roads in relation to their potential significant effects and substantiate whether the proposed road will minimize significant adverse effects in comparison to upgrading and using the existing road.

NATC has reviewed YESAB's information request and is pleased to provide the following rationale for the proposed new access road through the Yukon to the Mactung mine site.

In the planning of the project, NATC and its consultants did consider an alternative access route to the Mactung mine site, specifically an upgrade and re-alignment of the existing access road that traverses a very small portion of the Northwest Territories (NWT). In considering this potential alternative and its feasibility, it became apparent that the development of a transboundary project was a distinct possibility if the use of this road was pursued. It is understood that a transboundary project can be completed as a joint assessment between the Yukon Environmental and Socio-economic Assessment Board (YESAB) and the Mackenzie Valley Environmental Impact Review Board (MVEIRB), or as two individual assessments within the two separate jurisdictions. Neither option was considered to be socially or economically feasible for the following primary reasons:

- assessment application preparation and processing;
- assessment scoping;
- timelines associated with the different assessment processes;
- compatibility of land use in the NWT; and,
- project benefits.

Each of these factors were reviewed relative to the scale of the proposed mine, its capital and operational costs and expected returns. NATC is committed to ensuring that the Mactung project will be completed in a fiscally and socially responsible manner that will benefit both the company and the Yukon as a whole. In order to pursue this development in such a manner, NATC has carefully considered its options for the access road and determined that entering into a dual assessment process would not be economically prudent and could put the entire project at risk. Therefore, the dual assessment option would not be socially responsible given the significant economic and social benefits of the project that would accrue to the Yukon.

Further information is provided below on the specific socio-economic factors considered.

Assessment Preparation and Processing

Within the jurisdiction of the *Mackenzie Valley Resource Management Act* in the NWT there are three levels of assessment; preliminary screenings, environmental assessment, and environmental impact reviews. The assessment process is a tiered approach with all projects beginning at the preliminary assessment level, and continuing through the assessment levels until potential effects are deemed mitigated and the project can proceed to permitting.

Based on NATC's and other mining companies' direct and ongoing experience in obtaining permits and licenses in the NWT it is expected that a proposed upgrade and realignment of the existing access road through a very small portion of the NWT would, at a minimum, be referred to the MVEIRB for an environmental assessment.

If NATC was required to provide an assessment application in the NWT then the application would need to meet the requirements specific to the MVEIRB. The development of a second assessment application for a different assessment process would place a significant additional financial burden and project risks on NATC, specifically for the application preparation, engagement of new stakeholders and government agencies and the general processing requirements (i.e. information requests; technical meetings, public hearings, etc.). This situation would also apply if the MVEIRB and YESAB made use of the *Cooperation Agreement* that exists between the two agencies.

Assessment Scoping

Within the MVEIRB Guidelines it is stated "even if the authorization is required for only a small part of the development, the preliminary screening must consider the whole development and its potential effects on the ecological, social and cultural environments." (MVEIRB, 2004). This is an important point to consider when reviewing options as it allows the Board to scope projects broadly. This may result in an assessment of the road; mine traffic; mine supplies, and other mine-related activities. The scoping of items already considered under the YESAA Executive Committee Screening would place an additional onus on NATC to coordinate potential mitigation measures (terms and conditions) between the two assessments to ensure that they were able to satisfy the necessary requirements of both suites of environmental review and regulatory approvals processes. The potential for increased process complexity and additional delays as a result of the two agencies coordinating their independent assessments is also a significant concern. The dedication of resources and the potential for time delays could jeopardize the success of the project and its ability to engage and maintain investors in an already sensitive economic climate.

Timelines Associated with Assessment

The assessment process under YESAA contains timelines from which industry can develop project plans and projections and, as a result, engage investors. For a publicly traded company this is an important consideration for project feasibility. Timelines are not defined in the same manner under the MVEIRB assessment process, leaving NATC to manage and coordinate dual assessment processes that may not run parallel to each other or necessarily reach complementary decision based on differing and perhaps incompatible interests.

Land Use Compatibility

The NWT has Regional Land Use Planning Boards for settled land claim areas. Where these plans exist applications must be made where a proposed development does not comply with the plan. A draft plan currently exists for the Sahtu region, the area in which the North Canol Road extends into the NWT.

Where the road enters the NWT, the area is delineated as the Headwaters and Backbone Range Conservation area as designated within the Sahtu Land Use Plan. Within the Plan, this area has been identified for its ecological importance, specifically as a calving area for mountain woodland caribou and as year-round habitat for Dall's sheep. The area has also been identified for its historic trails. Given the proposed designation of the area, upgrades of the existing access road in the NWT would be very challenging from an assessment and regulatory perspective and not in the best interests of the overall project.

Project Benefits

The Mactung mineral reserve and project is located in the Yukon, transportation links and supporting infrastructure are based in the Yukon, and employment/business opportunities/benefits and resource revenues will flow to the Yukon. As a result, there will be no tax or royalty revenue to NWT and likely to be minimal opportunity for the NWT to benefit from the Mactung project due to the difficulty in servicing the Mactung area from NWT. Therefore, there is little incentive for the NWT to support the project.

Conclusion

In considering all of the factors detailed above, an upgrade to the existing mine access road in the NWT is not a feasible option and it would place the Mactung project at considerable risk. The practicality of developing an all-Yukon project for the scale of the mine is far better served through the existing Yukon-only assessment and regulatory process.

A consequence of pursuing an upgrade to the existing access road through the NWT is the potential loss of the project for the Yukon due to the significant risks associated with unknown timelines, process decisions and likely delays in receiving financing for the project. Therefore, a Yukon-only project is the best option to pursue both socially and economically for the Yukon and for NATC.

3.4.3 Proper Construction and Maintenance Practices for the Road

The proposal states that standard mitigation measures for road design, construction, and maintenance will be adhered to. Currently however, no further details or references to standardized guidelines have been provided. In North American Tungsten Corporation's submission to the Watson Lake Designated Office for the Mactung Advanced Exploration project (YESAB Project # 2008-0289), this information was appended to the submission. Please provide the following information.

a) A description of what these standard mitigation measures for road design, construction and maintenance will be, or provide an indication of where the supporting documents/information can be found.

Standard Operating Procedures for road construction including culvert installation are included in Appendix A Some additional information on the road design and construction is provided below.

Codes & Standards Used For This Study & Others That May Be Needed For the Next Stage of the Project

- BC Forestry Road Guidelines, Ministry of Forests BC
- BC Mines Act, Regulations and Codes
- Handbook for Mineral and Coal Exploration in BC, The Mining Association of BC, Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment

- Low Volume Roads – Interim Guidelines, Highway Engineering Design Manual BC
- Design of Surface Mine Haulage Road Manual – Department of Interior USA
- Guidelines for Mine Haul Road Design, Department of Civil and Environmental Engineering, University of Alberta
- Resource Road Rehabilitation Handbook, Ministry of Environment, Land and Parks and Ministry of Forests BC
- Highway Geometric Design Guide, Transportation Association of Canada (TAC)
- Best Management Practices Handbook: Hillslope Restoration in BC, Ministry of Forests BC
- Other Government of Yukon Design Guidelines

Design Criteria

The road will be designed and built in accordance with the above Codes and Standards, and the following design criteria:

- The road is designed to carry about 3 to 4 concentrate/supply trucks or semitrailers per day (including service equipment);
- Stabilized road width of 8 m for the road from the existing Canol Road to the proposed mine site and 5 m width for the road from the junction of the main access road to the proposed pump house;
- Average design speed of 30 to 50 km/h;
- Minimum 35 m radius for 30 km/h design speed, 65 m for 40 km/h design speed, 100 m for 50 km/h design speed;
- Vertical curves with minimum K values of 4.9 and 3.0 for sag and crest curves, respectively at 30 km/h design speed;
- Minimum overall clearing width of 25 m for 8.0 m road; minimum overall clearing width of 20 m for 5.0 m road;
- No turnouts for 8.0 m wide road, not less than 4 turnouts per km for 5.0 m wide road;
- For 8.0 m wide road, maximum adverse gradient to be 6% for sustained sections and 8% for pitches up to 100 m long; for 5.0 m wide road, maximum adverse gradient to be 8% for sustained sections and 10% for pitches up to 200 m long;
- For 8.0 m wide road, maximum favourable gradient to be 8% for sustained sections and 10% for pitches up to 150 m long; for 5.0 m wide road, maximum favourable gradient to be 12% for sustained sections and 14% for pitches up to 150 m long;
- For 8.0 m wide road, maximum gradient to be 6% on switchbacks; for 5.0 m wide road, maximum gradient to be 8% on switchbacks;

- Road to be surfaced with a minimum of 200 mm thickness of 25 mm crushed gravel;
- Check dams are to be used for erosion control when ditch slopes are steeper than 5%. Seeding the exposed surface for side slope, back slope, and ditch is required where grades are less than 5%;
- Guiderails may be required for downslope locations where retaining walls are required, and where the road drop-off is greater than 5.0 m in height;

Road Drainage Design Site Considerations

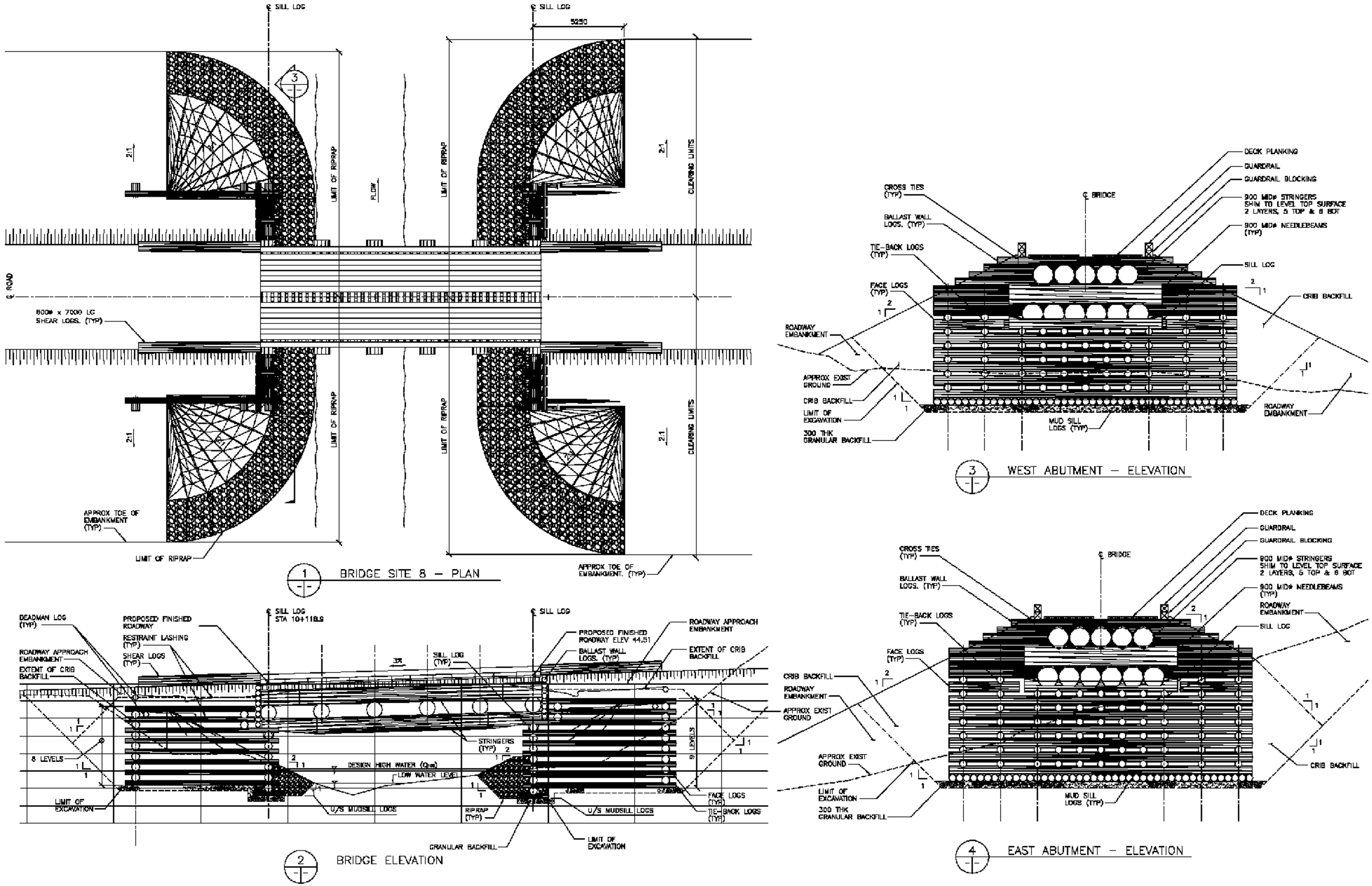
The Mactung Mine is located near the eastern border of the Yukon. Average local rainfall data were used for the road design. AES Intensity Duration Frequency (IDF) plots from three nearby rain gauge stations were averaged to construct an IDF for this site. The terrain is mountainous, and the proposed road alignment follows a river valley for much of its length. The road design includes a number of crossings over permanent streams, but will require culverts for cross drainage and the crossing of seasonal stream beds. Evaluation of local ground cover was based on recent observation of site conditions, and included moderately treed lower slopes with nearly bare upper slopes. The possibility of a rainfall event occurring while the soil is still frozen or partially frozen is a possibility. In order to reflect this condition, a high runoff coefficient was used.

3.5 BRIDGE DESIGN

The proposal states that there will be three river crossings (South Macmillan, Hess River Tributary A, and potentially Tributary E – Section 5.4.2.5) for the new access road that will require single lane bridges. No details have been provided on the design, or construction of the proposed single lane bridges. Given that the construction activities associated with these bridges will likely occur within the high water mark, there is the potential for significant adverse effects to water quality, fish and fish habitat, terrain and soil stability, as well as human safety. Therefore, please provide the following information.

a) Details on the proposed design and construction of the proposed single lane bridges.

The details of typical single lane bridges are provided in Figures 3.5-1 and 3.5-2.



NOTES:

DRAWING ADAPTED FROM ORIGINAL PROVIDED BY WARDROP ENGINEERING INC.

NORTH AMERICAN TUNGSTEN CORPORATION LTD

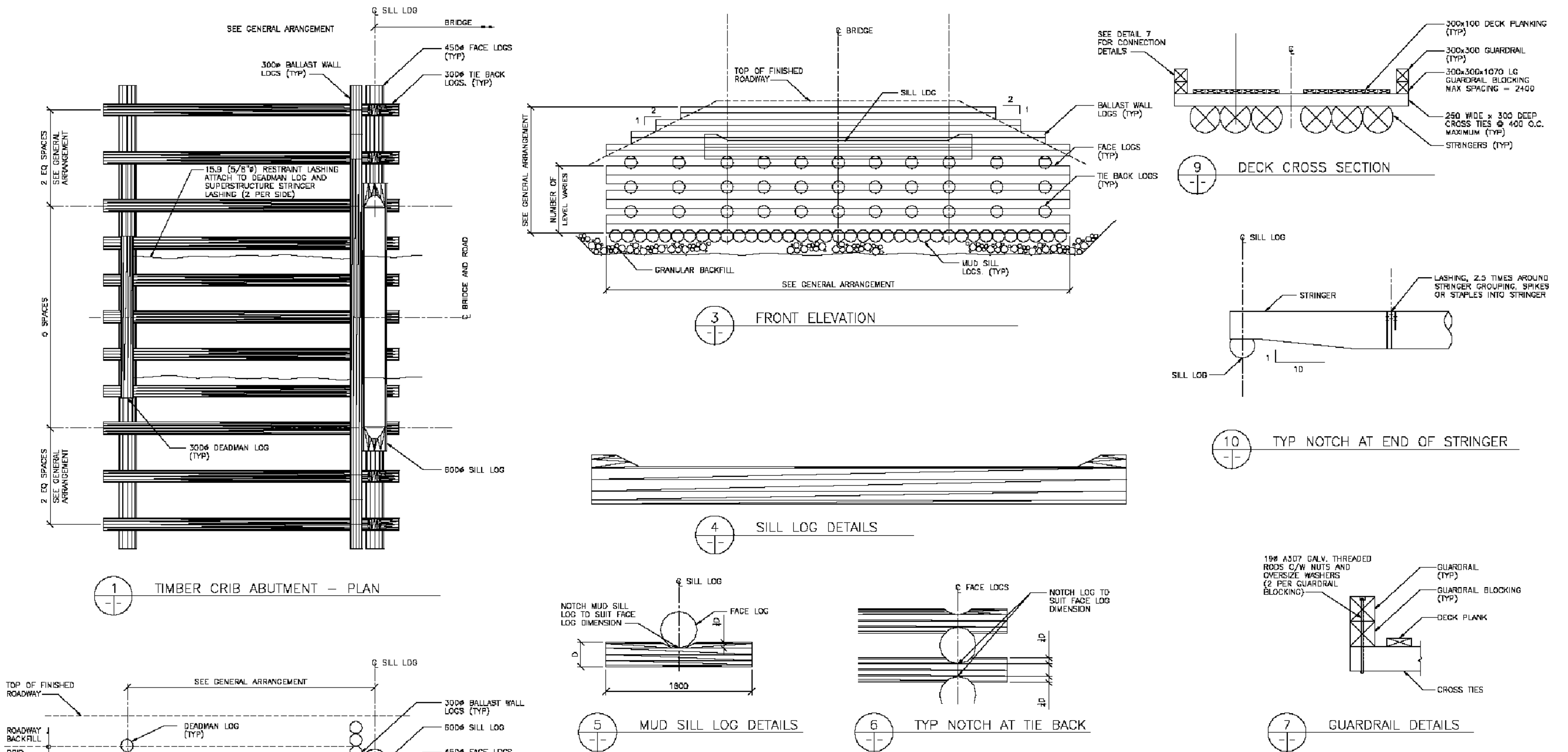
EBA Engineering Consultants Ltd.

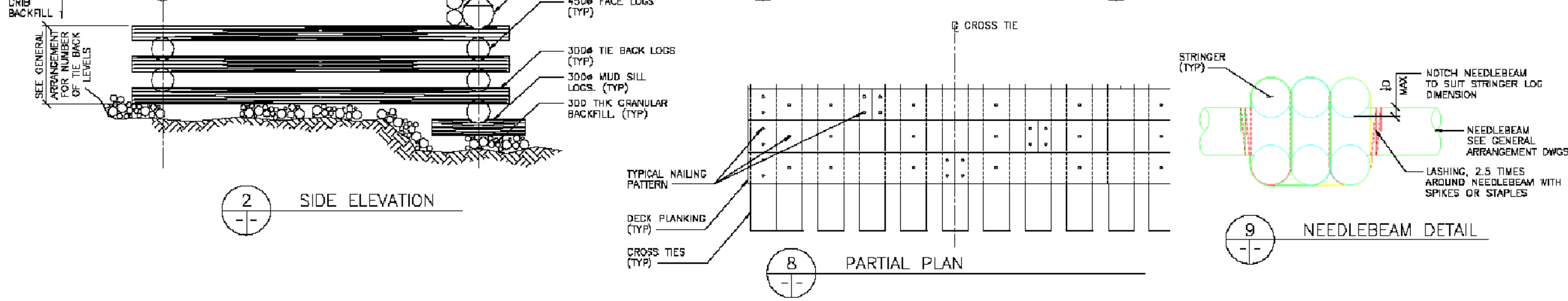
MACTUNG

LOG BRIDGE
PLAN & ELEVATIONS

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	GMR	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 3.5-1





NOTES:

1. LASHING TO BE GOOD QUALITY, FLEXIBLE, 6x26, XIP WIRE ROPE WITH A BREAKING STRENGTH 1/3 THE DESIGN LOAD OF THE BRIDGE.

DESIGN LOAD	MINIMUM BREAKING STRENGTH	MINIMUM SINGLE LASHING DIAMETER	MINIMUM DOUBLE LASHING DIAMETER
B-TRAIN	20.83 tons	22.1mm (7/8")	12.7mm (1/2")
L100	33.3 tons	22.1mm (7/8")	14.3mm (9/16")

2. ALTERNATE TAPERS TO LEVEL THE SURFACES.
3. SHIM AS NECESSARY.
4. BACKFILL INSIDE OF TIMBER CRIB WITH 75mm TO 150mm (3" TO 6") CLEAN ROCK TO LIMIT SHOWN ON GENERAL ARRANGEMENT DRAWINGS.
5. ALL CROSS TIES, DECK PLANKING AND GUARDRAIL TO BE CUT FROM LOCALLY HARVESTED HEMLOCK OR SPF ROUGH SAWN TO THE DIMENSIONS INDICATED.
6. CROSS TIES MUST BEAR ON THE STRINGERS. SHIM GAPS LARGER THAN 3mm AS NECESSARY.
7. SPIKE ALL CROSS TIES TO STRINGERS USING 12.7mmø SQ. SPIKES, GALVANIZED, WITH MUSHROOM HEADS AND CHISEL TIPS. LENGTH TO PENETRATE MINIMUM 300 INTO THE STRINGERS.
8. SPIKE ALL DECK PLANKING TO CROSS TIES USING 200 LONG (8") GALVANIZED COMMON SPIKES TO THE NAILING PATTERN INDICATED.

NOTES:

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MACTUNG

LOG BRIDGE
TYPICAL CONSTRUCTION DETAILS

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	GMR	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 3.5-2

b) Identify any mitigation measures that will be put in place during construction and through the life of the project, to minimize potential effects associated with their construction (e.g. increase sedimentation, adverse effects on water quality).

As shown in section 3.5(a), single span log bridges are typical of the major watercourse crossings to be used along the proposed access road, specifically for crossing the South MacMillan River, Tributary A, and Tributary E. As outlined in the Project Proposal, each of these watercourses is considered to be non fish-bearing. Consequently, no direct fish habitat losses are anticipated as result of the bridge construction, and therefore, the downstream indirect effects on potential fish habitat related to sediment or deleterious substances will be the primary focus.

Wherever possible, bridges will be constructed as clear span bridges (i.e. not encroaching on areas below the high water mark), and will also be constructed according to the terms outlined in DFO's "*Pacific Region Operational Statement on Clear Span Bridges*". Where the terms of this statement cannot be met, the bridge construction practices will be discussed with DFO to ensure that measures for the protection of fish and aquatic habitat are sufficient, and that if appropriate an Authorization for works pursuant to the *Fisheries Act* or letter of recommendation is obtained. The mitigation measures presented below will be implemented to minimize the effects of bridge construction and operation on the aquatic environment:

Fish Habitat

As noted above, due to the non fish-bearing status of the watercourses where bridges are to be installed, local fish habitat losses are not predicted to occur. Nevertheless, each bridge installation will be reviewed with DFO at the stage of detailed engineering to ensure that no loss of fish habitat will occur, and that mitigation measures are acceptable for the prevention of downstream effects on fish and fish habitat.

Erosion and Sediment Introduction

- Bridge-related construction activities will occur during periods of low flow, in particular any works that are to occur within the active channel.
- Construction activities will be isolated from the river channel by leaving an undisturbed buffer of native riparian vegetation along the river, and installing an appropriate isolation structure between the construction area and the edge of this buffer, leading from the upstream to the downstream ends of the construction footprint.
- The right-of-way for access to the work zone will be kept to a minimum. The access and work zone will be clearly delineated, and disturbance to vegetation outside the delineated area should be avoided.
- Any works such as excavation or recontouring that occurs within the active channel will be conducted in isolation form the channel to acceptably contain sediment from these activities. This isolation structure will be suited to the final detailed intake structure

plans. Silt-laden water from within the isolation area will be pumped as necessary or allowed to settle such that sediment levels downstream are maintained within acceptable levels.

- Any water pumped from an in-stream isolation area will be directed towards a vegetated area sufficiently far from the river such that in infiltrates to the substrate and does not re-enter the watercourse.
- Terrestrial and runoff sediments from the work site will be controlled with filter/silt fences and should be placed and maintained in a manner that effectively contains any disturbed and/or exposed soil.
- Top soil removed from the construction site should be stockpiled at least 30 m away from the watercourse, be kept covered, and provisions should be made to contain runoff (e.g., silt fences).
- Slopes and soils prone to erosion will be stabilized as soon as possible by revegetation and the use of erosion control mats.
- Work must be discontinued in the event of storms or other weather that may significantly increase the erosion/runoff potential.

The following long term erosion and sediment control measures will be implemented to ensure sediments will not enter the watercourse after construction activities are completed.

- Reclamation and stabilization of the site will be initiated as soon as practically possible. Initial stabilization will be undertaken using temporary measures until permanent vegetation has become established.
- Revegetation of exposed soil should prevent or minimize long-term sedimentation problems near the construction area. Live willow plantings will be utilized to recreate pre-construction habitat features, if applicable. Other areas will be seeded using appropriate vegetation as soon as possible. If less than 4 weeks of the growing season remain, seeding/revegetation should take place at the beginning of the next growing season.
- All construction-related structures and materials will be removed from the site upon completion of the works.
- Drainage ditches or other runoff channels that lead from the roadway toward the watercourse will lead into the vegetated riparian reserve area rather than to disturbed areas adjacent to the bridge. Any ditches or channels will be properly treated with gravels, rock check-dams, or commercially available solutions to prevent erosion, and sediment transport into the watercourse.

<u>Introduction of Deleterious Substances</u>

- Hydraulic and fuel systems of all machinery involved with work in or around the watercourse will be leak free and in good repair, to the extent possible.

- All equipment will arrive at the site clean (no external mud, grease, oils, and other deleterious substances).
- Servicing and washing of construction equipment will not occur within 100 m of the watercourse, and will be confined to a specially marked service area that does not drain towards the watercourse.
- Spent lubricants, oils, and other petroleum products will be disposed of in an appropriate manner.
- Risks of fuel spills will be minimized by ensuring all hoses, containers, and nozzles do not leak; using trained operators to monitor equipment during fuelling; and bleeding fuel hoses into a storage tank.
- The crew working at the site will be trained in spill response and containment procedures. A spill kit will be present at the site and spills will be reported to the appropriate authorities.
- Spill Contingency Plan (Appendix M2 of the Project Proposal) will be in effect for all works and the crews will be familiar with the plan.
- No treated wood products will be used for temporary structures during the construction.
- No acid generating or potentially acid generating rock will be used for construction in the vicinity of watercourses.

Bridge Maintenance

Periodic bridge maintenance activities that may be required during the operation phase of the project will be conducted according to DFO's Pacific Region *"Operational Statement on Bridge Maintenance"*. This may include deck cleaning, debris removal from beneath the bridge or abutments, as well as structural repairs. Where the scope of work required is beyond that covered in the statement, or if the terms of the statement cannot be adhered to, the corresponding authorities will be contacted for a review and permitting of the work required (i.e. DFO or Yukon Water Board).

3.6 OVERTOPPING DESIGN OF ROADWAY

In the Project Proposal it is indicated that roadways around the proposed 25 culverts will be designed for an overtopping scenario (p.342). Although Figure 5.4.2-7 provides an understanding of what this portion of the roadway will look like, it is unclear as to how effective this design is in accommodating increased water flow. Therefore, in order to corroborate the appropriateness and effectiveness of this design please provide the following information.

a) Provide a brief explanation as how this design element will work, and how it will serve to minimize potential adverse effects and facilitate project operations. Include in this explanation a description of the anticipated long-term performance of such sections, if overtopping scenarios occur frequently.

As stated in the proposal in Section 5.4.2.5 (p.342) the culverts will be sized to accommodate at least the 1:50 year peak flow with a minimum culvert size of 900 mm. A 1:50 year peak flow has a 2% chance of occurring in any given year. Therefore, overtopping is not expected to occur frequently during the current design life of the roadway of 17 years and the culverts are designed for a 1:50 year event. If a culvert overtops during the construction or operation phase of the project, its adequacy will be reviewed and if necessary a larger culvert or multiple culverts will be installed.

Since the probability of overtopping is low, the overtopping design element will be removed from the design and the project proposal. Culverts that are not designed for overtopping are used throughout the Yukon on all major and secondary roads and highways. Current typical Government of Yukon specification for installation will be adopted during the detailed design phase.

b) Provide examples of where this design has been implemented before, either in the Yukon or elsewhere, and explain any concerns and considerations that should be associated with their use.

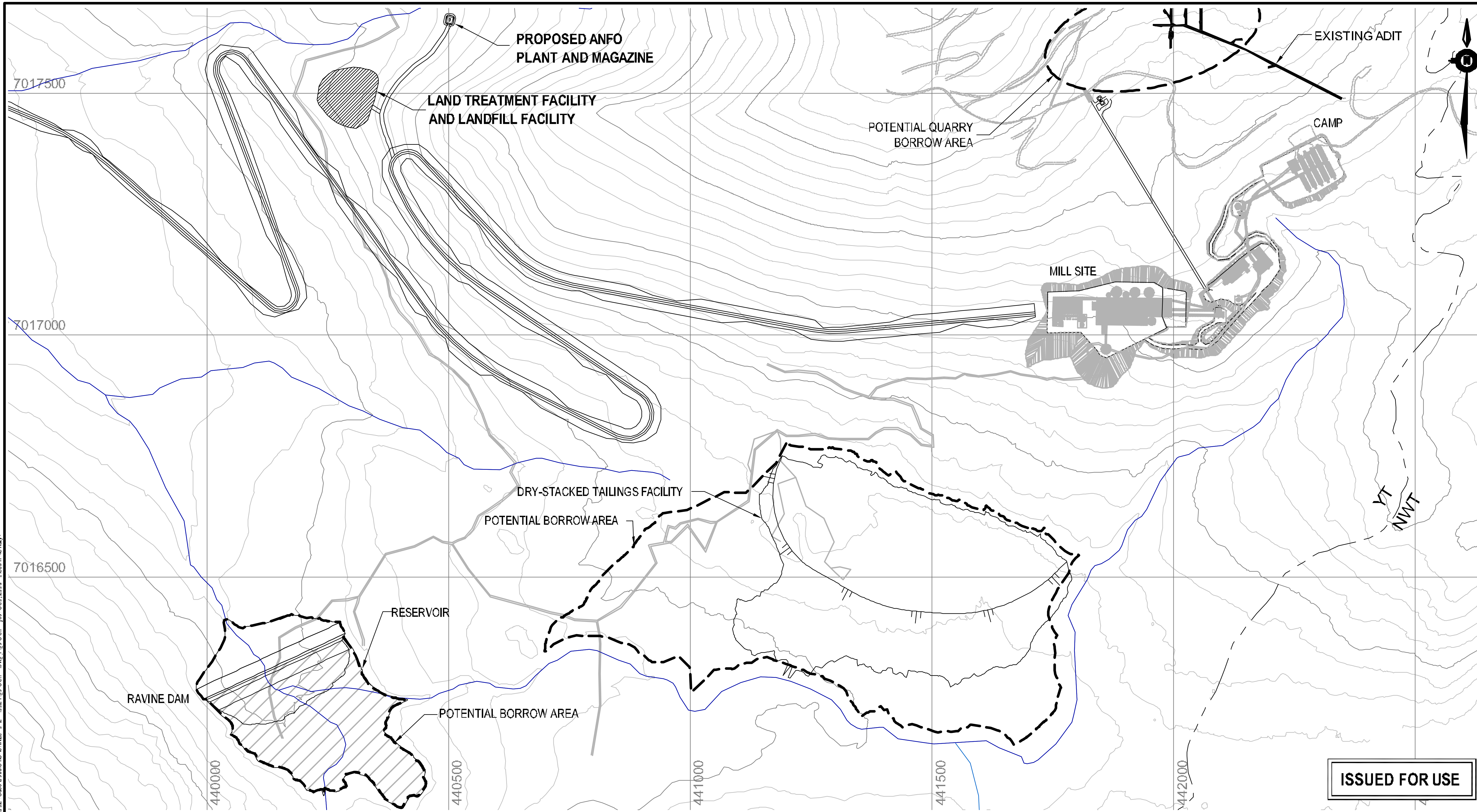
The culverts are no longer being designed to overtop since the probability of occurrence is only 2% in any given year. Therefore, no further information on this design element is provided.

3.7 ANFO PLANT LOCATION

Ammonia Nitrate Fuel Oil (ANFO) explosives will be used during the construction phase of the project as well as for underground long-hole blasting during the operations phase. Explosives will be manufactured on-site at the ANFO emulsion plant that is to be located on the west side of Mount Allen (p.404). The proposal states that the location is shown on Figure 5.4.3-8. In fact the figure does not reveal the specific location of the plant, nor does it provide an adequate understanding of the terrain and topography immediately surrounding the ANFO plant and its access road. Therefore, please provide the following information.

a) Details showing the specific location of the ANFO plant, as well as sufficient detail on the access road to the ANFO plant. An adequate description of the surrounding topography and terrain should be included in the response (e.g. map with adequate contours).

The location of the ANFO plant is shown in Figure 3.7-1. A more detailed map showing the surrounding topography is provided in Figure 3.7-2.



20 m CONTOUR INTERVAL

0 250
Scale: 1: 7 500 (metres)

NORTH AMERICAN TUNGSTEN CORPORATION LTD

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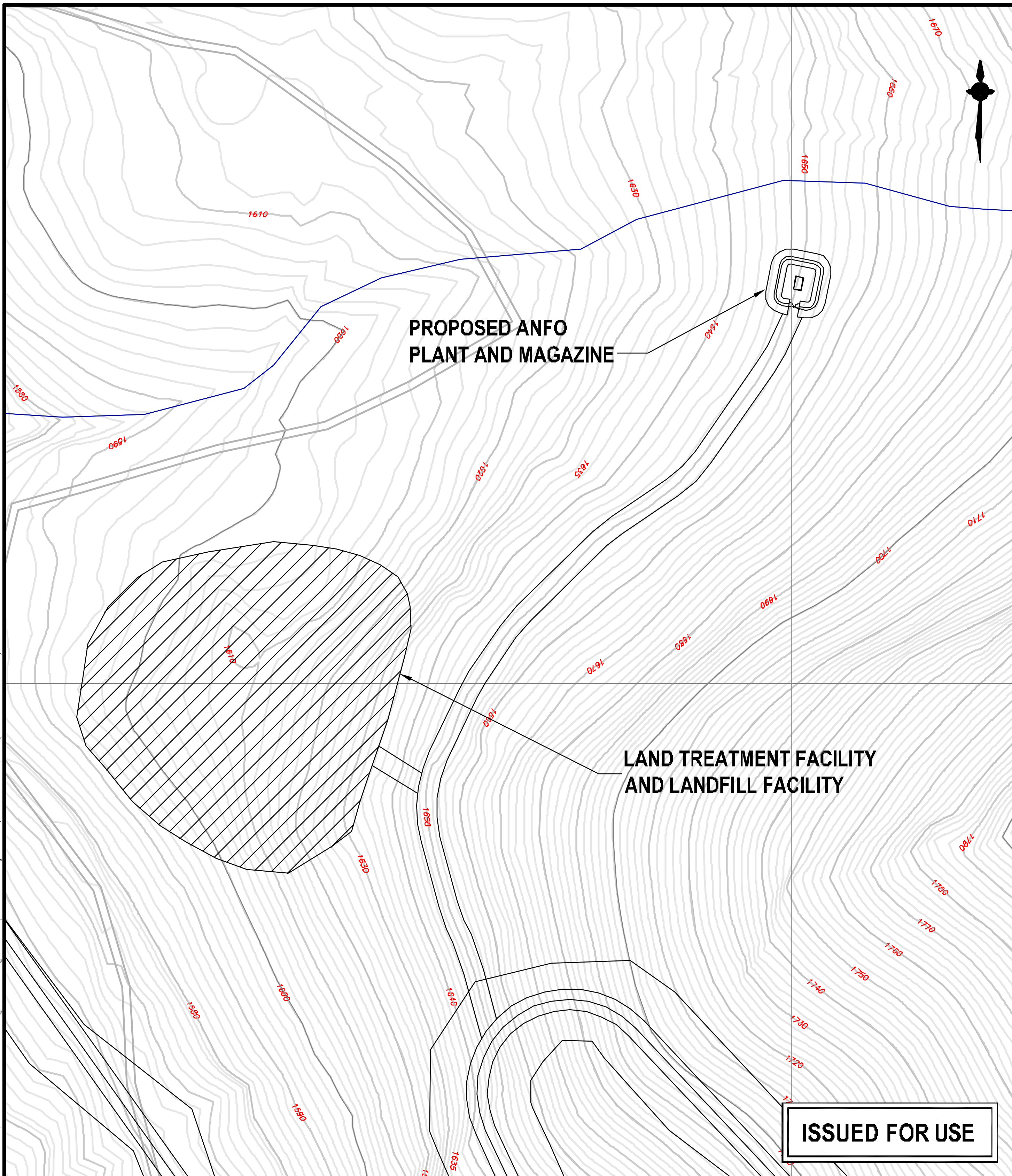
Location of Land Treatment Facility (LTF) Landfill Facility and ANFO Plant

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	GMR	0
OFFICE	DATE		
EBA-WHSE	June 17, 2009		

Figure 3.7-1



0 100
Scale: 1: 2 000 (metres)

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ANFO Plant, Landfill and LTF
Location Detail

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	GMR	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 3.7-2

3.8 GELDYNE

The proponent has indicated that both ANFO explosives as well as Geldyne high explosives may be used in infrastructure development and pre-production development of the underground mine. It is understood that ANFO explosives will be produced at the production plant, but no further details are provided on the sourcing, acquisition, transport, or long-term storage of Geldyne high explosives.

Even though it is understood by the Executive Committee that the acquisition, storage and use of explosives in mining operations is regulated by the *Explosives Act*, this information is important to the assessment process. It enables the Executive Committee to fully understand any potential effects that might be related to the transportation, storage, and use of this type of explosive, and to ensure that the proponent has identified and intends to implement appropriate mitigation measures. Therefore please provide the following information.

a) An explanation of the explosive Geldyne, where it will be made or acquired from, how it will be transported to the project site, where it will be stored on-site, and any appropriate regulations that may apply to its possession and use.

Geldyne will be purchased from an explosive supplier and it will be directly transported to the site by tractor trailer. The geldyne will be stored in the explosive magazine on site. The purchase, transportation, and the storage of Geldyne will meet the standards of the Explosives Act (Act: Explosives Act, R.S.C. 1985, c. E-17 Regulation: Explosives Regulations C.R.C., v.VI, c. 599, p.3961, as amended).

3.9 CEMENT AND CONCRETE PRODUCTION

During the construction phase of the project, concrete will be required for various components of infrastructure, including foundations, water course crossing infrastructure, the water intake facility, bulkheads and the ravine dam. The proponent acknowledges that concrete wastewater can have adverse effects on water quality, fish, and other aquatic organisms (e.g. effects on pH, increased toxicity to fish). The proposal states that concrete wastewater will be either disposed of in an acceptable manner, or it will be diverted to specifically assigned areas for treatment or disposal.

To fully understand the potential effects that concrete wastewater could have on the surrounding environment, and to determine the effectiveness of proposed mitigation measures, it is necessary for the Executive Committee to understand how and where concrete will be produced during the project, as well as how and where concrete wastewater will be managed. Please provide the following information.

a) Details on where concrete will be mixed on-site, what type of equipment will be used to produce the concrete (e.g. a mobile or stationary equipment), and the manner in which the concrete will be pumped or poured on the project site.

Bulkheads will not be constructed during the construction phase but during the operation phase of the project. Bulkheads are constructed after the stope is mined and before it is backfilled. Bulkheads will be constructed from wire mesh and shotcrete. Further information on the construction of the bulkheads is given in the response to 3.9(d).

The method of batching concrete for construction will be determined during the detailed design and tender phases of the project. Discussions with general contractors during the detailed design phase along with design details of the concrete elements to be constructed will aid in determining whether a stationary concrete batch plant is required or if a mobile concrete mixer can be used.

If a temporary stationary batch plant is mobilized to site, it is likely that it will be installed between the proposed camp and powerhouse facilities. Concrete will be batched and loaded into concrete mix trucks and hauled to the location where the concrete is required. If a mobile concrete mixer is used the mobile mixer will be set up at the location where the concrete is required. With either batching method the concrete ultimately comes off a chute (either the chute of the delivery truck or the chute of the mobile mixer).

Regardless of the batching method selected the production of concrete itself does not generate waste water. Wastewater is generated through aggregate processing and the cleaning of tools and equipment used to batch and place concrete.

The manner in which the concrete is placed (poured from the chute directly into the forms, or pumped through a concrete pump) is also dependent on the contractor's preference, location of pour, type of concrete being placed, and what building element the concrete is placed to construct. At this stage (feasibility level design) it is expected that several methods of concrete placement will be used, including, but not limited to: directly pouring the concrete into the form from the chute, pumping the concrete through a concrete pump and pipe, placement of concrete through the use of a crane and bucket, placement of concrete using a wheelbarrow.

b) A detailed explanation on how concrete wastewater will be captured, treated, and disposed of.

As mentioned in the response to information request 3.9(a) concrete wastewater is generated through aggregate processing and the cleaning of tools and equipment used to produce and place concrete. This means, regardless of where the concrete is batched and placed, NATC has control over where the tools and equipment are cleaned, with the exception of a temporary stationary concrete batch plant.

If a temporary stationary batch plant is mobilized to site for the construction phase of the project, an ex-filtration sump large enough to hold all the wastewater generated from cleaning the batch plant and mix trucks will be designed and installed adjacent to the batch plant. All wastewater will be directed into this sump and it will be designed to allow ex-filtration of the water into the ground. If build-up of cement particles in the sump prevents the sump from ex-filtrating efficiently, then the sump will be cleaned and excavated cement will be hauled to the landfill facility.

Washing of tools and equipment used to place the concrete can include, but is not limited to, pumps, buckets, shovels, wheelbarrows, testing equipment, floats, and trowels. Washing will be done in areas near where the concrete is placed. The wastewater generated from this is expected to be small and will be done over ground in areas that does not directly flow into a surface drainage.

There will be no washing of tools of equipment used to batch or place concrete within 30 m of a surface watercourse. Water used for concrete washing will be minimized to the lowest amount practicable for the task. All wastewater from washing will be left to ex-filtrate into the ground, either directly on the surface of the ground or in an ex-filtration sump. These are best management practices for the industry; they are currently used throughout the Yukon and are in accordance with the Canadian Ready Mix Association Environmental Management Practices for Ready Mix Concrete Operations in Canada (CRMCA, 2004).

Based upon independent review, it is nearly certain that underground bulkheads will have to be constructed out of concrete (i.e. wooden bulkheads are not feasible given project constraints). Depending upon the number of bulkheads to be constructed, the amount of cement required for on-site construction, and decommissioning/closure could increase substantially, as compared to a wooden bulkhead scenario. Please provide the following information.

c) Indicate whether the infrastructure currently proposed can sufficiently deal with this potentiality.

Bulkheads will be constructed from shotcrete and wire mesh as described in the response to 3.9(d). The infrastructure currently proposed for the mine will be able to handle the installation of wire mesh and the application of the shotcrete to the wire mesh surface. Both these tasks are also a part of the ground support system for the mine. The equipment included in the proposal for installation of ground support has the capacity to also install the bulkheads.

d) While it is clear that bulkheads will be used as a physical barrier to hold back backfill material, clarify and provide a rationale as to whether these bulkheads will be engineered in any way to prevent or control water flow and/or to monitor water quality. How will the performance of these be monitored and how would water draining from these structures be managed? Provide details on the design of these structures.

Bulkheads will be designed for hydrostatic pressure. Water flow, if any, will be managed through drain pipes at the base of the bulkhead, and any collected water will be pumped back to the central pumping system with further pumping to the mill for use as process water.

3.10 LAND TREATMENT FACILITY

In the Project Proposal on page 558 (Section 6.2.8.2), the proponent indicates that a land treatment facility will be in operation on-site in order to remediate hydrocarbon contaminated soils. The proposal does not provide any further information on the location, design, operation, or projected volumes of material that will be treated by the facility. Given that the proposal identifies it as an activity that will occur as part of the mine operations and hence the scope of the project, sufficient information and detail must be provided as part of the Executive Committee screening. Please provide the following information.

a) Details on the design, construction, location and operation of the land treatment facility.

NATC requests that a Land Treatment Facility (LTF) be included within the scope of the Mactung environmental and socio-economic assessment even though every effort will be made by NATC to prevent the need for one through the use of correct handling procedures for fuels and other potential contaminants.

The construction, location, and operation of the LTF will meet or exceed the requirements as provided in the LTF Guidelines published by the Environmental Programs Branch of the Government of Yukon. In general, this requires the LTF to be:

- constructed with a slope of less than 6%;
- greater than 3 m from the seasonal high groundwater table;
- greater than 100 m from a surface water body;
- outside of a 25-year floodplain; and,
- greater than 60 m from a residential property or building.

The proposed general location of the LTF is provided in Figure 3.7-1 and will be adjacent to the landfill to help with the efficient excavation and use of material during construction and decommissioning. The LTF will be located within the polygon shown in the figure, in an area that will ensure that the above noted conditions are met. The depth to groundwater in the area will be confirmed by testpitting at the site prior to construction. If required, additional inert material will be placed to increase the liner elevation over the seasonal high groundwater table.

The facility will be constructed with either a compacted silt, or a synthetic liner with a maximum hydraulic conductivity of less than 10^{-7} m/s. Local soils for use in liner construction will be selected based on hydraulic conductivity as calculated from grain size analysis as currently accepted by the Environmental Programs Branch. The source of natural liner material is expected to be encountered during access road construction. The required volume of natural liner material, for the minimum one metre thick liner, would be excavated from the road alignment and hauled to the proposed LTF site. If an insufficient volume of low permeability soil is encountered during access road construction then a synthetic liner would be used during LTF construction.

b) An estimate of the volume of material that the facility will treat over the life of the project.

The proposed facility will be capable of treating up to 900 m^3 of soil at any one time (or temporarily storing up to 2800 m^3 from a single spill event). The proposed facility is based on an estimated annual generation of 100 m^3 of material and a yearly maximum of 300 m^3. Soil treatment typically requires two to three treatment seasons to reach Park Land Use Standards as stated in the Contaminated Sites Regulation. The proposed facility design would allow for treatment of the estimated yearly maximum of new soil on a continuing basis.

Based on the design capacity the layout would be approximately 40 m by 25 m inside berm dimensions. Berms would be approximately 0.5 m high and 1.5 m base width. The LTF would be permitted as a multi-use facility as each spill or source of contaminated soil must be handled separately.

Once treatment has resulted in materials below Park Land Use standards, soil would be removed and either reused on site or stockpiled for future use. If more capacity was required then the facility could be used as a temporary storage location and soil backhauled to a commercial facility under a relocation permit issued by Government of Yukon.

c) Details on any additional infrastructure required in order to construct, operate, and/or decommission the proposed land treatment facility.

Approximately 100 m of access road would be constructed into the LTF. The operation of the facility would use equipment already on site for tasks such as routine maintenance and the monthly tilling of soil (June to Sept). Decommissioning would require up to three years of soil treatment following placement of the last stockpiles of contaminated material. Once remediation of soil contamination was complete the soil would be reused as fill material or for reclamation media, e.g., for the landfill or dry-stacked tailings facility. It should be noted that using these soils as reclamation media would allow for revegetation activities to provide additional phyto-remediation treatment of any residual hydrocarbons.

3.11 DRY-STACKED TAILINGS FACILITY (DSTF)

The project proposal indicates that with "a diligent tailings disposal procedure, there is no concern of the tailings freezing in place before they can be placed and compacted in the DSTF" (p.329). The project proposal provides some detail regarding the placement and compaction of tailings as well as experience from the Minto Mine. The exposed tailings will be subjected to freeze/thaw cycles and if they are not optimally compacted during the winter, may experience increased thaw and water flow during the spring. These freeze/thaw cycles may increase the ARD/ML potential from the DSTF. Please provide the following information.

a) Details regarding site specific tailings disposal procedure, with particular focus on cold weather disposal.

The tailings are deposited off a conveyor stacker outside the mill building. The tailings will exit the mill at a temperature somewhere between 10ºC and 20ºC (as a result of grinding, scheelite flotation and pumping). Since new warm tailings will continuously pile over the cooling tailings there is no concern for the tailings freezing in place so long as the tailings are constantly being deposited in one location from the mill.

The current plan is to haul tailings from the mill discharge location to the DSTF at least once per shift. In the event that tailings cannot be moved from the mill discharge location to the DSTF (e.g. site whiteout conditions) they will be temporarily piled at the discharge location. At this time the tailings will be subject to freezing temperatures and the outer edge of the tailings pile may freeze.

One-dimensional freezing calculations, as described in Andersland and Ladanyi (2004), estimate that in 7 days of -40ºC weather the crust will freeze between 100 and 300 mm. Experience from the Minto Mine shows that the tailings placed in a conical pile will develop a frozen edge with a thickness of less than to 100 mm in 4 to 6 hours. Experience at the EKATI Diamond Mine shows similar results, however; EKATI's coarse processed kimberlite has a coarser gradation and higher moisture content.

If an emergency or breakdown occurs and the tailings are left out for 7 days without being transported to the DSTF we can expect that there will be a 300 mm thick edge of frozen tailings around all piles. The tailings beneath the frozen edge will be thawed and still compactable. The thawed tailings will be hauled to the DSTF and placed in accordance with the standard tailings placement method. The frozen edge of tailings will be hauled to a location within the DSTF (at least 30 m from any edge) and placed in a loose state. The frozen tailings will not be covered until they have thawed and are properly compacted. All tailings placed in the DSTF will be properly compacted.

The standard placement method of the tailings is explained on page 402 of the project proposal. Experience at Minto Mine shows that this tailings procedure will result in placement and proper compaction of tailings in cold weather. A procedure similar to this has also been successfully used for placement and compaction of granular materials for the construction of frozen core facilities (three at EKATI, one at Polaris, and one at Jericho) in Northern Canada.

Soils will freeze faster while being spread and compacted than they will if left in a pile. Therefore, once the tailings are hauled to the DSTF they must be immediately spread and compacted. NATC will conduct regular quality control testing to ensure that the tailings are being compacted to at least 95% of maximum dry density as per ASTM D698.

A total of 2,130,000 m^3 potential acid generating tailings will be placed in the DSTF over a period of 11 years. The DSTF will cover an area approximately 25 ha and will have a 4H:1V slope at completion. Experts retained by the Executive Committee have made the observation that the DSTF appears to cover a greater surface area than necessary. Given the risks associated with the installation of a synthetic liner over potentially acid generating tailings, a smaller surface area may reduce potential liabilities of the DSTF. Please provide the following information:

b) A discussion on alternative methods of developing the DSTF such as a smaller surface footprint and higher stacked tailings. Include in this discussion a prediction (based upon manufacturer information or experience in the field as well as an understanding of site hydrology) of water flow into and out of the DSTF post closure, under these scenarios (i.e. 25 ha versus smaller).

The risk of instability of the DSTF becomes greater with an increased height and smaller footprint, especially in an earthquake area. Slope stability calculations conducted on the DSTF pile show that the factor of safety against failure of the pile decreases with height. The extent and magnitude of run-out associated with failure will increase with an increased pile height (BC Mine Waste Rock Research Committee, 1995).

The BC Investigation and Design of Mine Dumps – Interim Guidelines (Piteau, 1991) provide a dump rating scale, where points are allocated based on several factors associated with their design and construction. That rating system was used to develop the summary in Table 3.11-1. As seen in Table 3.11-1 by increasing the height of the slope and decreasing the footprint area the failure hazard assessment of dump changes from low to moderate. The main factors driving this change are the dump height, foundation slope and placement speed. The DSTF is currently designed with a maximum height of 50 m. If the DSTF is built higher than that shown in the project proposal then the crest of the pile need to move up the mountain slope by 20 to 30 m to significantly reduce the footprint area. This will increase the overall slope of the DSTF foundation to above 10º. If the footprint of the DSTF is less than proposed then the crest length will also be smaller. Thus, in order to place the same volume of tailings each day the crest will advance out quicker.

TABLE 3.11-1: DSTF DUMP RATING SUMMARY				
	DSTF as designed		Proposed Higher DSTF	
Key Factors Affecting Stability	Description	Points	Description	Points
Dump Height	Less than 50 m	0	50 m – 100 m	50
Dump Volume	1 – 50 million m³	50	1 – 50 million m³	50
Dump Slope	14º	0	14º	0
Foundation Slope	7 º	0	11 º	50
Degree of Confinement	Unconfined	100	Unconfined	100
Foundation Type	Competent	0	Competent	0
Dump Material Quality	Poor (>25% fines)	200	Poor (>25% fines)	200
Method of Construction	Favourable	0	Favourable	0
Piezometric and Climatic Conditions	Intermediate	100	Intermediate	100
Dumping Rate	Moderate (0.1 m to 1.0 m of crest advancement per day)	100	High (greater than 1 m of crest advancement per day)	200
Seismicity	Moderate	50	Moderate	50
Total Points Used to Determine Failure Hazard	Low (300 – 600)	600	Moderate (600 – 1200)	800

With a height of 50 m and a dump-face slope of 14º the sloping face of the DSTF will be approximately 200 m long. Placement of a synthetic liner (geomembrane cover) down this slope is possible. Increasing this slope length without the addition of benches in the pile could lead to construction problems at closure. If the DSTF were stacked higher and benches used to reduce the closure construction problems, the overall footprint of the pile may not be significantly reduced.

Since the surface runoff from the catchment above the DSTF is diverted using the proposed diversion berms and ditches (see page 376 of the Project Proposal) the water flow into the DSTF is expected to be limited to direct precipitation on undiverted ground. The expected volume of runoff from varying catchment areas is summarized in Table 3.11-2 (assuming a conservative estimate of 700 mm of runoff per year). For the calculations summarized in Table 3.11-2 the Rational Method and runoff coefficient of 0.7 were used.

TABLE 3.11-2: RUNOFF VOLUME FOR VARYING DSTF FOOTPRINT AREAS						
DSTF Configuration	Area (m^2)	Runoff (m/year)	Runoff Volume (m^3/year)	Difference in Volume from Proposed DSTF (m^3/year)	Percentage of Undiverted Runoff Reporting to Ravine Dam	Comments
Proposed (25 ha)	250,000	0.7	131,250	--	10%	Currently Proposed Size
Smaller and Higher-1 (20 ha)	200,000	0.7	105,000	-26,250	8%	May have constructability concerns as noted above
Smaller and Higher-2 (15 ha)	150,000	0.7	78,750	-52,500	6%	May not be possible to design a stable pile of this footprint area, included for illustration only

NATC does not believe that reducing the yearly volume by 26,250 m^3 is a sufficient enough reason to increase the probability and possible extent of failure in the dump Also the cost of reclamation and closure will likely increase for a higher stacked dump due to the complexities of construction of the synthetic liner on the high slope.

3.12 RAVINE DAM AND RESERVOIR

The Project proposal indicates that the reservoir is designed to work as a plug flow reactor to allow process water approximately 30 days residence time prior to re-use. If reagents are not allowed the appropriate time to break down, the water cannot be re-used in the milling process. This may cause additional water to be withdrawn from the Hess River tributary which may cause the reservoir to fill to capacity faster than anticipated.

Also, in order for the dam to not overtop (or for untreated water to discharge into the environment), water is required to exfiltrate to ground. The proposal suggests that this exfiltration will happen at a consistent rate over the life of the project. This assumption may be questionable on the basis that hydroxide precipitates will accumulate over time on the reservoir floor, thus reducing or preventing the outflow of water over time. Concurrently, groundwater is said to be at or near the surface, which suggests that water will not naturally exfiltrate unless the head is increased. The information regarding the water balance of the reservoir and dam is very general in nature, and does not speak to these issues which may fundamentally affect the ability of the reservoir to function as proposed. For instance, as noted by Environment Canada, a minimum volume of 120,000 m^3 of water is required in the reservoir to ensure proper operation of the facility and for reaction of mill reagents. The presence of this minimum volume of water in the reservoir reduces the volume of available operating capacity. Please provide the following information.

a) A water balance including sensitivity analyses which clearly demonstrate that the reservoir can handle variations in flows and the total volumes of water anticipated throughout the life of the mine. A table showing the anticipated available storage throughout the life of the mine would be useful to the assessment of this project.

Please refer to Section 5.4 and to Tables 5.4-1 through 5.4-9.

b) Details regarding the manner in which the plug flow reactor will operate, as well as the methods used to ensure the reservoir will function as anticipated (i.e. process water can be aged appropriately). Information about the implications of not achieving plug flow such as changes in water quality, and modifications to overall water management should be provided.

A plug flow system is a model to predict residency time in a reservoir, and there are many factors governing its design, construction, and operation. An ideal plug flow system has no mixing along its length, complete mixing along its cross-section at the inlet and a uniform velocity through its profile. Since a reservoir doesn't completely meet these assumptions, it is important to consider dead zones, areas of diffusion (mixing) and short circuits that may exist in the system.

A quick way to determine if a reservoir will have notable dead zones is to compare its effective length to effective width. To minimize dead storage, the effective length should be at least twice the effective width. Effective length is the shortest distance in a reservoir that an element of water will travel through from point of inflow to point of discharge. The effective width is the reservoir's surface area divided by its effective length. The reservoir has an effective length to effective width ratio of 1.46, which is smaller than the recommended 2.0, so we can expect to have dead zones in the reservoir. These dead zones will be accounted for in the detailed design for water treatment.

Dispersion is a form of mixing and occurs in reservoirs due to temperature changes, wind and ice formation. It is expected that some dispersion will occur in the reservoir.

Short circuiting of a reservoir can occur when the distance the water unit travels within the system is shorter than the effective length, thus decreasing the overall retention time of that particular unit of water. Short-circuits typically occur in reservoirs where the bathometry is not considered during the design of inlet and outlet locations.

In designing the reservoir to operate as a plug flow system, the above factors will be considered. There will be a portion of the reservoir, which will be the total volume minus dead zone volume, dispersion volume, and short circuited volume that can be used to achieve plug flow. The concentration change achieved in the plug flow system will have to be such that it accounts for the lack of concentration change in the other areas.

In the case of the reservoir, it is operating as a plug flow system to properly age the process water prior to returning it to the mill. The reaction occurring in the system is oxidation of organic compounds.

If there are times when plug flow will not be achieved, it will be during times of high inflow from surface runoff. It is expected that the ratio of runoff water to process water will be high enough to negate any effects of not having the process water aged for 30 days prior to reuse in the mill.

If plug flow is not achieved during a period of low runoff inflow (winter months) and the aging time for the process water is less than 30 days it is expected that the water will still be acceptable for use in the mill. The 30 day aging processing is considered beneficial to the milling process but not essential.

c) Include in the discussion whether site conditions such as ice formation, wind, and reservoir depth are conducive to plug flow rather than fully mixed conditions.

Specific conditions of ice formation, wind and reservoir depth are addressed in the response 3.12(b). Should the plug flow system be deemed too inefficient due to dead zones, diffusion, and short circuiting, there are remedial measures that can be taken to increase the detention time, such as placement of curtain baffles.

d) Details regarding any anticipated reduction in exfiltration rates from the reservoir due to the accumulation of precipitates over the mine life.

Although the process water from the mill will be filtered before discharge to the reservoir, fines passing the filter and sediments in the catchment runoff will accumulate in the reservoir over the mine life. In addition, changes in the chemistry of the water, especially the availability of oxygen and the alkaline pH may promote the formation of precipitates, which will also accumulate at the bottom of the reservoir over time. The predictive water quality modelling for the reservoir (see Section 6.2.8.2 of the project proposal) indicated that especially iron (oxy)hydroxides may precipitate along with other (hydroxide) minerals.

The accumulation of fine sediments and precipitates at the bottom of the reservoir may cause a reduction of the exfiltration rate with time. The exfiltration rate may even decrease to negligible values depending on the accumulation rate and hydraulic properties of the accumulated sediments.

It is important to note, however, that the reservoir is not intended to operate as an exfiltration pond and that operation of the reservoir does not rely on exfiltration in any way. The water level in the reservoir would at all times be controlled by discharge of water through the spillway. Even if the exfiltration rate decreases to zero the discharge through the spillway could simply be increased correspondingly. Tables 5.4-1 to 5.4-3 and 5.4-7 to 5.4-9 present different scenarios for the water balance accounting for maximum exfiltration (6.6 L/s) and minimum exfiltration (0 L/s), respectively.

e) A discussion regarding anticipated reductions in exfiltration rates from the reservoir due to the groundwater level.

The reservoir will be situated in a natural discharge zone with a vertical (upward) component of the hydraulic gradient. The reservoir and its hydraulic connection to and influence on the local groundwater system after construction will not change these conditions substantially, (i.e., the area will remain a groundwater discharge area). The hydraulic gradient in the immediate vicinity of the reservoir may temporarily be reversed causing some exfiltration of water from the reservoir into the shallow aquifer. However, in addition to a potential reduction of the exfiltration rate due to accumulation of fine sediments, and precipitates, the exfiltration rate will be controlled by the hydraulic gradient between the water level of the reservoir and the adjacent groundwater elevation. Both the water level of the reservoir and the groundwater elevation will vary seasonally. Hence, the exfiltration rate, which is directly proportional to the hydraulic gradient, will vary seasonally as well. The water level of the reservoir will range from a maximum of about 1510 m asl in July to a minimum elevation of about 1506 m asl in October (1:2 scenario, see Table 5.4-2). In the vicinity of the reservoir (MW-MT-08-06), natural fluctuations in groundwater elevation are less pronounced with a maximum of about 1490.3 m asl in late summer and a minimum of about 1488.6 m asl in late winter (see Table 5.2-2). Note that the groundwater in MW-MT-08-07 is slightly artesian and representative of a deeper aquifer that would not be in immediate hydraulic contact with the reservoir.

Importantly, as mentioned in Section 3.12(d) the operation of the reservoir will not rely on any exfiltration from the reservoir. The water level in the reservoir could always be controlled by discharge through the spillway.

f) Provide details regarding the implications on water quality, and water management if plug flow is not achieved within the reservoir, or if exfiltration rates are not as high as predicted.

Details on the operation of the reservoir as a "plug flow" system and factors that may potentially interfere with its proper functioning are presented in the responses 3.12 (b) and 3.12 (c).

The residence time of the water within the reservoir is expected to be in the order of about 30 days during which process chemicals (fatty acids) will break down before the water is reused for the milling process. It is important to note, however, that this aging of the water and the associated break down of process chemicals would be beneficial to the process but is not essential. Even if the actual residence time in the reservoir was considerably shorter, NATC expects that the water would still be of acceptable quality for its reuse in the milling process. Furthermore, it is anticipated that if plug flow was not achieved it would be during high water inflow from surface runoff when the inflow considerably exceeds the process water demand and when dilution of the process water is greatest and process water only amounts to about 15 to 20% of the total inflow.

As per Section 6.2.9.4 of the project proposal, no adverse effects on fish or fish habitat are expected to occur by remnants of process chemicals in the discharge water. However, the precise details of discharge water makeup and resulting risk cannot be fully understood at this stage of the project. Therefore, as outlined in Section 6.2.9.4 of the project proposal, toxicity testing will be conducted prior to discharge to help in the development of safe water release protocols in compliance with applicable regulatory guidelines.

In conclusion, although water chemistry may be affected if the anticipated residence time of about 30 days within the reservoir could not be achieved, NATC still expects the water quality being acceptable for the re-use as process water. Also, as outlined in the response to Question 3.12 (c), mitigation measures are available to increase the water retention time in the reservoir if required.

As described in the response to Questions 3.12 (d) and 3.12 (e), changes in exfiltration rates can be compensated for by adjusting the discharge through the spillway. The water balance scenarios presented in Tables 5.4-7 to 5.4-9 account for zero exfiltration and adjusted discharge rates.

The Project proposal indicates that a coffer dam, settling ponds, and flow interception works will be constructed within the un-diverted ravine dam catchment area. These infrastructure requirements are required in order for the proposed project to be undertaken, and therefore form part of the project scope. Please provide the following information.

g) Details on these works including location, size, and associated activities as well as a discussion on the effects and proposed mitigations associated with these activities.

Coffer dams, settling ponds, and flow interceptions used for the construction of the ravine dam are mitigation measures and will not require further mitigation measures. The details including size, location, and associated activities will be determined during the detailed design and tender phases of the project.

Specific details relating to the size and location of coffer dams required for the project will be determined by a Professional Engineer, registered to practice in the Yukon, and it will be dependent on the type of diversion system selected for construction. Typical methods of constructing a diversion system include a coffer dam upstream and downstream of the construction area and a method of conveying water around the construction area. Typical conveyance methods are culverts, pumps and pipes, flumes, and diversion channels. There is typically some kind of erosion protection at the conveyance outfall. There can also be a settling pond or some other sedimentation control in the process prior to discharging back into the stream, if the method of diversion has increased the sediment in the water.

The anticipated procedure for construction of the ravine dam is to construct coffer dams approximately 400 m upstream and 100 m downstream of the extents of construction around the ravine dam and convey the water around the construction area using either a constructed flume, pipe or a pump and pipe system. The dam will likely be constructed to final crest elevation prior to decommissioning the coffer dams. The contractor will also likely construct diversion berms on the south side of the valley prior to constructing the ravine dam. The contractor may also construct temporary diversion berms up to 100 m away from the footprint of the ravine dam between the two coffer dams on the north side of the valley. The contractor will use sediment control measures (settling ponds, hay bales, silt fences, etc.) as required. Additional information regarding the use of site controls when working in the vicinity of water courses can also be found in Appendix A (Standard Operating Procedures for Road Construction Including Culvert Installation).

4.0 ACID ROCK DRAINAGE (ARD) AND METAL LEACHING (ML)

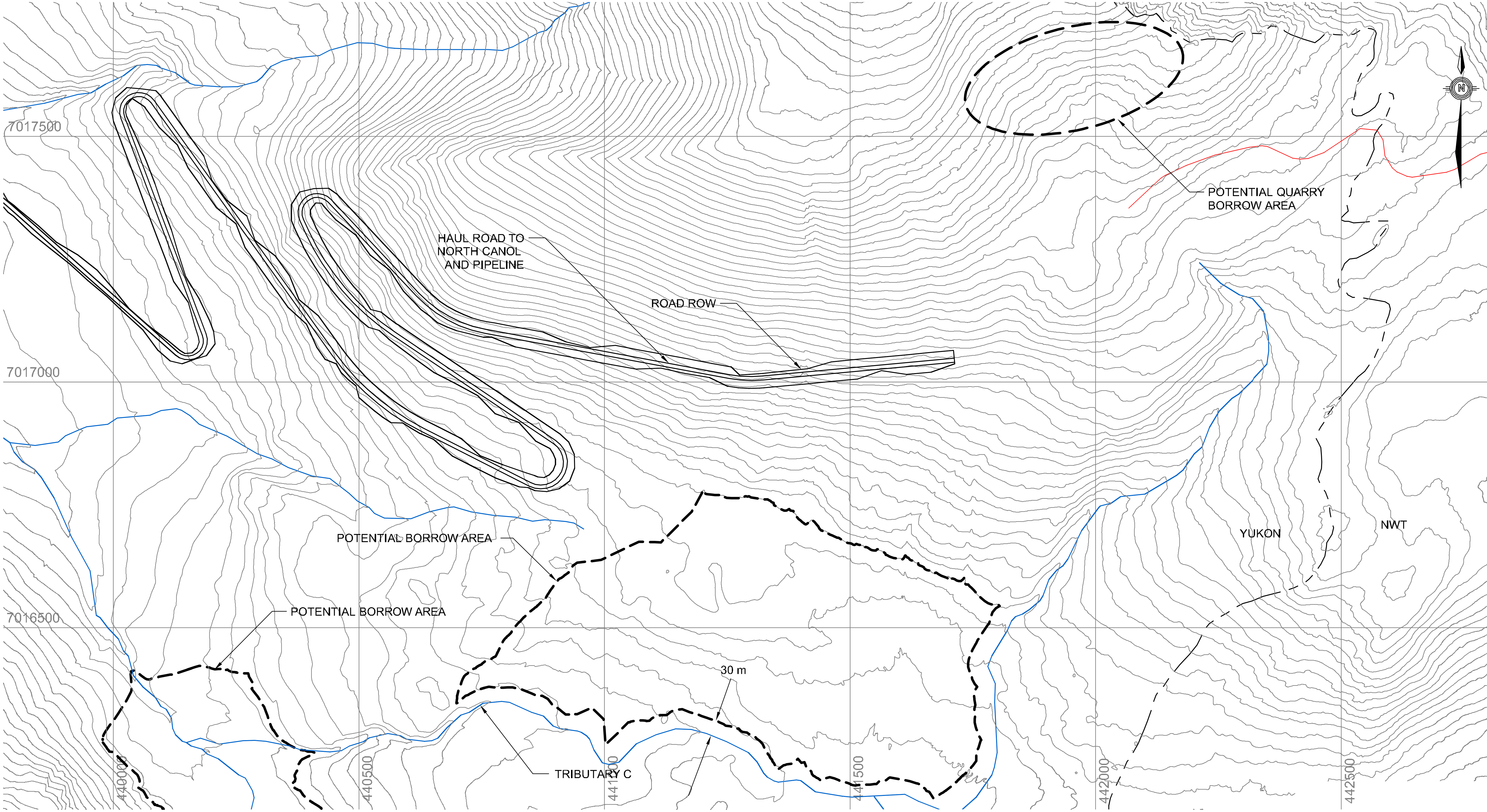
4.1 MINE SITE QUARRY DEVELOPMENT

The project is proposed to include the development of a quarry at one of three proposed borrow areas at the mine site. Two of the borrow sites are identified as borrow pits while the third is identified as a quarry, although the proposal does not clarify which of the three is the quarry. It has been estimated that approximately 500,000 m³ of fill will be removed from the two borrow pits. Approximately 50,000 m³ of high quality aggregate will be removed from the quarry. As this quarry is developed, low quality and unacceptable material for mine site development is to be stored in the pit (p.353). However, it is unclear how this approach will work realistically in the initial development stages of the quarry pit. If the initial development of the quarry is primarily of low quality material, it is conceivable that there will not yet be an adequately sized pit developed to accommodate this material. It is also unclear as to what mitigations will be in place to minimize and address ARD/ML potential from the low quality material. Because this area is known to have high ARD/ML potential, it is important that the Executive Committee understand where and how lower quality excavated material will be stored and how the potential for ARD/ML generation will be accommodated.

The potential effects from the development of borrow pits may be significantly different from the potential effects from the development of a quarry, particularly in relation to ARD since unweathered material will be exposed. Additional details regarding the borrow areas at the mine site are required in order to effectively assess potentially adverse effects. Please provide the following information.

a) Identify which of the borrow areas represents the proposed quarry.

The location of the quarry is shown in Figure 4.1-1.



NOTE:
Contours shown at 10 m intervals.

ISSUED FOR USE

0 250

Scale: 1: 7 500 (metres)

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Potential Site Borrow Areas

PROJECT NO.	DWN	CKD	REV
W23101211.002	BR	CJD	0

OFFICE	DATE
WHSE	June 2009

Figure 4.1-1

Q:\Edmonton\Drafting\DIVISIONS2007\Other Offices\W231\W23101211\002\W23101211.002-Yesaa Figure 4.1-1.dwg [FIGURE 4.1-1] June 15, 2009 - 10:49:37 am (BY: BOB RICHMOND)

b) Identify how much total material is anticipated to be extracted from the quarry (suitable material + unsuitable material).

As stated in the Project Proposal on page 353 the anticipated volume of usable material expected to be borrowed from the quarry is 50,000 m^3. Exploration drilling logs indicate that the average weathered rock and overburden thickness is 5 m in the area of the proposed quarry. Review of the exploration logs indicates that approximately 25% of the rock in the proposed quarry area may be unsuitable for high quality aggregate totalling a volume of 16,500 m^3. However, this material is still suitable for the construction of roads, infrastructure pads, and for use as general fill, subject to geochemical characterization.

The volume of overburden stripped from the quarry will depend on the footprint of the quarry. The footprint of the quarry will depend on the depth of rock acceptable for use as high quality aggregate. If the depth of the quarry below overburden surface is 5 m then the volume of stripped overburden would be 66,500 m^3. If the depth of quarry below the overburden surface is 7.5 m then the volume of stripped overburden would be 45,000 m^3.

c) Where will unsuitable quarry material be stored during active development of the pit?

The quarry overburden is a colluvial soil that is not expected to be acceptable for use in construction of any structural foundations, the ravine dam or roadways. The soil can be used as landscaping backfill and construction of pads and laydowns. If there is no use for the colluvial soil at the time it is stripped, it will be stockpiled near the quarry. The soil can be used at future date for fill if required or it will be used during reclamation.

Any quarried rock that isn't considered suitable for the production of high quality aggregate can be used in construction as general fill or for the construction of roads subject to geochemical characterization. If there is no demand for fill at the time of stripping the material will be stockpiled within the quarry and used at a later date or used during reclamation.

d) What steps or measures will be in place to monitor, measure, and mitigate ARD/ML potential from stored low quality material prior to being placed in the developed quarry pit?

Samples of geological materials intended for use as aggregate will be classified for ARD potential prior to being placed in the quarry during drilling activities. The classification will be based on a predetermined Carbon-Sulphur (C-S) relation developed for the individual rock types. Additional detail on the C-S relation which is a modified form of acid-base accounting is presented later in the response to Section 4.1.2. Any material classified as PAG will be placed into a temporary stockpile and then hauled underground during the construction phase as per the project proposal. The short time frame for storage of PAG materials at the surface (< 2 years) is not considered sufficient for the onset of ARD.

e) Have alternative quarry and borrow resources been identified if the proposed ones are primarily of low quality or have high ARD/ML potential?

Section 4.1.3 of the proposal describes surficial geology and soils in the vicinity of the mine site development. The surficial geology and soils in the area are summarized in Figure 4.1.3-1 of the project proposal. The surficial geology map shows that the blanket-type deposit of till we are planning to borrow for general fill construction extends northwest down the valley towards for the Tributary A for at least 3 km. If NATC cannot supply a sufficient amount of suitable material from the two proposed pit borrow sites, alternative sources of material exists further from the areas to be constructed. These areas are only considered alternatives if the material is not available in the proposed borrow areas as it is less economical to haul from borrow sources further away from the construction site.

If the proposed quarry area is unsuitable for development, the alternative is to investigate the potential for developing a quarry in the rock beneath an existing borrow pit. The two proposed borrow pits are in the valley near the site and the rock type expected is argillite.

The development of proposed quarries and borrow sites involves the exposure of rock and overburden in a region known for natural acidic drainage and elevated metals. Drilling and blasting activities associated with quarrying exposes un-weathered bedrock and may introduce fractures in the bedrock beyond the quarry walls. Exposed bedrock and fractures may substantially increase the surface area of bedrock exposed to weathering and thus the potential for ARD/ML. It is critical for this proposal to present more detailed information in order to predict the potential for ARD/ML from the proposed borrow areas at the mine site. This information will inform the assessment as to whether these activities may have significant adverse effects. Please provide the following information.

f) Identify and describe all geological materials that will be excavated, exposed, or otherwise disturbed in the use of borrow areas to the standards outlined in *The Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia* (Price and Errington, 1998) and the *Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia* (Price, 1997) [BC Guidelines].

The current proposed sources for aggregate include potential use of NAG waste rock from pre-development and/or sourcing from the identified surface quarry location. If the pre-development waste rock from the underground workings and identified quarry location are not suitable for use as aggregate then ARD/ML testing will be conducted on bedrock in the borrow areas in order to identify an aggregate source as part of the permitting process. The number of samples selected for quarry material characterization will correspond to the guidance contained in the *Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia* (Price, 1997).

g) Predict through appropriate lab testing (as outlined in the BC Guidelines) the ARD/ML potential for each geological unit in relation to the forms and environmental conditions in which it will be exposed. Include granular resources if they are expected to be crushed.

The high quality aggregate will be preferentially sourced from pre-development waste rock from the underground workings. The results of geochemical testing on Unit 3C were contained in the project proposal. The pre-development waste rock will be classified during construction in order to ensure that PAG materials are identified and directed to a temporary surface stockpile. Suitable NAG (NPR $\geq$ 2.0) rock for use as aggregate will be stockpiled in a separate location near to the crushing plant location. Geochemical testing (C-S and shake flask) to characterize borrow materials will be conducted prior to the quarrying within the surface borrow with the number of samples corresponding to the guidance contained in Price (1997).

h) Consider the potential effects of these activities, as well as any appropriate mitigation, pursuant to section 50(2)(a) of YESAA.

The potential effects of the required high quality aggregate materials from the underground development or within the footprint of a granular borrow are not deemed to be significant as they are localized to a small area that will already be disturbed as a result of infrastructure construction. Any potential effects will be localized within the footprint of a proposed granular borrow and would utilize the existing sediment and erosion control system to contain any potentially deleterious substances to the site. NAG reject materials will be stockpiled within the existing borrow and placed back into the quarry footprint as part of progressive reclamation activities at the site. Geochemical and geotechnical characterization of geological materials prior to quarrying will allow for optimization of the quarry design to minimize the generation of unsuitable materials.

Development of a quarry at the identified location will involve stripping of overburden and bedrock within the upper 10 to 12 m. The drainage in the area of the proposed quarry reports to a central sump that is currently utilized for non-potable water required during exploration activities. Soils are thin and there is not anticipated to be a high potential for erosion and sediment-related issues from the proposed quarry. Bedrock will be classified geochemically prior to development with all unsuitable PAG materials being placed into the temporary PAG dump and re-handled back underground with other development PAG rock.

Re-contouring of the exposed quarry slopes as part of progressive reclamation will be conducted following quarrying. Geological mapping of the final quarry face would be conducted to allow for a better understanding of potential ARD/ML from these faces. NATC will conduct monitoring of quarry drainage chemistry during the operations phase in order to ensure that appropriate remediation measures, where required, are designed and implemented for the quarry.

It should be noted that the use of PAG rock within the aggregate may be acceptable as the rock will be bound in a fixed manner and subject to minimal oxidation. Quarry drainage will be monitored periodically to confirm that there.

4.1.1 Underground Geological and Mineralogical Characterization

In order to accurately predict the ARD/ML potential and determine appropriate mitigation measures, it is important to adequately identify and characterize all geological and mineralogical properties of rock that will be potentially affected by the project.

The BC Guidelines state that "an understanding of the geology is necessary to ensure that all possible sources of ML/ARD are evaluated, that then entire range in geological variability is addressed and that subsequent testwork is representative and comprehensive."

Price and Errington indicate that while initial separation of rock types are usually based on differences in lithology, additional characterization may be necessary. Although ARD/ML potential is often correlated with lithology, there may be significant variation within lithological units. Furthermore, the project proposal Appendix D1, Geochemical Characterization of Waste and Mineralized Rocks, Mactung Deposit, Yukon Territory, states that through sample descriptions and petrographic analysis, "mineralogical content within a single lithologic unit can be highly variable."

The proposal identifies regional bedrock and Mactung deposit bedrock geology shown in Figures 4.1.3-3 and 4.1.3-4. Various rock types in at the Mactung site have been grouped into nine lithologic units summarized in Table 4.1.4-2. Three of the nine rock units will be affected by underground mining activities while one unit contains the mineralized ore grade materials.

It is critical for the Executive Committee to have a clear and accurate understanding of the underground geological and mineralogical characterization as well as how underground activities will affect the various rock units. These details will inform the assessment as to whether the proposed activities may have significant adverse effects associated with ARD/ML from proposed underground mining activities. Please provide the following information.

a) Statistical analysis as described in 4.1.2 below (acid-base accounting).

Details on the statistical analysis of the deposit are provided below in the response to 4.1.2.1(b).

b) Provide a statistical analysis to describe the variability within each rock type.

A statistical analysis of the variability within each individual rock types based on the available exploration program assays was presented as part of the Mactung project proposal. Table 4.1.4-5 and Figures 4.1.4-2 through 4.1.4-8 in the project proposal contain the tabular statistical geochemical summary and graphical information for the different rock types within each unit.

An analysis of materials identified as being encountered within the proposed underground workings was conducted by Mr. Dave Tenney of NATC based on a comparison of the proposed underground workings and the exploration drill hole database. Tables identifying the volume of individual rock types and their relative percentage per rock unit by project phase (development versus operations) are presented below in Tables 4.1.1-1 through 4.1.1-3.

TABLE 4.1.1-1: DEVELOPMENT - LITHOLOGY LENGTHS IN DDH BY UNIT

* R = any combination of sulphide minerals.
** = visual estimate of sulphide content.

UNIT 1

LITHOLOGIES	% sulphide**	ROCK CODE*	LENGTH m	VOLUME	S.G.	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	>40	1	0	0	3.14	0			
Semi massive pyrrhotite skarn + calc silicates	20-40	1/-	0	0	3.14	0			
Calc silicate skarn with pyrrhotite	15-20	-/1	0.78	3,450	3.14	10,835	15.0%	17.1%	17.1%
Calc silicate skarn +/- trace sulphides	<1	2	0	0	2.7	0	0.0%	0.0%	
Calc silicate skarn minor sulphides	1-5	2R	0	0	2.7	0	0.0%	0.0%	
Hornfels minor sulphides	<1	3	1.03	4,556	2.7	12,302	19.8%	19.4%	19.4%
Hornfels +/- trace sulphides	1-5	3R	0	0	2.7	0	0.0%	0.0%	
Phyllite +/- trace sulphides	<1	4	0	0	2.7	0			
Phyllite +/- trace sulphides	1-5	4R	0	0	2.7	0			
Schist =/- trace sulphides	<1	5	0	0	2.7	0			
Schist minor sulphides	1-5	5R	0	0	2.7	0			
Pelite +/- trace sulphides	<1	6	3.38	14,952	2.7	40,371	65.1%	63.6%	63.6%
Pelite minor sulphides	1-5	6R	0	0	2.7	0	0.0%	0.0%	
Limestone +/- trace sulphides	<1	7	0	0	2.7	0			
Limestone minor sulphides	1-5	7R	0	0	2.7	0			
Black shale +/- trace sulphides	<1	8	0	0	2.7	0			
Black shale minor sulphides	1-5	8R	0	0	2.7	0			
Siliciclastics +/- trace sulphides	<1	9	0	0	2.7	0			
Siliciclastics minor sulphides	1-5	9R	0	0	2.7	0			
Dolomite +/- trace sulphides	<1	1O	0	0	2.7	0			
Dolomite minor silphides	1-5	1OR	0	0	2.7	0			
Breccia/conglomerate +/- trace sulphides	<1	11	0	0	2.7	0			
Breccia/conglomereate minor sulphides	1-5	11R	0	0	2.7	0			
Dyke +/- trace sulphides	<1	12	0	0	2.7	0			
Dyke minor sulphides	1-5	12R	0	0	2.7	0			
Vein +/- trace sulphides	<1	13	0	0	2.7	0			
Vein minor sulphides	1-5	13R	0	0	2.7	0			
Acid intrusive +/- trace sulphides	<1	14	0	0	2.7	0			
Acid intrusive minor sulphides	1-5	14R	0	0	2.7	0			
Fault +/- trace sulphides	<1	15	0	0	2.7	0			
Fault + minor sulphides	1-5	15R	0	0	2.7	0			
15 CATEGORIES		TOTAL	5.19	22,959		63,508			100.0%
WARDROP TOTAL VOLUME CU.M.				22,959					

UNIT 2B

LITHOLOGIES	LENGTH m	VOLUME	S.G.	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	0.3	1,737	3.14	5,455	5.7%	6.2%	37.8%
Semi massive pyrrhotite skarn + calc silicates	1.52	8,803	3.14	27,641	28.7%	31.6%	
Calc silicate skarn with pyrrhotite	0	0	3.14	0	0.0%	0.0%	24.5%
Calc silicate skarn +/- trace sulphides	0	0	2.7	0	0.0%	0.0%	
Calc silicate skarn minor sulphides	1.37	7,934	2.7	21,422	25.8%	24.5%	
Hornfels minor sulphides	2.11	12,220	2.7	32,993	39.8%	37.7%	37.7%
Hornfels +/- trace sulphides	0	0	2.7	0	0.0%	0.0%	
Phyllite +/- trace sulphides	0	0	2.7	0			
Phyllite +/- trace sulphides	0	0	2.7	0			
Schist =/- trace sulphides	0	0	2.7	0			
Schist minor sulphides	0	0	2.7	0			
Pelite +/- trace sulphides	0	0	2.7	0			
Pelite minor sulphides	0	0	2.7	0			
Limestone +/- trace sulphides	0	0	2.7	0			
Limestone minor sulphides	0	0	2.7	0			
Black shale +/- trace sulphides	0	0	2.7	0			
Black shale minor sulphides	0	0	2.7	0			
Siliciclastics +/- trace sulphides	0	0	2.7	0			
Siliciclastics minor sulphides	0	0	2.7	0			
Dolomite +/- trace sulphides	0	0	2.7	0			
Dolomite minor silphides	0	0	2.7	0			
Breccia/conglomerate +/- trace sulphides	0	0	2.7	0			
Breccia/conglomereate minor sulphides	0	0	2.7	0			
Dyke +/- trace sulphides	0	0	2.7	0			
Dyke minor sulphides	0	0	2.7	0			
Vein +/- trace sulphides	0	0	2.7	0			
Vein minor sulphides	0	0	2.7	0			
Acid intrusive +/- trace sulphides	0	0	2.7	0			
Acid intrusive minor sulphides	0	0	2.7	0			
Fault +/- trace sulphides	0	0	2.7	0			
Fault + minor sulphides	0	0	2.7	0			
TOTAL	5	30,694	2.85	87,511			100.0%
WARDROP TOTAL VOLUME CU.M.		30,694					

UNIT 3C

LITHOLOGIES	LENGTH m	VOLUME	S.G.	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	0	0	3.14	0	0.0%	0.0%	1.2%
Semi massive pyrrhotite skarn + calc silicates	0.3	1,837	3.14	5,767	1.0%	1.2%	
Calc silicate skarn with pyrrhotite	0	0	3.14	0	0.0%	0.0%	5.2%
Calc silicate skarn +/- trace sulphides	0	0	2.7	0	0.0%	0.0%	
Calc silicate skarn minor sulphides	1.56	9,550	2.7	25,785	5.2%	5.2%	
Hornfels minor sulphides	14.8	90,602	2.7	244,626	49.3%	49.2%	74.2%
Hornfels +/- trace sulphides	7.53	46,097	2.7	124,462	25.1%	25.0%	
Phyllite +/- trace sulphides	0	0	2.7	0			
Phyllite +/- trace sulphides	0	0	2.7	0			
Schist =/- trace sulphides	0	0	2.7	0			
Schist minor sulphides	0	0	2.7	0			
Pelite +/- trace sulphides	4.63	28,344	2.7	76,528	15.4%	15.4%	15.4%
Pelite minor sulphides	0	0	2.7	0	0.0%	0.0%	
Limestone +/- trace sulphides	0	0	2.7	0			
Limestone minor sulphides	0	0	2.7	0			
Black shale +/- trace sulphides	0	0	2.7	0			
Black shale minor sulphides	0	0	2.7	0			
Siliciclastics +/- trace sulphides	0	0	2.7	0			
Siliciclastics minor sulphides	0	0	2.7	0			
Dolomite +/- trace sulphides	0	0	2.7	0			
Dolomite minor silphides	0	0	2.7	0			
Breccia/conglomerate +/- trace sulphides	0	0	2.7	0			
Breccia/conglomereate minor sulphides	0	0	2.7	0			
Dyke +/- trace sulphides	0.3	1,837	2.7	4,959	1.0%	1.0%	1.0%
Dyke minor sulphides	0	0	2.7	0	0.0%	0.0%	
Vein +/- trace sulphides	0	0	2.7	0			
Vein minor sulphides	0	0	2.7	0			
Acid intrusive +/- trace sulphides	0	0	2.7	0	0.0%	0.0%	2.0%
Acid intrusive minor sulphides	0.61	3,734	2.7	10,083	2.0%	2.0%	
Fault +/- trace sulphides	0.3	1,837	2.7	4,959	1.0%	1.0%	1.0%
Fault + minor sulphides	0	0	2.7	0	0.0%	0.0%	
TOTAL	30	183,837	2.70	497,168			100.0%
WARDROP TOTAL VOLUME CU.M.		183,837					

TOTAL

LITHOLOGIES	LENGTH m	VOLUME	S.G.	TONNES	
Semi massive pyrrhotite skarn	0.3	1,737	2.14	5,455	May contain sections or fragments of other rock types.
Semi massive pyrrhotite skarn + calc silicates	1.82	10,639	2.14	33,408	May contain sections or fragments of other rock types.
Calc silicate skarn with pyrrhotite	0.78	3,450	2.14	10,835	May contain sections or fragments of other rock types.
Calc silicate skarn +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Calc silicate skarn minor sulphides	2.93	17,484	2.7	47,207	May contain sections or fragments of other rock types.
Hornfels minor sulphides	17.94	107,378	2.7	289,922	May contain sections or fragments of other rock types.
Hornfels +/- trace sulphides	7.53	46,097	2.7	124,462	May contain sections or fragments of other rock types.
Phyllite +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Phyllite +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Schist =/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Schist minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Pelite +/- trace sulphides	8.01	43,296	2.7	116,899	May contain sections or fragments of other rock types.
Pelite minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Limestone +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Limestone minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Black shale +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Black shale minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Siliciclastics +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Siliciclastics minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Dolomite +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Dolomite minor silphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Breccia/conglomerate +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Breccia/conglomereate minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Dyke +/- trace sulphides	0.3	1,837	2.7	4,959	May contain sections or fragments of other rock types.
Dyke minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Vein +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Vein minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Acid intrusive +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Acid intrusive minor sulphides	0.61	3,734	2.7	10,083	May contain sections or fragments of other rock types.
Fault +/- trace sulphides	0.3	1,837	2.7	4,959	May contain sections or fragments of other rock types.
Fault + minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
TOTAL	41	237,490	2.73	648,187	

WARDROP CALCULATION

Unit Name	Development (m3)	Stoping (m3)		
Unit 1	22,959	43,162	66,121	
Unit 3C	183,837	460,080	643,918	
Upper 2B	19,846	1,648,479	1,668,325	2,131,309
Lower 2B	11,118	451,866	462,984	
	237,760			

Table 4.1.1-2: OPERATIONS (STOPING) - LITHOLOGY LENGTHS IN DDH BY UNIT

* R = any combination of sulphide minerals.
** = visual estimate of sulphide content.

UNIT 1

LITHOLOGIES	% sulphide**	ROCK CODE*	LENGTH m	VOLUME	S.G.	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	>40	1	50.84	2,901	3.14	9,111	6.7%	7.4%	17.8%
Semi massive pyrrhotite skarn + calc silicates	20-40	1/-	70.8	4,041	3.14	12,687	9.4%	10.3%	
Calc silicate skarn with pyrrhotite	5-20	-/1	55.7	3,179	3.14	9,982	7.4%	8.1%	18.1%
Calc silicate skarn +/- trace sulphides	<1	2	24.92	1,422	3.14	4,466	3.3%	3.6%	
Calc silicate skarn minor sulphides	1-5	2R	43.44	2,479	3.14	7,785	5.7%	6.3%	
Hornfels minor sulphides	<1	3	138.53	7,906	2.7	21,346	18.3%	17.4%	19.5%
Hornfels +/- trace sulphides	1-5	3R	17.06	974	2.7	2,629	2.3%	2.1%	
Phyllite +/- trace sulphides	<1	4	266.29	15,197	2.7	41,033	35.2%	33.4%	39.8%
Phyllite +/- trace sulphides	1-5	4R	50.44	2,879	2.7	7,772	6.7%	6.3%	
Schist =/- trace sulphides	<1	5	0	0	2.7	0			
Schist minor sulphides	1-5	5R	0	0	2.7	0			
Pelite +/- trace sulphides	<1	6	0	0	2.7	0			
Pelite minor sulphides	1-5	6R	0	0	2.7	0			
Limestone +/- trace sulphides	<1	7	1.22	70	2.7	188	0.2%	0.2%	0.2%
Limestone minor sulphides	1-5	7R	0	0	2.7	0	0.0%	0.0%	
Black shale +/- trace sulphides	<1	8	0	0	2.7	0			
Black shale minor sulphides	1-5	8R	0	0	2.7	0			
Siliciclastics +/- trace sulphides	<1	9	0	0	2.7	0			
Siliciclastics minor sulphides	1-5	9R	0	0	2.7	0			
Dolomite +/- trace sulphides	<1	1O	0	0	2.7	0			
Dolomite minor silphides	1-5	1OR	0	0	2.7	0			
Breccia/conglomerate +/- trace sulphides	<1	11	0	0	2.7	0			
Breccia/conglomereate minor sulphides	1-5	11R	0	0	2.7	0			
Dyke +/- trace sulphides	<1	12	0	0	2.7	0			
Dyke minor sulphides	1-5	12R	0	0	2.7	0			
Vein +/- trace sulphides	<1	13	1.89	108	2.7	291	0.2%	0.2%	0.5%
Vein minor sulphides	1-5	13R	2.44	139	2.7	376	0.3%	0.3%	
Acid intrusive +/- trace sulphides	<1	14	0	0	2.7	0			
Acid intrusive minor sulphides	1-5	14R	0	0	2.7	0			
Fault +/- trace sulphides	<1	15	21.75	1,241	2.7	3,351	2.9%	2.7%	4.1%
Fault minor sulphides	1-5	15R	10.97	626	2.7	1,690	1.5%	1.4%	
52 CATEGORIES		TOTALS	756.29	43,162	2.84	122,707			100.0%

UNIT 2B

LITHOLOGIES	LENGTH m	VOLUME	S.G.	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	222.1	316,707	3.14	994,459	15.1%	15.5%	29.5%
Semi massive pyrrhotite skarn + calc silicates	201.95	287,973	3.14	904,237	13.7%	14.1%	
Calc silicate skarn with pyrrhotite	389.12	554,871	3.14	1,742,295	26.4%	27.1%	54.4%
Calc silicate skarn +/- trace sulphides	92.5	131,902	3.14	414,171	6.3%	6.4%	
Calc silicate skarn minor sulphides	298.62	425,821	3.14	1,337,079	20.3%	20.8%	
Hornfels minor sulphides	82.05	117,000	2.7	315,901	5.6%	4.9%	5.9%
Hornfels +/- trace sulphides	17.03	24,284	2.7	65,567	1.2%	1.0%	
Phyllite +/- trace sulphides	63.1	89,978	2.7	242,941	4.3%	3.8%	3.8%
Phyllite +/- trace sulphides	0	0	2.7	0	0.0%	0.0%	
Schist =/- trace sulphides	1.13	1,611	2.7	4,351	0.1%	0.1%	0.1%
Schist minor sulphides	0	0	2.7	0	0.0%	0.0%	
Pelite +/- trace sulphides	8.88	12,663	2.7	34,189	0.6%	0.5%	0.7%
Pelite minor sulphides	2.43	3,465	2.7	9,356	0.2%	0.1%	
Limestone +/- trace sulphides	7.85	11,194	2.7	30,223	0.5%	0.5%	1.1%
Limestone minor sulphides	10.51	14,987	2.7	40,465	0.7%	0.6%	
Black shale +/- trace sulphides	7.37	10,509	2.7	28,375	0.5%	0.4%	0.4%
Black shale minor sulphides	0	0	2.7	0	0.0%	0.0%	
Siliciclastics +/- trace sulphides	0	0	2.7	0			
Siliciclastics minor sulphides	0	0	2.7	0			
Dolomite +/- trace sulphides	0	0	2.7	0			
Dolomite minor silphides	0	0	2.7	0			
Breccia/conglomerate +/- trace sulphides	0	0	2.7	0			
Breccia/conglomereate minor sulphides	0	0	2.7	0			
Dyke +/- trace sulphides	0	0	2.7	0			
Dyke minor sulphides	0	0	2.7	0			
Vein +/- trace sulphides	15.88	22,644	2.7	61,140	1.1%	1.0%	1.1%
Vein minor sulphides	2.5	3,565	2.7	9,625	0.2%	0.1%	
Acid intrusive +/- trace sulphides	0	0	2.7	0			
Acid intrusive minor sulphides	0	0	2.7	0			
Fault +/- trace sulphides	44.21	63,042	2.7	170,213	3.0%	2.6%	3.0%
Fault minor sulphides	5.7	8,128	2.7	21,946	0.4%	0.3%	
TOTALS	1472.93	2,100,345	3.06	6,426,532			100.0%

UNIT 3C

LITHOLOGIES	LENGTH m	VOLUME	S.G.	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	104.76	49,657	3.14	155,924	10.8%	11.5%	23.6%
Semi massive pyrrhotite skarn + calc silicates	109.56	51,933	3.14	163,069	11.3%	12.1%	
Calc silicate skarn with pyrrhotite	115.81	54,895	3.14	172,371	11.9%	12.7%	34.5%
Calc silicate skarn +/- trace sulphides	38.62	18,306	3.14	57,482	4.0%	4.3%	
Calc silicate skarn minor sulphides	158.7	75,226	3.14	236,209	16.4%	17.5%	
Hornfels minor sulphides	253.75	120,280	2.7	324,757	26.1%	24.0%	28.3%
Hornfels +/- trace sulphides	45.5	21,568	2.7	58,232	4.7%	4.3%	
Phyllite +/- trace sulphides	33.35	15,808	2.7	42,682	3.4%	3.2%	3.6%
Phyllite +/- trace sulphides	4.62	2,190	2.7	5,913	0.5%	0.4%	
Schist =/- trace sulphides	20.23	9,589	2.7	25,891	2.1%	1.9%	2.8%
Schist minor sulphides	8.83	4,186	2.7	11,301	0.9%	0.8%	
Pelite +/- trace sulphides	18.41	8,727	2.7	23,562	1.9%	1.7%	2.3%
Pelite minor sulphides	5.84	2,768	2.7	7,474	0.6%	0.6%	
Limestone +/- trace sulphides	22.98	10,893	2.7	29,411	2.4%	2.2%	2.7%
Limestone minor sulphides	5.8	2,749	2.7	7,423	0.6%	0.5%	
Black shale +/- trace sulphides	0	0	2.7	0			
Black shale minor sulphides	0	0	2.7	0			
Siliciclastics +/- trace sulphides	0	0	2.7	0			
Siliciclastics minor sulphides	0	0	2.7	0			
Dolomite +/- trace sulphides	0	0	2.7	0			
Dolomite minor silphides	0	0	2.7	0			
Breccia/conglomerate +/- trace sulphides	0	0	2.7	0			
Breccia/conglomereate minor sulphides	0	0	2.7	0			
Dyke +/- trace sulphides	0	0	2.7	0			
Dyke minor sulphides	0	0	2.7	0			
Vein +/- trace sulphides	1.78	844	2.7	2,278	0.2%	0.2%	0.3%
Vein minor sulphides	1.9	901	2.7	2,432	0.2%	0.2%	
Acid intrusive +/- trace sulphides	2	948	2.7	2,560	0.2%	0.2%	0.2%
Acid intrusive minor sulphides	0	0	2.7	0	0.0%	0.0%	
Fault +/- trace sulphides	7.53	3,569	2.7	9,637	0.8%	0.7%	1.7%
Fault minor sulphides	10.64	5,043	2.7	13,617	1.1%	1.0%	
TOTALS	970.61	460,080	2.94	1,352,225			100.0%

TOTAL

LITHOLOGIES	LENGTH m	VOLUME	S.G.	TONNES	
Semi massive pyrrhotite skarn	377.7	369,265	3.14	1,159,494	May contain sections or fragments of other rock types.
Semi massive pyrrhotite skarn + calc silicates	382.31	343,947	3.14	1,079,993	May contain sections or fragments of other rock types.
Calc silicate skarn with pyrrhotite	560.63	612,945	3.14	1,924,648	May contain sections or fragments of other rock types.
Calc silicate skarn +/- trace sulphides	156.04	151,630	3.14	476,119	May contain sections or fragments of other rock types.
Calc silicate skarn minor sulphides	500.76	503,526	3.14	1,581,072	May contain sections or fragments of other rock types.
Hornfels minor sulphides	474.33	245,187	2.7	662,004	May contain sections or fragments of other rock types.
Hornfels +/- trace sulphides	79.59	46,825	2.7	126,428	May contain sections or fragments of other rock types.
Phyllite +/- trace sulphides	362.74	120,984	2.7	326,657	May contain sections or fragments of other rock types.
Phyllite +/- trace sulphides	55.06	5,069	2.7	13,685	May contain sections or fragments of other rock types.
Schist =/- trace sulphides	21.36	11,201	2.7	30,242	May contain sections or fragments of other rock types.
Schist minor sulphides	8.83	4,186	2.7	11,301	May contain sections or fragments of other rock types.
Pelite +/- trace sulphides	27.29	21,389	2.7	57,751	May contain sections or fragments of other rock types.
Pelite minor sulphides	8.27	6,233	2.7	16,830	May contain sections or fragments of other rock types.
Limestone +/- trace sulphides	32.05	22,156	2.7	59,822	May contain sections or fragments of other rock types.
Limestone minor sulphides	16.31	17,736	2.7	47,888	May contain sections or fragments of other rock types.
Black shale +/- trace sulphides	7.37	10,509	2.7	28,375	May contain sections or fragments of other rock types.
Black shale minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Siliciclastics +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Siliciclastics minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Dolomite +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Dolomite minor silphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Breccia/conglomerate +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Breccia/conglomereate minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Dyke +/- trace sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Dyke minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Vein +/- trace sulphides	19.55	23,596	2.7	63,709	May contain sections or fragments of other rock types.
Vein minor sulphides	6.84	4,605	2.7	12,433	May contain sections or fragments of other rock types.
Acid intrusive +/- trace sulphides	2	948	2.7	2,560	May contain sections or fragments of other rock types.
Acid intrusive minor sulphides	0	0	2.7	0	May contain sections or fragments of other rock types.
Fault +/- trace sulphides	73.49	67,852	2.7	183,202	May contain sections or fragments of other rock types.
Fault minor sulphides	27.31	13,798	2.7	37,253	May contain sections or fragments of other rock types.
TOTALS	3,200	2,603,587	3.03	7,901,463	

WARDROP TOTAL VOLUME CU.M.: Unit 1: 43,162; Unit 2B: 2,100,345; Unit 3C: 460,080

WARDROP CALCULATION

Unit Name	Development (m3)	Stoping (m3)	
Unit 1	22,959	43,162	
Unit 3C	183,837	460,080	
Upper 2B	19,846	1,648,479	2,100,345
Lower 2B	11,118	451,866	
		2,603,587	

TABLE 4.1.1-3: ENTIRE PROJECT - LITHOLOGY LENGHTS IN DDH BY UNIT

* R = any combination of sulphide minerals.
** = visual estimate of sulphide content.

UNIT 1

LITHOLOGIES	% sulphide**	ROCK CODE*	VOLUME	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	>40	1	2,901	9,111	4.4%	4.9%	11.71%
Semi massive pyrrhotite skarn + calc silicates	20-40	1/-	4,041	12,687	6.1%	6.8%	
Calc silicate skarn with pyrrhotite	5-20	-/1	6,629	20,816	10.0%	11.2%	18%
Calc silicate skarn +/- trace sulphides	<1	2	1,422	4,466	2.2%	2.4%	
Calc silicate skarn minor sulphides	1-5	2R	2,479	7,785	3.7%	4.2%	
Hornfels minor sulphides	<1	3	12,462	33,648	18.8%	18.1%	19.48%
Hornfels +/- trace sulphides	1-5	3R	974	2,629	1.5%	1.4%	
Phyllite +/- trace sulphides	<1	4	15,197	41,033	23.0%	22.0%	26.21%
Phyllite +/- trace sulphides	1-5	4R	2,879	7,772	4.4%	4.2%	
Schist =/- trace sulphides	<1	5	-	-	0.0%	0.0%	
Schist minor sulphides	1-5	5R	-	-	0.0%	0.0%	
Pelite +/- trace sulphides	<1	6	14,952	40,371	22.6%	21.7%	21.68%
Pelite minor sulphides	1-5	6R	-	-	0.0%	0.0%	
Limestone +/- trace sulphides	<1	7	70	188	0.1%	0.1%	0.10%
Limestone minor sulphides	1-5	7R	-	-	0.0%	0.0%	
Black shale +/- trace sulphides	<1	8	-	-	0.0%	0.0%	
Black shale minor sulphides	1-5	8R	-	-	0.0%	0.0%	
Siliciclastics +/- trace sulphides	<1	9	-	-	0.0%	0.0%	
Siliciclastics minor sulphides	1-5	9R	-	-	0.0%	0.0%	
Dolomite +/- trace sulphides	<1	1O	-	-	0.0%	0.0%	
Dolomite minor silphides	1-5	1OR	-	-	0.0%	0.0%	
Breccia/conglomerate +/- trace sulphides	<1	11	-	-	0.0%	0.0%	
Breccia/conglomereate minor sulphides	1-5	11R	-	-	0.0%	0.0%	
Dyke +/- trace sulphides	<1	12	-	-	0.0%	0.0%	
Dyke minor sulphides	1-5	12R	-	-	0.0%	0.0%	
Vein +/- trace sulphides	<1	13	108	291	0.2%	0.2%	0.36%
Vein minor sulphides	1-5	13R	139	376	0.2%	0.2%	
Acid intrusive +/- trace sulphides	<1	14	-	-	0.0%	0.0%	
Acid intrusive minor sulphides	1-5	14R	-	-	0.0%	0.0%	
Fault +/- trace sulphides	<1	15	1,241	3,351	1.9%	1.8%	2.71%
Fault minor sulphides	1-5	15R	626	1,690	0.9%	0.9%	
52 CATEGORIES		TOTALS	66,121	186,214			100.00%

UNIT 2B

LITHOLOGIES	VOLUME	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	318,444	999,914	14.9%	15.4%	29.66%
Semi massive pyrrhotite skarn + calc silicates	296,776	931,877	13.9%	14.3%	
Calc silicate skarn with pyrrhotite	554,871	1,742,295	26.0%	26.7%	54%
Calc silicate skarn +/- trace sulphides	131,902	414,171	6.2%	6.4%	
Calc silicate skarn minor sulphides	433,755	1,358,501	20.4%	20.9%	
Hornfels minor sulphides	129,220	348,894	6.1%	5.4%	6.36%
Hornfels +/- trace sulphides	24,284	65,567	1.1%	1.0%	
Phyllite +/- trace sulphides	89,978	242,941	4.2%	3.7%	3.73%
Phyllite +/- trace sulphides	-	-	0.0%	0.0%	
Schist =/- trace sulphides	1,611	4,351	0.1%	0.1%	0.07%
Schist minor sulphides	-	-	0.0%	0.0%	
Pelite +/- trace sulphides	12,663	34,189	0.6%	0.5%	0.67%
Pelite minor sulphides	3,465	9,356	0.2%	0.1%	
Limestone +/- trace sulphides	11,194	30,223	0.5%	0.5%	1.09%
Limestone minor sulphides	14,987	40,465	0.7%	0.6%	
Black shale +/- trace sulphides	10,509	28,375	0.5%	0.4%	0.44%
Black shale minor sulphides	-	-	0.0%	0.0%	
Siliciclastics +/- trace sulphides	-	-	0.0%	0.0%	
Siliciclastics minor sulphides	-	-	0.0%	0.0%	
Dolomite +/- trace sulphides	-	-	0.0%	0.0%	
Dolomite minor silphides	-	-	0.0%	0.0%	
Breccia/conglomerate +/- trace sulphides	-	-	0.0%	0.0%	
Breccia/conglomereate minor sulphides	-	-	0.0%	0.0%	
Dyke +/- trace sulphides	-	-	0.0%	0.0%	
Dyke minor sulphides	-	-	0.0%	0.0%	
Vein +/- trace sulphides	22,644	61,140	1.1%	0.9%	1.09%
Vein minor sulphides	3,565	9,625	0.2%	0.1%	
Acid intrusive +/- trace sulphides	-	-	0.0%	0.0%	
Acid intrusive minor sulphides	-	-	0.0%	0.0%	
Fault +/- trace sulphides	63,042	170,213	3.0%	2.6%	2.95%
Fault minor sulphides	8,128	21,946	0.4%	0.3%	
TOTALS	2,131,039	6,514,044			100.00%

UNIT 3C

LITHOLOGIES	VOLUME	TONNES	% Unit Volume	% Unit Tonnes	% Unit for Type (tonnes)
Semi massive pyrrhotite skarn	49,657	155,924	7.7%	8.4%	17.56%
Semi massive pyrrhotite skarn + calc silicates	53,769	168,835	8.4%	9.1%	
Calc silicate skarn with pyrrhotite	54,895	172,371	8.5%	9.3%	27%
Calc silicate skarn +/- trace sulphides	18,306	57,482	2.8%	3.1%	
Calc silicate skarn minor sulphides	84,776	261,993	13.2%	14.2%	
Hornfels minor sulphides	210,883	569,383	32.7%	30.8%	40.67%
Hornfels +/- trace sulphides	67,665	182,694	10.5%	9.9%	
Phyllite +/- trace sulphides	15,808	42,682	2.5%	2.3%	2.63%
Phyllite +/- trace sulphides	2,190	5,913	0.3%	0.3%	
Schist =/- trace sulphides	9,589	25,891	1.5%	1.4%	2.01%
Schist minor sulphides	4,186	11,301	0.7%	0.6%	
Pelite +/- trace sulphides	37,070	100,090	5.8%	5.4%	5.82%
Pelite minor sulphides	2,768	7,474	0.4%	0.4%	
Limestone +/- trace sulphides	10,893	29,411	1.7%	1.6%	1.99%
Limestone minor sulphides	2,749	7,423	0.4%	0.4%	
Black shale +/- trace sulphides	-	-	0.0%	0.0%	0.00%
Black shale minor sulphides	-	-	0.0%	0.0%	
Siliciclastics +/- trace sulphides	-	-	0.0%	0.0%	
Siliciclastics minor sulphides	-	-	0.0%	0.0%	
Dolomite +/- trace sulphides	-	-	0.0%	0.0%	
Dolomite minor silphides	-	-	0.0%	0.0%	
Breccia/conglomerate +/- trace sulphides	-	-	0.0%	0.0%	
Breccia/conglomereate minor sulphides	-	-	0.0%	0.0%	
Dyke +/- trace sulphides	1,837	4,959	0.3%	0.3%	0.27%
Dyke minor sulphides	-	-	0.0%	0.0%	
Vein +/- trace sulphides	844	2,278	0.1%	0.1%	0.25%
Vein minor sulphides	901	2,432	0.1%	0.1%	
Acid intrusive +/- trace sulphides	948	2,560	0.1%	0.1%	0.68%
Acid intrusive minor sulphides	3,734	10,083	0.6%	0.5%	
Fault +/- trace sulphides	5,406	14,596	0.8%	0.8%	1.53%
Fault minor sulphides	5,043	13,617	0.8%	0.7%	
TOTALS	643,917	1,849,393			100.00%

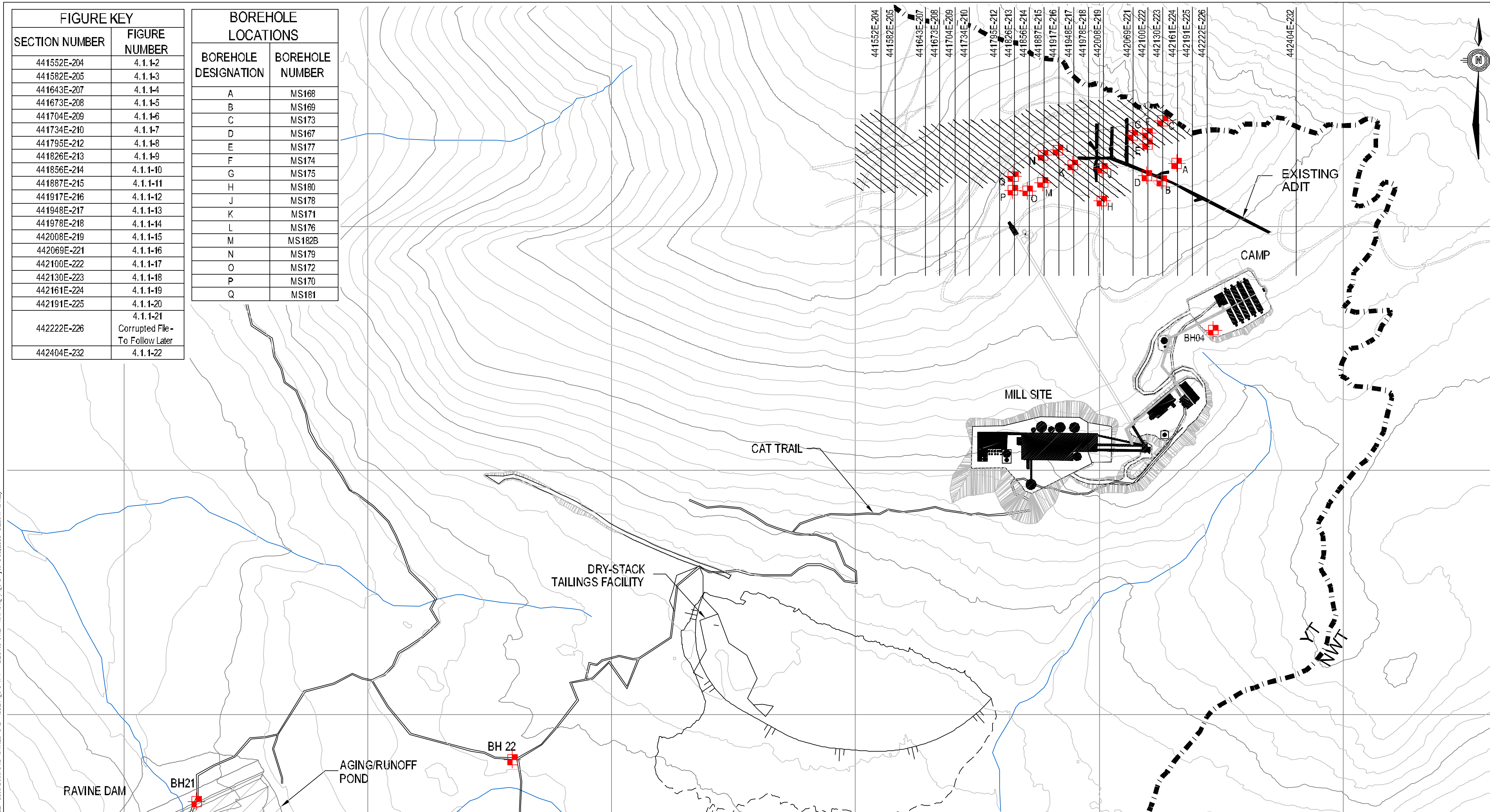
c) Provide plan view and cross-section maps identifying the spatial relationship between various rock units and underground and surface mine workings. The number of cross-section diagrams should represent the lithological, mineralogical, and structural complexities observed in the area. Details in the diagrams should include, but are not limited to:

  i. proposed underground workings and infrastructure;
  ii. shape and location of impacted bedrock;
  iii. proximity to sources of mineralization, alteration, weathering, or leaching; and,
  iv. spatial distribution and location of core-hole samples used in geological characterization.

Cross-sections and plan views showing the available rock information, underground workings and the location of samples used for geochemical characterization are presented in Figures 4.1.1-1 through 4.1.1-22.

FIGURE KEY	
SECTION NUMBER	FIGURE NUMBER
441552E-204	4.1.1-2
441582E-205	4.1.1-3
441643E-207	4.1.1-4
441673E-208	4.1.1-5
441704E-209	4.1.1-6
441734E-210	4.1.1-7
441795E-212	4.1.1-8
441826E-213	4.1.1-9
441856E-214	4.1.1-10
441887E-215	4.1.1-11
441917E-216	4.1.1-12
441948E-217	4.1.1-13
441978E-218	4.1.1-14
442008E-219	4.1.1-15
442069E-221	4.1.1-16
442100E-222	4.1.1-17
442130E-223	4.1.1-18
442161E-224	4.1.1-19
442191E-225	4.1.1-20
442222E-226	4.1.1-21 Corrupted File - To Follow Later
442404E-232	4.1.1-22

BOREHOLE LOCATIONS	
BOREHOLE DESIGNATION	BOREHOLE NUMBER
A	MS168
B	MS169
C	MS173
D	MS167
E	MS177
F	MS174
G	MS175
H	MS180
J	MS178
K	MS171
L	MS176
M	MS182B
N	MS179
O	MS172
P	MS170
Q	MS181



LEGEND

PROPOSED UNDERGROUND WORKINGS

BOREHOLE LOCATION

0 250

Scale: 1: 7 500 (metres)

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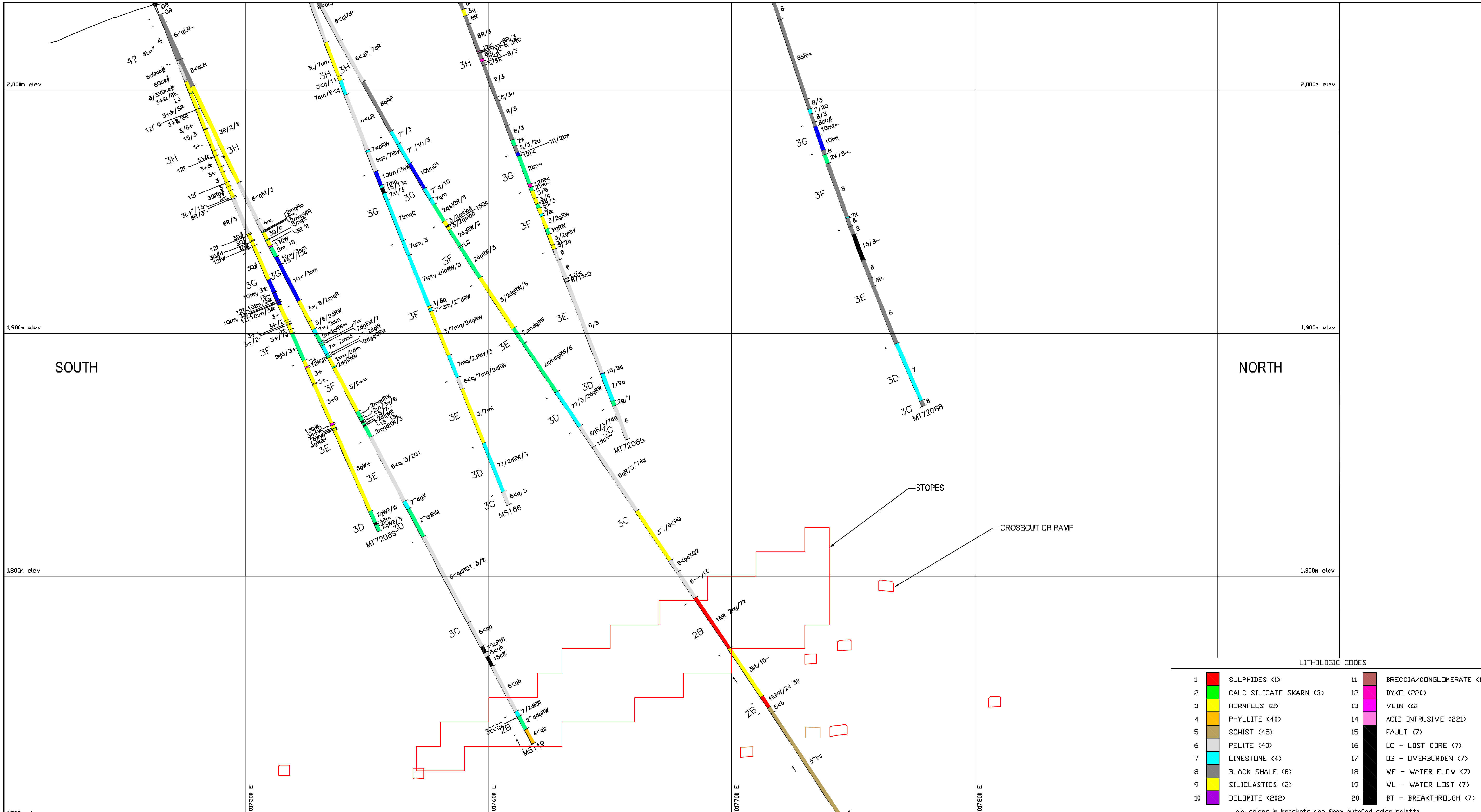
GEOCHEMICAL SAMPLE SECTIONS LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-1



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (40)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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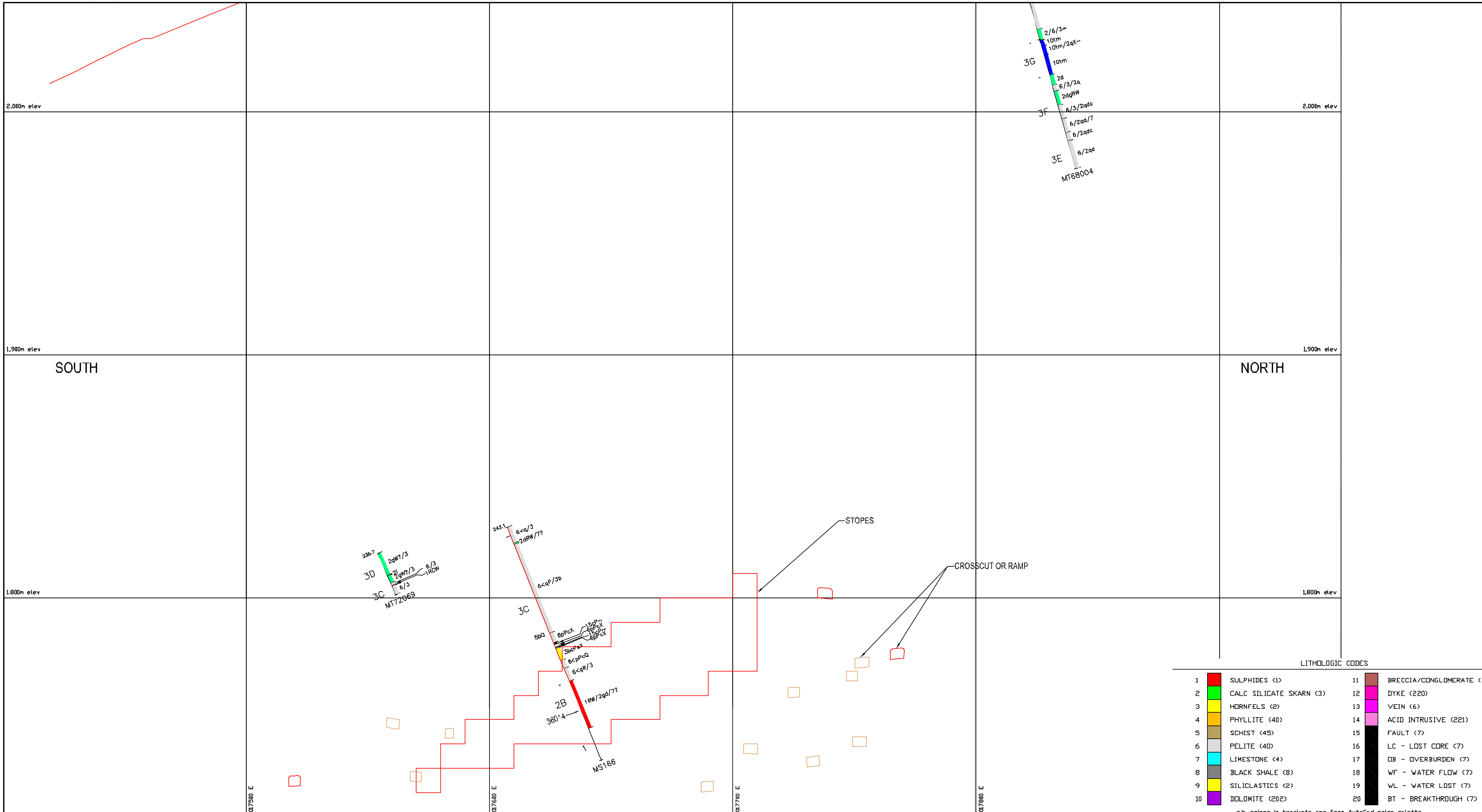
GEOCHEMICAL SAMPLE SECTIONS 441552E-204

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE: EBA-WHSE	DATE: JUNE 2009		

Figure 4.1.1-2



NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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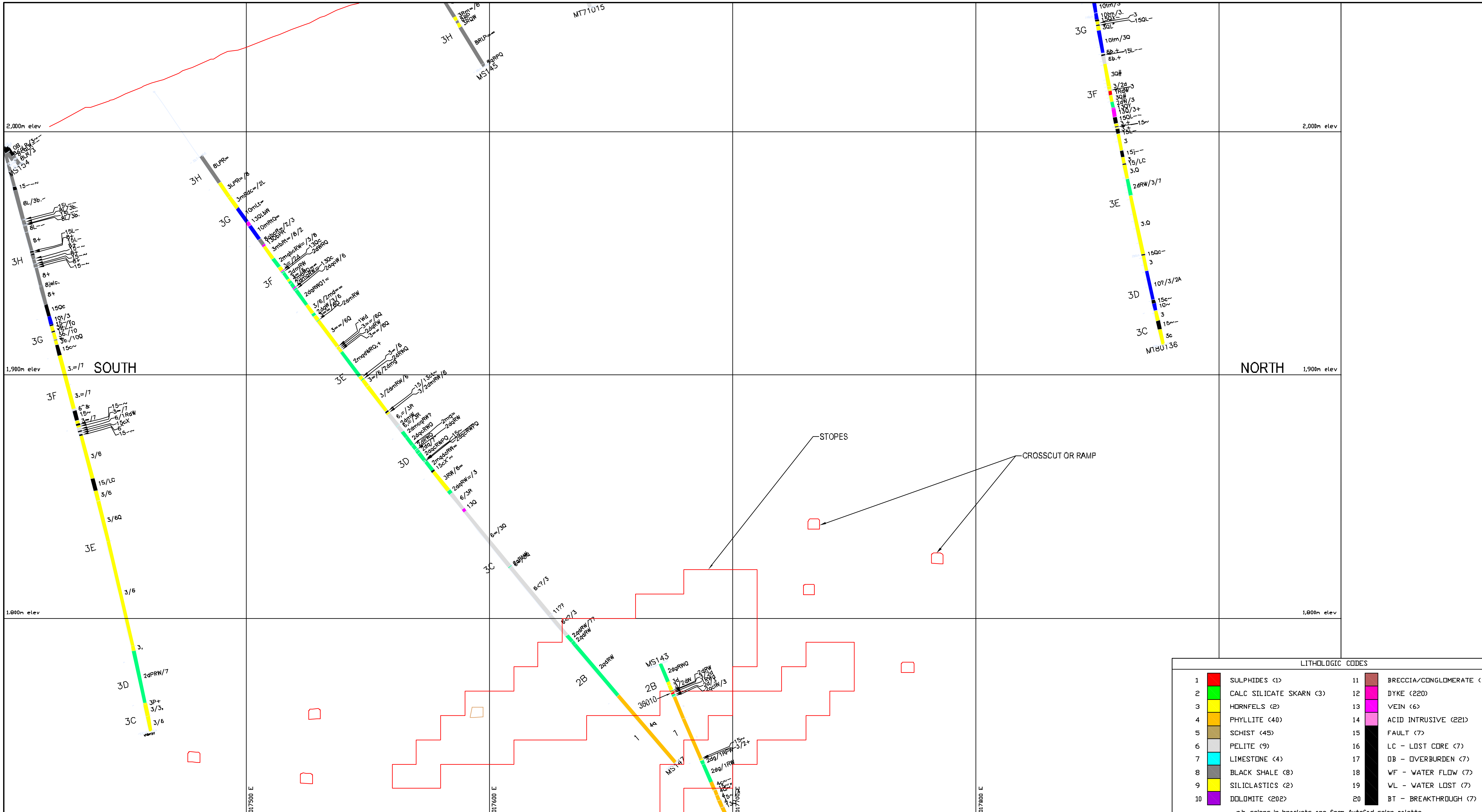
GEOCHEMICAL SAMPLE SECTIONS
441582E-205

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-3



	LITHOLOGIC CODES		
1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50
Scale: 1: 1 500 (metres)

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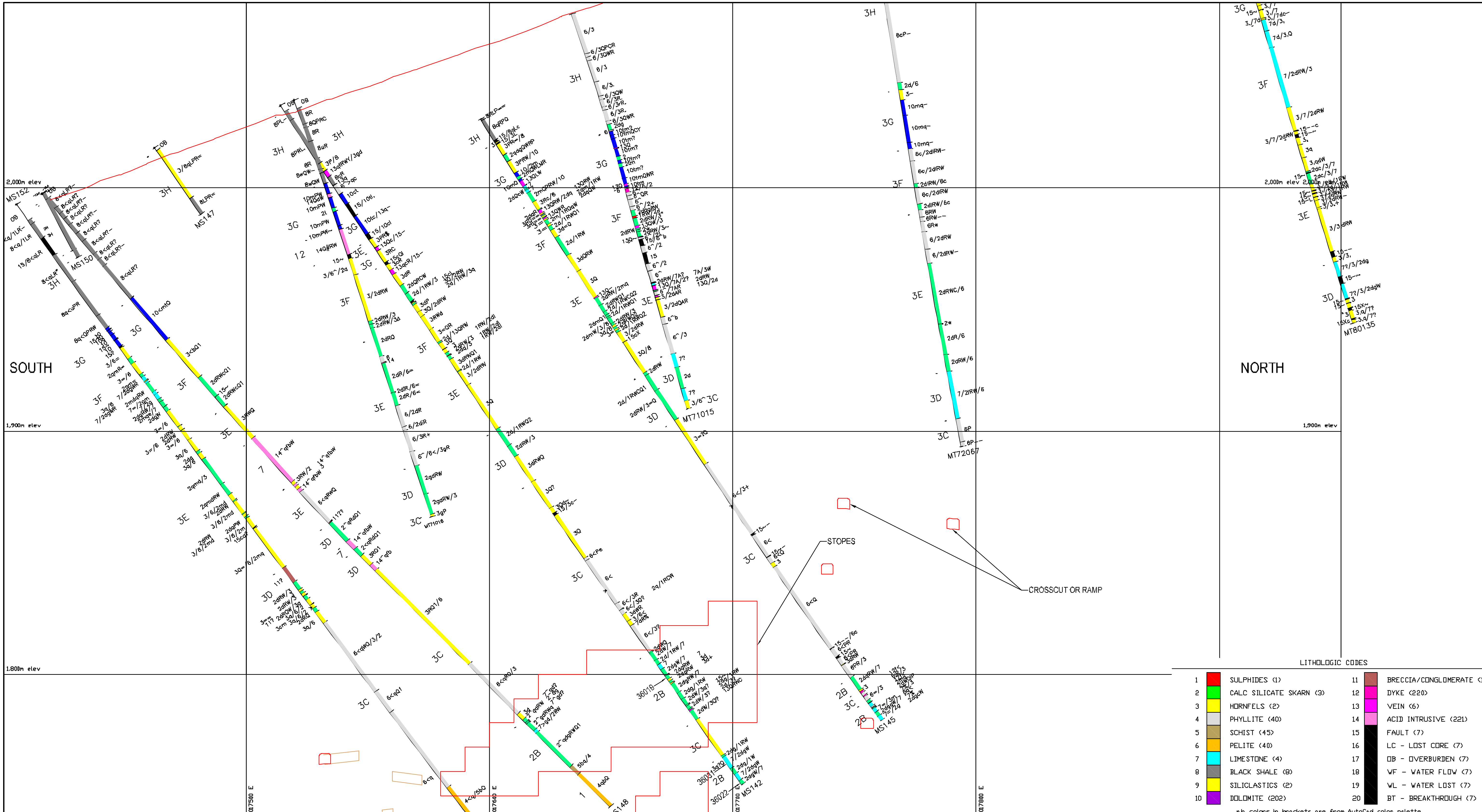
GEOCHEMICAL SAMPLE SECTIONS
441643E-207

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-4



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (40)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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NORTH AMERICAN TUNGSTEN CORPORATION LTD

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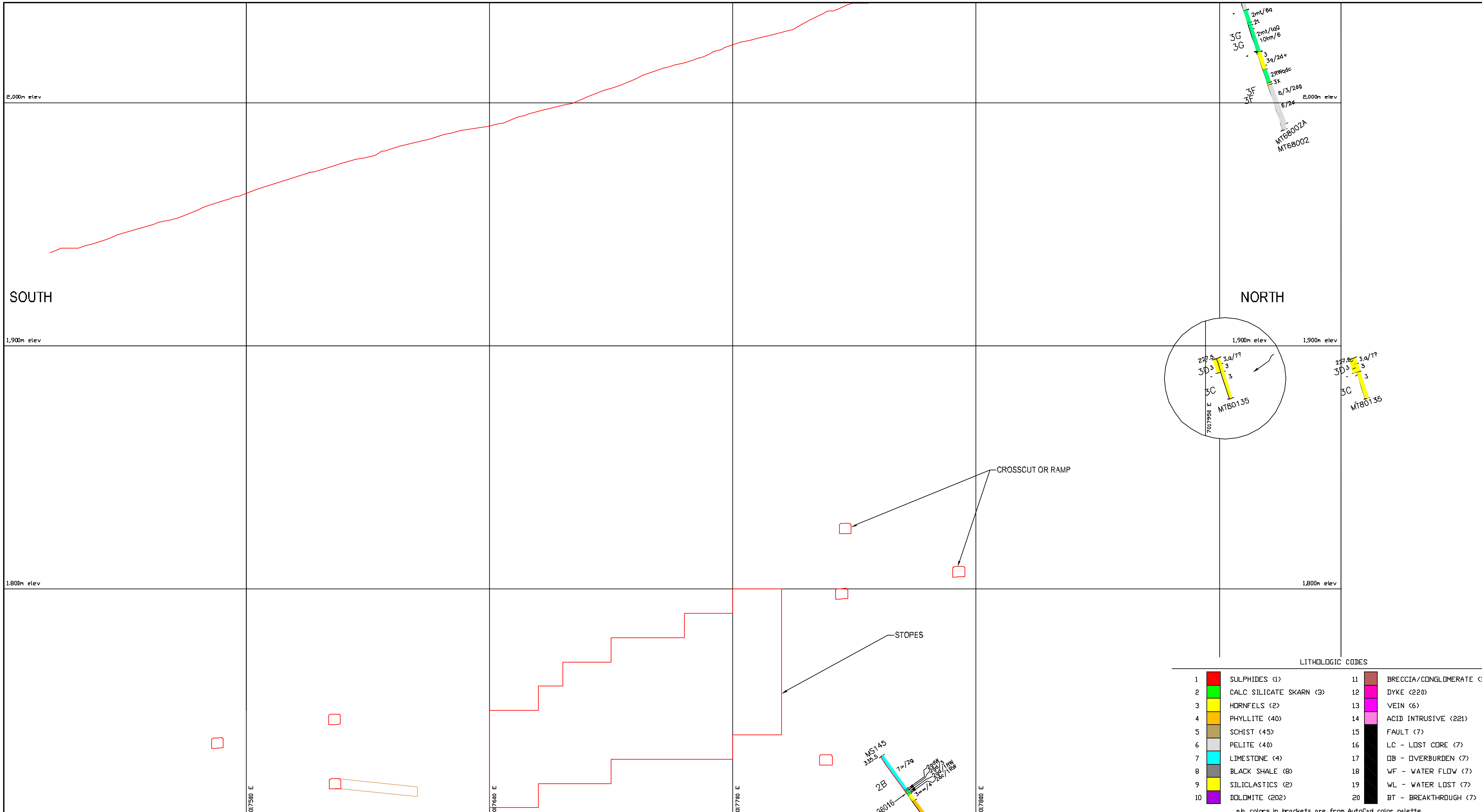
GEOCHEMICAL SAMPLE SECTIONS

441673E-208

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE: EBA-WHSE	DATE: JUNE 2009		

Figure 4.1.1-5



LITHOLOGIC CODES

1	SULPHIDES (1)		11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)		12	DYKE (220)
3	HORNFELS (2)		13	VEIN (6)
4	PHYLLITE (40)		14	ACID INTRUSIVE (221)
5	SCHIST (45)		15	FAULT (7)
6	PELITE (40)		16	LC - LOST CORE (7)
7	LIMESTONE (4)		17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)		18	WF - WATER FLOW (7)
9	SILICLASTICS (2)		19	WL - WATER LOST (7)
10	DOLOMITE (202)		20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

ISSUED FOR USE

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

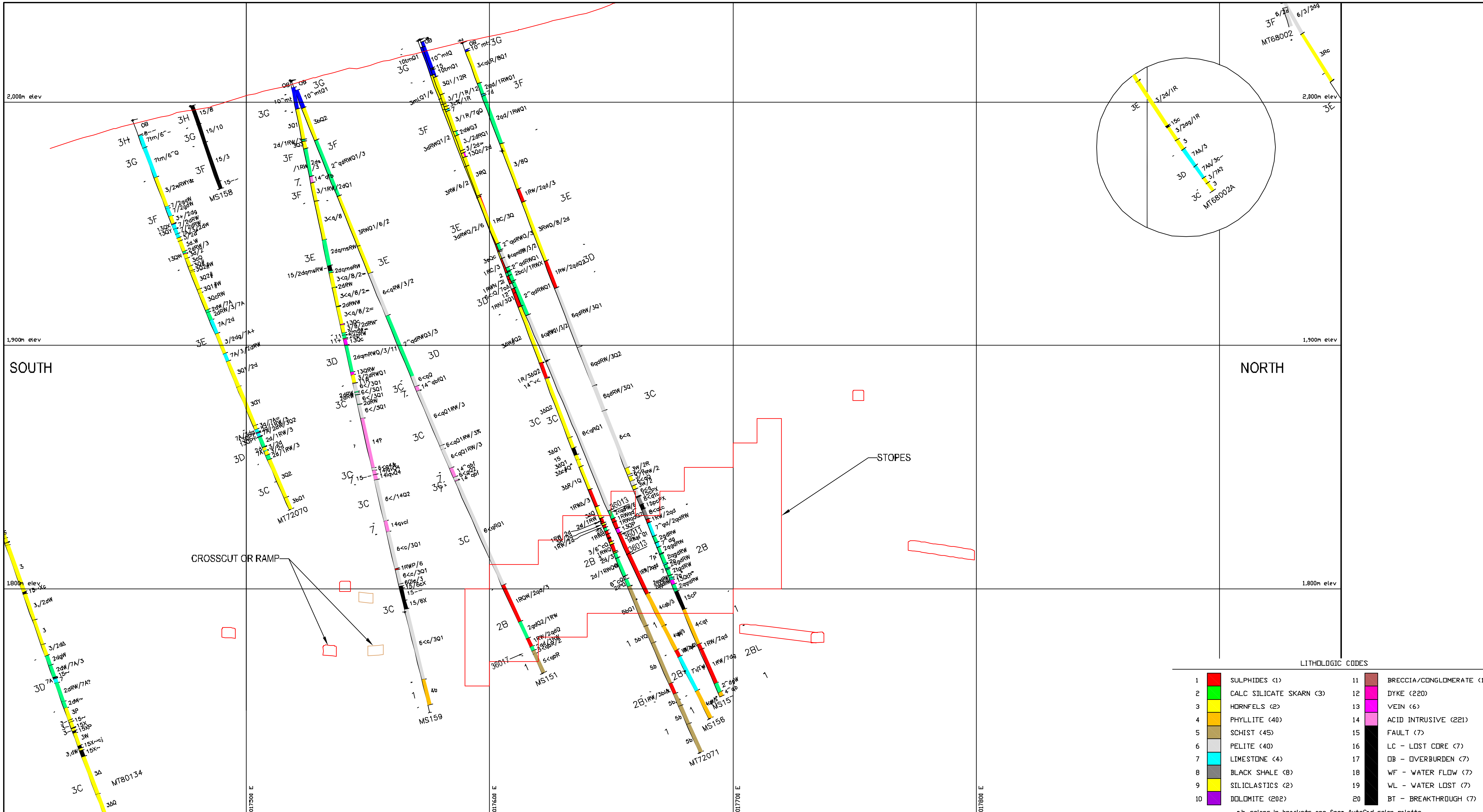
MACTUNG

GEOCHEMICAL SAMPLE SECTIONS
441704E-209

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-6



LITHOLOGIC CODES

1	SULPHIDES (1)		11	BRECCIA/CONGLOMERATE (15)	
2	CALC SILICATE SKARN (3)		12	DYKE (220)	
3	HORNFELS (2)		13	VEIN (6)	
4	PHYLLITE (40)		14	ACID INTRUSIVE (221)	
5	SCHIST (45)		15	FAULT (7)	
6	PELITE (40)		16	LC - LOST CORE (7)	
7	LIMESTONE (4)		17	OB - OVERBURDEN (7)	
8	BLACK SHALE (8)		18	WF - WATER FLOW (7)	
9	SILICLASTICS (2)		19	WL - WATER LOST (7)	
10	DOLOMITE (202)		20	BT - BREAKTHROUGH (7)	

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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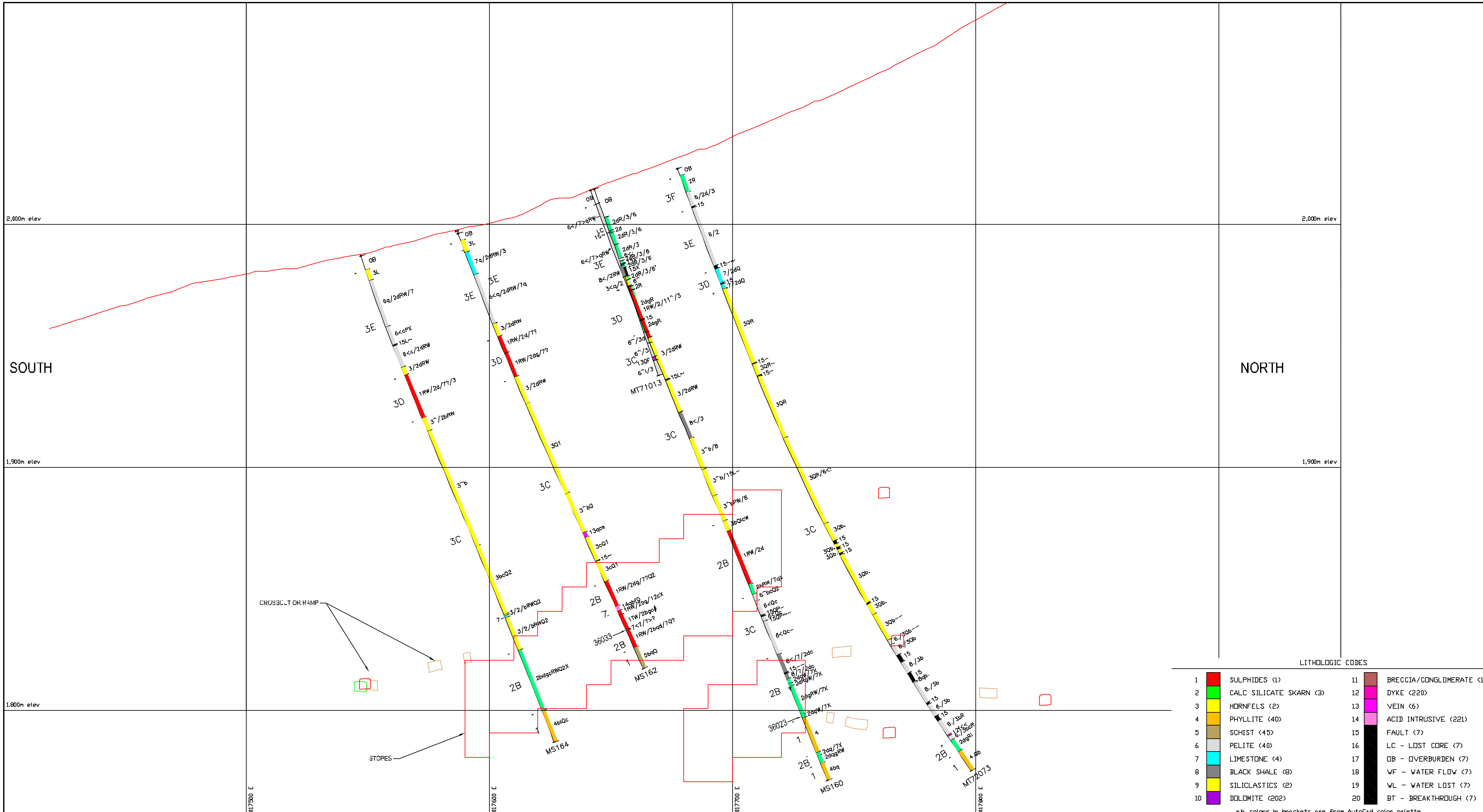
GEOCHEMICAL SAMPLE SECTIONS
441734E-210

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-7



NOTES:
1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50
Scale: 1: 1 500 (metres)

ISSUED FOR USE

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GEOCHEMICAL SAMPLE SECTIONS
441795E-212

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-8

LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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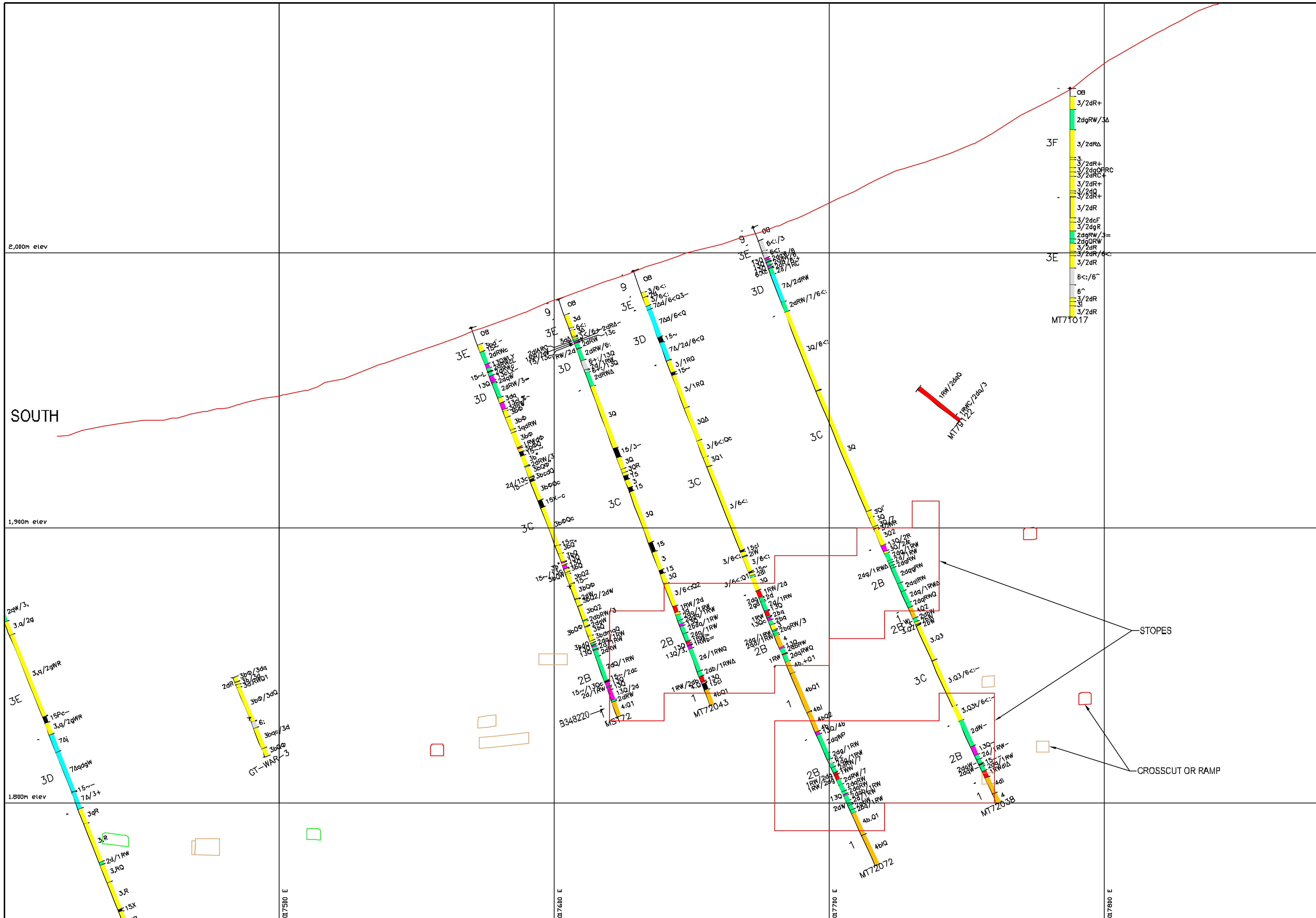
GEOCHEMICAL SAMPLE SECTIONS 441826E-213

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-9



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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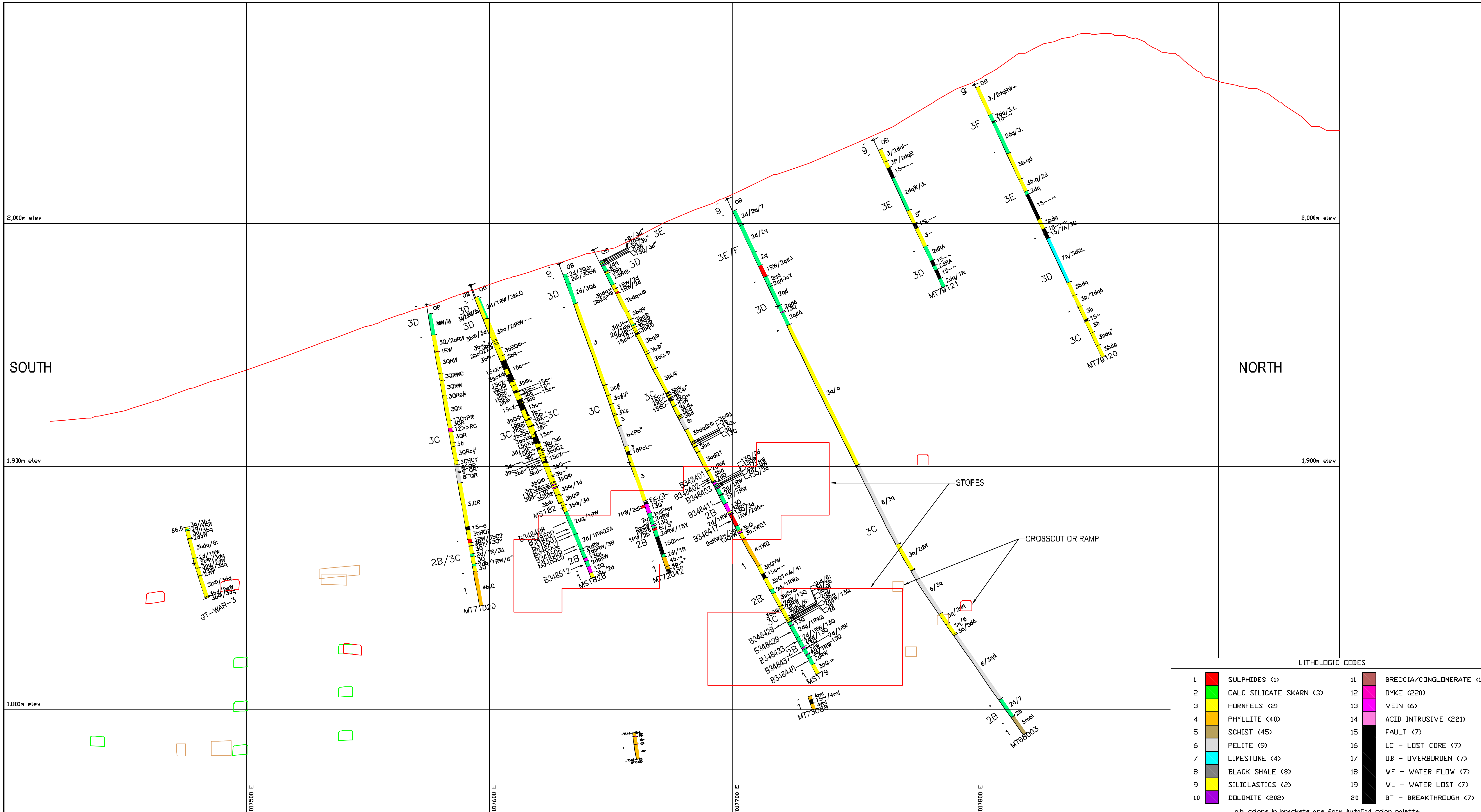
GEOCHEMICAL SAMPLE SECTIONS

441856E-214

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-10



NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50
Scale: 1: 1 500 (metres)

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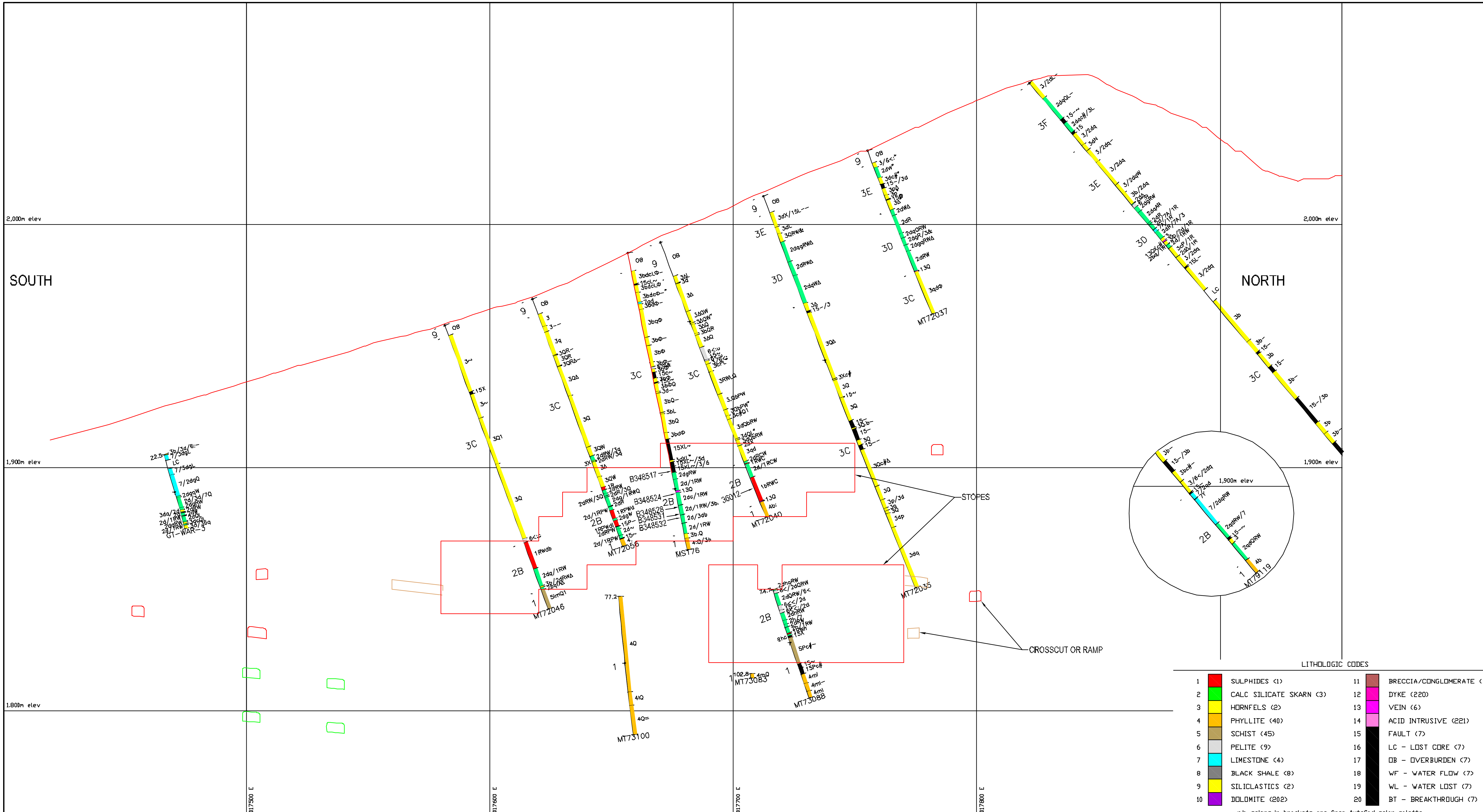
GEOCHEMICAL SAMPLE SECTIONS
441887E-215

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-11



LITHOLOGIC CODES

1	SULPHIDES (1)		11	BRECCIA/CONGLOMERATE (15)	
2	CALC SILICATE SKARN (3)		12	DYKE (220)	
3	HORNFELS (2)		13	VEIN (6)	
4	PHYLLITE (40)		14	ACID INTRUSIVE (221)	
5	SCHIST (45)		15	FAULT (7)	
6	PELITE (9)		16	LC - LOST CORE (7)	
7	LIMESTONE (4)		17	OB - OVERBURDEN (7)	
8	BLACK SHALE (8)		18	WF - WATER FLOW (7)	
9	SILICLASTICS (2)		19	WL - WATER LOST (7)	
10	DOLOMITE (202)		20	BT - BREAKTHROUGH (7)	

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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NORTH AMERICAN TUNGSTEN CORPORATION LTD

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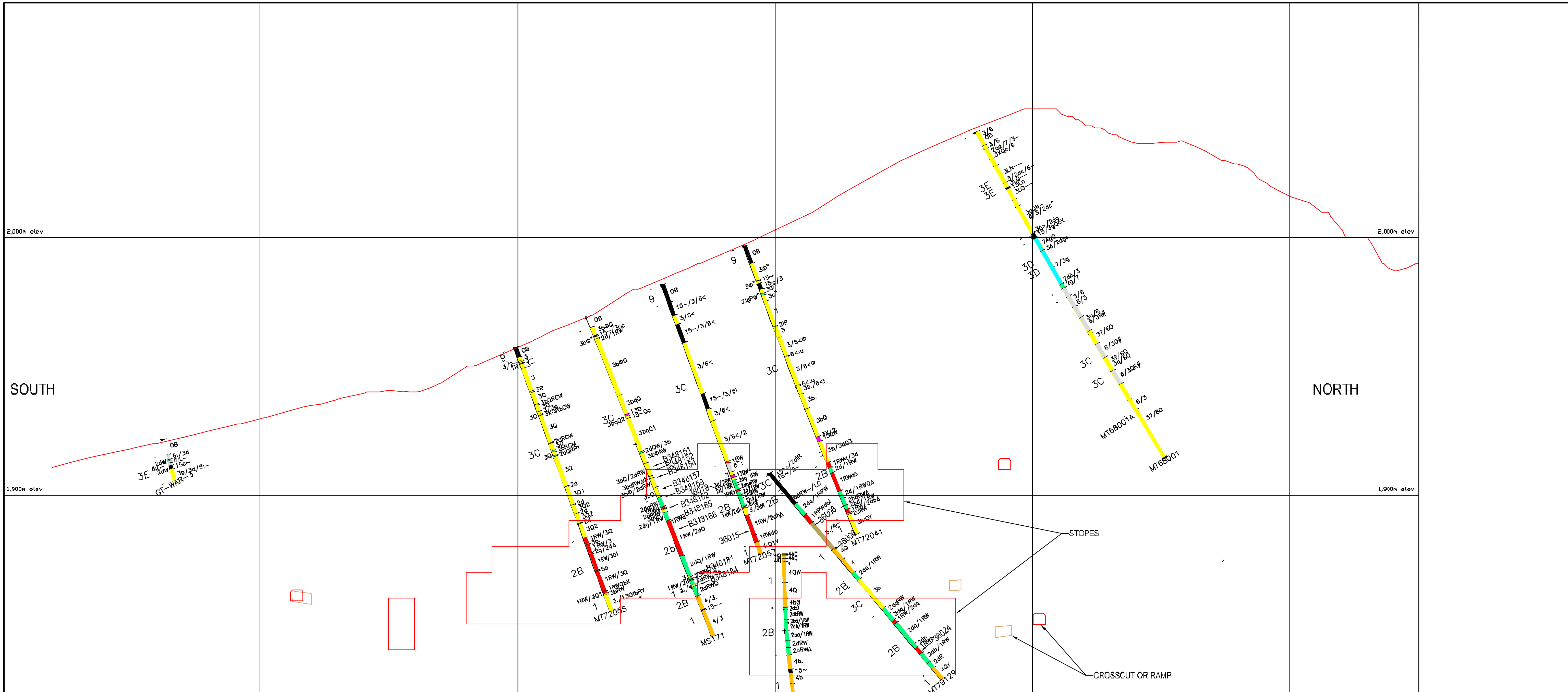
GEOCHEMICAL SAMPLE SECTIONS
441917E-216

EBA Engineering Consultants Ltd.

PROJECT NO	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-12



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

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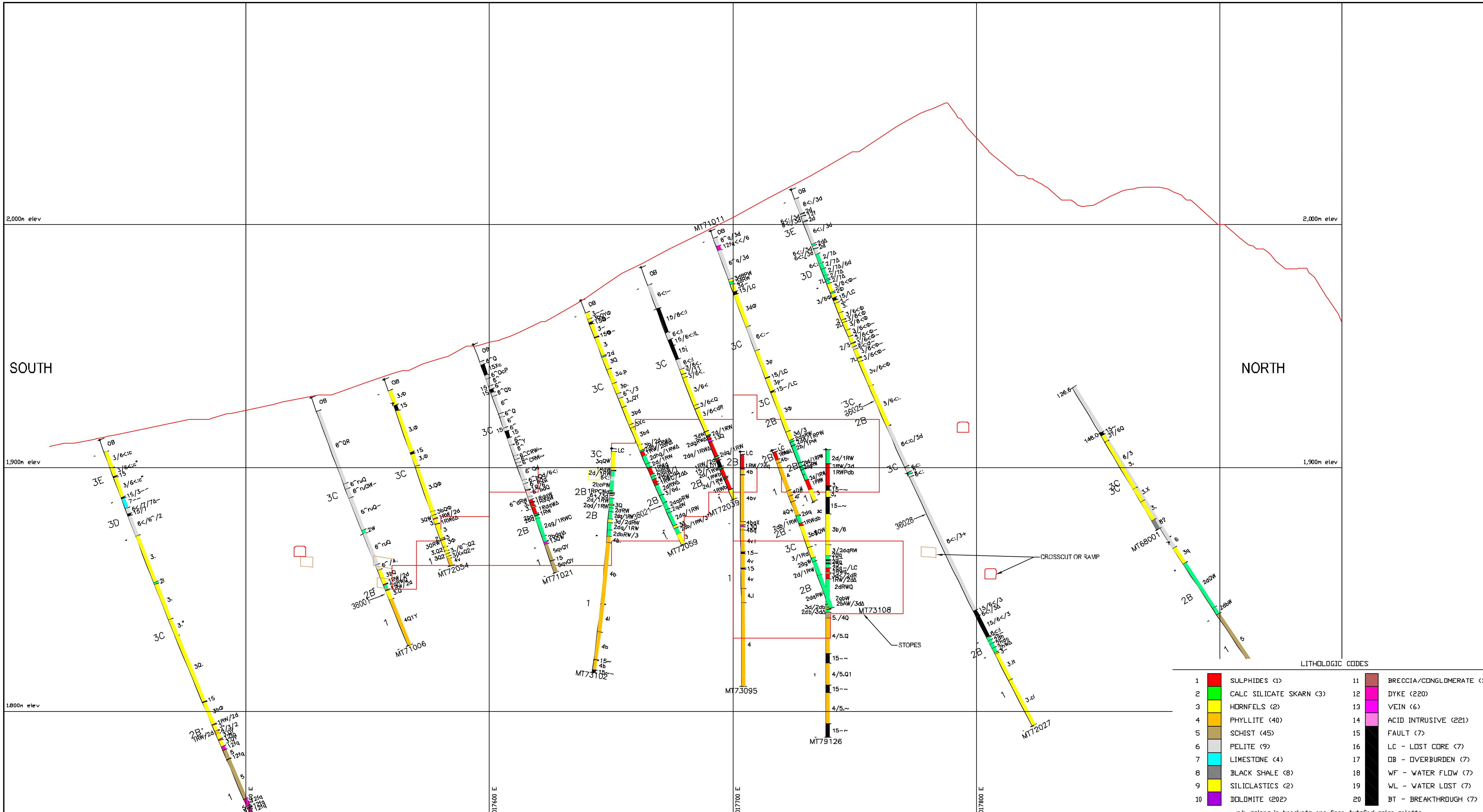
GEOCHEMICAL SAMPLE SECTIONS
441948E-217

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-13



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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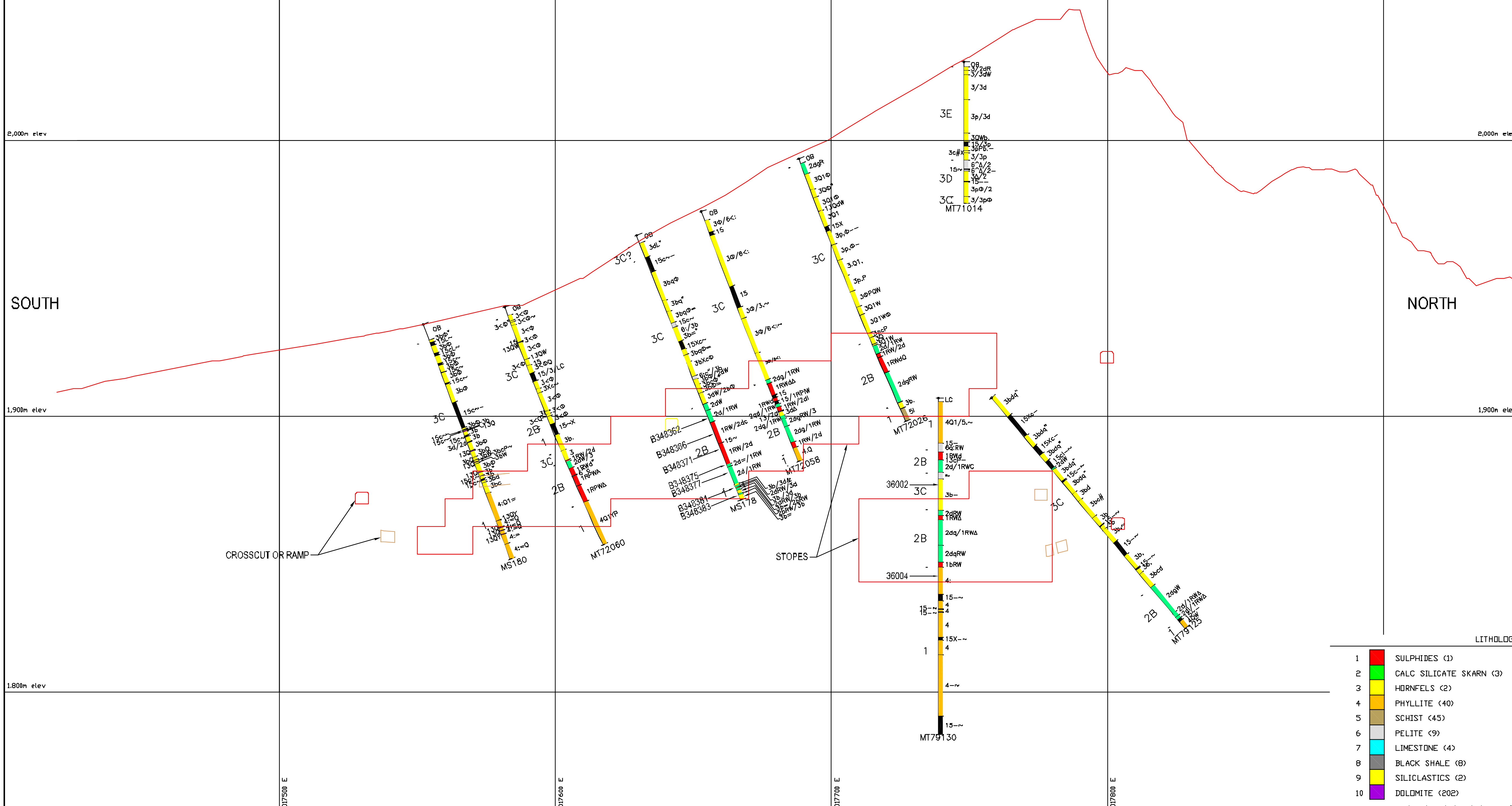
GEOCHEMICAL SAMPLE SECTIONS
441978E-218

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE: EBA-WHSE	DATE: JUNE 2009		

Figure 4.1.1-14



LITHOLOGIC CODES

1	SULPHIDES (1)		11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)		12	DYKE (220)
3	HORNFELS (2)		13	VEIN (6)
4	PHYLLITE (40)		14	ACID INTRUSIVE (221)
5	SCHIST (45)		15	FAULT (7)
6	PELITE (9)		16	LC - LOST CORE (7)
7	LIMESTONE (4)		17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)		18	WF - WATER FLOW (7)
9	SILICLASTICS (2)		19	WL - WATER LOST (7)
10	DOLOMITE (202)		20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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NORTH AMERICAN TUNGSTEN CORPORATION LTD

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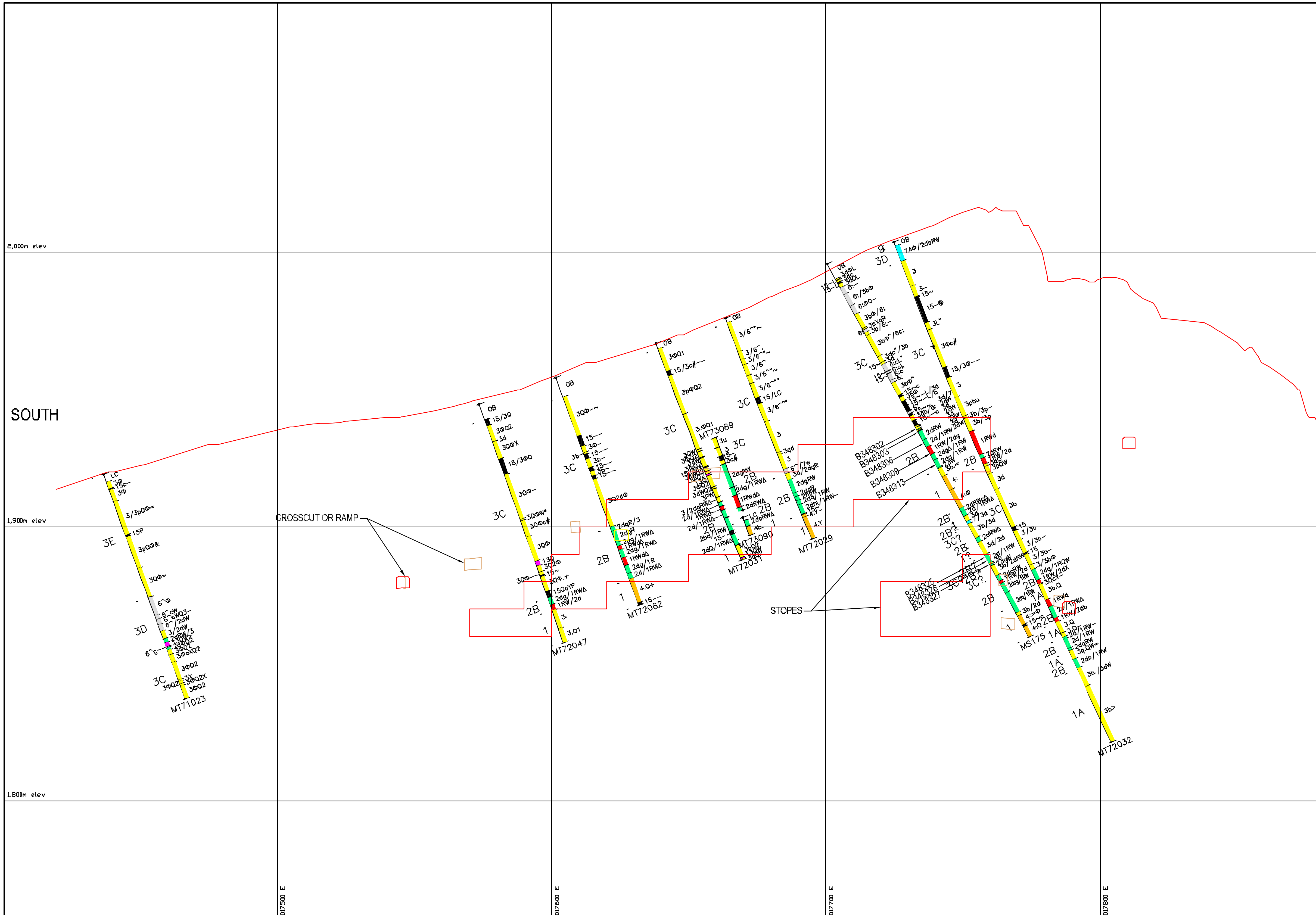
GEOCHEMICAL SAMPLE SECTIONS
442008E-215

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-15

Q:\Whitehorse\Data\0201drawings\MacTung\W23101211.002 Yosaa Supplemental\CROSS SECTIONS\W23101211.002 Figure 4.1.1-16 4412069E-221.dwg [FIGURE 4.1.1-16] June 29, 2009 - 6:04:17 pm [BY: KEN TOMCZYK]



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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NORTH AMERICAN TUNGSTEN CORPORATION LTD

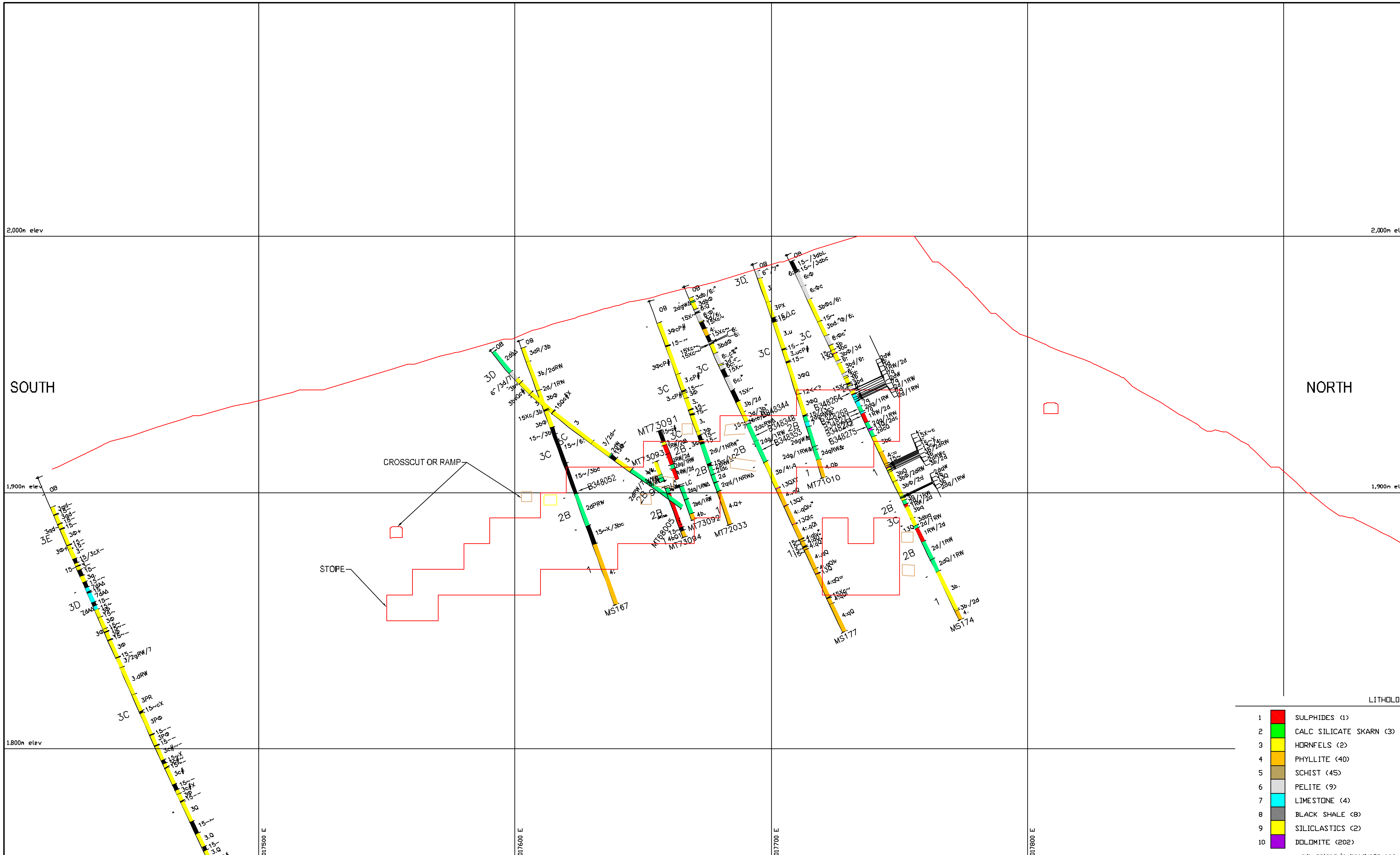
MACTUNG

GEOCHEMICAL SAMPLE SECTIONS
4412069E-221

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-16



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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NORTH AMERICAN TUNGSTEN CORPORATION LTD

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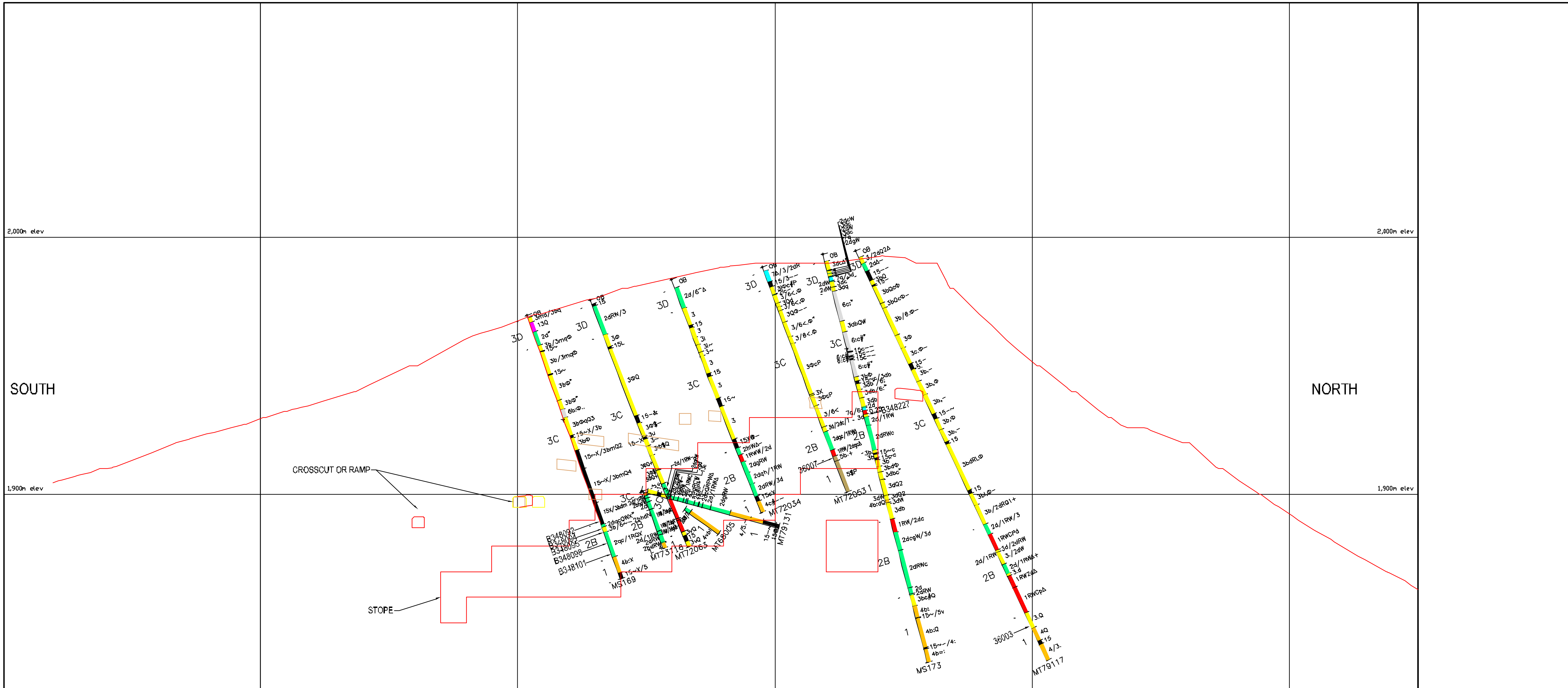
GEOCHEMICAL SAMPLE SECTIONS
442100E-222

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-17



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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NORTH AMERICAN TUNGSTEN CORPORATION LTD

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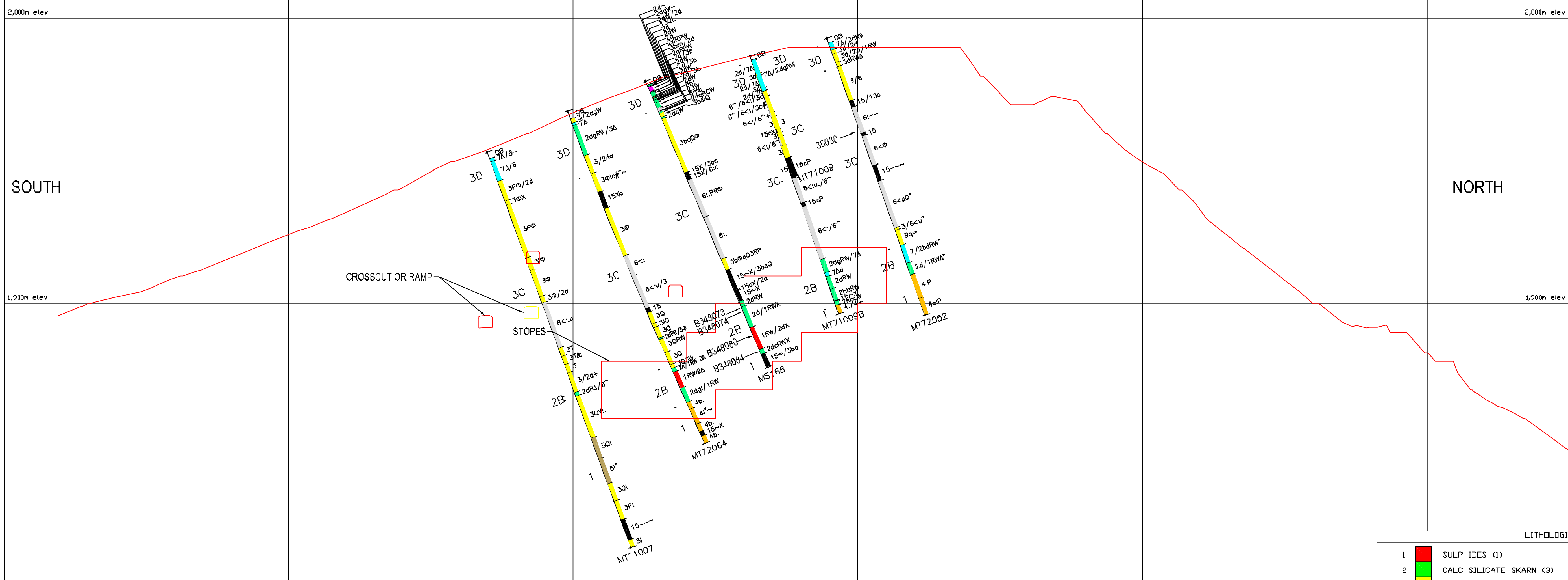
GEOCHEMICAL SAMPLE SECTIONS
442130E-223

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-18



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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NORTH AMERICAN TUNGSTEN CORPORATION LTD

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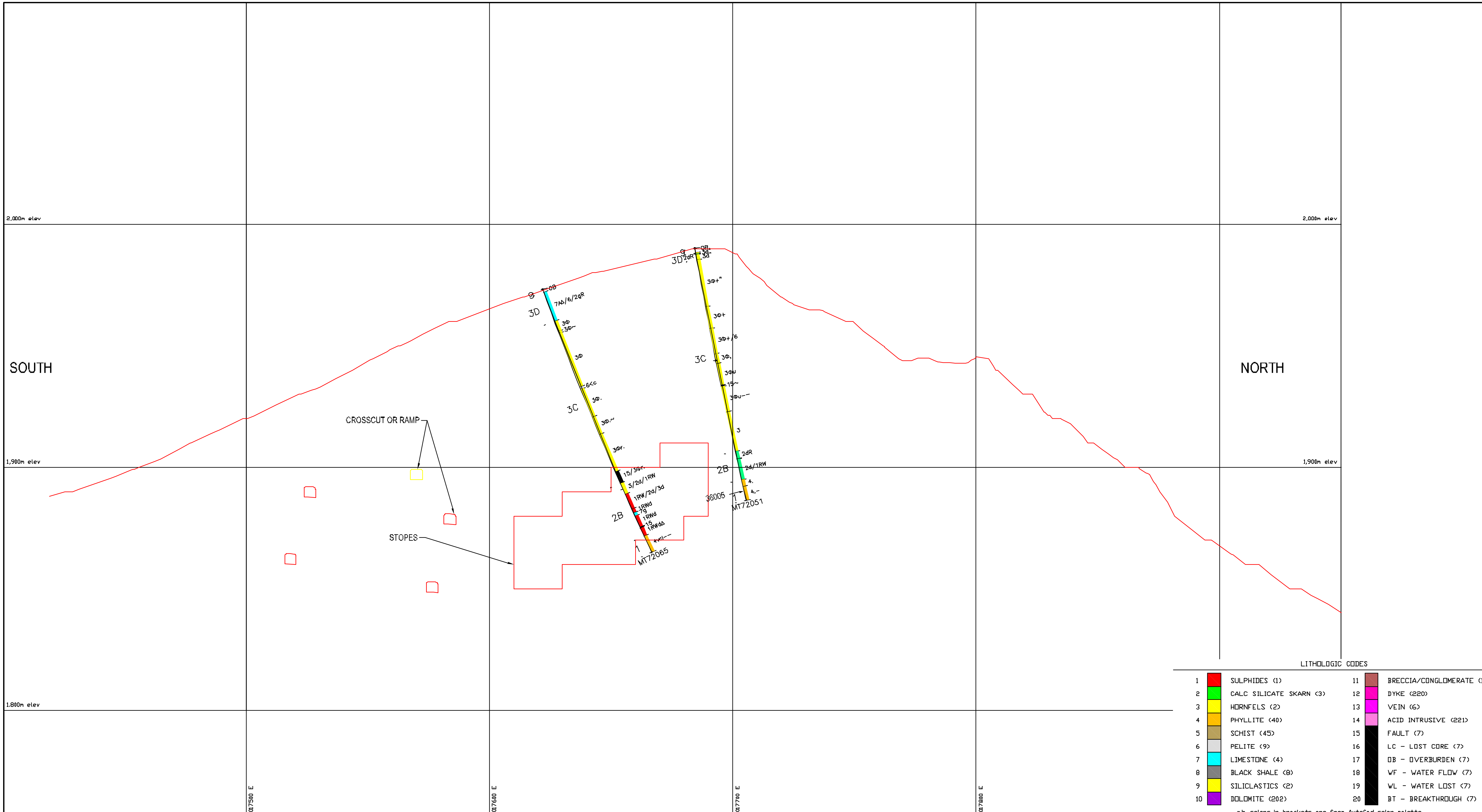
GEOCHEMICAL SAMPLE SECTIONS
442161E-224

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.1-19



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (9)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50
Scale: 1: 1 500 (metres)

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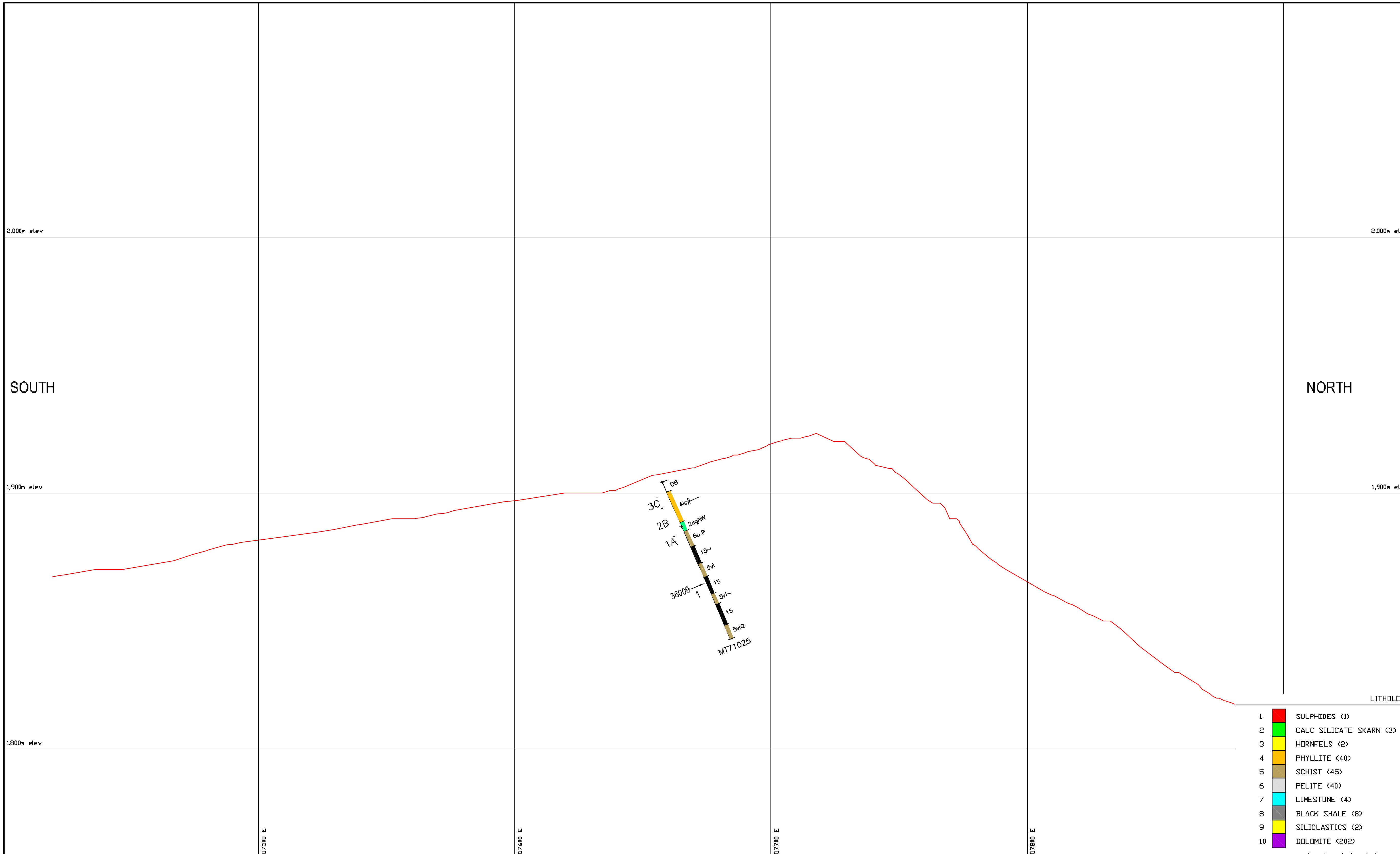
GEOCHEMICAL SAMPLE SECTIONS
442191E-225

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0

OFFICE: EBA-WHSE
DATE: JUNE 2009

Figure 4.1.1-20



LITHOLOGIC CODES

1	SULPHIDES (1)	11	BRECCIA/CONGLOMERATE (15)
2	CALC SILICATE SKARN (3)	12	DYKE (220)
3	HORNFELS (2)	13	VEIN (6)
4	PHYLLITE (40)	14	ACID INTRUSIVE (221)
5	SCHIST (45)	15	FAULT (7)
6	PELITE (40)	16	LC - LOST CORE (7)
7	LIMESTONE (4)	17	OB - OVERBURDEN (7)
8	BLACK SHALE (8)	18	WF - WATER FLOW (7)
9	SILICLASTICS (2)	19	WL - WATER LOST (7)
10	DOLOMITE (202)	20	BT - BREAKTHROUGH (7)

n.b. colors in brackets are from AutoCad color palette.

NOTES:

1. GEOCHEMICAL SAMPLE: 360– OR B348–
2. PLEASE REFER TO TABLE 4.1-6 FOR ROCK CODE LEGEND.
3. DRAWING PROVIDED IN COLOUR, REPRODUCTIONS MAY NOT BE REPRESENTATIVE OF ORIGINAL.

0 50

Scale: 1: 1 500 (metres)

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GEOCHEMICAL SAMPLE SECTIONS
442404E-232

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	SCD	0
OFFICE: EBA-WHSE	DATE: JUNE 2009		

Figure 4.1.1-22

d) Quantify and summarize the mass/volume of each rock type that will be affected by the underground workings.

Volumes of each rock unit that would be disturbed as a result of the proposed underground mining were provided by Wardrop Engineering Incorporated (WEI). Table 4.1.1-4 contains the estimated volume and calculated tonnage of the individual rock units that would be disturbed as a result of the proposed underground mining. The specific gravity information for the individual rock units within Table 4.1.-4 was taken from Lacroix and Associates (2009) and from available literature describing specific gravity ranges for different rock types known to exist at the Mactung site (Pocket Ref, Sequoia Publishing Inc., Weights and Properties of Materials pp. 427-436, 2001).

TABLE 4.1.1-4: SUMMARY OF PROPOSED MACTUNG DEVELOPMENT VOLUME AND TONNAGE BY ROCK UNIT

Unit	Development Volume (m3)	Stoping Volume (m3)	Total Volume (m3)	Specific Gravity	Development Tonnage (tonnes)	Stoping Tonnage (tonnes)	Total Tonnage (tonnes)
1	22,959	43,162	66,121	2.70	61,989	116,537	178,526
2B	30,964	2,100,345	2,131,309	3.14	97,227	6,595,083	6,692,312
3C	183,837	460,080	1,668,325	2.99	549,673	1,375,639	1,925,310

The rock units at the site are comprised of a number of different rock types. A statistical analysis of drill core logging from the different rock units was conducted by Mr. Dave Tenney of NATC to determine the primary and secondary rock types within each unit and their relative abundance. The division of the identified rock units into rock types allows for distribution of sample across the primary and secondary rock types in order to ensure sufficient sample numbers for characterization. Table 4.1.-5 shows the summary of primary and secondary rock types which account for the majority of the three rock units affected by the proposed underground development. The use of a minimum total of 90% resulted in the inclusion of secondary rock types representing less than 10% of the overall rock unit for Unit 2B and 3C.

TABLE 4.1.1-5: ABUNDANCE (%) OF PRIMARY AND SECONDARY ROCK TYPES BY UNIT

Rock Unit	Primary Rock Types			Secondary Rock Types				Total
	Calcified silicate skarn	Phyllite	Hornfels	Calcified silicate skarn	Pyrrhotite skarn	Hornfels	Pelite	All types
1		26.2		18.0	11.7	19.5	21.7	97.1
2B	54.0				29.7	6.4		90.1
3C			40.7	27.0	17.6		5.8	91.1

e) Provide a description of the methods used in collecting exploration samples. Details should include, but are not limited to:

i. size and location of samples;
ii. whether or not samples were sub-sampled; and,
iii. how samples were subcategorized from unit into lithology.

The following information on exploration sampling methodology and analysis were obtained from the 2007 NR 43-101 reporting by Scott Wilson RPA Associated Ltd. for the Mactung Property.

2005 Exploration Program

Diamond drill core selected for assaying was marked off in the core box using a red crayon, and a metal tag with the sample number inscribed on it, nailed to the core box at the start of the sample run. A pre-numbered paper sample tag was placed with it. A record of the sample "from" and "to" was made in the sample book on the appropriate sample ticket stub. This information was also recorded on the drill log along with the sample number and the recovered length of core, which was usually 100%. Diamond drill core, which was mainly sampled in lengths of 1.5 m, was split with a hydraulic core splitter set up in a room attached to the core storage shed on the Mactung Property. Some core was split with a diamond saw. Once the sample was split, it was placed in a large polyethylene bag, which also had the sample number marked on it in black felt marker. This bag was then placed inside a second identical bag and the paper sample tag placed between the two bags, which were then sealed with a single plastic tie. The samples were transported in rice bags, each rice bag containing about five samples. The rice bags were sealed with a numbered plastic security tie and shipped by commercial carrier from Whitehorse or Watson Lake to Global Discovery Laboratories (Global Discovery) in Vancouver. Sample pulps were shipped by Global Discovery to ALS Chemex of Vancouver and Becquerel Laboratories of Toronto for further assaying.

Exploration Duplicates

All duplicate testing for Mactung was performed on splits from the same pulps used for the original assays. The duplicate program did not include analysis of separate splits from the core. Consequently, the results from the various check assay programs at Mactung are primarily a measure of laboratory precision and accuracy rather than sample variability and/or bias. Future programs should include analysis of separate splits of core to assess the variability in sampling. Check assays were performed by a number of laboratories over the years, including Bondar Clegg (Vancouver), Chemex (North Vancouver), Warnock Hersey (Vancouver), and Crest Laboratories (Vancouver).

Additional Information on Geologic Identification of Lithologic Units

Core logging was conducted by NATC geologic personnel on the available drill core to identify the lithologic distribution of the various rock types. The core logging also included identification of the major rock units based on stratigraphic and geological observations. The core logging information was entered into a database that allows for interpretation and plotting of the relevant geological information. A copy of the core logging identification key used by the exploration geology staff for the Mactung Property is presented in Table 4.1.1-6 on the following page.

TABLE 4.1.1-6: MACTUNG GEOLOGY ROCK CODES

LITHOLOGIES

COLOUR	ROCK CODE	DESCRIPTION
red	1	SULPHIDES
lt. green	2	CALC SILICATE SKARN
dk. Green	3	HORNFELS
grey	4	PHYLLITE (unit 1)
brown	5	SCHIST (unit 2-1)
orange	6	PELITES (unit 1, 3D, 3E)
cyan	7	LIMESTONE (unit 2B,3D, 3E)
dk.grey	8	BLACK SHALE (unit 3C, 3H, 4)
yellow	9	SILICICLASTICS (unit 2B)
blue	10	DOLOMITE (unit 3G)
brown	11	BRECCIA/CONGLOMERATE (unit 6)
lt.magenta	12	DYKE (unit 8)
magenta	13	VEIN
pink	14	ACID INTRUSIVE (unit 7)
black	15	FAULT
white	16 or LC	LOST CORE
white	17 or OB	OVERBURDEN
white	18 or WF	WATER FLOW
white	19 or WL	WATER LOST
white	20 or BT	BREAKTHROUGH

Pelite(6) = mudstone(6<<), shale(6<), siltstone(6^), greywacke(6>)

MINERAL CODES

SULPHIDES ETC.		SILICATES ETC.	
A	APATITE	a	ACTINOLITE
B	BISMUTH	b	BIOTITE
C	CHALCOPYRITE	c	CALCITE
F	FLUORITE	d	PYROXENE
G	GALENA	e	EPIDOTE
H	HEMATITE	f	FELDSPAR
L	LIMONITE	g	GARNET
M	MAGNETITE	h	AMPHIBOLE
N	MANGANESE	i	IDOCRASE
P	PYRITE	j	CLAY MINERALS
Q	VEIN QUARTZ	k	K-SPAR
R	PYRRHOTITE	l	CHLORITE
S	ARSENOPYRITE	m	TREMOLITE
T	TOURMALINE	o	PHOSPHATE
W	SCHEELITE	p	GRAPHITE
Y	MOLYBDENITE	q	SILICIFICATON
Z	SPHALERITE	r	CORDIERITE
		s	SERPENTINE
		t	TALC
		u	ANADALUSITE
		v	MUSCOVITE
		w	WOLLASTONITE
		x	DOLOMITE
		y	GYPSUM
		z	ZEOLITES

BEDDING		STRUCTURES (PRIMARY)		STRUCTURES (SECONDARY)	
$	MASSIVE	*	DISSEMINATED	!	FOLIATED
+	BEDDED (bands >10cm)	Δ	CLASTS - ANGULAR	~	SHEAR/GOUGE
=	BANDED (bands <10cm)	Φ	CLASTS - ROUNDED	&	CONTORTED
==	LAMINATED	;	FOSSILIFEROUS	#	STRINGERS
		X	BRECCIA	%	VUGS
		π	PORPHYRITIC	@	SAND

GRAIN SIZE		ALTERATION		CORE CONDITION	
<	FINE GRAINED	,	BLEACHED (WHITE)	-	BROKEN CORE
^	MEDIUM GRAINED	:	HORNFELSED	"	FRACTURED/BLOCKY
>	COARSE GRAINED	.	SPOTTED		

D.Tenney June 1/2005

DESCRIPTION OF UNITS

UNIT	ROCK CODE	DESCRIPTION
9	17	TALUS AND OVERBURDEN.
8	12	FELSITE DYKES AND SILLS.
7	14	QUARTZ MONZONITE.
6	7/11	BLACK SHALE AND CONGLOMERATE.
5	7;	GREY BIOCLASTIC LIMESTONE
4	8;	GRAPTOLITIC BLACK SHALE
3H	6/7:	ARGILLACEOUS SILTSTONE AND SHALE, MINOR LIMESTONE, ALTERED TO HORNFELS AND SKARN.
3G	10tmQ1	TALC TREMOLITE DOLOMITE WITH 5 TO 10% QUARTZ VEINING.
3F	7/6<X:	PREDOMINANTLY LIMESTONE WITH LESSER INTERBEDDED SHALE ALTERED TO HORNFELS AND SKARN. UPPER MEMBER OF UPPER MINERALIZED HORIZON.
3E	6/7X:	PREDOMINANTLY SHALE WITH LESSER INTERBEDDED LIMESTONE ALTERED TO HORNFELS AND SKARN. MIDDLE MEMBER OF UPPER MINERALIZED HORIZON.
3D	11	BRECCIA AND CONGLOMERATE COMPRISING SHALE FRAGMENTS IN A LIMESTONE MATRIX, SHALE AND SILTSTONE, ALTERED TO SKARN AND HORNFELS. LOWER MEMBER OF UPPER MINERALIZED HORIZON.
3C	8/6/7dg	BLACK SHALE AND SILTSTONE, MINOR LIMESTONE ALTERED TO HORNFELS.
2B	7/6X/2	LIMESTONE AND LIMESTONE-SHALE BRECCIA ALTERED TO SKARN; LOWER MINERALIZED HORIZON
2-1	5b	BROWN BIOTITE SCHIST
1	4	PHYLLITE

QUARTZ VEINING

0 - 1 %	NO IDENTIFIER
1 - 5%	Q
5 - 10 %	Q1
10 - 20 %	Q2
20 - 40 %	Q3
40+ %	Q4

SULPHIDE CONTENT EXAMPLES*

1RW	>40% sulphides.		
1RW/2	20	to	40%
2/1RW	5	to	20%
2dRW	1	to	5%

* = including scheelite

4.1.2 Prediction of Acid Rock Drainage and Metal Leaching Potential

In order to determine appropriate mitigation measures to address ARD/ML effects, it is critical to accurately predict the ARD/ML potential and timing for each different geological material. As indicated by Price and Errington, the ARD/ML potential must consider all the materials that will be affected (waste rock, tailings, and mine walls) and the conditions in which those materials will be exposed (deposited aerially or under water).

It is critical for the Executive Committee to have a clear and accurate understanding of the ARD/ML prediction for the mine site. Appropriate prediction will inform the assessment as to: the geological materials (in situ or in storage) which are at risk of going acid, the projected time period for this to take place (i.e. how long until ARD/ML occurs), the expected duration of ARD/ML, and the quality of effluent anticipated to be produced.

YESAB has requested that sampling and testing be conducted in accordance with the Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia (Price, 1997). This document was developed to provide screening criteria for development of static and kinetic testing programs. There has been considerable research and publication of materials in the area of Acid Rock Drainage (ARD) and Metal Leaching (ML) since 1997. NATC in preparation of its geochemical characterization program has also included consideration of the results of published studies released since 1997 in order to ensure that it is using the best available scientific practices and approaches to prediction, management and mitigation of issues associated with ARD/ML. Currently, Natural Resources Canada (NRCan) is in the process of finalizing a revised National Guidance document outlining criteria for the prediction of ARD/ML from waste materials; however this document has not yet been released.

Discussions with Dr. Price indicated that there are two relevant references outlining appropriate criteria for characterization of waste materials. These documents are Price (2005) and International Network for Acid Prevention (INAP) Global Acid Rock Drainage Guide, INAP (2009), which is an online resource on the subject of ARD/ML. Both Price (2005) and INAP (2009) contain information that identifes an NPR value of 2 as being appropriate for the characterization of materials as either PAG or NAG. This information is considered to be the most relevant that should be applied for materials characterization.

The operation phase of the mine life is over 11 years which, with the two year construction period, is deemed to be adequate time to confirm the use of an NPR of 2. Materials with an NPR greater than 2 will be subject to ongoing characterization and field kinetic monitoring during construction and operation. NATC will develop appropriate management and mitigation strategies where the results of the ongoing characterization program indicate that there are materials with ARD or ML potential.

The following technical information is provided in support of the Mactung project proposal. This information describes local modifiers that will affect acid rock drainage and metal leaching at the site. This section is based on a review of available case studies and thermodynamics and is presented to assist the reader in understanding weathering processes and their effects at the proposed Mactung Mine.

Free Oxygen in the Underground Stopes

Tailings in the underground workings will be co-disposed with waste rock in the stopes. During operation, mining ventilation will provide air to the stopes to support safe mining. At the end of the mining sequence, the stopes will be sealed off with a shotcrete bulkhead designed to prevent earthquake liquefied tailings from flowing through the workings. The bulkheads are not designed to prevent water flow or to limit oxygen movement even though they will greatly reduce both. Stopes will be developed and closed out over a short period of time (typically < 1 year) based on a total of 20 stopes mined over the 11.2 year life of the project. This last factor is important as it governs the exposure time of geologic materials within the backfill to oxidation.

Oxygen within the pore space of the backfill will begin to be consumed immediately at placement at a rate governed by the weathering rate of any sulphide mineralization within the material. Once the little amount of oxygen available in the pore spaces is consumed by the oxidation of the sulphides, the oxidation process will stop. The oxygen will be replenished in the pore space at the diffusion rate of oxygen from the surface, which is very slow. Once the stopes are closed there will be no available oxygen to diffuse to the noted pore spaces due to the placement of the bulkheads. The limited amount of oxidation products will be isolated in the pore spaces where they are produced. Complete filling of the stopes is not feasible and there will typically be a small open space at the top of the stope. Oxygen supply will be very limited following bulkhead installation as openings into the mined out stope will be bulkheaded using shotcrete. Oxygen consumption within the closed stope may result in formation of a pressure gradient depending on the rate of oxygen consumption and the degree of fracture of the surrounding rock in the area of the bulkheaded openings. Weathering of backfill under these conditions would occur as a progressive front starting at the exposed surface of the backfill.

Oxygen depletion in bulkheaded stopes in both the frozen and unfrozen bedrock zones is expected to be the same during drained conditions. The oxygen supply will be further limited by the depth of the underground workings of more than 100 m below surface and the presence of permafrost which causes partial sealing of near surface fractures with ice, limiting potential diffusion pathways.

Process Water in Underground Backfill

The backfilled tailings will have a residual water content of approximately 15% to 20% based on process-related information. This moisture will be comprised of process water which is characterized as being alkaline in nature with the ability to provide some buffering capacity to acidic weathering products. Some of the alkaline process water contained within the tailings is expected to drain from the backfilled tailings; however there will be some retained in pore spaces that will provide additional buffering capacity. Temperature of the backfill materials and the surrounding rocks will dictate drainage characteristics. Placement into the frozen bedrock zone will promote freezing of the backfilled materials which will reduce material drainage. Some drainage into open fractures or voids may occur; however, these are not expected to allow for significant transport in the frozen bedrock zone due to the presence of freezing conditions.

Groundwater and Dissolved Oxygen in the Underground Stopes

The volume of water within the open stopes will depend on the stope location. Stopes located within the area of frozen bedrock and those above the natural groundwater table will not flood after mine closure due to a lack of water, while those located below the natural groundwater table will be subject to flooding following the end of mining operations. Observations from advanced exploration activities at the site indicate that the bedrock is not ice-rich based on the degree of fracture and void space present in the core (estimated less than 1%). The lack of significant ice within the frozen bedrock indicates that there will be minimal water produced during active mining operations when underground rock temperatures may periodically increase above zero degrees Celsius.

Backfilled tailings and waste rock placed in the unfrozen bedrock stopes, which are located below the natural groundwater table (about 40% of the underground workings), will be subject to draining conditions for a minimum period of 5 years during mining, plus the time required for the groundwater table to recover. This is based on the current estimate of mining in the unfrozen bedrock starting in year 6 of operations and extending to the end of mine life in year 11. The duration of exposure to drained conditions will depend on stope elevation with the final stopes being mined possibly only having drained conditions existing for less than a single year.

Flooding of the backfilled tailings and waste rock will occur in a progressive manner which will fill pore spaces and displace residual oxygen from the backfill. Groundwater sampling at the site has indicated that Mt. Allen groundwater has a pH range of between 8.5 and 9.0. The neutral to slightly alkaline nature of the groundwater will buffer any residual acidic weathering products that may dissolve during the flooding process and the submerged state of the tailings will stop any possible further oxidation.

Monitoring of deep groundwater at the Mactung site recorded dissolved oxygen concentrations of less than 0.5 mg/L. Therefore, flooding of the backfilled materials will effectively eliminate the oxygen controlled processes that drives ARD. Groundwater movement through the flooded component of the underground working will be controlled by the small hydraulic conductivity of the host rock and the small natural hydraulic gradient of about 0.025. A bulk hydraulic conductivity of approximately 5×10^{-7} m/s has been estimated based on a pumping test conducted on the host rock down gradient of the proposed underground workings.

Temperature Effects on ARD and ML Processes

Temperatures within the frozen bedrock are expected to be approximately -1.5°C. Temperatures within the unfrozen bedrock are expected to be approximately 1 to 2°C. This range of temperatures would be considered as refrigerated for the purposes of describing temperature effects on ARD and ML processes. MEND (2006) is a summary document describing cold temperature effects on geochemical weathering. A review of available case studies showed that oxidation rates from controlled laboratory experiments can be reasonably estimated by use of the Arrhenius equation (Equation 1) shown below.

Equation 1: $k = Ae^{(-Ea/RT)}$

Where:

- → A – prefactor
- → k – reaction rate
- → Ea – activation energy for the reaction
- → R – gas constant
- → T – temperature

Using Equation 1, the evaluation of temperature effects on oxidation rates at different temperatures can be described by Equation 2.

Equation 2: $\ln(k_1/k_2) = Ea\ (T_1\text{-}T_2)/(RT_1T_2)$

Where:

- → k_1, k_2 – reaction rates at temperatures T1 and T2.
- → Ea – activation energy for the reaction
- → R – gas constant
- → T_1, T_2 – temperatures used for determination of rate sensitivity

Figure 4.1.2-1 shows the decrease in the reaction rate with decreasing temperatures relative to 20°C for the oxidation of different sulphide minerals. The difference in reaction rates increases as the activation energy increases. Assuming a typical groundwater temperature of 1 to 2°C at Mactung, the oxidation rate of pyrrhotite, which is the dominating sulphide mineral at Mactung, would be about 3 times smaller than at 20°C. Experimental results from several northern mines confirmed these results.

The natural refrigeration of the backfill as a result of low ambient temperatures will greatly reduce the oxidation rates of sulphide mineralization within the backfilled underground workings which would increase the time to acidity for any materials identified as being PAG.

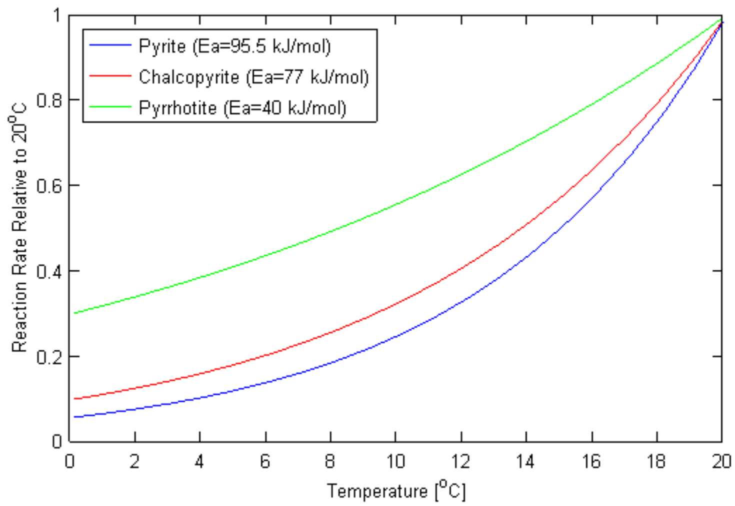


Figure 4.1.2-1

Relative Sulphide Oxidation Rates as a Function of Temperature

Decrease of the oxidation rate of sulphide minerals with decreasing temperatures is predicted using the Arrhenius equation (Equation 1). Activation energies Ea were taken from Ahonen and Tuovinen (1991).

The review of the effect of temperature on acid buffering minerals is also described in MEND (2006). The availability of alkalinity within water is controlled by the solubility of carbon dioxide, which increases with decreasing temperature. The dissolution of carbon dioxide in water results in carbonic acid which reacts with carbonates and silicates. Limited information on the temperature effects on buffering minerals is available but thermodynamic evaluation indicates that carbonates such as calcite and dolomite are up to 1.4 to 1.6 times more soluble at low temperatures. This would result in an increased availability of alkalinity to buffer acidic weathering processes. MEND (2006) indicates that there was no evidence that the increased solubility resulted in more rapid flushing of neutralization potential from materials.

The information on cold temperature sulphide oxidation and alkalinity effects indicates that the primary result of cold temperatures is an increase in the time to acidity resulting from a decreased sulphide oxidation rate. This delay in the time to acidity is also described in a case study and literature reviews that describe potentially acid-generating tailings in northern climates (MEND, 1993, 2001).

Another consideration with respect to temperature effects on ARD and ML at the Mactung site is with respect to the availability of oxygen in cold water. As the solubility of oxygen increases with decreasing temperature, the diffusivity of oxygen decreases with the same drop in temperature. Figure 4.1.2-2 shows the temperature dependence of the solubility and diffusivity of dissolved oxygen in water. With a temperature drop from 20°C to 0°C, the solubility increases by a factor of 1.6 whereas the diffusivity decreases by a factor of 1.8. That is, the decrease in diffusivity exceeds the increase in solubility, so that the overall availability of oxygen for the oxidation of sub-aqueously disposed material is reduced under cold temperature conditions. Elberling (2001) calculated a 90% reduction in the oxygen flux at 2°C compared to that at 15°C for a 30 cm saturated sand column and suggests that sub-aqueous disposal at low temperatures is likely to be more effective than in temperate areas.

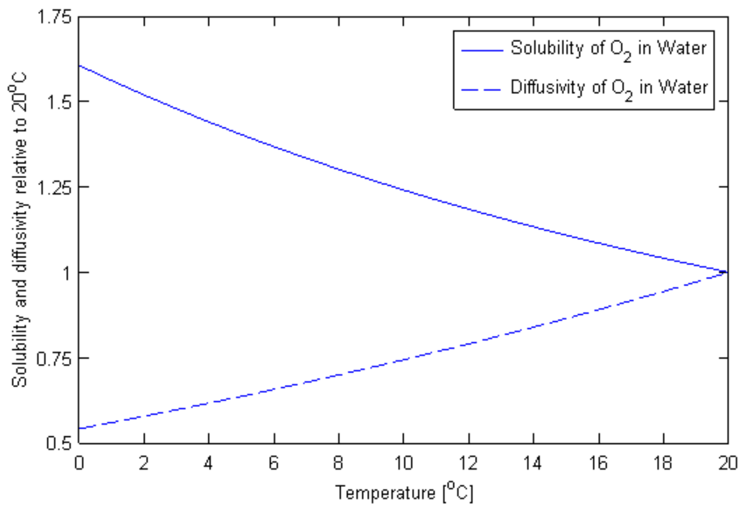


Figure 4.1.2-2

Temperature dependence of the solubility and diffusivity of dissolved oxygen in water.

Weathering Rime Development in Unsaturated Backfill

Weathering rimes will develop on the faces of sulphide mineral grains within the unsaturated underground workings. The development of weathering rimes helps to limit the rate of sulphide oxidation by restricting oxygen access. Weathering rimes are less common where materials interact with water as a result of the solubility of the secondary weathering products which form the rimes. The development of weathering rimes is expected to occur in the frozen portion of the underground workings where water is essentially restricted to residual process water within the backfilled tailings.

4.1.2.1 Acid-Base Accounting

The proponent conducted acid-base accounting (ABA) based upon the methods described by Price (1997). Table 4.1.4-3 summarizes the ABA results for 47 samples of ore, mine waste, mill site waste, ravine dam waste, tailings area waste, and existing dump waste. The samples were collected from a variety of sources over a number of years. The project proposal does indicate the number of samples submitted for ABA analysis as well as when the samples were collected. However, statistical representation of the samples used has not been provided. Statistical representation must be addressed in order to have an accurate representation of ABA results for the ore body and waste. For example, based upon the information provided in the project proposal, 15 samples were taken to perform ABA on an ore body of roughly 8-10 million tonnes, suggesting each sample is representative of 267,000 m^3 of material. The B.C. guidelines suggest a minimum of 80 samples per 10 million tonnes. There is no data presented in the proposal that would support a conclusion that the material has been properly classified. Please provide the following information.

a) Provide a statistical analysis (as outlined in the BC Guidelines) to show that a significant number of representative samples were acquired from each rock type for geochemical analysis, and submitted for static and kinetic testing.

b) If current sampling is found to be incomplete, please update accordingly with a suitable number of samples for ABA, as well as appropriate kinetic testing (as outlined in the BC Guidelines).

The YESAB Adequacy Report requests that the sample size guidelines from Price (1997) be followed to ensure a statistically significant sample size. The minimum sample size guidelines are contained in Section 6 of this document and are based on total tonnage of material to be excavated. Table 4.1.2-1, below, is a copy of Table 6-1 from this document. Table 4.1.2-1 shows that as unit tonnage increases, the number of samples also increases, but at a slower rate. The result is that the volume of material represented by an individual sample increases with tonnage from approximately 1 sample per 3,333 tonnes at 10,000 tonnes to approximately 1 sample per 125,000 tonnes at 10,000,000.

TABLE 4.1.2-1: MINIMUM NUMBER OF SAMPLES FOR PRELIMINARY STATIC TESTING (TABLE 6-1 FROM PRICE, 1997)

Total of Unit (metric tonnes)	Minimum Number of Samples
< 10,000	3
< 100,000	8
< 1,000,000	26
< 10,000,000	80

The application of the guidelines contained in Table 4.1.2-1 to the tonnages reported previously in Table 4.1.2-2 allows for the estimation of the minimum number of samples that are required to properly classify each rock unit. The determined minimum number of samples can then be compared to the existing number of samples to determine additional sampling requirements. Table 4.1.2-2, below, contains the additional sample numbers for each rock unit based on this methodology.

TABLE 4.1.2-2: DETERMINATION OF ADDITIONAL SAMPLING REQUIREMENTS BY ROCK UNIT					
Rock Unit	Total Tonnage	Estimated Minimum Number of Samples	Sample Frequency	Existing Number of Samples	Additional Sample Requirements
1	178,526	13	1:17,853	9	4
2B	6,692,312	62	1:103,000	18	44
3C	1,925,310	34	1:60,165	8	26
Sample Number Totals:		**109**		**35**	**74**

Additional Sample Selection Methodology

Sample selection for this program was based on a review of the estimated volumes of each rock unit that would be disturbed as a result of the proposed underground mining activities. Borehole logs were compared to the mining plan in order to identify sections that pierced the proposed underground workings. Samples for analysis were then randomly selected from within the different rock sections based on the drilling logs and geologic description of the rock units. The random selection of samples provides a statistically representative understanding of the overall rock units without biasing sample selection towards a single unit or area within the deposit. Spatial representation of the samples was provided by selection of samples from different cross-sections along the deposit.

Samples from outside of the underground workings were used where additional characterization samples for a rock type were required. This was the case for some of the Unit 3C samples where existing 2008 exploration samples were focussed on increasing characterization of the mineralized zone. The list of samples selected for the additional static testing is shown in Table 4.1.2-3. NATC will provide a supplementary report containing results from the static testing of the samples in Table 4.1.2-3 by July 31, 2009. NATC will continue to utilize conservative assumptions and design standards with the additional testing results expecting to validate the conservative nature of the current project design.

TABLE 4.1.2-3. MACTUNG ADDITIONAL SAMPLE NUMBERS AND STATIC TESTING SUMMARY

SAMPLE	HOLE	FROM	TO	Unit	C-S	Carbonate Carbon	ABA	Shake Flask
B348184	MS171	111.94	113.55	1	Y	Y	Y	Y
B348381	MS178	97.4	98.9	1	Y	Y	Y	Y
B348383	MS178	100.4	101.25	1	Y		Y	Y
B348220	MS172	146	147.5	1	Y		Y	Y
B348524	MS176	100.63	101.63	2B	Y		Y	
B348326	MS175	122.2	123.7	2B	Y			
B348512	MS182B	123.15	124.4	2B	Y			
B348313	MS175	82.5	84	2B	Y		Y	
B348306	MS175	73.5	75	2B	Y			
B348275	MS174	73.2	74.7	2B	Y	Y	Y	
B348272	MS174	68.66	70.2	2B	Y		Y	
B348271	MS174	67.9	68.66	2B	Y	Y	Y	
B348268	MS174	65.72	67.22	2B	Y			
B348528	MS176	105.7	107.2	2B	Y	Y		
B348168	MS171	88.94	90.44	2B	Y		Y	
B348325	MS175	120.7	122.2	2B	Y			
B348165	MS171	84.44	85.94	2B	Y			
B348162	MS171	79.94	81.44	2B	Y	Y	Y	
B348159	MS171	75.44	76.94	2B	Y			
B348143	MS170	163.96	165.46	2B	Y	Y		
B348141	MS170	160.96	162.46	2B	Y	Y	Y	
B348137	MS170	154.96	156.46	2B	Y			
B348134	MS170	150.46	151.96	2B	Y			
B348101	MS169	98	99.5	2B	Y	Y	Y	
B348098	MS169	93.5	95	2B	Y			
B348095	MS169	89	90.5	2B	Y	Y	Y	
B348094	MS169	87.5	89	2B	Y	Y	Y	
B348084	MS168	102	103.5	2B	Y			
B348080	MS168	96	97.5	2B	Y	Y	Y	
B348181	MS171	107.5	109	2B	Y		Y	
B348417	MS179	124.46	126	2B	Y		Y	
B348506	MS182B	116.2	117.7	2B	Y			
B348505	MS182B	114.7	116.2	2B	Y		Y	
B348440	MS179	190.5	192	2B	Y	Y	Y	
B348437	MS179	186.04	187.5	2B	Y			
B348433	MS179	181.28	182.78	2B	Y		Y	
B348309	MS175	78	79.5	2B	Y	Y		
B348429	MS179	176.78	178.28	2B	Y	Y		
B348531	MS176	108.7	110.2	2B	Y		Y	
B348411	MS179	115.5	117	2B	Y		Y	
B348377	MS178	91.4	92.9	2B	Y			
B348375	MS178	88.4	89.9	2B	Y	Y		
B348366	MS178	76.4	77.9	2B	Y		Y	
B348532	MS176	110.2	111.7	2B	Y	Y		
B348348	MS177	63.76	65.26	2B	Y			
B348353	MS177	69.76	71.26	2B	Y			
B348362	MS178	70.4	71.9	2B	Y		Y	
B348371	MS178	82.4	83.9	2B	Y			
B348327	MS175	123.7	125.4	3C	Y			
B348517	MS176	90.7	92.2	3C	Y		Y	Y
B348472	MS181	152.09	153.59	3C	Y		Y	Y
B348498	MS182B	104.2	105.7	3C	Y			
B348500	MS182B	107.2	108.7	3C	Y	Y	Y	Y
B348501	MS182B	108.7	110.2	3C	Y			
B348092	MS169	84.5	86	3C	Y		Y	
B348344	MS177	57.76	59.26	3C	Y		Y	Y
B348074	MS168	87	88.5	3C	Y	Y		
B348127	MS170	142.13	143.71	3C	Y	Y		
B348402	MS179	106.2	106.4	3C	Y	Y	Y	Y
B348302	MS175	67.5	69	3C	Y		Y	
B348401	MS179	104.7	106.2	3C	Y			
B348264	MS174	58.4	60.2	3C	Y	Y	Y	Y
B348151	MS171	62.28	64.28	3C	Y			
B348227	MS173	64.07	65.57	3C	Y			
B348152	MS171	64.28	65.78	3C	Y			
B348403	MS179	106.4	107.5	3C	Y		Y	Y
B348052	MS167	62.25	63.75	3C	Y	Y	Y	
B348157	MS171	71.78	73.61	3C	Y	Y	Y	Y
B348154	MS171	67.28	68.78	3C	Y			
B348473	MS181	153.59	155.09	3C	Y		Y	Y
B348303	MS175	69	70.5	3C	Y			
B348426	MS179	172.18	173.68	3C	Y	Y	Y	Y
B348073	MS168	85.4	87	3C	Y			
B348502	MS182B	110.2	111.7	3C	Y			

Geochemical - Static Testing Program

The proposed static testing program will build on the existing testwork results to provide a more thorough understanding of the characteristics of geological materials to be disturbed as a result of the proposed underground development. The static testing program will attempt to develop statistical carbon to sulphur (C-S) relation in order to develop a reliable characterization procedure that may also be applied to the construction and operations phases of the project. More detailed static testing using acid-base accounting (ABA) methodologies will be conducted on a lesser number of samples to provide statistical support for the C-S analysis method. A brief description of the proposed testing protocols that are to be conducted are provided below.

Carbon – Sulphur (C S) Analysis

Details on the carbon – sulphur analysis method were obtained from White, Lapakko, and Cox (1998) which cites Bucknam (1995) as the relevant reference for this method. Bucknam's work on this method was aimed at development of an ASTM standard for total carbon and sulphur determination to estimate carbonate and sulphide for acid base accounting (ABA). This simplified ABA method allows for an increased number of samples to be analysed at a lower cost than traditional ABA techniques while also providing quick turn around times for results which is critical when this method is applied to the construction or operational phase of a development project. The C-S method involves correlation of carbon content with neutralization potential and sulphur content with acid potential. The sample is subject to partial-decomposition procedures (pyrolysis at 550^0C and chemical decomposition), followed by combustion infrared spectrophotomettric C-S analysis. The pyrolysis burns off sulphide sulphur as sulphur dioxide and organic carbon as carbon dioxide. All remaining sulphur is assumed to be sulphate sulphur while all remaining carbon is assumed to be carbonate.

Previous mineralogical assessment of the rock units at Mactung (EBA, 2008) have shown that sulphide mineralization consists of pyrite (FeS_2), chalcopyrite ($CuFeS_2$) and pyrrhotite (Fe_7S_8), which validates the application of the carbon – sulphur analysis method. All of the samples identified in Table 4.1.2-3 will be analyzed using the carbon – sulphur method. It should be noted that the C-S method is currently used for mining-related operational materials characterization within British Columbia.

Total Carbon vs Carbonate Carbon Analysis

Analysis to confirm the carbonate carbon:total carbon relation was conducted on 25 samples (refer to Table 4.1.2-3 for specific sample numbers), which is a frequency of approximately 1 carbonate analysis per 4.4 samples. The testing for carbonate carbon is a Quality Assurance / Quality Control component of the Mactung static testing program.

Acid Base Accounting

A total of 35 samples from exploration drilling-related to underground development were submitted for acid base accounting (ABA) during the initial round of testing. An additional 38 samples will be submitted for ABA analysis as the second round of testing to provide a sufficient dataset to support the C-S method of analysis. Samples for ABA analysis were selected randomly from the C-S samples within each available rock type.

The following parameters will be measured or calculated as part of the second round of ABA testing:

- Total sulphur (%-S), sulphate sulphur, sulphide sulphur;
- Total carbon (%-C), total inorganic carbon (%C_{inorg}), total organic carbon (%C_{org});
- Maximum Potential Acidity (MPA);
- Sobek (NP_{Sobek}) and carbonate (NP_{Carb}) neutralization potential;
- Net neutralization potential (NNP); and,
- Sobek (NPR_{Sobek})and Carbonate (NPR_{Carb})Neutralization Potential Ratio.

The results of the second round of ABA testing will be incorporated with the initial ABA testing results to provide more characterization information on geological materials to be disturbed by the proposed development. They will also be used to support the C-S method for characterization of geological materials at the Mactung site.

Kinetic Testing Program

The second round of testing for this project includes the establishment of humidity cells for collecting kinetic test information on tailings solids produced during the current metallurgical testing program. Tailings samples for the kinetic testing program were produced from the 2008 (MT2009-1) and 2005 (MT2009-2) exploration program drill core rejects. The drill core rejects were subjected to bench scale milling to produce a tailings sample representative of that which will be produced during operations.

The 2005 material test sample comprises 53 samples of 2005 drill core reject taken from the Mactung 2B horizon. Approximately every fifth sample lying within the Unit 2B was selected and 250 ml of the reject material placed into a clean 5 gallon plastic pail using a plastic beaker. The reject material was noted to be dry except for two samples, with little apparent oxidation of the reject material. An 8 kg sub-sample was removed from the 5 gallon pail after a thorough mixing and shipped to Vancouver for testing.

The ore composite used for production of the 2008 tailings sample was obtained through compositing a 250 g grab sample from every fifth sample within the defined diamond drill intersections. The composite samples included both ore grade and sub-ore grade materials. Compositing of the bulk ore sample was conducted at Global Discovery Laboratories in Vancouver while the humidity cell and metallurgical testing is being conducted by

SGS Laboratories of Vancouver, BC. Table 4.1.2-4 lists the 47 sample numbers that were used to create the 2008 composite sample along with select assay results. Table 4.1.2-5 lists the 53 samples that were used to create the 2005 composite sample along with select assay results. More complete reporting of assay results for these met program samples along with sections showing the spatial locations will be provided to YESAB with the July 31, 2009 interpretive report. Results from the humidity cell testing program will be forwarded to YESAB as they are received. Interpretive humidity cell data summaries will also be generated on a monthly basis and provided to YESAB.

The underground backfill at the Mactung property will be a mixture of tailings and waste rock. The tailings from Unit 2B has a higher level of mineralization than the waste rock and will also have higher metal leaching potential as a result of its finer grain size. Characterization of the underground backfill within the unfrozen bedrock zone will be based on the tailings humidity cell as this will represent the worst-case scenario for metal loadings.

Field kinetic cells will be established by NATC during the operations phase to provide field based kinetic information on backfilled materials, which will be used as part of ongoing refinement of the site geochemical predictions. The use of field kinetic cells provides more reliable information on geological material behaviour due to the larger sample size.

Static testing as described above will be conducted on the ore and tailings samples prepared as part of the kinetic testing program. The humidity cell will be operated on a weekly cycle in accordance with standard operating procedures. Effluent from the weekly leaching will be collected and analyzed for dissolved metals, alkalinity, sulphate, pH, acidity and other major anions required as input for predictive modeling.

c) Please update Table 4.1.4-4 with relevant values and rationale for their classification. Given the lithological characteristics of the sampled rock, the table as contained in the proposal is overly simplistic for classifying samples as potentially acid generating or non-acid generating.

Table 4.1.4-4 will be updated based on the results of the additional static testing program described above. This information will be provided to YESAB once the results from the additional testing become available and can be incorporated into the existing dataset. NATC will submit a supplementary report to YESAB containing this additional information prior to July 31, 2009.

TABLE 4.1.2-4. SAMPLE ASSAY INFORMATION FOR 2008 SAMPLE MET TESTING COMPOSITE									
Sample	HOLE_ID	S (%)	Se (ppm)	Fe (%)	Cu (ppm)	Zn (ppm)	Al (%)	Ca (%)	Na (%)
B348078	MS168	8.43	18	13.6	2219	58	1.97	4.62	0.04
B348100	MS169	7.49	15	12.94	2351	140	1.93	8.17	0.04
B348127	MS170	1.4	7	2.99	297	33	2.75	4.07	0.18
B348133	MS170	1.98	12	5.39	540	44	2.13	3.19	0.09
B348138	MS170	3.7	21	6.74	1000	42	2.28	3.34	0.1
B348143	MS170	2.59	16	5	623	23	2.47	3.52	0.12
B348205	MS172	5.85	42	10.22	1220	58	2.83	3.75	0.11
B348211	MS172	4.5	44	8.47	1672	55	2.62	5.9	0.07
B348053	MS167	4.51	-5	9.59	1354	164	2.21	6.53	0.04
B348057	MS167	5.56	6	10.53	1379	88	0.85	4.44	0.03
B348073	MS168	1.45	5	4.77	538	74	2.28	6.29	0.09
B348231	MS173	1.48	-5	4.56	280	113	2.03	5.97	0.05
B348236	MS173	0.99	6	2.77	132	70	2.33	8.85	0.05
B348240	MS173	15.1	19	23.7	3494	45	2.31	3.41	0.07
B348247	MS173	0.33	-5	1.47	144	72	2.19	6.18	0.04
B348253	MS173	3.31	5	5.24	876	39	3.04	5.12	0.08
B348275	MS174	3.45	5	5.87	852	73	1.14	4.31	0.03
B348285	MS174	3.65	36	5.7	659	419	3.13	4.81	0.1
B348291	MS174	10.66	18	15.19	2710	51	3.15	4.66	0.07
B348296	MS174	0.79	5	1.41	167	20	2.63	4.28	0.04
B348304	MS175	3.75	-5	7.31	798	84	2.07	7.85	0.04
B348309	MS175	15.67	16	25.04	3483	47	1.79	2.25	0.09
B348331	MS175	1.75	5	5.38	491	119	2.09	5.06	0.05
B348336	MS175	4.94	9	7.99	1241	23	3.37	5.06	0.1
B348341	MS175	1.86	23	3.91	443	38	3.96	7.69	0.14
B348522	MS176	9.09	13	15.94	1648	31	1.67	4.08	0.06
B348528	MS176	3.23	22	6.67	680	87	2.29	3.19	0.13
B348535	MS176	10.62	21	20.34	3093	56	1.89	2.28	0.09
B348360	MS178	6.33	36	10.27	1174	120	3.68	4.72	0.04
B348365	MS178	19.05	46	28.71	4207	66	3.2	3.07	0.04
B348371	MS178	13.93	62	19.06	2745	69	3.75	4.3	0.04
B348376	MS178	10.74	39	14.81	1822	51	5.84	6.32	0.09
B348381	MS178	3.69	32	5.39	747	21	6.02	8.51	0.11
B348406	MS179	3.92	25	7.94	248	15	0.74	1.77	0.04
B348412	MS179	3.29	6	5.74	1058	16	1.18	2.02	0.07
B348418	MS179	17.34	35	31.26	5422	70	1.57	0.76	0.05
B348431	MS179	2.32	6	4.17	550	43	2.1	3.32	0.08
B348436	MS179	0.07	-5	0.29	24	2	0.61	0.81	0.04
B348443	MS181	1.35	6	2.61	176	242	1.85	2.69	0.13
B348462	MS181	1.79	20	4.56	409	75	2.59	3.28	0.09
B348467	MS181	18.26	41	28.34	2724	63	2.35	3.54	0.09
B348473	MS181	2.12	18	5.27	528	75	3.54	5.06	0.08
B348478	MS181	4.06	10	7.28	895	17	1.68	2.32	0.08
B348483	MS181	2.56	25	5.64	874	31	1.42	1.86	0.06
B348499	MS182B	6.22	16	10.97	1460	41	1.56	2.71	0.07
B348504	MS182B	6.24	49	11.86	1800	50	2.1	3.29	0.14
B348509	MS182B	0.16	6	1.41	46	26	3.16	6.99	0.28

TABLE 4.1.2-5. SAMPLE ASSAY INFORMATION FOR 2005 SAMPLE MET TESTING COMPOSITE							
Sample	HOLE_ID	Fe (%)	Cu (ppm)	Zn (ppm)	Al (%)	Ca (%)	Na (%)
B347237	MS142	1.76	227	5	1.15	10.53	0.03
B347247	MS142	1.23	38	16	1.03	6.53	0.01
B347252	MS142	2.91	404	33	1.65	2.2	0.07
B346240	MS143	2.8	24	38	0.63	6.27	0.03
B346245	MS143	1.27	15	15	4.21	4.03	0.13
B346250	MS143	1.74	121	25	4.95	4	0.17
B347401	MS146	1.94	34	43	2.19	3.66	0.06
B347406	MS146	2.56	52	48	2.86	7.21	0.05
B347411	MS146	3.9	39	103	1.57	8.71	0.02
B347416	MS146	9.31	770	45	3.08	3.29	0.07
B347385	MS147	1.87	61	34	3.66	4.45	0.1
B347390	MS147	3.59	484	23	3.75	4.7	0.11
B347395	MS147	2.47	304	64	5.82	4.59	0.23
B347454	MS148	2.45	303	32	2.03	4.23	0.06
B347458	MS148	2.98	190	24	1.67	7.95	0.04
B347464	MS148	3.73	283	41	4.51	4.97	0.1
B347469	MS148	3.22	286	31	4.25	4.15	0.09
B346385	MS149	2.87	158	60	2.07	4.81	0.08
B346390	MS149	3.48	432	40	1.69	11.55	0.06
B346395	MS149	4.1	428	1431	4.18	4.24	0.13
B347519	MS151	9.59	2041	46	4.56	4.24	0.21
B347525	MS151	9.17	1246	52	3.7	4.04	0.14
B347529	MS151	7.32	1411	21	3.87	3.41	0.15
B347534	MS151	1.79	33	27	0.66	0.17	0.08
B346458	MS156	15	2434	24	3.14	3.22	0.14
B346464	MS156	24.38	3595	25	3.57	3.83	0.24
B346469	MS156	3.69	423	22	4.79	4.23	0.15
B346474	MS156	6.71	1142	31	2.94	3.06	0.13
B346479	MS156	5.86	809	20	7.09	5.2	0.23
B347594	MS157	2.57	243	16	0.91	16.81	0.06
B347598	MS157	7.6	1134	15	3.51	3.46	0.14
B347605	MS157	6.8	672	48	0.8	5.58	0.03
B347610	MS157	1.1	75	33	5.9	4.62	0.23
B346535	MS160	12	2070	40	2.37	3.05	0.15
B346541	MS160	9.45	1091	25	2.72	2.45	0.12
B346546	MS160	17.25	2033	27	4.54	3.4	0.17
B346551	MS160	2.45	293	21	8.26	5.61	0.36
B347725	MS161	13.64	1497	49	2.37	3.59	0.14
B346666	MS162	1.94	149	20	2.43	2.6	0.15
B346671	MS162	1.57	221	10	1.25	2.23	0.07
B346676	MS162	12.89	1586	40	5.62	3.63	0.15
B346682	MS162	11.38	1058	39	4.2	2.7	0.16
B347758	MS163	5.16	194	790	3.44	6.99	0.18
B347764	MS163	1.78	57	70	5.35	5.02	0.18
B347769	MS163	3.22	68	75	0.99	3.71	0.07
B347774	MS163	6.15	497	28	5.26	5.25	0.16
B347779	MS163	4.6	162	56	7.14	5.87	0.22
B346714	MS164	7.06	1109	36	2.71	2.93	0.12
B346719	MS164	9.76	1230	143	3.13	4.65	0.05
B346725	MS164	9.23	1093	63	1.72	8.06	0.03
B346604	MS166	5.19	150	37	1.82	8.79	0.09
B346609	MS166	5.19	214	56	0.64	11.36	0.08
B346614	MS166	4.09	372	19	5.41	4.7	0.2

Table 10 (Comparison of Sobek-NP and Carbonate NP) in Appendix D1 indicates that non-carbonate sources provide a significant amount of the neutralization potential. The predictability of non-carbonate neutralization must be considered, since over the long-term, non-carbonate neutralization potential sources may act to release the acid they have appeared to neutralize. Please provide the following information.

d) Identify the non-carbonate neutralization potential source.

YESAB has requested information on non-carbonate neutralization potential sources within the Mactung geological materials given concerns over potential long term acid generation by these source materials. To resolve this concern NATC commits to utilizing the carbonate neutralization potential (NP_{Carb}) for the purposes of the geochemical characterization of geological materials at the site. The NP_{Carb} only accounts for neutralization by carbonate mineralization as opposed to the Sobek neutralization potential (NP_{Sobek}) which includes non-carbonate neutralization sources found at the site including alumino-silicates and scheelite.

e) Provide information regarding the long-term neutralization potential of the rock.

Information on the long term neutralization potential of the rock will be obtained from a humidity cell constructed of tailings materials. The use of tailings within the humidity cell is intended to provide worst-case information on potential metal loading from mined or milled materials. NATC has considered worst-case scenarios in the development of the proposed Mactung project and the results of the humidity cell testing will be used as confirmation. Humidity cell results will be provided to YESAB as they are received from the analytical laboratory with periodic interpretive reports also being issued.

Field kinetic cells will be established by NATC during the construction and operations phase to provide field based kinetic information on different rock types which will be used as part of ongoing refinement of the site geochemical predictions. The use of field kinetic cells provides more reliable information on geological material behaviour due to the larger sample size and a more representative grain size distribution. Field kinetic cells will also be established by NATC should additional bulk sampling be conducted at the property as part of ongoing advanced exploration activities.

4.1.2.2 Metal Concentrations and Metal Leaching Potential

The project proposal analyzed exploration program and geochemical program samples for metals concentrations. Table 4.1.4-5 summarizes the metal concentrations using samples from the exploration program while Table 4.1.4-6 summarizes the metals concentrations using samples from the geochemical program. The samples were collected from a variety of sources over a number of years. The project proposal does indicate the number of samples submitted for metal concentration analysis as well as when the samples were collected, however statistical representation of the samples used has not been provided. Statistical representation must be addressed in order to have an accurate representation of metal concentration in the various rock sources. The statistical analysis provided in item 4a (above) should be sufficient to address this issue.

The project is located in an area that generally experiences some level of natural ARD/ML. The project proposal has noted that there are areas of exposed bedrock that has been subject to weathering within the mine site area. Furthermore, there is evidence of acid-generating waste rock in the area from past exploration activities. Site conditions indicate that during mine operations rock may be exposed to acidic drainage from natural and/or mine sources. All metal leaching tests were run using the standard distilled water method. As suggested by the BC Guidelines, ML work should be conducted using slightly acidic conditions, given the site conditions noted above. A slightly acidic pH may result in more metal leaching, which would have a significant impact on the water quality predictions for the site. To ensure that testing results adequately reflect site conditions, please provide the following information.

a) Metal leaching analysis using a weak acidic extraction procedure (as outlined in the Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia) to more accurately reflect the natural background site characteristics. If it is possible for the lab to correlate results based on something smaller than the full suite of samples, or if a conservative defensible multiplication (or other) factor can be applied, please provide suitable justification along with the updated values.

Shake flask testing was conducted on 19 samples previously submitted for the static testing program. The initial shake flask testing was conducted using the distilled water extraction method outlined in Price (1997), which provides results that are representative of neutral drainage conditions. The independent YESAB reviewer for the geochemical program felt that shake flask testing should be conducted using the weak acid extraction method outlined in Price (1997) to provide information on effluent quality under low pH conditions. Additional samples for shake flask analyses were selected from waste rock within Unit 1 and 3C as prior shake flask testing had been limited to testing of Unit 2B.

The use of the weak acid extraction technique will only be partially applicable to the Mactung Project based on the availability of in-situ neutralization potential from the mined rock. This will act to neutralize any acid produced during initial oxidation of sulphide bearing mine wastes. Should the in-situ neutralization potential of the mine waste materials be consumed then there is the potential that acidic drainage conditions could occur; however the time to onset of acidity from mined wastes is affected by the method of materials disposition and also the thermal regime of the site.

A total of 14 weak acid extraction tests will be conducted to determine the potential effects of acidic and neutral drainage conditions on geological materials to be mined at the site. The results will then be compared with those from prior extraction testing in order to determine the implications of drainage pH on environmental management for the project.

4.1.2.3 Underground Mine Wall and Floor Surfaces

Geochemical characterization was not conducted for rock units 4 and 5/6 as they are considered basement rocks for the mine and will not be excavated in the current mine plan. Geochemical characterization of basement rock may still be necessary. Wall and floor surfaces may contribute to the overall ARD/ML in the underground workings. Furthermore, blasting and fracturing of rock in these areas may expose more surface area to weathering processes. In order to have an understanding of how underground mining activities will interact with wall and floor surfaces to determine potential effects, please provide the following information.

a) Describe how the proposed mine plan will interact with underground wall and floor surfaces including the possible impact of blasting and fracturing on rock unit 4 and rock unit 5/6.

The diamond drill core from the site was reviewed. Unit 4 and Unit 5/6 do not occur within 100 m of the proposed underground development. The spatial separation of these units is sufficient that they are not deemed to be subject to influence as a result of the underground development.

b) Identify and describe all geological materials that will be exposed or otherwise disturbed in the underground mine workings, and predict through appropriate lab testing (as outlined in the BC Guidelines) the ARD/ML potential for these materials in relation to the forms and environmental conditions in which they will be exposed.

The information on volumes for this response has already been presented above in the response to Section 4.1.1d. The form and condition of materials exposed underground will vary. Walls and floors in the development ramps and areas will be primarily excavated through Unit 3C as this unit is not mineralized. Stopes will have floors and ceilings excavated within Unit 3C with walls being excavated in a mixture of Unit 2B and Unit 3C depending on the local structural controls.

c) Provide, based upon the outcome of this prediction, appropriate mitigation or monitoring measures as required.

Monitoring of underground minewall and floor sections will be conducted during the operations phase of the project. NATC does not anticipate significant ARD/ML to occur on walls and floors in the frozen bedrock zone due to temperature and moisture controls on ARD/ML processes in this area. Dewatering within the unfrozen bedrock zone will reduce available water inflows into the underground workings; however there may be still some areas in the unfrozen zone where seepage through walls and ceilings is encountered.

NATC will initiate an underground wall monitoring program to monitor ARD/ML in the underground workings. Monitoring stations will be established in both the frozen and unfrozen bedrock zones during operations. Information from this program will be used to confirm initial assumptions with respect to ARD/ML and also to guide development of appropriate closure plans for the underground workings. Station construction and monitoring will be comparable to the Minewall method described in Price (1997) with monitoring results included in annual site reporting.

4.1.3 Mine Tailings and Potentially Acid Generating Waste Rock Disposal

The project proposal indicates that 50 percent of tailings produced will be placed underground as backfill while the remaining 50 percent will be surface stacked. Underground backfilled tailings will be classified, dewatered, and unconsolidated. Surface stacked tailings will be spread within the DSTF and compacted to 95 percent the maximum dry density. Please provide the following information.

a) Clarify whether or not tailings will be classified prior to placement underground. If not, discuss any issues related to potential liquefaction.

Materials will be classified as PAG or NAG during mining activities at surface and underground disposal will be conducted concurrently due to the ongoing requirement for underground backfill material. Materials placed underground as backfill will not be characterized with respect to liquefaction potential.

The tailings that will be produced at the Mactung Mine have not been geochemically characterized. Rather, comparisons of the Mactung and Cantung ore grade materials and the Cantung tailings were conducted. Based on these results, the project proposal anticipates the tailings produced at the Mactung Mine to be potentially acid generating. The project proposal indicates that the Mactung Mine tailings will be characterized during ongoing detailed design and mine planning. Results from static ARD/ML testwork and kinetic humidity cell testwork will be available prior to final permitting of the DSTF.

Conclusions drawn from a comparison between ore and tailings may not provide an accurate representation of the tailings. The milling process results in finer grain sizes, addition of amendments, and a fairly homogenous mixture. Therefore, the tailings may be significantly different than ore in terms of potential for ARD/ML. As well, tailings at the Mactung Mine may be significantly different from the tailings from the Cantung Mine based on the difference in mineralogy and higher sulphur content in Mactung ore.

The project proposal indicates that representative bulk tailings samples will be collected in order to establish a field monitoring program. As indicated, the time to acid for the tailings has been estimated at less than 9 years based on Cantung tailings. As discussed above, a comparison with Cantung tailings may not be appropriate. An understanding of the time to onset of ARD for tailings and waste rock is important prior to tailings disposal in the underground or in the DSTF, as well as an understanding of the quality of water that will be produced. Without kinetic testing, there is no data to suggest when tailings or potentially acid generating waste rock will become net acid producers, and the extent to which this may represent a liability on the site.

Time to onset of ARD is critical information to determine appropriate mitigation measures for dealing with potentially acid generating waste rock and tailings. If waste rock stockpiled on the surface were to become acid generating, or if tailings were to become acid generating before they could be flooded, it may compromise the success of underground disposal, or result in higher effects from the outset. The time to onset for ARD may also affect the length of post mining monitoring required. Furthermore, if the mine were to stop operating for an undetermined amount of time, the waste rock piles or the DSTF may pose an ARD/ML concern.

In order to address these issues, please provide the following information.

b) Predict through appropriate lab testing (as outlined in the BC Guidelines) the ARD/ML potential for representative tailings to be produced at the Mactung Mine, including:
   i. metal leaching analysis (as outlined in the Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia) of representative tailings to be produced at the Mactung Mine; and
   ii. kinetic testwork to determine the time to onset of ARD for tailings and potentially acid generating waste rock.

Tailings are currently being produced from ore grade materials collected during the 2008 bulk sampling campaign. The head sample for the metallurgical testing is a composite sample constructed from 250 g grab samples collected from every fifth sample. This information is also presented in the response to Section 4.1.2.1b.

The underground backfill at the Mactung property will be a mixture of tailings and waste rock. The tailings from Unit 2B has a higher level of mineralization than the waste rock and will also have higher metal leaching potential as a result of its finer grain size. Characterization of the underground backfill will be based on the tailings humidity cell data as this will represent the worst-case scenario for time to acidity and potential metal loadings. Field kinetic cells will also be established during the operations phase to provide additional field based kinetic information which will be used as part of ongoing refinement of the site geochemical model.

c) Given that results from the field monitoring program will not be available until well into the operation of the mine and the progressive placement of tailings in the DSTF, please indicate how results may affect the DSTF and decommissioning.

This question requests information on the incorporation of field kinetic data into the DSTF design and decommissioning. The initial geochemical model for the Mactung site will incorporate humidity cell data from kinetic testing conducted on a tailings composite sample produced from ongoing metallurgical testing being performed by NATC. Field geochemical information is used to validate or refine humidity cell results and to confirm final site closure designs. Information presented earlier regarding temperature effects on ARD/ML are considered relevant to this portion of the response.

Reference is made within the YESAB Adequacy Report to the Cantung tailings humidity cell. The Cantung Mine tailings humidity cell is operated at 20^0C and has an estimated time to acidity of approximately 9.1 years, based on the estimated time to deplete the available carbonate neutralization potential. The depletion of carbonate mineralization is a direct function of the sulphide oxidation rate so the application of a temperature correction factor of 0.3 to the sulphide oxidation rate for that humidity cell would result in an estimated time to deplete carbonate neutralization of approximately 30.3 years. The temperature correction factor is based on the estimated site temperatures and another purpose of the field kinetic cells is to assist in understanding local cold temperature effects on ARD/ML.

It is also important to understand that scaling and testing protocol differences between tests make it difficult to make conclusive statements; however, field kinetic testing is conducted on larger samples that are exposed to the same climatic conditions as the larger infrastructure components they are used to represent. Results from the field kinetic testing program will be used to determine the behaviour of tailings materials under actual field conditions and to determine whether there is a need for incorporating neutralization material amendments into the final closure design. The addition of a layer of neutralizing material (e.g. limestone) onto the surface of the DSTF prior to placement of the geo-synthetic liner at closure is one example of the addition of neutralizing material. Placement of these neutralizing materials in a crushed form onto the surface of tailings stored in the DSTF eliminates contact with water to primarily precipitation, which tends to be lower in aluminum concentration than local groundwater and surface water. This method of placement would reduce the potential for the formation of precipitate armouring on the surface of the limestone, which was identified as a concern in Section 4.1.5 of the YESAB Adequacy Response.

d) Provide a detailed plan should field monitoring reveal the early onset of ARD in the tailings.

Underground ARD generation is not anticipated to be an issue as a result of the natural modifiers described at the start of Section 4.1.2. The development of a detailed plan requires that a detailed design be completed for the DSTF facility. NATC can provide the following conceptual plan based on the detection of ARD in tailings through field monitoring. The conceptual plan that would be implemented would include:

- Confirmation sampling of site surface and groundwater sampling locations used to identify the presence of ARD. Should the onset of ARD be indicated by the field kinetic cells, then the confirmation sampling would involve collection of additional samples from these cells, in addition to a review of sampling data from recent surface water and groundwater sampling events;
- Field grab sampling of tailings would be conducted from DSTF to characterize in-situ condition of tailings materials through a combination of paste pH, and C-S and/or ABA analysis;
- Test-pitting within the footprint of the DSTF to collect tailings samples at depth to characterize in-situ condition of tailings materials through a combination of paste pH, and C-S and/or ABA analysis. The test pitting program may also be combined with the

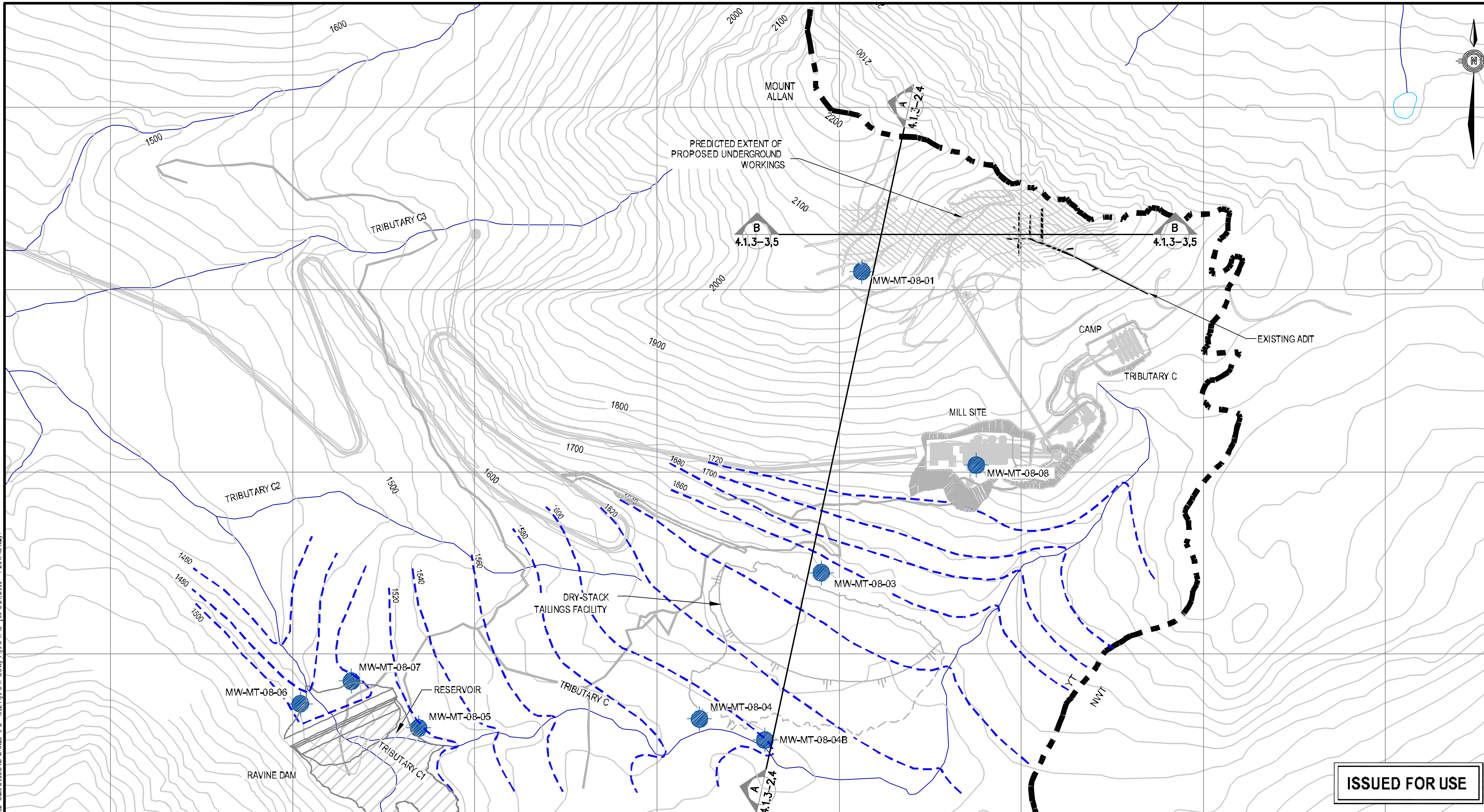
installation of shallow groundwater observation wells within the DSTF as part of increased monitoring activities;

- Development of an appropriate remedial strategy to address ARD concerns within the DSTF based on the aforementioned investigative sampling program. The remedial measures would be dependent on how the onset of ARD was detected. The onset of ARD detected in field kinetic cells does not mean that the larger facility would react in the same time frame due to scaling and other factors associated with kinetic tests. The detection of ARD in the field kinetic cells would be used as a trigger to increase monitoring of seepage and groundwater in the area of the DSTF;
- Remedial measures that could potentially be implemented to address ARD include temporary or passive water treatment systems, the addition of crushed neutralization material to the surface of the dump, or progressive closure of the facility to minimize ARD processes. Should ARD be determined to be occurring in closed stopes, then an appropriate mitigation strategy would be developed. Remedial mitigation measures for this type of a scenario may include pressure grouting or addition of a chemical additive(s) through injection methods; and,
- The placement of potentially acid generating tailings in underground workings can be an acceptable method of disposal if the appropriate conditions are met. Flooded or frozen underground workings can prevent or reduce sulphide oxidation and may provide an appropriate method for disposal of potentially acid generating tailings and waste rock. However natural freeze thaw cycles near edges of permafrost or underground workings that are not fully submerged may result in increased ARD/ML potential. To ensure this method of disposal is suitable, a comprehensive understanding of groundwater, permafrost, and mine workings is essential.

The project proposal has provided a conceptual baseline hydrogeological model to describe the pre-mine conditions. Cross sections of the model are presented in Figures 4.1.10-18 and 4.1.10-19. This model provides a general description of hydrogeology but does not provide a clear understanding of the relationship between the groundwater table, permafrost, and backfilled stopes within the underground workings. This information is important to allow the Executive Committee to consider the potential effects of backfilling potentially acid generating tailings and waste rock. Please provide the following information.

e) A clear description of the relationship between the groundwater table, permafrost, freeze/thaw zone, and backfilled stopes.

As indicated in the YESAB adequacy review report, "YESAB, Environment Canada, Yukon Government and experts retained by the Executive Committee have indicated that the relationship between the groundwater table, permafrost, and underground workings is not well represented or understood". Based on the information collected during the Detailed Hydrogeological Assessment (DHA) and subsequent monitoring events (August 18, 2008, April 16, 2009, and May 31, 2009) the conceptual hydrogeology cross section that was presented in the DHA and project proposal has been updated, and new cross sections have been developed. Figure 4.1.3-1 presents the locations of the cross-sections on the predicted hydraulic head map during mining operations. Figure 4.1.3-2 presents the conceptual hydrogeology for existing conditions and post closure conditions, while Figure 4.1.3-4 presents the conceptual hydrogeology during mining for Section A (north-south perpendicular to the underground workings). Figures 4.1.3-3 and 4.1.3-5 present the existing conditions, post closure and during mining conceptual hydrogeology schematics for Section B (east to west transverse through the proposed underground workings). The intent of these updated cross-sections, and the text provided below is to refine and clarify the active zone (freeze-thaw zone), permafrost, groundwater conditions, and closure backfill details in the vicinity of the proposed underground workings to address the concern expressed by YESAB and others.



LEGEND

GROUNDWATER OBSERVATION WELL LOCATION

INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR DURING MINING (YEARS 6-11) (m-asl)

NOTE:

20 m CONTOUR INTERVAL

0 500

Scale: 1: 10 000 (metres)

Client

NORTH AMERICAN TUNGSTEN CORPORATION LTD

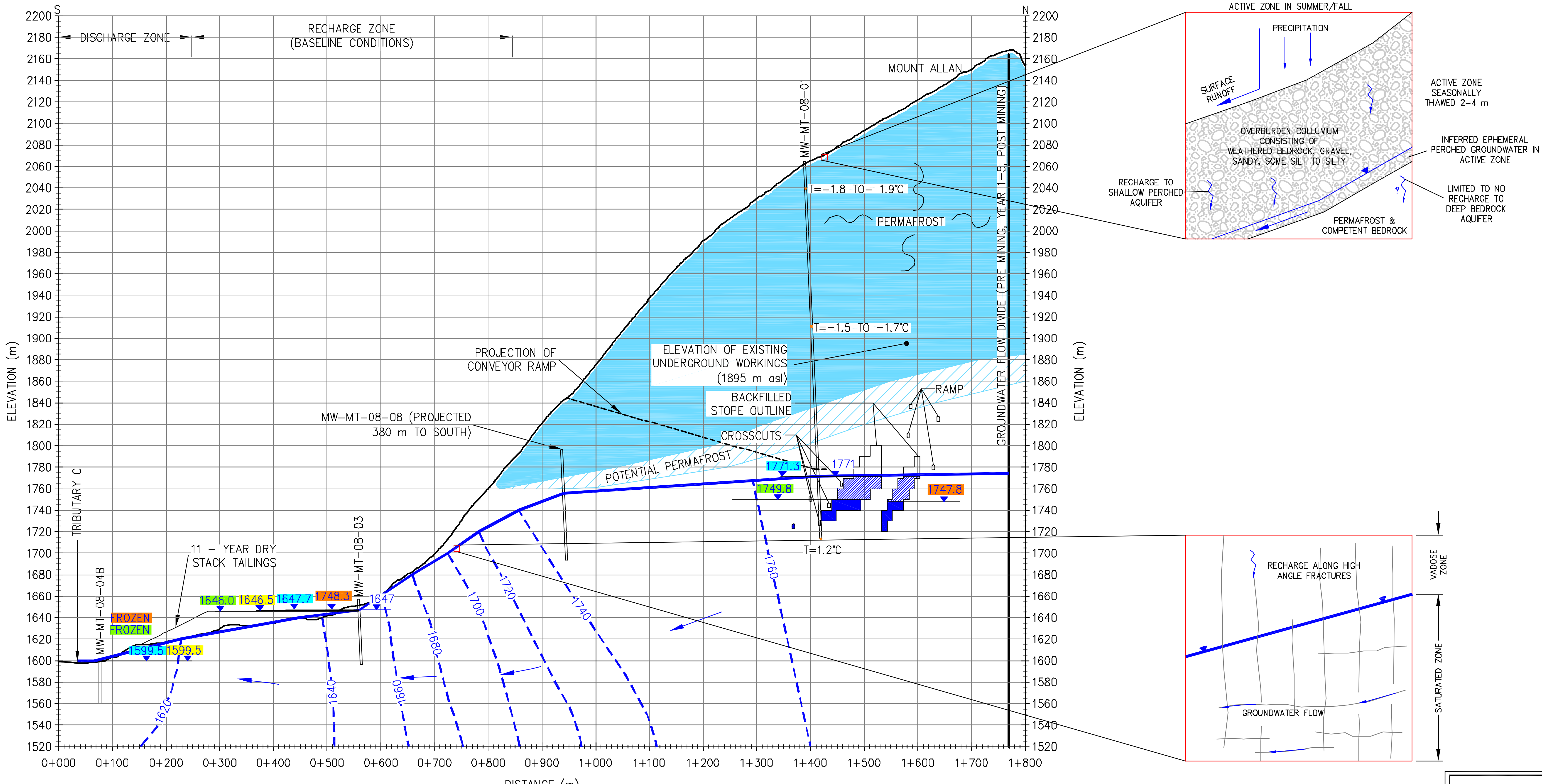
EBA Engineering Consultants Ltd.

MACTUNG

Predicted Hydraulic Head Map During Mining Operation

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.3-1



SECTION A - LOOKING WEST-NORTHWEST
SCALE 1:7,500H 1:3,750V

ISSUED FOR USE

LEGEND

▼ 1490 HYDRAULIC HEAD MEASUREMENT OBSERVED (SEPT 2008) IN DEEP INSTALLATIONS (m asl)

- - - INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR (m asl)

GROUNDWATER ELEVATIONS
- AUGUST 2008
- NOVEMBER 2008
- APRIL 2009
- MAY 2009

PORTION OF UNDERGROUND WORKINGS BELOW GROUNDWATER IN PRE- AND POST MINING

PORTION OF UNDERGROUND WORKINGS THAT MAY BE SEASONALLY BELOW GROUNDWATER IN PRE- AND POST MINING

NORTH AMERICAN TUNGSTEN CORPORATION LTD

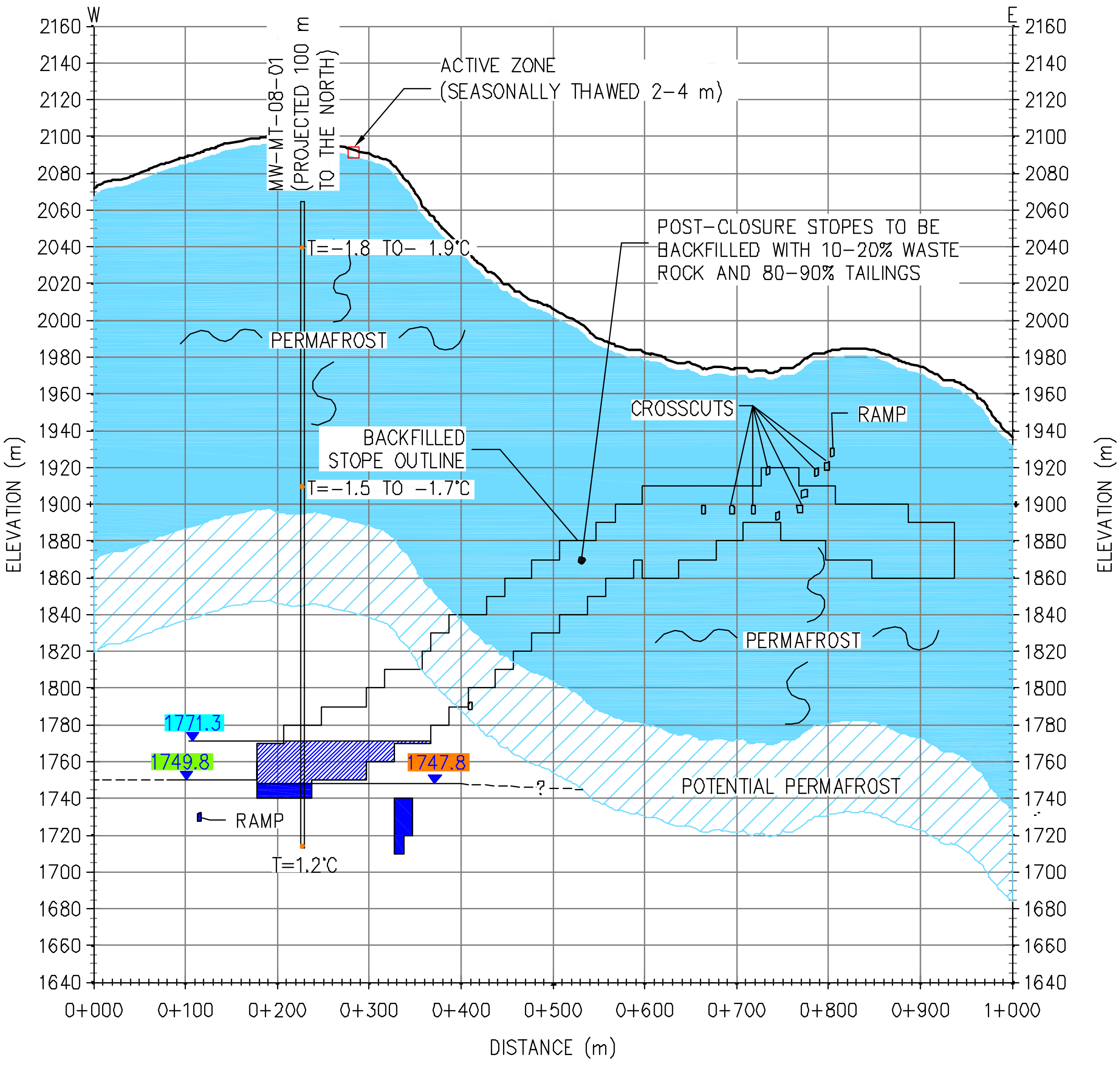
EBA Engineering Consultants Ltd.

MACTUNG

Existing Conceptual Hydrogeology Schematic
Cross Section A

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	RMM	0
OFFICE: EBA-WHSE	DATE: JUNE 2009		

Figure 4.1.3-2



B
4.1.3-1

SECTION B - LOOKING NORTH

SCALE 1:7,500H 1:3,750V

LEGEND:

GROUNDWATER ELEVATIONS

AUGUST 2008

APRIL 2009

MAY 2009

ISSUED FOR USE

PORTION OF UNDERGROUND WORKINGS BELOW GROUNDWATER IN PRE- AND POST MINING

PORTION OF UNDERGROUND WORKINGS THAT MAY BE SEASONALLY BELOW GROUNDWATER IN PRE- AND POST MINING

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

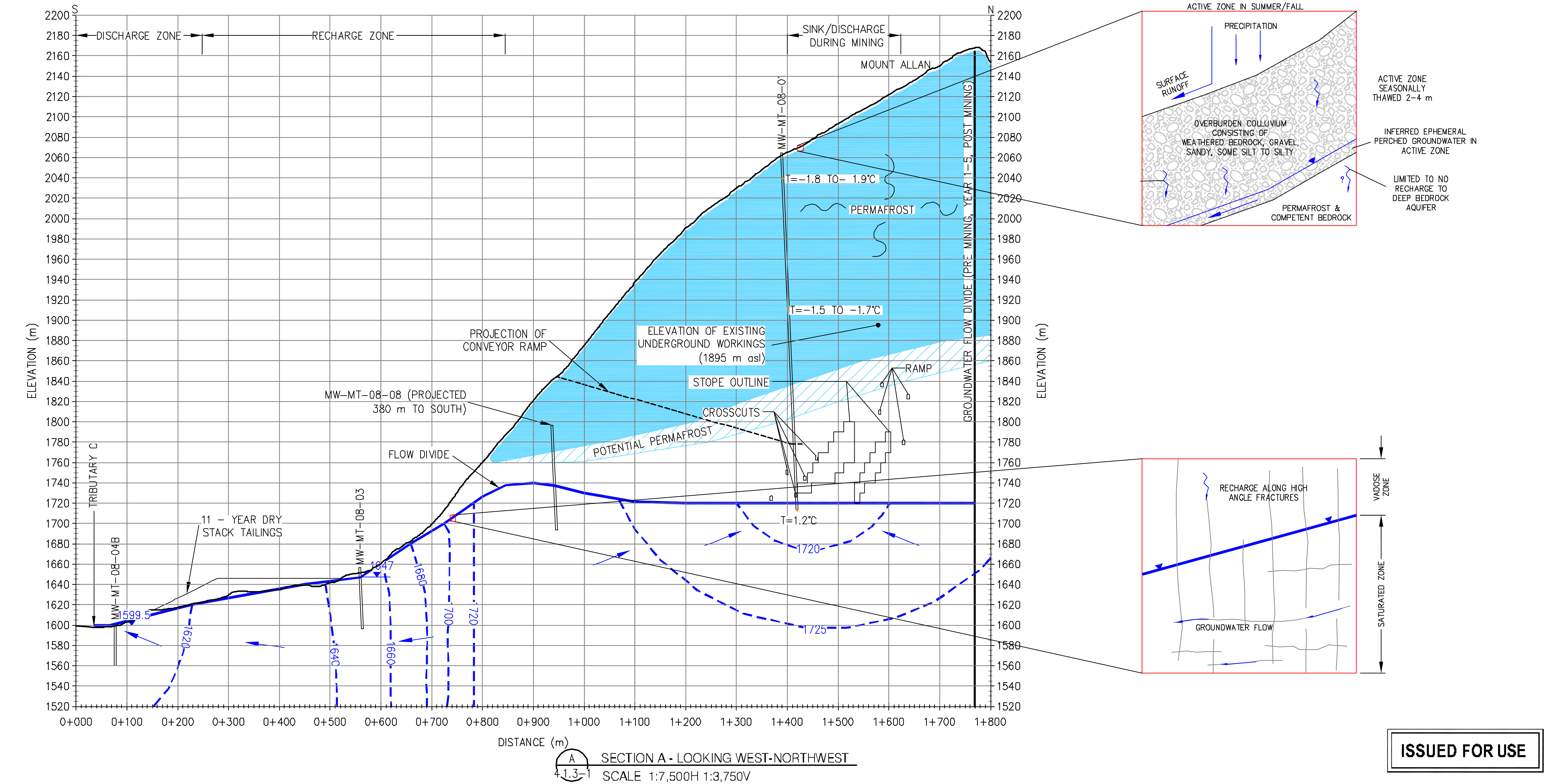
MACTUNG

Existing Conceptual Hydrogeology Schematic
Cross Section B

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.3-3

Q:\Whitehorse\Data\0201drawings\Mactung\W23101211.002 Moose Supplement\W23101211.002 Figure 4.1.3.dwg [FIGURE 4.1.3-3] June 24, 2009 - 1:28:29 pm (BY: KENTOWCZYK)



A
4.1.3-1
SECTION A - LOOKING WEST-NORTHWEST
SCALE 1:7,500H 1:3,750V

ISSUED FOR USE

LEGEND

▼ 1490 HYDRAULIC HEAD MEASUREMENT OBSERVED (SEPT 2008) IN DEEP INSTALLATIONS (m asl)

- - - INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR (m asl)

Client: NORTH AMERICAN TUNGSTEN CORPORATION LTD

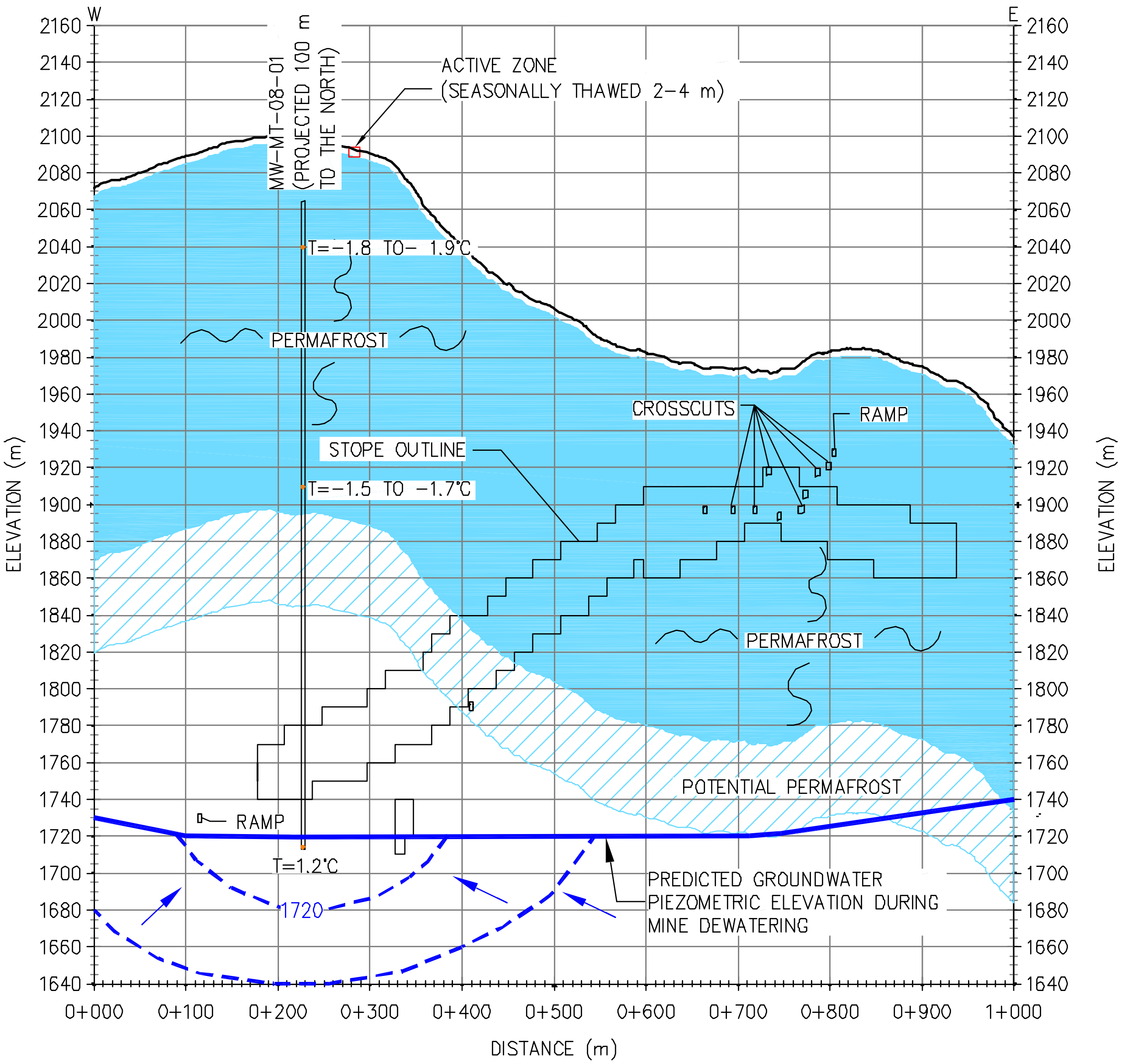
MACTUNG

Conceptual Hydrogeology Schematic During Mining Cross Section A

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.3-4



B
4.1.3-1

SECTION B - LOOKING NORTH

SCALE 1:7,500H 1:3,750V

ISSUED FOR USE

LEGEND:

INFERRED GROUNDWATER EQUIPOTENTIAL CONTOUR (m asl)

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Conceptual Hydrogeology Schematic During Mining
Cross Section B

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	RMM	0
OFFICE	DATE		
EBA-WHSE	JUNE 2009		

Figure 4.1.3-5

Permafrost and Active Zone (Freeze/Thaw Zones)

Nested vibrating wire piezometers (VWP) installations in observation well MW-MT-08-01 (vicinity of the west end of the proposed underground workings), indicate the presence of permafrost in the northern part of the Site. Temperature data were collected on six different occasions between the time of installation (July 20, 2008) and the most recent monitoring event (May 31, 2009). Since it stabilized following installation, the VWP installed at 20 m in depth at MW-MT-08-01 has consistently indicated a temperature of -1.8 to -1.9˚C. The VWP installed at 144 m below grade has consistently indicated temperatures between -1.5 and -1.7˚C. The deep VWP installation at 337 m below grade has been consistent at 1.2˚C. Field observations through testpitting suggest that the top 2 to 4 m of overburden and weathered bedrock near surface is seasonally active (thawed in late summer and fall, and frozen in winter and spring). Permanently frozen ground exists below 4 m, and is inferred to extend to depths of about 200 to 250 m below ground surface (bgs) in the vicinity of the underground workings (see Figures 4.1.3-2 through 4.1.3-6). The bottom extent of the permafrost is inferred by linear interpolation between the temperatures at the 144 m and 337 m deep VWP installations.

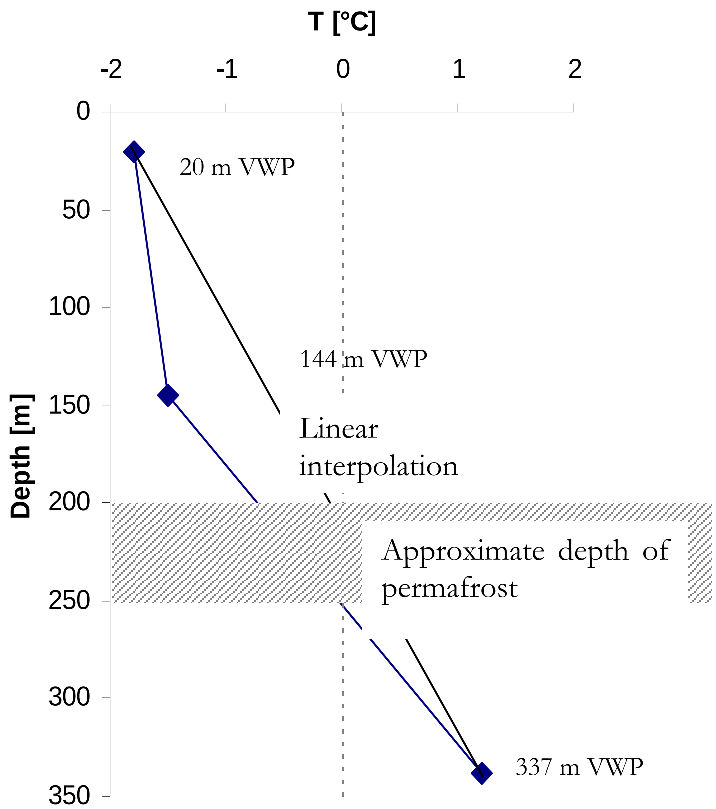


Figure 4.1.3-6
Linear interpolation of bottom of permafrost in the vicinity of MW-MT-08-01

Sections A (Figures 4.1.3-2 and 4.1.3-4) and B (Figures 4.1.3-3 and 4.1.3-5) have been updated to show the top and bottom (range) of the permanently frozen ground. As indicated on the Sections B, the majority of the underground workings exist within permanently frozen ground; however, the proposed western end of the underground workings would be mined in bedrock that is not permanently frozen.

Groundwater

In the upland areas of Mt. Allan, groundwater within bedrock occurs in rock discontinuities (fractures and faults) beneath the permanently frozen bedrock. Monitoring events completed on three occasions over the 10 months since installation indicate that the deep VWP at MW-MT-08-01 has consistently had positive pore water pressure readings indicating that groundwater exists above the VWP installation. From this, we infer that groundwater would also exist within the westernmost portion of the underground workings. The pressure readings suggest that the groundwater elevation is beneath the base of the permafrost. This indicates that the groundwater in the vicinity of MW-MT-08-01 is not confined by permafrost and there is no indication of direct contact between permafrost and groundwater. The groundwater elevation at MW-MT-08-01 was measured to be 1771.3 m in August 2008. (Note that this reading was previously reported as 1768 m asl, however, it has been corrected based on actual DDH orientation by down hole survey information provided by NATC). Subsequent readings on April 16, 2009 (1749.8 m asl) and May (1747.8 m asl) indicate lower porewater pressures and therefore lower groundwater elevations at MW-MT-08-01. In view of recent readings, it is probable that the August 2008 reading was not at steady state, but still receding to some extent from drilling-induced water mounding. The data still indicate that the lower and westernmost portion of the underground workings will have groundwater inflow, and require dewatering during mining of these parts of the site (years 6 – 11).

The relatively flat hydraulic gradient between observation wells MW-MT-08-01 and MW-MT-08-08 (Figure 4.1.3-2) suggests that little to no recharge takes place in the upland areas (i.e., water infiltration is reduced by the presence of permafrost). The previous interpretation that there may be minor recharge in the upper reaches of Mt. Allan is not supported by these most recent data, and suggests that there may be very little to no recharge to deep groundwater from the areas higher on Mt. Allan where permafrost exists.

Backfilled Stopes

The stopes will be backfilled with both waste rock and tailings. According to Wardrop, the percentage of tailings within the backfill will range from 80 to 90% (at 1900 kg/m^3), while the waste rock will range from 10 to 20% of the total backfill volume. Geochemical information with respect to the tailings to be used for backfill is being addressed as part of the kinetic testing program described in Section 4.1.2.

f) Plan view and cross-section diagrams identifying the spatial relationship between backfilled tailings, waste rock, and final underground mine workings at closure. Details in the diagrams should include, but are not limited to:
   i. composition, mass, and location of backfilled tailings and waste rock; and
   ii. groundwater table, permafrost, and backfilled stopes.

Plan view and Cross-section schematics are included as Figures 4.1.3-1 through 4.1.3-5 in Section 4.1.3. Additional details are also described Section 4.1.3.

4.1.4 Blending Potentially Acid Generating and Non-Acid Generating Material

The project proposal indicates that potentially acid generating waste rock from underground workings and surface infrastructure may be blended with non-acid generating material. This blended material will then be used in construction of surface infrastructure. The proponent has proposed to collect samples from waste rock as it is removed and conduct an acid-base accounting analysis to determine suitability for blending. If blending is not suitable, the materials will be separated and temporarily stored at the surface in the identified temporary waste piles.

The proponent has indicated that "[a] minimum overall blended neutralization potential ratio (NPR) of 3.0 with the potentially acid generating component volume equalling less than 50% of the overall volume has been used for the construction materials suitability" (p.434). Further, bulk samples of the blended material will be collected to establish a field monitoring program.

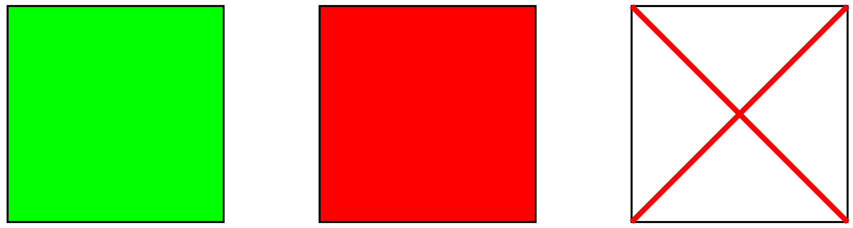
Price and Errington indicate that "blending requires comprehensive material characterization and, in the case of a segregated blend, waste design and construction plans, both of which must be supported by detailed prediction information." Furthermore, it may not be feasible to characterize waste rock as it is being removed. Proper characterization and prediction of acid generating/neutralizing potential may not be feasible on a short time scale as proposed. Further information is required prior to assessing the potential effects of blending as well as the effectiveness of blending as a mitigation strategy. Please provide the following information.

a) Provide a detailed plan for blending potential acid generating and non-acid generating materials (as outlined in the Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia), supported by detailed prediction information.

NATC has reviewed the comments provided by YESAB with respect to potential blending of waste materials. NATC commits to not blending potentially acid generating (PAG) and non-acid generating (NAG) waste rock for the purposes of surface infrastructure construction. PAG rock will be stored separately on surface from NAG rock and will be disposed of underground as backfill during the construction phase, as per the project proposal.

b) Provide details on how potentially acid generating and non-acid generating materials are going to be characterized in the field while construction is occurring.

Construction characterization of materials requires careful planning and timely analysis. The following methodology is based on prior experience with remote construction characterization programs from British Columbia. Characterization of materials during construction will be based on the results of carbon – sulphur (C-S) analysis. This method allows for a quick sample analysis with results often available within six hours of the sample arriving at the lab. Samples will be collected from drill cuttings and shipped to an off-site analytical laboratory for analysis. Materials mucked from the blasts will be temporarily stockpiled separately from each other until the analytical results are available. Bannerboards, shown below, will be used to show whether a material is PAG, NAG, or results pending.



NAG PAG Results Pending

Materials that are determined to be NAG will then be available for use in surface infrastructure construction while PAG materials will be temporarily stockpiled in the footprint of the existing waste rock dump prior to re-handling underground during construction. There are no surface PAG stockpiles planned as part of the proposed Mactung Project.

4.1.5 Access Road

Road construction and the development of borrow sites (and associated infrastructure) associated with this project involve the exposure of rock and overburden in a region known for natural acidic drainage and elevated metals. The project proposal indicates that sections of the access road will require rock cuts and that potentially acid generating material is expected to be encountered. This potentially acid generating material will be stockpiled prior to disposal as sub-grade construction material or encapsulated in the road bed.

It is critical to present more detailed information in order to predict the potential for ARD/ML and the success of proposed mitigations. This information will inform the assessment as to whether these activities may have significant adverse effects. Furthermore, it may not be feasible to adequately characterize potentially acid generating material for use as construction material during construction. Geochemical characterization of potentially acid generating material may take more time than is available to the construction crews. Please provide the following information.

a) Provide details on how potentially acid generating and non-acid generating materials are going to be characterized in the field while construction is occurring.

Geochemical characterization of materials in the field is described above in the response to Section 4.1.4b.

b) Identify all borrow pits and associated infrastructure that will be developed in relation to the proposed roads.

Potential borrow areas have been located as per the guidelines identified in the response to Section 3.4.1(b). Borrows will be developed on areas with slopes less than 30% and greater than 30 m from streams. The location and size of borrow pits will be determined during detailed road design as the volume of materials required for construction will then be known.

Test-pitting will be conducted during detailed design on the access road alignment and at proposed borrow pit locations to confirm the properties of any surficial materials that will be excavated, exposed or otherwise disturbed in the use of borrow pits and road construction. The results of the sub-surface investigations will be incorporated into the detailed road design.

c) Identify and describe all geological materials that will be excavated, exposed or otherwise disturbed in the use of borrow pits and road construction.

Geological materials used for access road sub-grade construction will be primarily granular resources and shallow fractured bedrock present along the alignment. Fresh rock will only be exposed where drilling and blasting activities through unweathered bedrock are required.

A geologic description, in addition to the collection of geochemical characterization samples for ARD/ML, will be collected from areas where drill and blast operations are identified as part of the detailed design. The number of samples submitted for characterization will correspond to the guidance contained in Price (1997).

d) If granular resources are expected to be crushed, predict through appropriate lab testing (as outlined in the BC Guidelines) the ARD/ML potential for each geological material in relation to the forms and environmental conditions in which it will be exposed.

NATC's preference for road surfacing material would be to use locally available fine gravel deposits that would not require crushing. Testing to characterize ARD/ML potential will be conducted prior to source material identification should it be determined that there will be a need to crush existing aggregate resources to create road surfacing materials. The estimated volume of material requiring crushing will be less than 65,000 m^3 based on the length and width of roads to be constructed.

Samples will be submitted from borrow sources identified during geotechnical assessment of the proposed road route in order to characterize ARD/ML potential of these borrow sources. Only materials with a neutralization potential ratio of greater than or equal to 2.0 will be used for crushing to create road surfacing materials. The number of samples submitted for characterization will correspond to the guidance contained in Price (1997).

e) Provide, based on the outcome of this prediction, appropriate mitigation and/or monitoring.

Mitigation strategies will be developed on a site-by-site basis for areas where un-weathered PAG geological materials are identified as being encountered during access road construction. Monitoring of drainage quality in the area of known PAG exposures will be conducted during the operation phase to determine if changes are occurring as a result of road construction. Drainage monitoring will be conducted during the snow-free period on a monthly basis, with samples collected for routine parameters, major anions, and dissolved metals. Mitigation strategies will be developed as required to address site-specific concerns.

f) Provide the location(s) of the proposed temporary potentially acid generating material stockpiles along the access road, and a description of where runoff from these works are anticipated to report to.

Stockpiles for PAG materials encountered along the access road will be located, where possible, within the footprint of construction borrow areas. The use of construction borrow sites as proposed PAG stockpile locations allows for the installation of drainage controls within the existing disturbed footprint. Drainage from the PAG stockpiles will be directed into an exfiltration sump.

g) Provide information on how potentially acid generating material used as construction material will be dealt with during decommissioning and reclamation of the access road, as outlined.

Unweathered PAG geological materials (NPR<2.0) will not be utilized for road construction materials to minimize the incorporation of PAG materials into the access road. PAG materials that are stockpiled during road construction will be potentially disposed of in encapsulated stockpiles. Additional discussion on disposal and encapsulation design criteria and performance monitoring are presented below in the response to Section 4.1.5h.

h) The project proposal provides design criteria that will be used for the encapsulation of potentially acid generating material encountered along the access road during construction. Provide references substantiating the amount and effects of neutralizing material on the long-term performance of the encapsulation pad. For example, how has armouring of the limestone been considered in the design criteria given that water quality analysis conducted at the mine site indicates aluminum concentrations are consistently above the Canadian Council of Ministers of the Environment (CCME) guidelines?

Encapsulation of PAG geological materials was presented as a potential mitigation strategy for access road PAG materials. YESAB has requested additional information on the long term performance considerations for enclosed encapsulation structures, based on concerns over limestone armouring and other potential factors that may influence performance.

NATC will establish a monitoring program for encapsulated PAG materials to determine whether design modifications are required prior to final closure. The access road PAG materials will be encountered during the construction phase and there will be an 11 year operations phase for collection and refinement of the PAG encapsulation design. The access road PAG monitoring program will include drainage chemistry monitoring as part of the Mactung progressive reclamation research program. Physical inspections and test-pitting of any PAG stockpiles will be conducted periodically (every 3-5 years) during the operations phase to characterize the encapsulation design and operating performance. Information from the drainage monitoring and physical inspections will be used to develop final decommissioning plans for these materials.

There is the potential that some armouring of limestone could occur on the base pad of an encapsulation facility based on the high natural background aluminum concentrations. A review of MEND reports into passive neutralization systems indicates that the degree to which armouring occurs is highly variable. The proposed monitoring program will provide sufficient information in a timely manner to allow for modification of encapsulation design prior to closure.

Modification of the encapsulation design to address limestone armouring could potentially include:

- Addition of crushed limestone as part of the cover design to provide buffering capacity to water prior to contact with aluminum leaching PAG rock. Water interacting with limestone in the surface cover would only be subject to potential leaching from the overlying cover materials.
- Installation of a geosynthetic liner over the surface of the stockpile to reduce oxygen and water access to encapsulated PAG materials. The geosynthetic is then covered with a soil layer to protect the liner. The use of geosynthetic liners helps ensure the stockpile remains anoxic which prevents the armouring of limestone particulates by metal hydroxides (MEND 1996, Skousen, 1996). This is a standard encapsulation design used for remediation of PAG materials at former mine sites such as the Silver Standard property near Smithers, BC.

The project proposal indicates that inspections will be conducted along the access road in areas where potentially acid generating materials are known to occur. Inspections will look for evidence of acidic run-off along the road related to construction phase materials (p.431 of the project proposal).

i) Please indicate what measures will be taken if inspections discover areas where acidic run-off is occurring due to materials used in road construction.

The use of an NPR of greater than 2.0 to classify geological materials for use as access road construction materials will eliminate concerns associated with acidic drainage of road construction materials. Potential areas where acidic drainage may be encountered from geological materials intended for use as access road construction materials will be addressed on a site-specific basis.

An inspection program to determine potential effects and existing conditions would be initiated where acidic drainage is discovered to be occurring from road construction materials. This inspection program will evaluate the volume and quality of the identified acidic drainage, in addition to measuring local drainage quality in the areas upstream and downstream of the access road. The comparison of road run-off to local drainage chemistry is important to understanding potential effects, given that a number of streams in the area have measured drainage pH values of less that 6.0, which is indicative of naturally occurring ARD processes. An inspection report will be generated and provided to permitting agencies identifying the results of the inspection and also any proposed mitigations that are deemed to be necessary to address the location.

5.0 WATER QUALITY AND QUANTITY

5.1 MINE SITE

5.1.1 Surface Water Quality and Hydrology

An understanding of the hydrology in the area is critical to the Executive Committee's assessment of potential effects to surface water from project activities. Accurate hydrological data will also allow for appropriately designed infrastructure and the implementation of effective mitigation strategies.

There is conflicting information in the project proposal as to whether or not Tributary A flows during the winter. In the project proposal, page 213 states that "winter flows were not recorded, but are assumed to be near zero as the creeks freeze under sub-zero temperatures" while page 224 states "observations in the field suggest that Tributary A flows year round." Please provide the following information.

a) Supporting evidence to clarify the extent to which Tributary A flows seasonally.

The project proposal contained conflicting statements on page 213 and page 224. The information provided on page 224 is the correct assumption with respect to Tributary A and Tributary C flows (i.e., that Tributaries A and C flow year-round). NATC conducted further field sampling during the winter of 2008/2009 and observed flow within both Tributary A and Tributary C. Minimum measured flows for Tributary A during this winter sampling were approximately 0.166 m^3/s during March 2009. Tributary C flows were not measurable during March due to ice conditions and freezing temperatures. Additional ongoing sampling of water quantity on a monthly basis is described in the response to Section 5.1.1(i).

The project proposal indicates that five spot manual discharge measurements were taken from Tributaries A and C. From these measurements, an average ratio between the two streams was calculated. While the hydrometric station on Tributary A was well defined, there is no description of where discharge measurements were taken from Tributary C. Please provide the following information.

b) Identify and describe the locations of discharge measurements taken from Tributary C.

Tributary C discharge measurements were collected along a transect four metres upstream of the confluence of Tributary C with Tributary A. The WSG 84 coordinates for the velocity measurement transect were N63º 17' 22.2", W130º 17' 21.6". Tributary C at this location flows in a 3.2 m wide by 0.45 m deep rectangular channel with near vertical banks.

The bed is rough; consisting of cobbles and rocks with diameters less than 0.30 m. Typical average creek velocity during the summer months is 0.8 m/s.

Monitoring of flow in the three tributaries occurred only during the open water seasons for a period of three years for Tributary A and C, and a period of one year for the Hess River Tributary. Tributary A was the only stream that was continuously gauged during the baseline monitoring program. The earliest and latest measurement taken during any given year was June 18, 2008, and September 20, 2006 respectively. Based on provided air temperature data it appears that spring freshet and fall freeze-up conditions were not sampled. Page 213 of the project proposal indicates that "since instrumentation was not installed prior to the snowmelt, maximum freshet flows have likely not been recorded."

A discharge hydrograph and flow estimates were generated for Tributary C using a calculated flow ratio with Tributary A. A hydrometric station was installed on the Hess River Tributary and recorded data between June 18 and September 3 of 2008. Additionally, one flow recording was taken March 28, 2008 and used as the minimum winter flow measurement for the Hess River Tributary.

In the absence of comprehensive year-round sampling data, the annual hydrological regime was estimated using those samples that were taken and extrapolated. Given that proposed activities, water withdrawals and discharges will occur throughout the life of the project, and that some of these events will occur during periods for which there has been no sampling, a more thorough understanding of the regional hydrological regime is required. Further discussion related to the methodology used to estimate hydrological flow data is required in order to provide a sufficient degree of confidence in the assumptions. This information will allow the Executive Committee to consider the potential effects and proposed mitigations related surface water hydrology. Please provide the following information.

c) Describe the methods and rationale used for determining the median basin elevation for Tributary A.

The median elevation of a drainage basin corresponds to the contour line that divides the basin area into half. It is different from the average of the maximum and minum basin elevations. The boundary of Tributary A basin was delineated on a 1:50,000 NTS map. The contour line that corrsponds to the median basin elevation was visually estimated and then refined by trial and error.

d) Based on Figures 4.1.10-2 and 4.1.10-4 (discharge hydrographs for Tributaries A and C respectively) explain why manual discharge measurements from 2007 and 2008 do not match the discharges depicted on the hydrograph.

The discharge hydrographs for Tributaries A and C (Figures 4.4.10-2 and -4 of the project proposal) are based on conversion of the recorded stage data to discharges, based on the stage discharge curves. The stage discharge curves were developed by establishing a mathematical best-fit line through the actual stage discharge data points measured in the field, by minimizing the standard deviations from the line. There is a certain amount of error associated with each field measurement (in the order of a few percent), leading to some scatter in the data points. The best fit line smoothes out this scatter and provides a relationship that can be used to predict discharge from measured stage. The scatter in the discharge data measured in the field explains why the measured points do not lie exactly on the derived hydrographs.

e) Provide the discharge regime for each of the regional hydrometric stations (Hess River above Emerald Creek, South Macmillan River at km 407 Canol Highway, and Boulder Creek at km 387 Canol Highway).

The hydrological regime of the Hess River and the South Macmillan River hydrometric stations, as shown in Figure 5.1.1-1, is dominated by the spring freshet resulting from snowmelt. Peak runoff occurs May through July in response to snowmelt and low flow conditions can occur from November through April depending on prevailing climatic conditions. A decreasing autumn flow trend is typically experienced from August to October in response to decreasing rainfall, and prior to freezing. The hydrological regime of Boulder Creek, which is a tributary of the South Macmillan River, is only available from May to September due to seasonal operation of the gauge. The freshet peaks in May and declines until September.

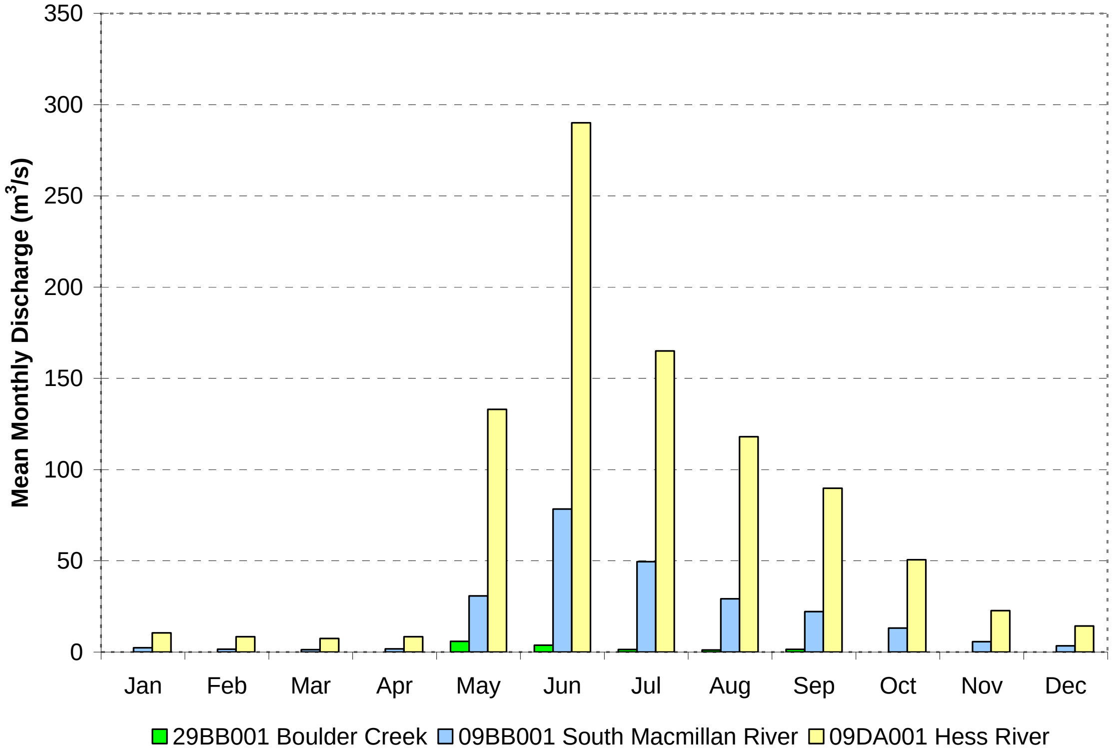


Figure 5.1.1-1
Mean Monthly Discharge for Regional Hydrometric Stations

f) The discharge ratio between Tributaries A and B have been referenced but not provided, please provide this ratio.

The discharge ratio between Tributaries A and C is stage dependent. A linear regression of the 8 near simultaneous flow measurements collected on both creeks yielded the resultant best fit line as:

$y = 0.3384x - 0.203$ Where Y = Tributary C discharge (m^3/s)

and X = Tributary A discharge (m^3/s)

The discharge ratio is .3384 with a $R^2 = .9815$

This method is discussed in full in the report titled "2008 Mactung Hydrometeorological Report", Section 2.2.6 on page 5 contained in Appendix H3 of the project proposal.

g) The project proposal provides an estimated flow regime for Tributary A by using runoff (estimates in mm). Further in the report, discharge estimates are given as a volume (m^3/s). Please provide discharge estimates for Tributary A in cubic meters per second.

Furthermore, please provide monthly discharge estimates for Tributaries C and B and the Hess River Tributary.

The discharge (m^3/s) at Tributary A was converted from runoff (mm) by multiplying by the drainage area. The mean and extreme monthly discharges for Tributary A are listed in Table 5.1.1-1. The corresponding monthly discharges in Tributary B were scaled down from Tributary A using the area ratio of 0.28. The monthly discharges at the mouth of Tributary C and in H. Tributary were scaled from Tributary A using the average flow ratios of 0.338 and 3.488 calculated from the field monitoring program.

TABLE 5.1.1-1 MONTHLY DISCHARGES AND DISTRIBUTIONS IN TRIBUTARIES A, B AND C AND HESS RIVER SOUTH TRIB													
Mean Monthly and Annual Discharges (m^3/s)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Trib. A Discharge	0.20	0.14	0.12	0.15	2.68	6.83	4.31	2.54	1.93	1.14	0.50	0.30	1.74
Trib. B Discharge	0.06	0.04	0.03	0.04	0.75	1.92	1.21	0.71	0.54	0.32	0.14	0.08	0.49
Trib. C Discharge	0.07	0.05	0.04	0.05	0.91	2.31	1.46	0.86	0.65	0.39	0.17	0.10	0.59
Hess River South Trib.	0.70	0.49	0.41	0.52	9.34	23.82	15.05	8.87	6.74	3.99	1.74	1.03	6.08
Monthly Distribution (%)													
Distribution	11.5	8.1	6.8	8.6	153.7	391.8	247.5	145.9	110.8	65.6	28.5	16.9	100.0
10-YEAR WET AND DRY MONTHLY AND ANNUAL DISCHARGES (M^3/S)													
Trib. A 10-Year Wet Discharge	0.24	0.16	0.14	0.18	3.16	8.06	5.09	3.00	2.28	1.35	0.59	0.35	2.06
Trib. A 10-Year Dry Discharge	0.17	0.12	0.10	0.13	2.25	5.74	3.63	2.14	1.62	0.96	0.42	0.25	1.46
Hess River South Trib. 10-Year Wet Discharge	0.83	0.58	0.48	0.61	11.03	28.14	17.78	10.48	7.96	4.71	2.06	1.22	7.16
Hess River South Trib. 10-Year Dry Discharge	0.59	0.41	0.35	0.44	7.90	20.15	12.73	7.50	5.70	3.37	1.47	0.87	5.12

h) Given the importance of Tributary A in developing the annual hydrological regime for the site, additional information regarding the accuracy of estimates for Tributary A is required. Based on the methods used to estimate Tributary A runoff, please provide a discussion on the accuracy of estimated values.

The estimated mean monthly discharges for Tributary A, as listed in Table 5.1.1-1, were compared to the 2006-2008 gauging record from the project site (Table 4.1.10-1 in the project proposal). The comparison was made only to the average monthly discharges over the summer period (July to September), based on the available data. This showed that the estimated discharges from regional hydrological analysis are approximately 23% higher than the site data for July and 7% and 15% lower than the site data for August and September. While the three month average discharge from the regional analysis is only 2.8% higher than the site data.

However, it should be noted that the lack of concurrent discharge records between the regional analysis and the site gauging is a limitation of this comparison. The regional analysis was based on long term mean monthly records from 1974 to1996, while the field gauging program was conducted from 2006 to 2008. According to an active hydrometric station Pelly River at Pelly Crossing (09BC001) in the project region, 2006 and 2007 were dry years with the mean annual discharge below the long term average.

Spot measurements at Tributaries A and C and the H. Tributary were conducted over the winter months (February to May) in 2009. The data listed in Table 5.1.1-2 have a lower level of accuracy due to the freezing, low flow and low velocity conditions that were commonly encountered in the winter. They are, however, a good indication of the magnitude of flow in the project regional.

TABLE 5.1.1-2: SPOT WINTER FLOW MEASUREMENTS IN TRIBUTARIES A, B, AND C AND H. TRIBUTARY

Date	H. Tributary	Tributary A	Tributary C
Feb 16, 2009	0.269	0.232	Trickle, Velocity<0.01 m/s
Mar 18, 2009	Not Measured	0.168	Not Measured
Apr 18-19, 2009	0.258	0.153	0.029
May 30- June 1, 2009	10.235	3.195	0.886

i) Due to the year-round withdrawals and discharges from the mine operations as well as the flow through nature of the reservoir, a greater certainty of understanding of the hydrological regime is necessary. Therefore, please present at a minimum, monthly flow data for one full year for Tributaries A and C and the Hess River Tributary. This flow data should then be incorporated into the estimated hydrological regime.

Additional discharge data for Tributary A and C and the H. Tributary have been collected since the project proposal was submitted. The best estimates of year round monthly flows are given in Table 5.1.1-1. This information is in accordance with the Proponent's Guide which requests estimates of peak, minimum, seasonal and annual average flows.

Sufficient surface water quality baseline data is critical in order for the Executive Committee to consider potential effects associated with various proposed activities. Accurate baseline data will also allow for the appropriate design of infrastructure and the implementation of effective mitigation strategies.

The surface water quality sampling program conducted appears to be spatially adequate but deficient with respect to the temporal sampling frequency. Samples taken at four water quality stations from 2006 through 2008 consistently exceeded CCME guidelines. Given that the area shows high metal concentrations, more sites should have been added earlier in the program in order to provide a more robust data set.

The three additional sites added in August of 2008 at the ravine dam and DSTF areas were only sampled once. These samples did not exceed CCME guidelines but no other water quality samples were taken from other locations at this time. Therefore, there can be no comparison between the locations and it is not possible to determine if the lower values are a result of site specific characteristics or seasonal fluctuations.

Based upon input from Yukon Government and Environment Canada, it is clear that additional information is required in order to characterize the baseline water quality in the proposed project area. This information will allow the Executive Committee to consider the potential effects and proposed mitigations related surface water quality. Please provide the following information.

j) In consideration of the year-round discharges from mine operations as well as the flow-through nature of the reservoir, provide further water quality sampling and analysis for all sampling locations, from each month of the year for a whole year. The Executive Committee recommends that the proponent contact the Yukon Government (Department of Environment) for information related to the sampling suite. Implications of nutrient loading to receiving waters resulting from the use of explosives (ANFO) on the site should be discussed.

In June 2009 there was correspondence between NATC, NATC's consultant, and YESAB regarding water quality data. All of the correspondence and data are included within Appendix B. The data are in accordance with the Proponent's Guide which requests a description of seasonal variability and range for water quality.

k) Flood flow estimation is important in determining the appropriate design of infrastructure and implementation of effective mitigation strategies where required. The project proposal indicated peak flows for Tributaries A, B, and C and the South Macmillan River Crossing were estimated using frequency analysis of sample data and regional hydrometric station data. However, the details on the analysis are not clear. Please provide the following information.

Frequency analysis was carried out on the annual maximum instantaneous flows for three hydrometric stations, as identified in the project proposal Section 4.1.10.3. The rationale for the selection of these stations was also provided in the same section. The analysis was undertaken using Environment Canada's Consolidated Frequency Analysis program (CFA 3.1). Flood frequencies derived from the regional hydrometric stations were calculated by taking the average of the results from four frequency distributions, as listed in Table 5.1.1-3.

TABLE 5.1.1-3: RESULTS OF THE FLOOD FREQUENCY ANALYSIS				
Boulder Creek at km 387.0 North Canol Highway (29BB001) Maximum Instantaneous Discharge (m^3/s)				
Frequency Distribution	10-yr	20-yr	100-yr	200-yr
Generalized Extreme Value (GEV)	29.5	32.7	38.4	40.3
3 Parameter Lognormal (3PLN)	29.3	32.5	38.8	41.1
LOG Pearson Type III (LPIII)	30.4	35.8	48.8	54.7
Wakeby	29.3	32.0	35.8	36.7
Average	29.6	33.3	40.5	43.2
South Macmillan River at km 407 Canol Road (09BB001) Maximum Instantaneous Discharge (m^3/s)				
Frequency Distribution	10-yr	20-yr	100-yr	200-yr
Generalized Extreme Value (GEV)	173.0	196.0	262.0	296.0
3 Parameter Lognormal (3PLN)	171.0	187.0	225.0	241.0
LOG Pearson Type III (LPIII)	170.0	189.0	237.0	260.0
Wakeby	176.0	199.0	256.0	282.0
Average	172.5	192.8	245.0	269.8
Hess River above Emerald Creek (09DA001) Maximum Instantaneous Discharge (m3/s)				
Frequency Distribution	10-yr	20-yr	100-yr	200-yr
Generalized Extreme Value (GEV)	859.0	966.0	1,190.0	1,280.0
3 Parameter Lognormal (3PLN)	889.0	1,060.0	1,510.0	1,730.0
LOG Pearson Type III (LPIII)	904.0	1,120.0	1,790.0	2,180.0
Wakeby	873.0	960.0	1,100.0	1,140.0
Average	881.3	1,026.5	1,397.5	1,582.5

l) Provide flood frequencies derived from the regional hydrometric stations used in the analysis.

Please refer to response 5.1.1(k) above.

m) Clarify and demonstrate the methods used in completing the flood frequency analysis for Tributaries A, B, and C and the South Macmillan River crossing. Please provide a discussion on the accuracy of flood frequency estimates.

The estimated maximum instantaneous discharges for the return periods of 10- to 200-years are plotted against drainage area in Figure 4.1.10-10 in the project proposal. The correlation equations shown on Figure 4.1.10-10 were used to predict return period peak snowmelt discharges as a function of drainage area. The drainage areas of Tributaries A, B, C, and South MacMillan River Crossing, as delineated from the 1:50,000 NTS map were determined to be 79.1, 22.2, 24.2, and 160.1 km^2 respectively.

The regional analysis for Tributary A is considered reasonably accurate as the basin area is similar to that of the Boulder Creek hydrometric station. The accuracy decreases as the drainage area becomes smaller, which leads to a reduced accuracy in the flood estimates for Tributaries B and C.

An alternative method for 200-year flood estimation at the aforementioned locations is snowmelt runoff analysis using hydrological modelling. However, this method requires the long term snow survey data and temperature records, which are not available for the project site.

5.2 GROUNDWATER QUALITY AND HYDROGEOLOGY

The project proposal indicates that groundwater quality from the flooded underground workings and the DSTF will be monitored during operation and post-closure. Given that the underground workings will be backfilled with potentially acid generating tailings and waste rock and the DSTF will consist of potentially acid generating tailings, please provide details on what steps will be taken if monitoring indicates that groundwater quality is being affected by mining activities both during operation and post-closure.

An understanding of the hydrogeology in the area is critical to allow the Executive Committee to consider potential effects from the interaction of various proposed activities and groundwater. Accurate hydrogeological data will also allow for appropriate design of infrastructure and implementation of effective mitigation strategies where required.

The hydrogeological regime presented by the proponent for the proposed project area was developed through data collection from eight groundwater observation wells. Data from each well was collected through the summer of 2008.

Environment Canada, Yukon Government, and experts retained by the Executive Committee have indicated that the relationship between the groundwater table, permafrost, and underground workings is not well represented or understood. With regards to reservoir water recovery, Environment Canada has stated that "[m]uch more hydrogeological information would be needed to properly design an effective pumping system that would capture a contaminant plume", and "additional groundwater sampling should be performed throughout the season to establish reliable baseline groundwater quality and water level conditions (i.e. piezometric head fluctuations).

Yukon Government has indicated that existing groundwater data is insufficient to conclude that groundwater coming off the ore body will not affect Tributaries C2 and C3. Furthermore, Environment Canada states that "the rate of infiltration of underground mine water into the workings is based on several assumptions such as modeling the workings as one large cylinder. The rock physical properties have been defined using packer testing boreholes. However, sensitivity to other assumptions should be discussed. A comparison of different assumptions and calculation methods might provide a better bound o the range of expected inflow rates". Since the success of this project is based, in part, on the effective flooding of underground workings, this information is important to the assessment.

Please provide the following information.

a) Additional groundwater samples, to the specifications of Yukon Government (Department of Environment) in order to appropriately establish baseline quality conditions and piezometric head fluctuations.

The project proposal contains water quality and hydraulic data collected during August and September 2008. In addition to this information, NATC continued to collect groundwater quality and piezometric head data over the course of one year to allow hydrogeological baseline conditions including seasonal changes to be assessed appropriately. Additional groundwater samples and piezometric head measurements were taken in late November 2008, middle of April 2009, and late May 2009. Groundwater samples were analyzed for the same suite of parameters as the first set of samples, including dissolved metals as per the requirements of the Yukon Government (YG), Department of Environment (see page 6 of YG comments on project proposal).

Groundwater Quality

Table 5.2-1 summarizes all water quality results of groundwater samples collected at the Site. Note that not all monitoring wells that were sampled during August 2008 and discussed in the Mactung project proposal could be sampled again because some wells were either dry or frozen during subsequent sampling events (see Table 5.2-2). Therefore, additional samples were taken from nearby wells where possible to provide shallow and deep groundwater samples from all areas of proposed major mine components over the course of one year. Field parameter measurements were not always possible due to immediate freezing of the field probes during winter sampling. However, pH, total dissolved solids, and electrical conductivity were also part of the laboratory analysis program.

All samples were collected using either a bailer or a Waterra inertial pump. The wells were purged prior to sample collection using a bailer or Waterra inertial pump. As part of the QA/QC program, trip blanks and duplicate samples were collected during the April 2009 and May 2009 sampling events, to determine whether cross-contamination occurred between samples in transit and to confirm that the combined sampling, shipping, and laboratory analysis process produced consistent repeatable results.

Comparison of the samples collected over the course of one year does not reveal any obvious major seasonal changes. The major ion composition determining the water type was very consistent throughout the seasons for all samples analyzed, except for an increase in magnesium concentration in MW-MT-08-06 and an increase in sodium concentration in MW-MT-08-08.

The measured dissolved metals concentrations were compared to the Yukon's Contaminated Sites Regulations (CSR) and Canadian Council of Ministers of the Environment (CCME) water quality guidelines. The CSR standards apply to groundwater whereas the CCME guidelines only apply to surface water. As groundwater ultimately discharges into surface water bodies, the CCME guidelines are included here for reference. As in the project proposal, the same approach of multiplying the CCME aquatic life guidelines by a factor of ten to account for dilution typically occurring when groundwater discharges to surface water was used to identify parameters that are naturally elevated. While it is noteworthy to document which groundwater parameters exceed these adjusted "guidelines", it is important to note that such exceedances do not compel action under the actual CCME guidelines.

All groundwater samples collected met the CSR standards for the parameters analyzed. As observed in the first set of water quality results, some of the dissolved metals concentrations exceeded the CCME guideline values for aluminum, cadmium, iron, selenium, and zinc. The cadmium concentrations in the samples taken from MW-MT-08-08 in November 2008 and May 2009 and the sample from MW-MT-08-04B collected in April 2009 also slightly exceeded the adjusted CCME guideline value. Groundwater in MW-MT-08-07 is artesian and the well was therefore grouted back to stop uncontrolled discharge. Hence, no further sampling was possible from this well. As mentioned in the project proposal, the iron concentration in the sample from MW-MT-08-07 exceeded the adjusted CCME guideline value.

The results of the field blanks and duplicate samples indicate that that no cross-contamination occurred and duplicates produced acceptably similar results.

Piezometric Head Information

The piezometric head measurements conducted in late August 2008, late September 2008, late November 2008, middle of April 2009, and late May 2009 are summarized in Table 5.2-2. In general, the lowest piezometric heads in both shallow and deep aquifers were observed in April 2009 representing late winter conditions, except for well MW-MT-08-01 which showed the lowest value in late May 2009. The highest piezometric heads were encountered during August/September 2008 in the deep aquifer and in May 2009 in the shallow aquifer.

The greatest change in piezometric head of 23.5 and 10.1 m was observed in the deep installations of MW-MT-08-01 and MW-MT-08-07, respectively. Note that the piezometric head data for MW-MT-08-01 have been slightly revised compared with those presented in the project proposal to reflect a depth correction based on downhole survey data that were not applied before. These downhole survey data allowed the depths of the vibrating wire piezometer installed in MW-MT-08-01 to be determined more precisely.

The change of piezometric head in the other deep monitoring wells was in the order of a few meters between August 2008 and April 2009. The deep groundwater piezometric head in MW-MT-08-05 was at grade in August 2008 but became slightly artesian in September 2008, overtopped the well casing, and froze preventing any further measurements in both shallow and deep installations of MW-MT-08-05. The deep groundwater in MW-MT-08-04B is also slightly artesian and was frozen from November 2008 until May 2009.

TABLE 5.2-1: SUMMARY OF GROUNDWATER CHEMISTRY AT MACTUNG PROPERTY

Analyte	Units	Reference Number	658097-4	678523-1	685651-2	678523-3	685651-4	638159-8	638159-7	638159-2	658097-5	678523-4	678523-7	685651-5	637977-3	Yukon CSR	CCME Guideline [1,2]	CCME Guideline [1,2]
		Sample Date	20-Nov-08	16-Apr-09	1-Jun-09	17-Apr-09	30-May-09	19-Aug-08	20-Aug-08	21-Aug-08	20-Nov-08	17-Apr-09	17-Apr-09	30-May-09	9-Aug-08			
		Site	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung			
		Well	MW-MT-08-03			MW-MT-08-04		MT-MW-08-04B	MT-MW-08-05	MT-MW-08-06					MW-MT-08-07			
		Sample Name	MT-MW-08-03	MW-MT-08-03	MW-MT-08-03	MW-MT-08-04	MW-MT-08-04	MT-MW-08-04B	MT-MW-08-05	MT-MW-08-06	MT-MW-08-06	MW-MT-08-06	MW-MT-08-061	MW-MT-08-06	MW-MT-08-07			
		Sample Location	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	Aquatic Life	Aquatic Life	Aquatic Life
		Matrix	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater			
		Relative Groundwater Depth	Deep	Deep	Deep	Deep	Deep	Deep	Deep	Deep	Deep	Deep	Duplicate (MW-MT-08-06)	Deep	Deep			× 10
		Detection Limit	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results			
Ion Balance	%		9.7	2.5	5.5	25.6	-6.1	-6.0	-5.9	-2.8	7.4	26.4	22.7	3.2	-0.6	-	-	-
Water type			Ca-SO4-HCO3	Ca-SO4-HCO3	Ca-SO4-HCO3	Ca-HCO3-SO4	Ca-HCO3-SO4	Ca-HCO3-SO4	Ca-Mg-SO4-HCO3	Ca-HCO3-SO4	Ca-SO4-HCO3	Ca-Mg-SO4-HCO3	Ca-Mg-SO4-HCO3	Ca-Mg-SO4-HCO3	Ca-SO4-HCO3	-	-	-
Field Parameters																		
Temperature	°C		-	1.2	3.2	2.0	3.9	2.8	2.4	2.5	-	0.9	0.9	2.7	2.9	-	-	-
pH	-		-	8.08	7.07	8.29	8.40	7.86	7.00	7.83	-	7.77	7.77	7.94	7.23	-	6.5 - 9	-
Dissolved O_2	mg/L		-	-	1.0	-	1.8	0.0	0.0	0.0	-	-	-	3.3	0.0	-	5.5 - 9.5	-
Electrical Conductivity	µS/cm at 25		-	290	311	205	205	259	515	382	-	366	366	361	515	-	-	-
TDS	ppm		-	145	156	102	103	130	257	190	-	182	182	179	255	-	-	-
Routine Water																		
pH	-		7.74	7.44	7.94	7.64	7.96	7.84	7.94	8.03	7.71	7.63	7.65	7.83	7.52	-	6.5 - 9	-
Electrical Conductivity	µS/cm at 25	1	296	298	318	215	212	240	469	351	294	373	369	365	497	-	-	-
Turbidity	NTU	0.1	5.2	5.6	0.5	1.7	18.0	15.0	6.6	0.2	0.7	3.5	3.3	18.0	15.0	-	-	-
Total Dissolved Solids	mg/L	1	181	196	215	150	130	162	337	245	176	246	242	235	334	-	-	-
Hardness	mg/L $CaCO_3$	1	139	152	170	128	93	118	264	196	141	227	219	185	267	-	-	-
Chloride		0.02	0.85	0.99	0.49	0.08	<0.02	0.07	0.04	0.04	0.34	0.06	0.06	<0.02	0.03	-	-	-
Ammonia - N		0.005	0.360	<0.01	0.030	<0.01	0.020	0.097	0.080	0.029	<0.01	0.010	0.020	0.010	0.014	11.3	1.54	15.4
Nitrate - N		0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	400	13	130
Nitrite - N		0.01	0.03	<0.01	<0.01	<0.01	<0.01	0.03	0.06	0.04	0.01	0.05	0.03	<0.01	0.04	0.2	0.06	0.6
Sulfate (SO4)	mg/L	0.05	67.40	83.80	103.00	46.40	46.80	58.60	149.00	97.60	77.40	94.90	95.10	100.00	140.00	1000	-	-
Hydroxide		5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-
Carbonate		6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	-	-	-
Bicarbonate		5	80	80	70	70	70	90	160	130	70	100	100	100	160	-	-	-
T-Alkalinity		5	70	65	56	57	60	74	130	105	57	92	91	93	131	-	-	-
Acidity	mg/L $CaCO_3$	5	6	<5	<5	<5	<5	<5	6	<5	<5	5	<5	<5	-	-	-	-
Metals - Dissolved																		
Mercury		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0	0.000026	0.00026
Aluminum		0.01	0.01	0.01	0.01	<0.005	0.01	0.02	0.01	0.02	0.01	<0.005	<0.005	<0.005	<0.01	-	0.1	1
Antimony		0.0002	0.0034	0.0009	0.0009	0.0007	0.0004	0.0024	0.0008	0.0032	0.0055	0.0008	0.0002	0.0063	0.0010	0.2	-	-
Arsenic		0.0002	0.0004	0.0003	<0.0002	<0.0002	<0.0002	0.0016	<0.0002	0.0016	0.0004	0.0008	0.0008	0.0008	0.0045	0.05	0.005	0.05
Barium		0.001	0.051	0.029	0.016	0.012	0.014	0.019	0.020	0.025	0.047	0.014	0.014	0.014	0.021	10	-	-
Beryllium		0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	0.053	-	-
Bismuth		0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Boron		0.004	0.007	<0.004	<0.004	<0.004	0.007	<0.004	<0.004	<0.004	0.011	<0.004	<0.004	0.006	<0.004	-	-	-
Cadmium		0.00001	**0.00014**	**0.00003**	**0.00002**	**0.00002**	**0.00002**	**0.00002**	0.00001	**0.00003**	**0.00015**	**0.00006**	**0.00002**	**0.00002**	<0.00001	0.0005-0.0006	0.000017	0.00017
Calcium		0.04	50.50	54.90	62.80	44.60	32.80	42.30	80.10	62.70	49.40	67.00	64.60	55.30	99.80	-	-	-
Chromium		0.0004	**0.0035**	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.0007	0.0006	<0.0004	<0.0004	<0.0004	<0.0004	0.0007	0.01	0.001[3]	0.01
Cobalt		0.00002	0.00041	0.00016	0.00009	0.00004	0.00006	0.00006	0.00006	0.00012	0.00019	0.00006	0.00005	0.00211	0.00248	0.009	-	-
Copper		0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05-0.09	0.002 - 0.004[4]	0.02-0.04
Iron		0.01	0.08	**0.34**	<0.01	0.02	<0.010	**0.55**	<0.01	0.11	0.03	0.14	0.15	0.06	**3.24**	-	0.3	3
Lead		0.0001	0.0003	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.0001	0.0002	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.06-0.16	0.007[5]	0.07
Lithium		0.001	0.004	0.002	0.001	0.003	0.003	0.004	0.002	0.005	0.003	0.004	0.004	0.004	0.003	-	-	-
Magnesium		0.04	3.05	3.48	3.15	4.07	2.73	3.07	15.70	9.59	4.37	14.60	14.10	11.30	4.29	-	-	-
Manganese	mg/L	0.0001	0.0611	0.1130	0.0207	0.0113	0.0127	0.0881	0.0101	0.0179	0.0464	0.0122	0.0121	0.0112	0.1310	-	-	-
Molybdenum		0.00002	0.00678	0.00300	0.00247	0.00385	0.00395	0.00188	0.00099	0.00768	0.01180	0.00879	0.00902	0.00922	0.00355	10	0.073	0.73
Nickel		0.001	0.003	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.002	0.002	<0.001	<0.001	<0.001	0.060	1.1-1.5	0.15[6]	1.5
Phosphorus		0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-
Potassium		0.04	0.70	0.30	0.20	0.70	0.50	2.53	1.71	1.64	2.10	1.80	1.70	1.40	0.99	-	-	-
Selenium		0.0006	0.0010	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	**0.0026**	<0.0006	<0.0006	<0.0006	<0.0006	0.01	0.001	0.01
Silicon		0.01	4.02	3.98	3.16	4.40	3.02	3.28	3.75	3.08	2.14	3.25	3.40	2.74	3.18	-	-	-
Silver		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.0005-0.015	0.0001	0.001
Sodium		0.04	5.20	2.70	2.20	3.60	2.80	2.11	1.50	1.95	2.30	2.80	2.70	2.60	0.66	-	-	-
Strontium		0.001	0.154	0.146	0.147	0.300	0.314	0.114	1.000	0.209	0.148	0.196	0.197	0.202	0.213	-	-	-
Thallium		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.003	-	-
Thorium		0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Tin		0.0001	0.0002	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	0.0006	<0.0001	-	-	-
Titanium		0.0001	0.0004	0.0005	0.0002	0.0003	0.0005	0.0010	0.0006	0.0008	<0.0001	0.0003	0.0002	0.0003	0.0003	1	-	-
Tungsten		0.0001	0.0098	0.0063	0.0112	0.0017	0.0023	0.0036	0.0017	0.0038	0.0306	0.0009	0.0009	0.0014	0.0004	-	-	-
Uranium		0.0004	0.0016	0.0012	0.0060	0.0013	0.0014	0.0035	0.0027	0.0117	0.0035	0.0111	0.0110	0.0107	0.0098	3	-	-
Vanadium		0.00004	0.00026	<0.00004	0.00014	<0.00004	<0.00004	0.00021	0.00021	0.00033	0.00023	<0.00004	<0.00004	<0.00004	0.00021	-	-	-
Zinc		0.001	0.007	0.002	0.001	0.001	0.002	0.003	0.002	0.003	**0.033**	0.003	0.002	0.002	**0.052**	0.15-2.4	0.03	0.3
Zirconium		0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	-	-	-

TABLE 5.2-1: SUMMARY OF GROUNDWATER CHEMISTRY AT MACTUNG PROPERTY (CONTINUED)

Analyte	Units	Reference Number	658097-4	678523-1	685651-2	678523-3	685651-4	638159-8	638159-7	638159-2	658097-5	678523-4	678523-7	685651-5	637977-3	Yukon CSR	CCME Guideline [1,2]	CCME Guideline [1,2]
		Sample Date	20-Nov-08	16-Apr-09	1-Jun-09	17-Apr-09	30-May-09	19-Aug-08	20-Aug-08	21-Aug-08	20-Nov-08	17-Apr-09	17-Apr-09	30-May-09	9-Aug-08			
		Site	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung			
			MW-MT-08-03			MW-MT-08-04		MT-MW-08-04B	MT-MW-08-05	MW-MT-08-06					MW-MT-08-07			
		Sample Name	MT-MW-08-03	MW-MT-08-03	MW-MT-08-03	MW-MT-08-04	MW-MT-08-04	MT-MW-08-04B	MT-MW-08-05	MT-MW-08-06	MT-MW-08-06	MW-MT-08-06	MW-MT-08-061	MW-MT-08-06	MW-MT-08-07			
		Sample Location	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	Aquatic Life	Aquatic Life	Aquatic Life
		Matrix	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater			
		Relative Groundwater Depth	Deep	Deep	Deep	Deep	Deep	Deep	Deep	Deep	Deep	Deep	Duplicate (MW-MT-08-06)	Deep	Deep			× 10
		Detection Limit	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results			
Metals - Total																		
Mercury		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0	0.000026	0.00026
Aluminum		0.005	0.734	0.040	0.019	0.117	0.078	0.143	0.132	0.017	0.039	0.020	<0.005	0.011	<0.005	-	0.1	1
Antimony		0.0002	0.0026	0.0004	0.0006	<0.0002	<0.0002	0.0010	<0.0002	0.0014	0.0033	<0.0002	<0.0002	<0.0002	0.0004	0.2	-	-
Arsenic		0.0002	0.0011	0.0003	<0.0002	<0.0002	<0.0002	0.0026	0.0004	0.0014	0.0004	0.0010	0.0010	0.0008	0.0044	0.05	0.005	0.05
Barium		0.001	0.066	0.031	0.017	0.014	0.016	0.025	0.023	0.024	0.041	0.016	0.015	0.015	0.022	10	-	-
Beryllium		0.00004	<0.00004	<0.00004	<0.00004	0.00005	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	<0.00004	0.053	-	-
Bismuth		0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Boron		0.005	0.006	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005	0.010	<0.005	<0.005	0.007	<0.005	-	-	-
Cadmium		0.00001	0.00066	0.00003	0.00002	0.00026	0.00006	<0.00001	0.00001	0.00001	0.00021	0.00010	0.00002	0.00005	<0.00001	0.0005-0.0006	0.000017	0.00017
Calcium		0.04	56.70	59.60	67.70	30.00	41.00	44.80	81.30	61.20	48.30	49.10	49.80	64.50	103.00	-	-	-
Chromium		0.0004	0.0028	<0.0004	<0.0004	<0.0004	<0.0004	0.0005	0.0009	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.0007	0.01	0.0013	0.01
Cobalt		0.00002	0.00091	0.00018	0.00010	0.00005	0.00005	0.00005	0.00012	0.00012	0.00018	0.00005	0.00003	0.00004	0.00254	0.009	-	-
Copper		0.001	0.016	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.05-0.09	0.002 - 0.0044	0.02-0.04
Iron		0.01	2.25	0.85	0.15	0.22	0.20	1.64	0.87	0.17	0.18	0.47	0.46	0.49	3.73	-	0.3	3
Lead		0.0001	0.0036	0.0004	0.0002	0.0006	0.0004	<0.0001	0.0002	<0.0001	0.0003	0.0006	0.0001	<0.0001	0.0002	0.06-0.16	0.0075	0.075
Lithium		0.001	0.005	0.002	0.001	0.003	0.003	0.004	0.002	0.004	0.003	0.004	0.004	0.004	0.003	-	-	-
Magnesium		0.04	3.27	3.87	3.23	2.88	3.29	3.27	15.90	9.40	4.30	11.10	11.10	12.80	4.54	-	-	-
Manganese		0.0001	0.0814	0.1290	0.0231	0.0145	0.0144	0.0994	0.0120	0.0184	0.0399	0.0140	0.0129	0.0119	0.1360	-	-	-
Molybdenum	mg/L	0.00002	0.00587	0.00333	0.00270	0.00422	0.00428	0.00202	0.00107	0.00756	0.01010	0.00967	0.00981	0.01020	0.00379	10	0.073	0.73
Nickel		0.001	0.004	<0.001	<0.001	<0.001	<0.001	0.003	0.002	0.002	0.002	<0.001	<0.001	<0.001	0.062	1.1-1.5	0.156	1.5
Phosphorus		0.01	0.56	0.02	0.02	<0.010	<0.01	0.02	0.04	0.03	<0.01	<0.010	<0.010	<0.01	0.08	-	-	-
Potassium		0.04	0.90	0.50	0.30	0.50	0.70	2.78	1.78	1.65	2.00	1.20	1.10	1.60	1.03	-	-	-
Selenium		0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	<0.0006	0.0019	<0.0006	<0.0006	<0.0006	<0.0006	0.01	0.001	0.01
Silicon		0.01	5.16	4.44	3.31	3.25	3.86	3.63	4.03	3.03	2.15	2.77	2.75	3.14	3.29	-	-	-
Silver		0.00001	<0.00001	<0.00001	0.00006	<0.00001	0.00004	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	0.0005-0.015	0.0001	0.001
Sodium		0.04	5.23	3.18	2.47	2.66	3.46	2.40	1.70	2.10	2.32	2.33	2.31	3.07	0.90	-	-	-
Strontium		0.001	0.141	0.155	0.153	0.325	0.330	0.120	1.010	0.202	0.125	0.212	0.210	0.218	0.220	-	-	-
Sulfur		0.1	-	31.700	35.000	13.400	15.900	-	-	-	-	30.300	30.200	33.700	-	-	-	-
Tellurium		0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-	-
Thallium		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.003	-	-
Thorium		0.0001	0.00040	<0.0001	0.00060	0.00020	0.00040	-	-	-	0.00010	<0.0001	<0.0001	0.00010	-	-	-	-
Tin		0.0001	0.0026	0.0008	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0001	<0.0001	<0.0001	0.0001	-	-	-
Titanium		0.0001	0.0285	0.0020	0.0009	0.0034	0.0031	0.0049	0.0062	0.0009	0.0011	0.0015	0.0006	0.0006	0.0005	1	-	-
Uranium		0.0004	0.0020	0.0013	0.0064	0.0015	0.0015	0.0040	0.0029	0.0116	0.0036	0.0116	0.0123	0.0118	0.0110	3	-	-
Vanadium		0.00003	0.00303	0.00013	0.00024	0.00014	0.00021	0.00119	0.00098	0.00039	0.00030	0.00016	<0.00004	0.00010	0.00023	-	-	-
Zinc		0.001	0.066	0.008	0.031	0.007	0.020	0.003	0.006	0.003	0.053	0.007	0.004	0.014	0.050	0.15-2.4	0.03	0.3
Zirconium		0.0001	-	<0.0001	0.0004	0.0010	0.0004	0.0002	0.0001	0.0002	-	0.0002	<0.0001	0.0001	<0.0001	-	-	-

TABLE 5.2-1: SUMMARY OF GROUNDWATER CHEMISTRY AT MACTUNG PROPERTY (CONTINUED)

Analyte	Units	Reference Number	638159-6	638159-3	658097-1	678523-5	685651-7	637977-1	685651-1	658097-3	658097-2	678523-2	685651-3	685651-6	637977-5	637977-2	638159-9	638159-1	638159-5	638159-4	678523-6	Yukon CSR	CCME Guideline [1,2]	CCME Guideline [1,2]
		Sample Date	18-Aug-08	18-Aug-08	18-Nov-08	19-Apr-09	31-May-09	5-Aug-08	31-May-09	19-Nov-08	19-Nov-08	17-Apr-09	31-May-09	31-May-09	21-Jul-08	9-Aug-08	19-Aug-08	21-Aug-08	18-Aug-08	20-Aug-08	17-Apr-09			
		Site	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung			
		Well	MT-MW-08-08					Warm Spring	MT-MW-08-03	MT-MW-08-04	MT-MW-08-04B			MW-MT-08-08	n/a									
		Sample Name	MT-MW-08-08	MT-MW-08-08	MT-MW-08-08	MW-MT-08-08	MW-MT-08-08	Warm Spring	MT-MW-08-03	MT-MW-08-04	MT-MW-08-04B	MW-MT-08-04B	MW-MT-08-04B	MW-MT-08-08	MT Spring	Drill Water #3	Drill Water #4B	Drill Water #6	Drill Water #8	Field Blank	MW-MT-08-13			
		Sample Location	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	Spring	Sump	Tributary C	Tributary C	Sump	Blank	Blank			
		Matrix	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Surface Water	Surface Water	Surface Water	Water	Water	Aquatic Life	Aquatic Life	Aquatic Life
		Relative Groundwater Depth	Deep	Duplicate (MW-MT-08-08)	Deep	Deep	Deep	Deep	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow	-	-	-	-	-			× 10
		Detection Limit	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results			
Ion Balance	%		-11.3	-0.8	12.6	11.8	5.6	1.6	-4.6	1.6	9.0	-4.1	-20.0	47.0	-2.7	-2.5	-4.8	-5.1	-13.1	-	-	-	-	-
Water type			Ca-SO4	Ca-SO4	Ca-Na-SO4	Ca-Na-SO4	Ca-Na-SO4	Na-SO4-CO3	Ca-SO4-HCO3	Ca-HCO3-SO4	Ca-HCO3-SO4	Ca-HCO3-SO4	Ca-HCO3-SO4	Ca-SO4	Ca-HCO3-SO4	Ca-SO4-HCO3	Ca-SO4-HCO3	Ca-SO4-HCO3	Ca-HCO3-SO4	-	-	-	-	-
Field Parameters																								
Temperature	°C		3.1	3.1	1.2	0.5	2.0	32.9	2.8	1.4	0.2	1.2	1.9	0.9	1.2	7.0	5.3	2.8	2.1	-	-	-	-	-
pH	-		9.38	9.38	-	8.54	8.18	9.68	6.21	8.40	7.43	7.35	8.25	6.86	7.35	7.16	7.40	7.59	7.59	-	-	-	6.5 - 9	-
Dissolved O_2	mg/L		0.3	0.3	-	-	4.7	0.5	9.3	9.9	7.5	-	-	13.2	11.2	11.7	10.6	11.3	11.3	-	-	-	5.5 - 9.5	-
Electrical Conductivity	µS/cm at 25		198	198	-	289	231	400	386	-	242	275	209	28	82	222	256	217	115	-	-	-	-	-
TDS	ppm		99	99	-	146	118	287	191	-	121	139	104	14	123	112	128	109	57	-	-	-	-	-
Routine Water																								
pH	-		8.99	**9.07**	7.28	6.95	7.18	**9.31**	7.80	7.81	7.78	7.55	7.88	6.57	7.81	7.63	7.72	7.81	7.65	6.06	6.20	-	6.5 - 9	-
Electrical Conductivity	µS/cm at 25	1	184	183	228	241	237	366	365	228	240	321	222	62	176	216	238	242	106	1	12	-	-	-
Turbidity	NTU	0.1	30.0	30.0	3.8	10.0	3.4	0.9	23.0	10.0	26.0	15000.0	23.0	26.0	0.7	0.5	<0.1	<0.1	<0.1	<0.1	0.3	-	-	-
Total Dissolved Solids	mg/L	1	136	137	145	160	159	314	243	140	140	196	130	40	120	138	164	169	72	<1	3	-	-	-
Hardness	mg/L $CaCO_3$	1	78	80	86	93	91	6	178	103	121	148	85	23	86	103	121	126	51	<1	2	-	-	-
Chloride		0.02	0.10	0.10	0.21	0.37	0.34	11.20	0.16	0.07	0.10	0.06	<0.02	0.20	0.08	0.04	0.06	0.05	0.07	<0.02	1.01	-	-	-
Ammonia - N		0.005	0.260	0.262	0.260	0.040	0.110	0.047	0.030	<0.01	<0.01	0.020	0.040	0.040	<0.005	<0.005	<0.005	<0.005	<0.005	0.011	<0.01	11.3	1.54	15.4
Nitrate - N		0.01	0.06	0.06	<0.01	0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01	<0.01	0.30	0.15	0.08	0.03	0.03	0.22	<0.01	<0.01	400	13	130
Nitrite - N		0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.03	0.04	<0.01	<0.01	0.01	0.01	0.02	0.02	<0.01	<0.01	<0.01	0.2	0.06	0.6
Sulfate (SO4)	mg/L	0.05	69.60	69.00	75.00	85.80	89.60	65.50	107.00	43.00	48.80	74.50	46.40	16.20	39.20	64.00	85.20	83.70	25.40	<0.05	0.12	1000	-	-
Hydroxide		5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-
Carbonate		6	7	8	<6	<6	<6	39	<6	<6	<6	<6	<6	10	<6	<6	<6	<6	<6	<6	<6	-	-	-
Bicarbonate		5	20	10	20	20	20	20	100	80	80	100	80	<5	60	50	50	60	40	<5	<5	-	-	-
T-Alkalinity		5	25	25	21	20	17	82	91	64	65	90	68	8	54	42	40	46	30	<5	<5	-	-	-
Acidity	mg/L $CaCO_3$	5	<5	<5	<5	<5	<5	-	<5	<5	<5	5	<5	9	-	-	<5	<5	<5	<5	6	-	-	-
Metals - Dissolved																								
Mercury		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0	0.000026	0.00026
Aluminum		0.01	**0.57**	**0.69**	**0.31**	0.04	0.02	0.03	**0.23**	**0.65**	<0.005	0.01	**0.16**	**0.20**	0.02	<0.01	0.03	0.02	0.01	0.01	<0.005	-	0.1	1
Antimony		0.0002	0.0108	0.0105	0.0141	0.0100	0.0107	<0.0002	<0.002	0.0010	0.0024	0.0009	<0.002	0.0030	0.0007	0.0005	0.0005	0.0006	0.0005	0.0006	0.0003	0.2	-	-
Arsenic		0.0002	**0.0058**	**0.0060**	**0.0060**	**0.0073**	**0.0072**	0.0005	<0.002	**0.0062**	0.0006	0.0009	<0.002	<0.002	<0.0002	<0.0002	0.0011	0.0012	0.0003	<0.0002	<0.0002	0.05	0.005	0.05
Barium		0.001	0.012	0.012	0.014	0.007	0.009	0.024	0.020	0.032	0.010	0.012	0.020	<0.01	0.007	0.009	0.021	0.024	0.005	<0.001	<0.001	10	-	-
Beryllium		0.00004	0.00006	0.00006	<0.00004	<0.00004	<0.00004	<0.00004	<0.0004	0.00007	<0.00004	<0.00004	<0.0004	<0.0004	<0.00004	<0.00004	0.00004	<0.00004	<0.00004	<0.00004	<0.00004	0.053	-	-
Bismuth		0.0001	<0.0001	0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Boron		0.004	<0.004	<0.004	0.010	0.006	0.011	0.448	<0.04	0.007	<0.004	<0.004	<0.04	<0.04	<0.004	0.005	<0.004	<0.004	<0.004	<0.004	0.014	-	-	-
Cadmium		0.00001	**0.00015**	**0.00009**	**0.00030**	**0.00015**	**0.00029**	<0.00001	*<0.0001*	**0.00013**	**0.00016**	**0.00030**	**0.00015**	**0.00010**	**0.00002**	<0.00001	**0.00024**	**0.00018**	0.00001	<0.00001	<0.00001	0.0005-0.0006	0.000017	0.00017
Calcium		0.04	30.30	31.40	33.10	36.20	35.20	2.41	67.60	36.00	43.50	53.00	30.10	8.30	31.80	39.30	43.70	46.10	18.80	0.26	0.41	-	-	-
Chromium		0.0004	0.0009	0.0009	0.0008	<0.0004	<0.0004	<0.0004	*<0.004*	**0.0017**	<0.0004	<0.0004	*<0.004*	*<0.004*	<0.0004	<0.0004	<0.0004	0.0008	<0.0004	<0.0004	<0.0004	0.01	0.001[3]	0.01
Cobalt		0.00002	0.00009	0.00010	0.00088	0.00010	0.00031	<0.00002	0.00040	0.00218	0.00147	0.00177	0.00030	<0.0002	0.00004	0.00002	0.00105	0.00026	<0.00002	0.00002	0.00002	0.009	-	-
Copper		0.001	0.002	0.001	0.002	0.002	<0.001	<0.001	*<0.01*	0.003	<0.001	<0.001	*<0.01*	*<0.01*	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.05-0.09	0.002 - 0.004[4]	0.02-0.04
Iron		0.01	**0.31**	**0.42**	0.17	<0.01	<0.01	<0.01	<0.1	**0.40**	<0.01	<0.01	<0.1	<0.1	0.02	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	-	0.3	3
Lead		0.0001	0.0012	0.0015	0.0006	0.0001	0.0001	<0.0001	<0.001	0.0015	<0.0001	<0.0001	<0.001	<0.001	0.0002	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	0.06-0.16	0.007[5]	0.07
Lithium		0.001	0.003	0.003	0.003	0.003	0.003	0.139	<0.01	0.003	0.002	0.002	<0.01	<0.01	<0.001	<0.001	0.002	0.002	<0.001	<0.001	<0.001	-	-	-
Magnesium		0.04	0.51	0.53	0.80	0.70	0.63	<0.04	2.10	3.25	2.91	3.82	2.40	0.60	1.60	1.14	2.98	2.79	0.89	<0.04	0.12	-	-	-
Manganese	mg/L	0.0001	0.0050	0.0059	0.0062	0.0055	0.0077	0.0004	0.0430	0.0400	0.3150	0.1710	0.0120	0.0020	0.0009	0.0004	0.0444	0.0092	0.0003	0.0004	0.0001	-	-	-
Molybdenum		0.00002	0.00842	0.00856	0.01040	0.01150	0.01130	0.00571	0.00400	0.01220	0.01260	0.00692	0.01500	0.00050	0.00203	0.00095	0.00100	0.00122	0.00213	<0.00002	<0.00002	10	0.073	0.73
Nickel		0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.01	0.004	0.011	0.014	<0.01	<0.01	<0.001	<0.001	0.009	0.004	<0.001	<0.001	<0.001	1.1-1.5	0.15[6]	1.5
Phosphorus		0.01	0.04	0.05	0.01	<0.01	0.06	<0.01	<0.1	0.04	<0.01	<0.01	<0.10	<0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-
Potassium		0.04	0.68	0.66	0.70	1.00	1.00	1.86	2.00	0.50	2.90	2.40	2.00	2.00	0.47	0.68	0.75	0.90	0.42	<0.04	0.20	-	-	-
Selenium		0.0006	**0.0024**	**0.0025**	**0.0024**	<0.0006	<0.0006	**0.0082**	*<0.006*	<0.0006	**0.0026**	**0.0012**	*<0.006*	*<0.006*	**0.0016**	**0.0026**	**0.0017**	**0.0023**	0.0010	<0.0006	<0.0006	0.01	0.001	0.01
Silicon		0.01	5.50	5.59	4.92	4.32	3.73	36.90	2.60	3.80	2.50	2.74	2.40	2.50	3.24	2.32	2.47	2.56	2.56	0.04	<0.05	-	-	-
Silver		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00010	<0.00001	<0.00001	<0.00001	<0.00010	<0.00010	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.0005-0.015	0.0001	0.001
Sodium		0.04	4.94	4.90	9.40	11.50	11.40	73.40	2.30	3.50	1.50	1.00	2.60	0.90	0.50	0.66	0.66	0.91	0.43	0.20	1.50	-	-	-
Strontium		0.001	0.042	0.044	0.052	0.051	0.052	0.043	0.120	0.280	0.080	0.104	0.300	0.030	0.047	0.083	0.096	0.102	0.025	0.001	0.002	-	-	-
Thallium		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.0001	<0.00001	<0.00001	<0.00001	<0.0001	<0.0001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.003	-	-
Thorium		0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.001	0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Tin		0.0001	<0.0001	<0.0001	0.0007	0.0005	0.0006	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Titanium		0.0001	0.0092	0.0090	0.0046	0.0005	0.0006	0.0029	<0.001	0.0091	0.0001	0.0005	<0.001	0.0010	0.0014	<0.0001	0.0005	0.0007	0.0005	0.0003	<0.0001	1	-	-
Tungsten		0.0001	0.0219	0.0224	0.0242	0.0298	0.0295	0.0552	0.0360	0.0294	0.0062	0.0024	0.1700	0.0010	0.0098	0.0005	0.0012	0.0008	0.0150	0.0003	0.0001	-	-	-
Uranium		0.0004	0.0006	0.0007	0.0009	0.0006	<0.0004	<0.0004	0.0010	0.0054	0.0015	0.0014	0.0136	<0.0004	0.0005	<0.0004	<0.0004	0.0006	<0.0004	<0.0004	<0.0004	3	-	-
Vanadium		0.00004	0.00480	0.00497	0.00380	0.00198	0.00152	0.00021	<0.0004	0.00114	0.00058	0.00024	<0.0004	0.00040	0.00036	0.00026	0.00015	0.00014	0.00043	<0.00004	<0.00004	-	-	-
Zinc		0.001	0.004	0.005	**0.032**	0.008	0.008	0.001	<0.01	0.004	0.002	0.008	<0.01	<0.01	0.003	<0.001	0.010	0.009	<0.001	0.002	0.001	0.15-2.4	0.03	0.3
Zirconium		0.0001	0.0003	0.0003	<0.0001	<0.0001	<0.0001	0.0003	<0.001	0.0005	<0.0001	<0.0001	<0.001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-

TABLE 5.2-1: SUMMARY OF GROUNDWATER CHEMISTRY AT MACTUNG PROPERTY (CONTINUED)

Analyte	Units																					Yukon CSR	CCME Guideline [1,2]	CCME Guideline [1,2]
		Reference Number	638159-6	638159-3	658097-1	678523-5	685651-7	637977-1	685651-1	658097-3	658097-2	678523-2	685651-3	685651-6	637977-5	637977-2	638159-9	638159-1	638159-5	638159-4	678523-6			
		Sample Date	18-Aug-08	18-Aug-08	18-Nov-08	19-Apr-09	31-May-09	5-Aug-08	31-May-09	19-Nov-08	19-Nov-08	17-Apr-09	31-May-09	31-May-09	21-Jul-08	9-Aug-08	19-Aug-08	21-Aug-08	18-Aug-08	20-Aug-08	17-Apr-09			
		Site	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung	Mactung			
			MT-MW-08-08					Warm Spring	MT-MW-08-03	MT-MW-08-04	MW-MT-08-04B			MW-MT-08-08	n/a									
		Sample Name	MT-MW-08-08	MT-MW-08-08	MT-MW-08-08	MW-MT-08-08	MW-MT-08-08	Warm Spring	MT-MW-08-03	MT-MW-08-04	MT-MW-08-04B	MW-MT-08-04B	MW-MT-08-04B	MW-MT-08-08	MT Spring	Drill Water #3	Drill Water #4B	Drill Water #6	Drill Water #8	Field Blank	MW-MT-08-13			
		Sample Location	DDH	Duplicate	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	DDH	Spring	Sump	Tributary C	Tributary C	Sump	Blank	Blank	Aquatic Life	Aquatic Life	Aquatic Life
		Matrix	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Surface Water	Surface Water	Surface Water	Water	Water			
		Relative Groundwater Depth	Deep	Deep	Deep	Deep	Deep	Deep	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow	Shallow	-	-	-	-	-			× 10
		Detection Limit	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results			
Metals - Total																								
Mercury		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.08000	0.11000	0.02000	0.04000	0.20000	0.34000	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0	0.000026	0.00026
Aluminum		0.005	1.050	1.000	1.100	0.534	0.962	0.123	288.000	131.000	261.000	126.000	410.000	383.000	0.030	0.015	0.078	0.020	0.021	<0.005	<0.005	-	0.1	1
Antimony		0.0002	0.0099	0.0098	0.0097	0.0103	0.0094	<0.0002	<0.1	<0.01	0.0100	0.0089	<0.1	<0.1	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.2	-	-
Arsenic		0.0002	0.0063	0.0060	0.0067	0.0087	0.0095	0.0006	<0.1	0.5210	0.2600	0.2380	1.4000	<0.1	0.0003	<0.0002	0.0011	0.0009	0.0003	<0.0002	<0.0002	0.05	0.005	0.05
Barium		0.001	0.022	0.021	0.029	0.016	0.031	0.038	4.000	4.600	7.580	2.960	10.000	3.000	0.007	0.008	0.020	0.021	0.005	<0.001	<0.001	10	-	-
Beryllium		0.00004	0.00006	0.00007	0.00005	<0.00004	0.00006	<0.00004	<0.02	0.01100	0.00920	0.00798	0.06200	0.04000	<0.00004	<0.00004	0.00008	<0.00004	<0.00004	<0.00004	<0.00004	0.053	-	-
Bismuth		0.0001	0.0005	0.0005	0.0002	0.0001	0.0001	<0.0001	<0.05	0.0670	<0.005	0.0052	0.2000	<0.05	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Boron		0.005	<0.005	<0.005	0.011	0.006	0.016	0.442	<2	<0.2	<0.2	<0.02	<2	<2	<0.005	0.007	<0.005	<0.005	<0.005	<0.005	0.016	-	-	-
Cadmium		0.00001	0.00008	0.00008	0.00014	0.00036	0.00258	0.00007	0.01700	0.01150	0.12400	0.12200	0.04600	0.02800	0.00001	0.00003	**0.00024**	0.00015	<0.00001	<0.00001	<0.00001	0.0005-0.0006	0.000017	0.00017
Calcium		0.04	32.90	33.00	33.60	27.10	39.00	2.27	276.00	237.00	377.00	158.00	88.20	27.20	31.80	40.10	44.30	44.20	18.80	<0.04	0.33	-	-	-
Chromium		0.0004	0.0018	0.0017	0.0022	0.0018	0.0035	<0.0004	0.3000	0.5000	0.6440	0.3630	1.5000	0.4000	0.0005	0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.01	0.0013	0.01
Cobalt		0.00002	0.00012	0.00011	0.00052	0.00024	0.00057	0.00009	0.14000	0.10900	0.26100	0.29100	0.27000	0.18000	0.00002	0.00002	0.00118	0.00026	<0.00002	<0.00002	<0.00002	0.009	-	-
Copper		0.001	0.001	0.001	0.011	0.004	0.010	<0.001	1.000	0.890	2.800	3.080	3.000	2.000	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05-0.09	0.002 - 0.0044	0.02-0.04
Iron		0.01	0.59	0.56	0.80	0.39	1.28	0.23	74.40	202.00	490.00	512.00	145.00	74.80	0.03	0.03	0.05	0.02	0.03	0.02	<0.01	-	0.3	3
Lead		0.0001	0.0016	0.0015	0.0020	0.0012	0.0054	0.0002	0.2000	1.0600	0.2700	0.2100	3.6000	0.2000	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0001	0.06-0.16	0.0075	0.075
Lithium		0.001	0.003	0.003	0.004	0.004	0.005	0.138	<0.5	0.200	0.550	0.300	0.700	0.700	<0.001	<0.001	0.002	0.001	<0.001	<0.001	<0.001	-	-	-
Magnesium		0.04	0.68	0.65	1.13	0.66	1.04	0.04	17.30	46.00	135.00	68.80	27.60	43.50	1.73	1.20	2.98	2.56	0.87	<0.04	0.11	-	-	-
Manganese		0.0001	0.0093	0.0087	0.0155	0.0132	0.0228	0.0023	6.2600	2.1600	7.7700	11.1000	5.9800	3.4000	0.0006	0.0006	0.0487	0.0091	0.0006	<0.0001	<0.0001	-	-	-
Molybdenum	mg/L	0.00002	0.00899	0.00889	0.00970	0.01300	0.01280	0.00839	0.05000	0.04600	0.24700	0.13000	0.09400	0.02000	0.00207	0.00104	0.00091	0.00108	0.00211	<0.00002	0.00005	10	0.073	0.73
Nickel		0.001	0.001	0.001	0.002	<0.001	0.003	<0.001	<0.5	0.300	1.200	1.690	0.800	0.600	<0.001	<0.001	0.009	0.004	<0.001	<0.001	<0.001	1.1-1.5	0.156	1.5
Phosphorus		0.01	0.07	0.07	0.07	0.01	0.23	0.03	21.60	21.20	37.40	20.20	8.94	3.88	0.02	0.01	0.02	0.01	0.03	0.02	<0.010	-	-	-
Potassium		0.04	0.88	0.86	0.90	0.50	1.10	1.78	12.00	40.00	130.00	46.00	26.00	11.00	0.46	0.71	0.76	0.83	0.44	<0.04	<0.1	-	-	-
Selenium		0.0006	0.0018	0.0017	0.0019	<0.0006	<0.0006	<0.0006	<0.3	<0.03	<0.03	0.0300	<0.3	<0.3	<0.0006	0.0007	0.0009	**0.0013**	0.0006	<0.0006	<0.0006	0.01	0.001	0.01
Silicon		0.01	6.69	6.63	6.00	3.69	5.19	38.00	132.00	251.00	423.00	133.00	182.00	79.30	3.20	2.39	2.52	2.40	2.60	0.04	<0.05	-	-	-
Silver		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	<0.00001	<0.005	0.01180	0.06300	0.02460	0.02800	<0.0050	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.0005-0.015	0.0001	0.001
Sodium		0.04	5.40	5.40	9.45	9.32	12.30	71.60	3.00	13.00	6.00	2.30	6.40	0.90	0.60	0.90	0.80	0.80	0.60	0.30	1.36	-	-	-
Strontium		0.001	0.045	0.046	0.052	0.057	0.058	0.041	2.000	1.000	0.820	0.450	2.000	1.000	0.047	0.084	0.095	0.096	0.026	<0.001	0.002	-	-	-
Sulfur		0.1	-	-	-	23.800	30.200	-	16.000	-	-	51.000	10.000	4.000	-	-	-	-	-	-	<0.1	-	-	-
Tellurium		0.0001	-	-	<0.0001	<0.0001	<0.0001	-	<0.05	<0.005	<0.005	0.001	<0.05	<0.05	-	-	-	-	-	-	<0.0001	-	-	-
Thallium		0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.005	<0.0005	0.00615	0.00592	0.01000	<0.005	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.003	-	-
Thorium		0.0001	-	-	0.00040	<0.0001	0.00010	-	0.08000	0.03000	0.08900	0.07620	<0.05	<0.05	-	-	-	-	-	-	<0.0001	-	-	-
Tin		0.0001	<0.0001	<0.0001	0.0015	0.0013	0.0036	0.0003	<0.05	<0.005	<0.005	0.0120	<0.05	<0.05	<0.0001	0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	-	-	-
Titanium		0.0001	0.0256	0.0229	0.0282	0.0149	0.0322	0.0029	7.6800	3.2100	10.3000	4.7400	8.7400	7.4700	0.0019	0.0006	0.0011	0.0004	0.0010	<0.0001	<0.0001	1	-	-
Uranium		0.0004	0.0007	0.0007	0.0010	0.0008	0.0008	<0.0004	<0.2	0.0630	0.1400	0.0888	0.2000	<0.2	0.0006	<0.0004	0.0004	0.0006	<0.0004	<0.0004	<0.0004	3	-	-
Vanadium		0.00003	0.00808	0.00761	0.00646	0.00395	0.00499	0.00078	0.92600	0.32700	1.86000	0.95800	1.32000	1.15000	0.00046	0.00034	0.00015	0.00009	0.00043	<0.00003	<0.00004	-	-	-
Zinc		0.001	0.007	0.010	0.207	0.096	0.119	0.005	2.000	1.400	11.000	10.600	5.000	4.000	0.002	0.002	0.011	0.009	0.004	0.003	0.006	0.15-2.4	0.03	0.3
Zirconium		0.0001	0.0003	0.0004	-	0.0002	0.0002	0.0004	0.0900	-	-	0.0380	0.0800	0.1000	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-

Notes:

"<" indicates less than the laboratory detection limit

"-" indicates no guidelines or no standards established

Applicable Standard: Underline indicates exceeds Yukon CSR Standard (note: CSR Standard compared with total metals concentrations for surface water, and dissolved metals concentrations for groundwater).

Comparison Guidelines: **Bold Highlighting- indicates results exceed CCME Aquatic life guidelines (Note: Used total metals for surface water and dissolved metals for groundwater)**

Comparison Guidelines: **Bold Highlighting and Borders- indicates results exceed CCME Aquatic life guidelines x 10 (Note: Used total metals for surface water and dissolved metals for groundwater)**

[1] Canadian Water Quality Guidelines for the Protection of Aquatice Life, Canadian Council of Ministers of the Environment ("CCME"), updated 6.0, July 2006

[2] Standard based on Canadian Trigger Ranges for ultra-oligotrophic, the most stringent of standards.

[3] Standard is for Chromium VI.

[4] Standard is based on hardness (CaCO3) where copper equals; 0.002 mg/L when hardness is 0 - 120 mg/l, 0.003 mg/L when hardness is 120-180 mg/L, 0.004 mg/L when hardness is >180 mg/L.

[5] Standard is based on hardness (CaCO3) where lead equals; 0.001 mg/L when hardness is 0 - 60 mg/l, 0.002 mg/L when hardness is 60-120 mg/L, 0.004 mg/L when hardness is 120 - 180 mg/L, 0.007 when hardness is >180 mg/L.

[6] Standard is based on hardness (CaCO3) where nickel equals; 0.025 mg/L when hardness is 0 - 60 mg/l, 0.065 mg/L when hardness is 60-120 mg/L, 0.110 mg/L when hardness is 120 - 180 mg/L, 0.150 when hardness is >180 mg/L.

TABLE 5.2-2: SUMMARY OF PIEZOMETRIC HEAD MEASUREMENTS

Well	Deep Installation										
	Grade Elevation	Depth to Middle of Screened Interval	Screen Length	Aug-09	Sep-08	Nov-08	Apr-09	May-09	Min	Max	Max-Min
	m asl	m	m	m asl					m asl		m
MW-MT-08-01*	2064.61	351.43	--	1771.30	--	--	1749.80	1747.84	1747.84	1771.30	23.46
MW-MT-08-03	1656.74	54.30	12.2	1647.65	1647.90	1646.53	1646.07	1648.29	1646.07	1648.29	2.22
MW-MT-08-04	1591.39	36.00	12.2	1591.17	1591.06	1590.31	1589.55	1590.79	1589.55	1591.17	1.62
MW-MT-08-04B	1599.29	33.45	12.2	1599.44	1599.48	artesian/frozen	artesian/frozen	artesian/frozen	1599.44	1599.48	0.04
MW-MT-08-05	1520.04	29.90	12.2	1520.09	1521.01	artesian/frozen	artesian/frozen	artesian/frozen	1520.09	>1521.14	>1.05
MW-MT-08-06	1497.69	53.97	12.2	1489.54	1490.34	1488.89	1488.64	1489.83	1488.64	1490.34	1.71
MW-MT-08-07*	1495.86	30.18	--	1509.60	1509.50	1505.00	1499.50	1505.63	1499.50	1509.60	10.10
MW-MT-08-08*	1796.44	96.90	12.2	1757.00	1756.60	1755.90	1753.80	1754.18	1753.80	1757.00	3.20

Well	Shallow Installation										
	Grade Elevation	Depth to Middle of Screened Interval	Screen Length	Aug-09	Sep-08	Nov-08	Apr-09	May-09	Min	Max	Max-Min
	m asl	m	m	m asl					m asl		m
MW-MT-08-01	2064.61	1.68	1.5	dry	dry	-	-	-	-	-	-
MW-MT-08-03	1656.74	3.53	1.5	1653.41	1653.42	1652.00	1651.54	1654.24	1651.54	1654.24	2.70
MW-MT-08-04	1591.39	3.51	1.5	1591.09	1591.01	1590.23	1589.53	1590.74	1589.53	1591.09	1.56
MW-MT-08-04B	1599.29	3.82	1.5	1598.45	1598.29	1597.53	1597.27	1598.51†	1597.27	1598.51	>1.24
MW-MT-08-05	1520.04	4.15	1.5	1518.53	1519.57	frozen‡	frozen‡	frozen‡	1518.53	-	-
MW-MT-08-06	1497.69	3.82	1.5	dry	1493.44	dry	dry	1497.65†	<1493.15	1497.65	>4.5
MW-MT-08-08	1796.44	1.35	1.5	dry	1794.43	1794.65	dry	1795.02	<1794.29	1795.02	>0.73

Notes: * Vibrating Wire Piezometer readings; converted into piezometric heads
† Frozen; measurement indicates minimum piezometric head
‡ Well casing pluged by ice due to overtopping of deep artesian groundwater

The groundwater elevation in the shallow monitoring wells also changed by a few meters between August 2008 and April 2009. The shallow monitoring well MW-MT-08-01 was dry during August and September 2008. The shallow installations in MW-MT-08-06 and MW-MT-08-08 were also temporarily dry. The shallow groundwater elevation in MW-MT-08-06 and MW-MT-08-04B increased between the sampling events in April and May 2009 and froze at shallow depth. Therefore only a minimum seasonal change can be shown for these wells. The shallow installation of MW-MT-08-05 was blocked by an ice plug due to overtopping of the artesian deep installation.

Although the piezometric heads in both shallow and deep aquifers at the Site change seasonally the groundwater flow regime does not change considerably. Figure 4.1.10-14 of the project proposal shows a piezometric head contour map indicating the direction of groundwater flow. The steep topography at the Site causes a similarly steep hydraulic gradient. Therefore, slight seasonal changes of piezometric head as observed between August 2008 and May 2009 do not alter the groundwater flow regime significantly, and the groundwater discharge zones remain essentially the same seasonally.

b) A clear description and illustration of the relationship between the groundwater table and permafrost, which incorporates any new hydrogeological information collected.

A revised description and illustration of the relationship between the groundwater table and permafrost, which incorporates all new hydrogeological information is provided in Section 4.1.3.

c) Detail a thorough understanding of groundwater and the hydrological regime in the area with particular focus on areas of groundwater and surface water interaction (i.e. Tributaries C, C2 and C3) and below the ravine dam in order to design an effective pumping system.

Updated information on the hydrological regime based on new monitoring data and an updated water balance is presented in Section 5.4.

Tributaries C, C2, and C3 are all located within groundwater discharge areas. Groundwater discharge estimates are based on the Regional Hydrological Analysis completed, and assume that base flow conditions in March of each year represent 100% groundwater discharge. The deep and shallow aquifers at the site have been observed to remain un-frozen in the valleys and therefore groundwater discharge to these surface water features occurs year round. Hydrology data collected on the site in winter confirms flow in these tributaries and corroborates the fact that groundwater discharge occurs year round. It is expected that groundwater discharge will increase slightly in summer months due to the significant recharge from snow melt. However, during these periods of increased groundwater discharge, there will also be significantly higher flows in these tributaries due to surface water run-off. The critical time with respect to groundwater-surface water interaction related to surface water quality is during winter base flow conditions.

The proposed mine infrastructure will not alter the groundwater-surface water interactions substantially, as the groundwater flow in both the deep and shallow aquifers is controlled by the steep topography bounding the valley in which Tributaries C, C2, and C3 exist.

Tributary C

Tributary C will remain a groundwater discharge area during mine operation in all areas with the exception of the reservoir. Upstream of the ravine dam, discharging groundwater will flow in Tributary C to the ravine dam where it will collect within the reservoir, and be mixed with process water, and surface runoff (see updated water balance in Section 5.4).

Groundwater and surface water interaction will be affected slightly in the area immediately around the reservoir. The topography, and groundwater gradients in this area are steep and the impoundment of water behind the dam will cause a localized surface water discharge to groundwater. At the ravine dam, some surface water from the reservoir will underflow the dam and recharge shallow groundwater. Because the Valley is steep and there is an observed upward vertical gradient, this groundwater would eventually discharge back to Tributary C (unless pump back from pumping wells is required).

Tributary C2 and C3

Within the project proposal submission, EBA had interpreted that all of the groundwater discharge from the proposed development at Mactung, including the proposed underground workings and ore body, would report to Tributary C above the location of the proposed ravine dam. A "boundary flow line" (see Figure 6.2.8-3) was presented based on the interpretation of hydraulic heads measurements from 15 monitoring wells (eight deep and seven shallow) and topography. However, according to YESAB, the Yukon Government has indicated that existing groundwater data are insufficient to conclude that groundwater coming off the ore body will not affect Tributaries C2 and C3. Two scenarios have now been considered to address this concern:

- Scenario 1: Groundwater flow through the area of the ore body and proposed underground workings all reports to Tributary C above the ravine dam (presented in the conceptual model in the project proposal); and,
- Scenario 2: Groundwater flow through the area of the ore body and proposed underground workings reports to Tributary C, C2, and C3. During the period of mining at the westernmost part of the underground workings (areas most likely to be upgradient of Tributaries C2 and C3) there will be active dewatering within that portion of the mine. Therefore there will be a reversed gradient and no groundwater flow towards Tributary C2 or C3 (See Figure 4.1.3-4). After closure, some of the groundwater flowing through the backfilled underground workings would report to Tributary C2 and C3 in this scenario. The significance of this occurrence is evaluated below using the same method presented in the project proposal regarding post closure water seepage through the mine workings.

In both scenarios, mined-out stopes will be backfilled with tailings and waste rock. After dewatering has ceased, the piezometric level will start to recover to its natural condition. As a result, the lowest part of the underground workings below an elevation of approximately 1,775 m asl (or lower based on new monitoring data) will flood and groundwater will move through the abandoned underground workings following the natural hydraulic gradient to the south towards Tributary C (Scenario 1) and possibly Tributary C2 and C3 (Scenario 2). Stope and drift walls as well as backfill materials will have been exposed to atmospheric oxygen during the operation phase and sulphide minerals may have started to oxidize. This provides the potential for the generation of acid rock drainage at least during the initial phase of flooding when oxygen will be available. However, after flooding, oxygen availability will be very limited due to the fact that stopes will be sealed off with bulkheads preventing any air circulation from atmosphere. Furthermore, the chemical condition of groundwater flowing through the mine will likely be reducing resulting in low amounts of dissolved oxygen. Therefore, in each scenario, potential acid generation and associated metals leaching will be mainly restricted to the initial phase of flooding of the underground workings.

The post closure flow rate through the underground workings is estimated to be 0.22 L/s (see project proposal). In Scenario 1, the conceptual outflow hydrograph for Tributary C at the ravine dam based on the regional hydrological model in post mining conditions (with no diversion of surface run-off post closure) indicates that the lowest (base) flow in Tributary C at the ravine dam location will be approximately 8 L/s. In Scenario 2, the conceptual outflow hydrograph for the watershed area that contributes to Tributary C, C1, C2, and C3 is increased by approximately 75% over Scenario 1 due to the increase in the contributing watershed. Based on the increased outflow, the calculated low flow in Tributary C at the confluence with Tributary C3 would be on the order of 14 L/s. The estimated groundwater discharge from the underground workings corresponds to less than 3% of base flow discharge in Tributary C at the ravine dam (Scenario 1) and less than 2% of the total estimated base flow discharge of Tributary C (at Tributary C3) in Scenario 2. Note that this only applies during the time of minimum base flow in Tributary C in late winter. At other times of the year when there is substantial surface water runoff, the contribution of the groundwater that might be affected by seepage through the underground workings will be even lower (<1%) by volume for both scenarios.

For each of these scenarios the magnitude of the effect is low, the extent is local, and the effect is long-term in duration. The overall significance of either scenario has been identified as being low because:

- acid generation and metals leaching will be very limited due to the low oxygen content in water within the flooded underground workings; and,
- the potentially affected groundwater represents only a small percentage (<1% to 2 or 3%) of the total discharge of Tributary C at the point of surface water discharge.

Below Ravine Dam

Tribuatry C below the ravine dam is currently a groundwater discharge area, and will remain a groundwater discharge area during the time that the reservoir dam exists and post closure after the dam is decommissioned. The reservoir dam will be constructed upon fractured bedrock and some groundwater seepage under the dam (through bedrock discontinuities, fractures or faults) is expected. As explained earlier in Section 3.12(d) and (e) the reservoir is not designed or relied upon to act as an exfiltration pond; however, it is expected that some dam underflow will occur. This underflow will mix with the underlying groundwater and potentially change the quality of the shallow groundwater. Seepage from the reservoir will occur throughout the year, and will increase in times of increased water retention behind the dam. Water retention behind the ravine dam will result in an increased hydraulic head and thus increased groundwater flow through discontinuities in the bedrock that underlies the dam. The rate of dam "underflow" has been predicted using a scoping-level 2D flow model to be in the order of 500 to 750 m^3/day. However, as mentioned in Sections 3.12(d) and (e), dam underflow may be reduced with time as fine sediments and mineral precipitates accumulate within the reservoir and decrease the hydraulic conductivity of the base of the reservoir in the vicinity of the dam.

If reservoir water quality exceeds discharge standards, groundwater samples will be collected monthly from the downstream monitoring/pumping wells to determine groundwater quality downgradient of ravine dam. The results will be used by NATC to determine whether pumping needs to be initiated to capture the dam underflow. If groundwater quality at the control point (monitoring/pumping wells) exceeds discharge criteria, the pumps would be activated, and water would be pumped back to the reservoir. This will be achieved through the use of pumping wells located approximately 100 m downstream of the dam. Based on the bedrock hydraulic properties from discrete test intervals in four drill holes in the vicinity of the dam, and the predicted dam underflow volume it has been calculated that between three to five wells would be required to capture the predicted dam underflow volumes (using Seaburn (1989)) capture zone method for recovery system design).

Environment Canada has stated that "much more hydrogeological information would be needed to properly design an effective pumping system that would capture a contaminant plume". This requested level of effort relates to detailed design and should not be required until later in the mine development design process. NATC agrees that additional testing information is required prior to final design of an adequate capture well system. Prior to development, NATC proposes to install a series of test wells and complete pumping tests to verify that the capture zone systems would be effective in capturing potential groundwater outflow from the reservoir. Based on the hydrogeological regime and groundwater surface-water interaction, an effective recovery system can and will be designed prior to operation.

d) Provide a comparison of different assumptions and calculation methods to better bound the range of expected inflow rates, into the underground.

Hydraulic data collected from the monitoring wells MW-MT-08-01 and MW-MT-08-08 at Mt. Allan (see Figures 4.1.3-2 and 4.1.3-3) indicate that the deepest, westerly part of the proposed underground workings will occur below the existing static piezometric water level. MW-MT-08-01 is equipped with a Vibrating Wire Piezometer (VWP) at a depth of 337 m below surface to measure insitu pore water pressure and temperature. The temperature measurements indicate that this VWP is installed at a depth below the base of the permafrost. The pore water pressure data collected in August/September 2008, April 2009, and late May 2009 suggest that the piezometric water level dropped from about 1772 m asl to 1750 m asl over that nine month period.

To estimate the magnitude of groundwater inflow to the proposed underground workings, it was assumed that the proposed underground workings below 1775 m asl would occur below the groundwater table. This assumption was based on the initial pore water pressure measurement in August/September 2008 and the additional consideration of possible seasonal fluctuations of the pore water pressure. Based on additional data collected since August 2008, a maximum hydraulic head of 1775 m asl appears to be a conservative assumption. The bottom of the proposed underground workings will be located at an elevation of about 1710 m asl. Therefore, based on available data and accounting for some additional uncertainty, a drawdown of the existing static piezometric water level by 30 to 70 m will become necessary to dewater the deepest, western part of the proposed underground workings.

Due to the complex hydrogeological conditions at the Site and the simplifying nature of the analytical models for mine inflow prediction, a considerable uncertainty is associated with the estimate of water inflow rates. To better constrain the possible inflow rates to the proposed underground workings, different models were used to calculate and compare rates of inflow under various conditions. In addition, different scenarios were simulated to account for uncertainty in parameter values.

A common and widely used method to estimate inflow rates to underground mine workings is the equivalent well approach. This approach assumes that dewatering of the mine is carried out by the use of an imaginary pumping well from which water is pumped at a uniform discharge rate to lower the piezometric level of the aquifer to below the bottom of the mine workings. Several analytical models have been developed to account for different aquifer types and hydraulic conditions (e.g., Singh and Reed, 1988; Singh and Atkins, 1984).

The hydraulic conductivity or transmissivity of the aquifer is the most critical parameter, determining the estimated inflow rate. Packer test data from three wells drilled at Mt. Allan (MW-MT-08-01, MW-MT-08-02, and MW-MT-08-08) and one pumping test in MW-MT-08-08 were used to determine the hydraulic properties of the deep aquifer in the vicinity of the proposed underground workings. Packer test results indicate hydraulic conductivities in the range from 10^{-8} to 10^{-6} m/s with the majority of the test intervals $<10^{-7}$ m/s. The bulk hydraulic conductivity determined by the pumping test in MW-MT-08-08 was 6×10^{-7} m/s, which is in good agreement with the results of the packer tests. Note that the bulk hydraulic conductivity obtained from the pumping test is higher than the mean hydraulic conductivity determined by packer tests, which is expected in a fractured aquifer where the hydraulic behaviour is often dominated by a few conductive joints.

Table 5.2-3 summarizes the analytical models and scenarios used and presents the resulting inflow rates. Depending on the model used, further parameters were varied to determine a range of anticipated inflow rates. The different scenarios account for parameter uncertainty and use a range of values based on field observations and typical literature values. The applied range of values for hydraulic conductivity and required drawdown were selected based on field data as described above. Values of storativity S and radius of influence of the drawdown R are based on typical literature values and aquifer lithology and geometry (e.g., Domenico and Schwartz, 1998; see also Section 6.2.8.3 of the project proposal). The inflow rates from the transient model 1 were calculated at two different times $t = 1$ year and $t = 6$ years because dewatering will become necessary from year 5 to 11 of the mine operation, i.e., over a period of time of 6 years.

Figures 5.2-1 to 5.2-4 illustrate the resulting anticipated ranges for the inflow rate to the proposed underground workings for the different models and scenarios summarized in Table 5.2-3.

The applied analytical models and different scenarios yield a range of inflow rates from about 1 m^3/day to 1000 m^3/day with an overall mean inflow rate of 75 m^3/day. Because the inflow rate Q is directly proportional to hydraulic conductivity K or transmissivity T, changes in K or T over several orders of magnitude cause correspondingly high changes in the inflow rate. The minimum and maximum estimates of the inflow rate correspond to the minimum and maximum K values determined by packer tests. Both estimates represent extreme scenarios and are likely to be unrealistic with respect to the bulk hydraulic properties of the aquifer. The "most probable scenario" in Table 5.2-1 is based on the bulk hydraulic conductivity obtained from a pumping test in MW-MT-08-08. EBA assumes that this scenario is the most realistic and yields the most reasonable estimate of the inflow rate ($Q_{MP,MEAN}$=90 m^3/day; mean value of "most probable scenario" from all four models used).

TABLE 5.2-3: ANALYTICAL MODELS FOR PREDICTION OF MINE WATER INFLOW RATES

Model	Model Assumptions	Equation	Scenarios	Results
1*	Equivalent well: Leaky aquifer, linear flow, transient state	$Q = \frac{4 \cdot \pi \cdot T \cdot s}{W(u)}$ $u = \frac{r^2 \cdot S}{4 \cdot T \cdot t}$	Parameter variation: K – 10^{-8} to 10^{-6} m/s s – 30 to 70 m S – 10^{-4} to 10^{-7} t – 1 and 6 years	Q_{MAX} = 516 m³/day Q_{MIN} = 1 m³/day Q_{MEAN} = 68 m³/day see Figures 5.2-1A and -1B
			Most probable scenario: $K = 6\times10^{-7}$ m/s s = 40 m $S = 10^{-6}$ t = 3 years	Q_{MP} = 85 m³/day
2	Equivalent well: Unconfined aquifer, linear flow, steady-state	$Q = \frac{\pi \cdot K \cdot s^2}{\ln(R/r)}$	Parameter variation: K – 10^{-8} to 10^{-6} m/s s – 30 to 70 m R – 300 to 1000 m	Q_{MAX} = 1919 m³/day Q_{MIN} = 1 m³/day Q_{MEAN} = 142 m³/day see Figure 5.2-2
			Most probable scenario: $K = 6\times10^{-7}$ m/s s = 40 m R = 700	Q_{MP} = 169 m³/day
3	Two-dimensional model: Unconfined aquifer, linear flow, steady state	$Q = \frac{K \cdot d \cdot s^2}{R}$	Parameter variation: K – 10^{-8} to 10^{-6} m/s s – 30 to 70 m R – 300 to 1000 m	Q_{MAX} = 423 m³/day Q_{MIN} = 0.2 m³/day Q_{MEAN} = 30 m³/day see Figure 5.2-3
			Most probable scenario: $K = 6\times10^{-7}$ m/s s = 40 m R = 700	Q_{MP} = 36 m³/day
4	Two-dimensional model: Confined aquifer, linear flow, steady state	$Q = \frac{2 \cdot K \cdot d \cdot s^2}{R}$	Parameter variation: K – 10^{-8} to 10^{-6} m/s s – 30 to 70 m R – 300 to 1000 m	Q_{MAX} = 846 m³/day Q_{MIN} = 0.5 m³/day Q_{MEAN} = 61 m³/day see Figure 5.2-4
			Most probable scenario: $K = 6\times10^{-7}$ m/s s = 40 m R = 700	Q_{MP} = 71 m³/day

Q – Discharge / inflow rate [m³/s]
K – Hydraulic Conductivity [m/s]
T – Transmissivity [m²/s]
s – Drawdown [m]
$W(u)$ – Well function (exponential integral)
R – Radius of influence [m]
r – Equivalent radius of underground workings = radius at which drawdown is required [m]
d – Equivalent length of underground workings = diameter of underground workings [m]
S – Storativity [-]

* This model was used in the original submission to estimate mine water inflow rates.

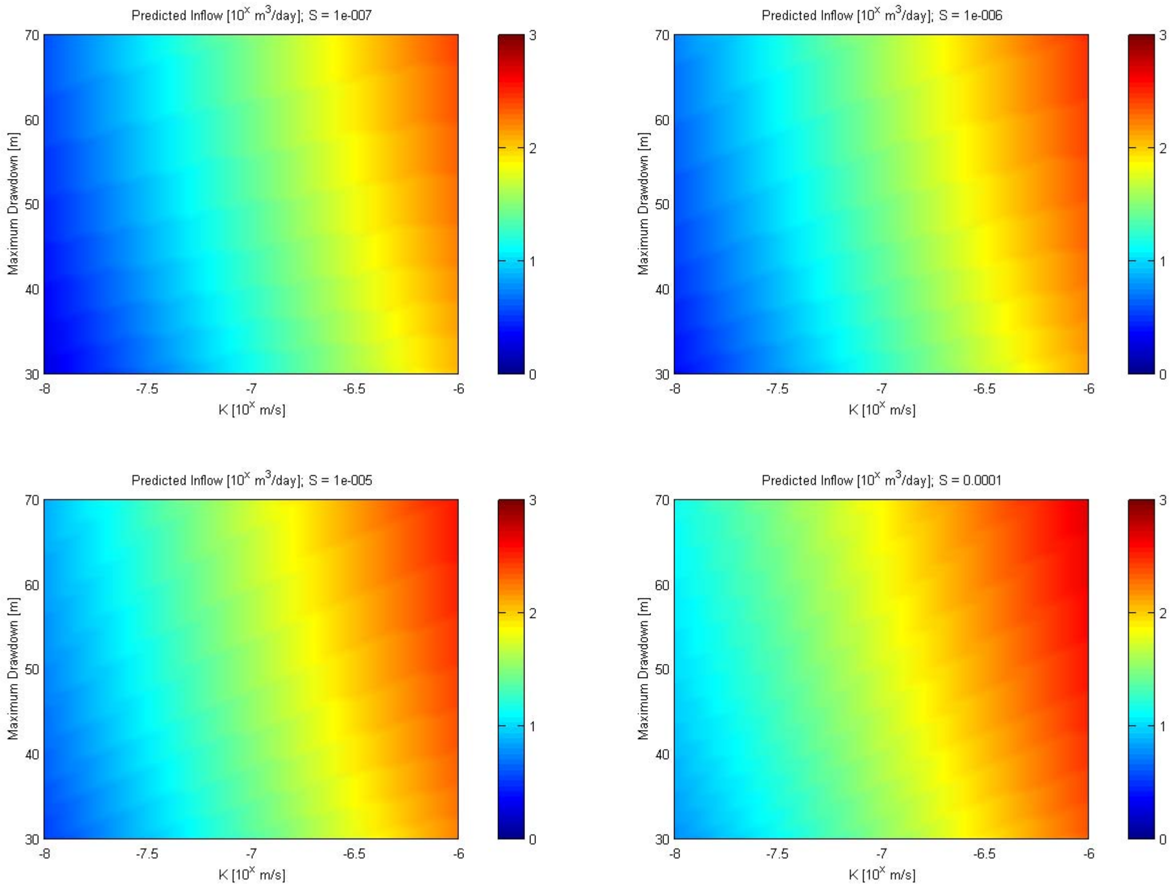


Figure 5.2-1A

Estimated inflow rates to the proposed underground workings as a function of K and s, for t = 1 year and four different values of S using Model 1 (see Table 5.2-3). Inflow rates are shown by colours, with colour bar at right indicating the inflow exponent. Note the logarithmic scale for both hydraulic conductivity K and predicted inflow rate. For example, yellow (2) on the colour bar means an inflow rate of 102 m3/day.

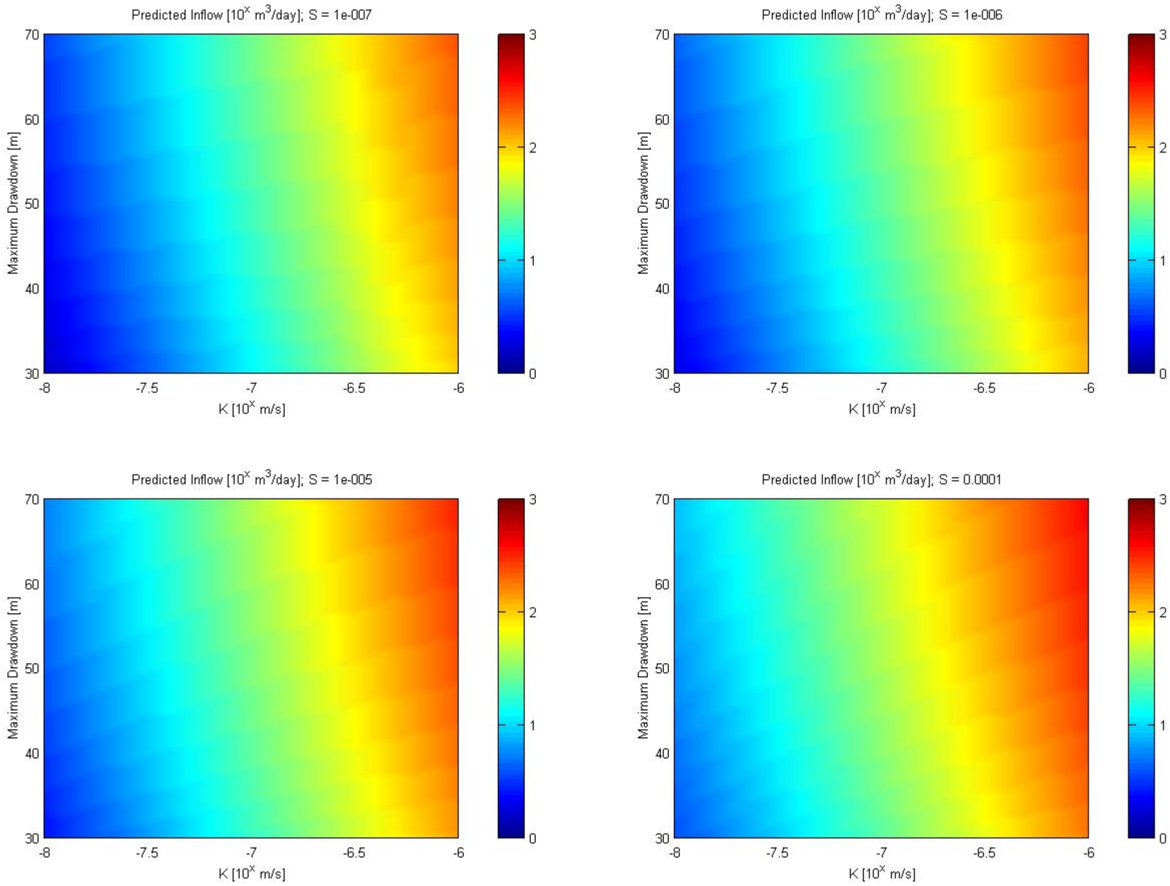


Figure 5.2-1B

Estimated inflow rates to the proposed underground workings as a function of *K* and *s*, for *t* = 6 years and four different values of *S* using Model 1 (see Table 5.2-3). Inflow rates are shown by colours, with colour bar at right indicating the inflow exponent. Note the logarithmic scale for both hydraulic conductivity K and predicted inflow rate. For example, yellow (2) on the colour bar means an inflow rate of 10^2 m3/day.

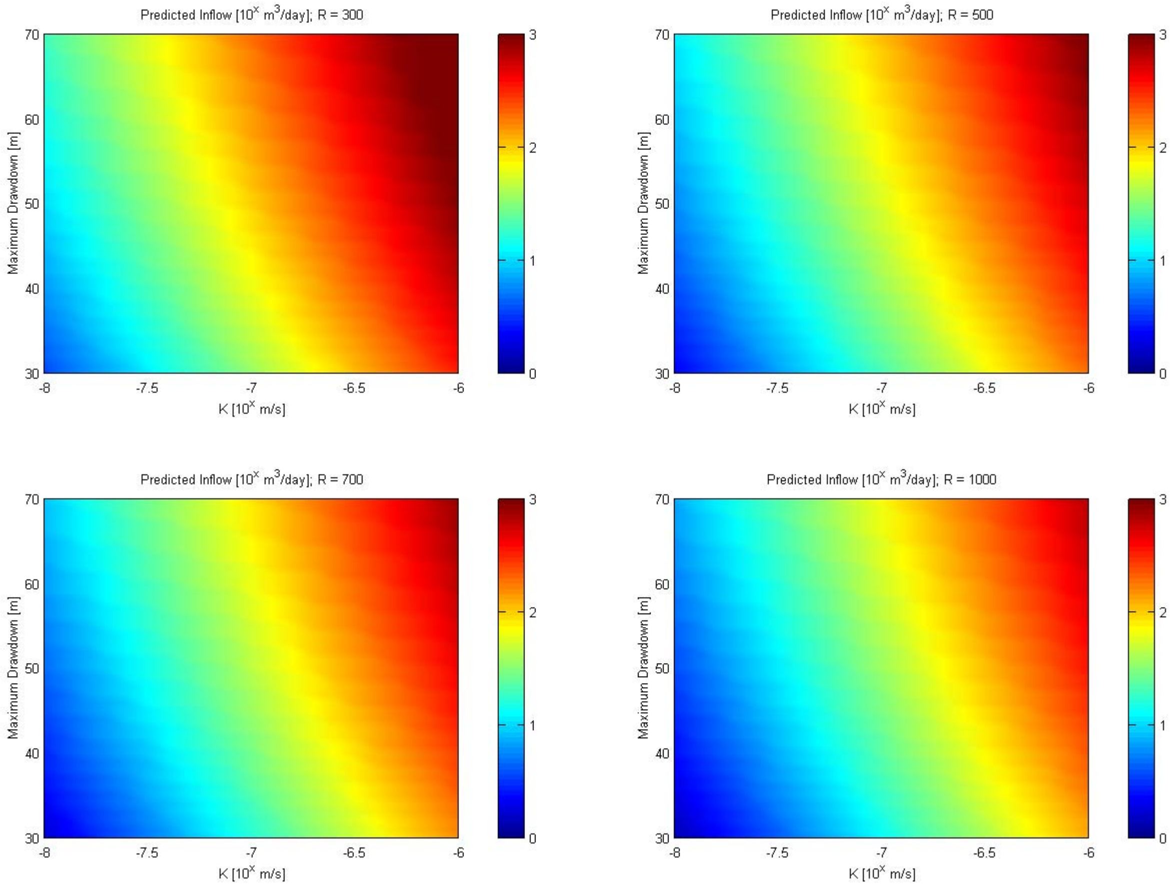


Figure 5.2-2

Estimated inflow rates to the proposed underground workings as a function of *K* and *s* and four different values of *R* using Model 2 (see Table 5.2-3). Inflow rates are shown by colours, with colour bar at right indicating the inflow exponent. Note the logarithmic scale for both hydraulic conductivity K and predicted inflow rate. For example, yellow (2) on the colour bar means an inflow rate of 10^2 m3/day.

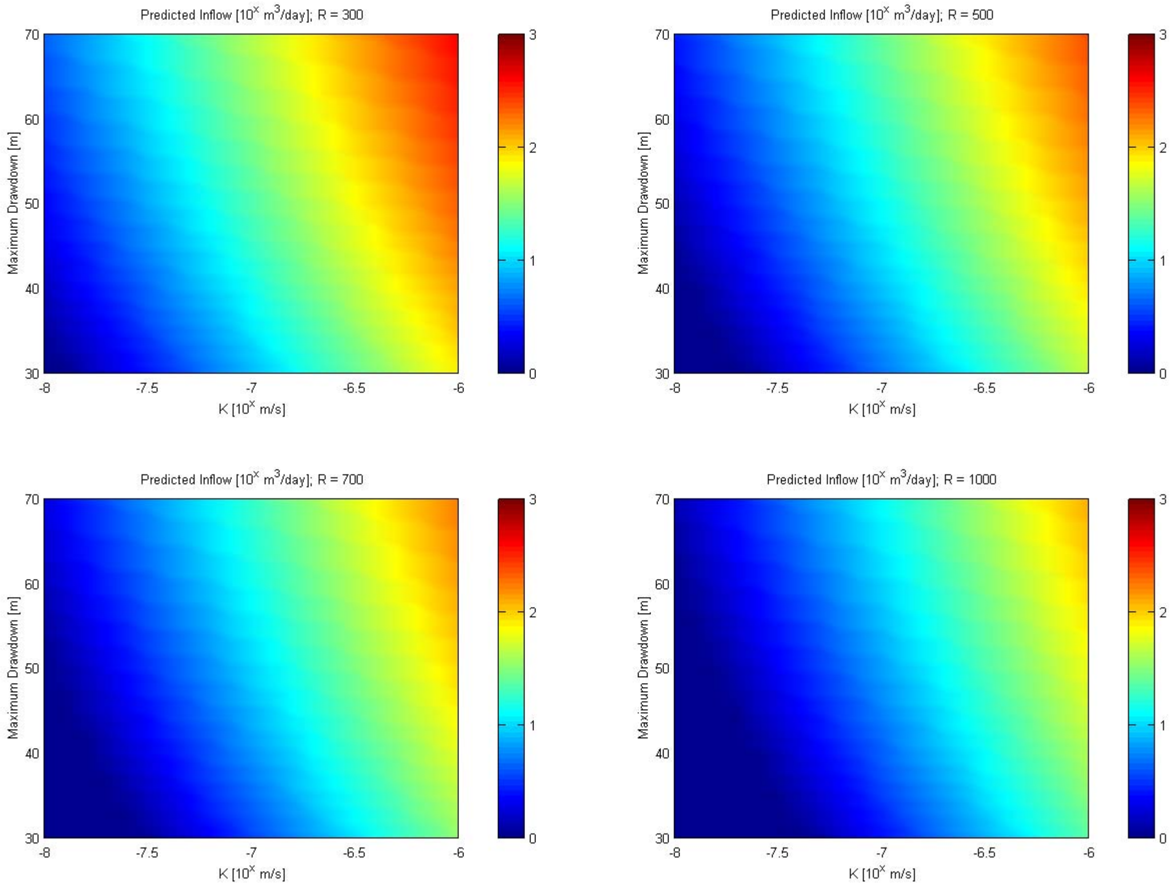


Figure 5.2-3

Estimated inflow rates to the proposed underground workings as a function of *K* and *s* and four different values of *R* using Model 3 (see Table 5.2-3). Inflow rates are shown by colours, with colour bar at right indicating the inflow exponent. Note the logarithmic scale for both hydraulic conductivity K and predicted inflow rate. For example, yellow (2) on the colour bar means an inflow rate of 10^2 m3/day.

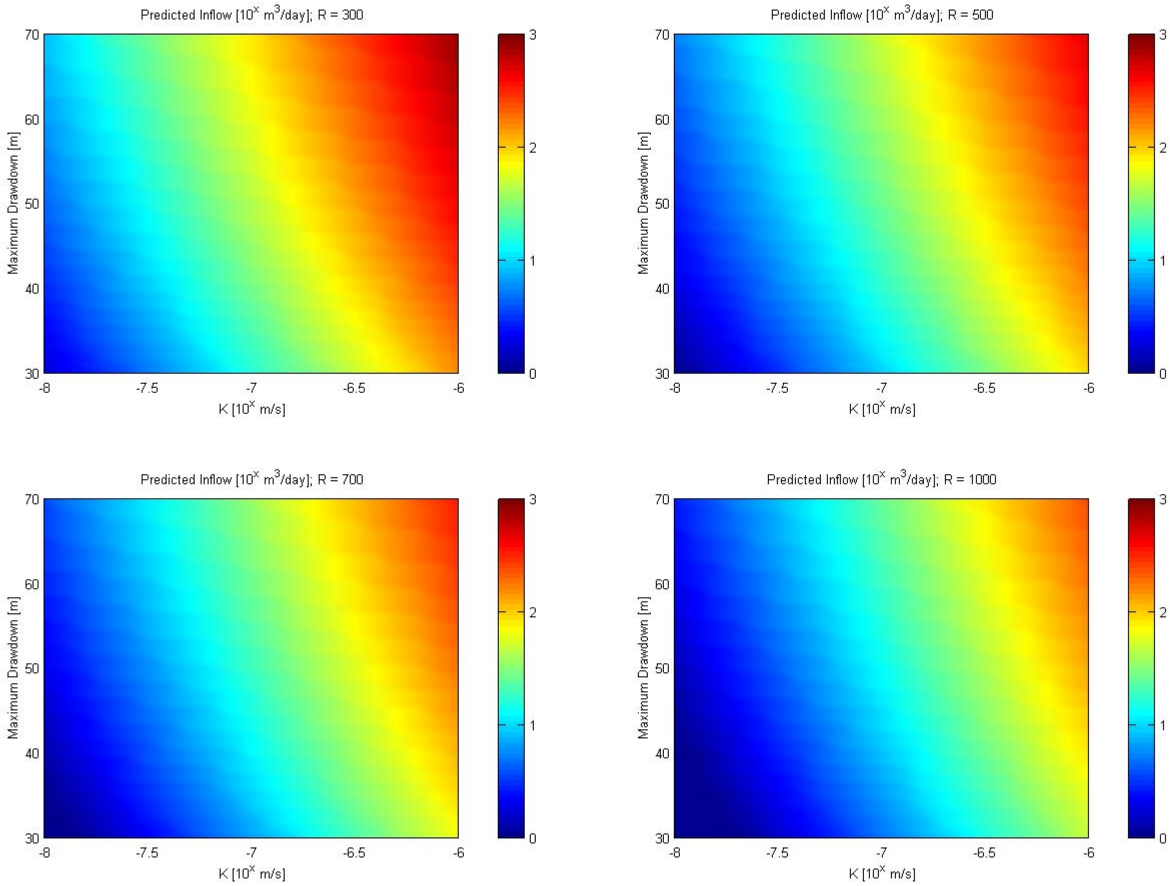


Figure 5.2-4

Estimated inflow rates to the proposed underground workings as a function of *K* and *s* and four different values of *R* using Model 4 (see Table 5.2-3). Inflow rates are shown by colours, with colour bar at right indicating the inflow exponent. Note the logarithmic scale for both hydraulic conductivity K and predicted inflow rate. For example, yellow (2) on the colour bar means an inflow rate of 10^2 m3/day.

5.3 METEOROLOGICAL DATA

Precipitation data, in particular snow survey data for the Mactung site were not provided with the project proposal. Rather, average monthly precipitation temperature data from the Macmillan Pass meteorological station was provided. From this data, the proponent anticipates that precipitation that falls between October and April will be snow and precipitation in either April or September may be snow or rain.

Environment Canada has noted that the record of precipitation from the Macmillan Pass meterological station is deficient, leading to uncertainty associated with predictions for the Mactung site. Furthermore, Appendix E2 (Mactung Project 2007 Hydrometeorological Survey) states that, due to elevation differences and mountainous terrain, "[p]recipitation data recorded at the Ministry of Environment operated MacMillan Pass meteorological station provides only a rough estimate of conditions at the MacTung Camp site." Appendix E2 and E3 from the project proposal also notes the absence of precipitation data and recommends that a precipitation gauge is installed near the proposed mine site. Further, Environment Canada notes that the 2007 hydrometeorological report provided states that "a yearly average of 663.4 mm was calculated…". This average figure is much lower and not statistically consistent with data from 2007 in the same report which states a total precipitation of 1 293 mm for only a partial year (282 days).

Precipitation in the proposed project area may have implications for the design of on-site mine infrastructure and mitigation measures related to various values. Furthermore, precipitation survey data will allow for a more accurate description of the mine site water balance (see below for mine site water balance discussion).

Of particular concern is the lack of information on snow. Given the potentially high levels of precipitation in the area, the elevation of the mine site, as well as various site specific characteristics, there is the potential for significant accumulation of snow in the area. Snow accumulation in combination with rates of snowmelt may have significant effects of the water balance in the area during freshet.

The information provided does not present the Executive Committee with a complete and concise understanding of precipitation in the area. Please provide the following information regarding precipitation in the mine area.

a) Conduct a snow survey of the mine site area and incorporate the results into the site water balance, and provide the results.

On April 16, 2009 a snow survey was conducted on the MacTung Property site. A total of 127 snow cores were collected and data on snow depth, snow density, and water content recorded. The five snowcourse areas were Mount Allan and the upper project elevations; mill area; camp area; ravine dam area, and the dry stack area/flat valley area. The average snow density for all the cores was 10.5% that of water.

Table 5.3-1 summarizes the average snowpack data collected for the five snowcourse areas.

Figure 5.3-1 indicates the locations of all 127 snow cores collected during the survey as well as the snowcourse areas, all of which were located in the areas of proposed mine infrastructure.

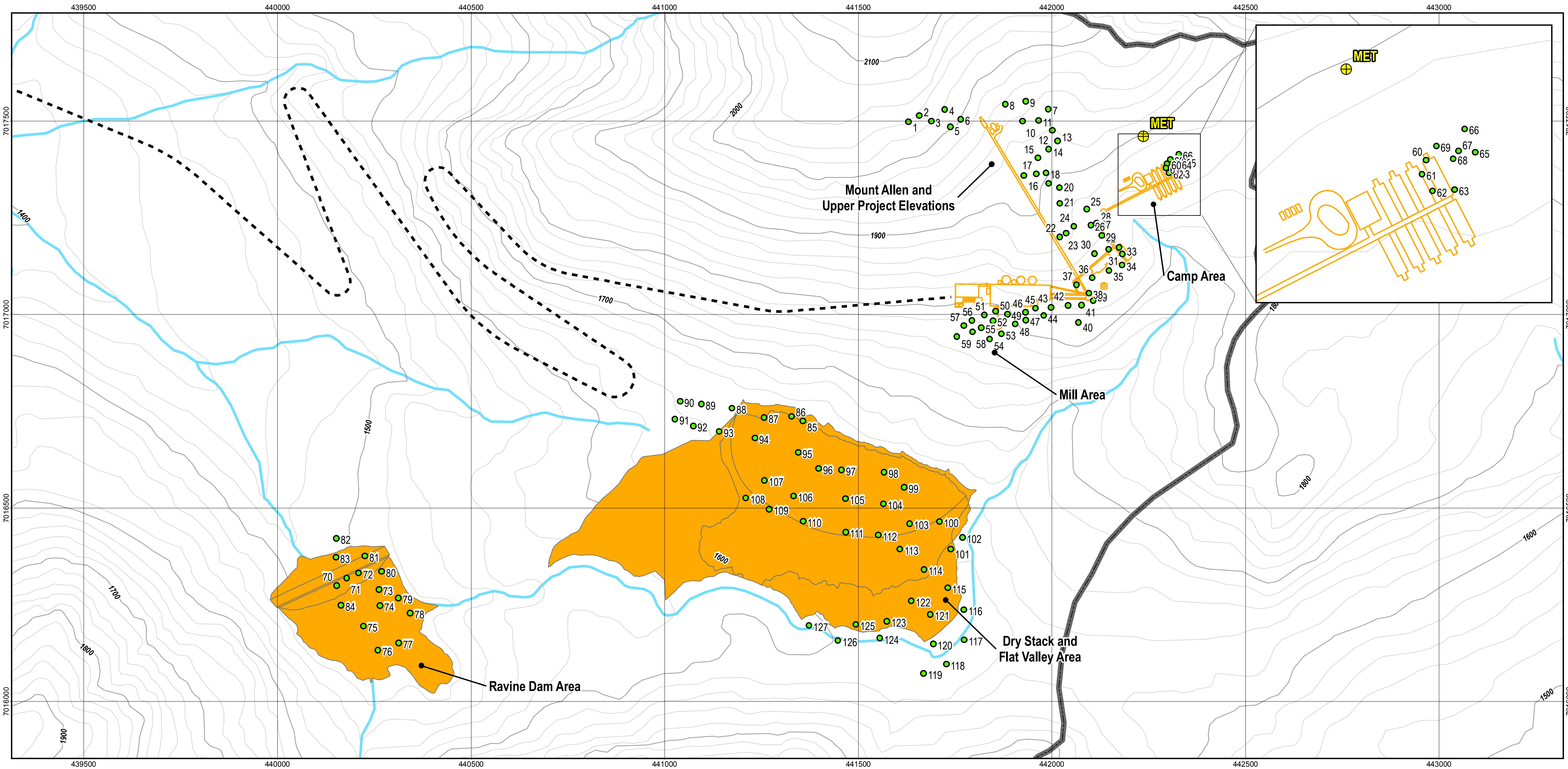
Table 5.3-2 contains data for each of the 127 snow cores sampled during the April 16, 2009 snow survey.

The timing of this survey was excellent in that the water contect of the snow was at a maximum for the winter period. In general the water content of snow in the Yukon increases until mid April then reduces after this date as the snow begins to melt.

TABLE 5.3-1: MACTUNG SNOW SURVEY APRIL 16, 2009 – SNOW CORE SUMMARY

Area Surveyed	WSG84 Easting (m)	WSG84 Northing (m)	Snow Depth (cm)	Water Content (mm)	Location Elevation (m SL)	Number of Sites in Area
Mt Allan and upper project elevations	441985	7017244	125	15	1800 to 2020	51
Mill area	441812	7016960	131	12	1770 to 1800	8
Camp area	442315	7017388	137	14	1960 to 1980	10
Ravine dam area	440232	7016280	128	11	1490 to 1520	15
Dry stack area / valley flat	441462	7016457	132	13	1580 to 1630	43

Note: The WSG 84 UTM position was determined by averaging all the coordinates for all the snow survey sites within the specified area.



LEGEND

- Hydrometric Station
- Samples
- Approximate Access Road Route
- Proposed Mine Site Infrastructure
- Contours (20m)
- Contours (100m)
- NWT - Yukon Border
- Watercourse
- Waterbody
- Wetlands

N
W E
S

NOTES
Base data source: NTDB 1:50,000

ISSUED FOR USE

MACTUNG

Mactung - April 2009 Snow Survey Sample Locations

PROJECTION	DATUM
UTM Zone 9	NAD83

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

EBA Engineering Consultants Ltd.

FILE NO.
W23101021_013_SnowSurvey.mxd

PROJECT NO.	DWN	CKD	REV
W23101021.013	MEZ	SD	0

OFFICE	DATE
EBA-VANC	June 17, 2009

Figure 5.3-1

Q:\Vancouver\GIS\ENVIRONMENTAL\W231\W23101021_MacTung\Maps\013\W23101021_013_SnowSurvey.mxd

TABLE 5.3-2: MACTUNG SNOW SURVEY DATA - APRIL 16, 2009					
Figure 1 Reference	WSG84 Easting (m)	WSG84 Northing (m)	Snow Depth (cm)	Water Content (mm)	Comments
Mt Allan and Upper Project Elevations					
1	441630	7017497	142	23	
2	441658	7017513	175	22	
3	441689	7017499	198	30	
4	441724	7017529	185	22	
5	441738	7017484	72	10	
6	441765	7017504	178	33	
7	441991	7017530	220	32	
8	441880	7017543	200	29	
9	441933	7017550	189	25	
10	441924	7017499	98	15	
11	441966	7017500	142	18	
12	442001	7017475	101	12	
13	442015	7017448	140	17	
14	441992	7017427	140	14	
15	441964	7017404	149	18	
16	441928	7017358	200	27	
17	441960	7017362	122	12	
18	441985	7017365	160	18	
19	441992	7017338	81	8	
20	442020	7017327	93	10	
21	442021	7017286	55	7	
22	442021	7017200	0	0	bare patch
23	442037	7017209	118	10	
24	442057	7017227	191	27	
25	442090	7017272	136	12	
26	442101	7017230	167	18	
27	442116	7017235	202	25	
28	442141	7017229	127	12	
29	442129	7017203	87	12	
30	442111	7017157	95	15	
31	442147	7017168	147	15	
32	442174	7017173	142	13	
33	442183	7017156	52	5	
34	442182	7017127	107	11	

35	442148	7017113	80	10	
36	442105	7017094	149	18	
37	442064	7017076	82	10	
38	442096	7017054	142	16	
39	442107	7017035	0	0	bare patch
40	442069	7016979	0	0	bare patch
41	442077	7017024	84	9	
42	442042	7017023	180	15	
43	441998	7017018	180	15	
44	441979	7016997	48	6	
45	441958	7017015	135	12	
46	441932	7017005	73	8	
47	441933	7016985	136	12	
48	441906	7016975	101	8	
49	441885	7017000	132	13	
50	441855	7017008	185	17	
51	441826	7016998	57	5	
Mill Area					
52	441848	7016983	169	17	
53	441870	7016949	157	16	
54	441840	7016936	118	11	
55	441818	7016965	190	16	
56	441794	7016984	73	7	
57	441773	7016970	90	7	
58	441796	7016954	127	12	
59	441755	7016942	120	11	
Camp Area					
60	442298	7017389	134	12	
61	442295	7017378	128	12	
62	442303	7017365	200	21	
63	442320	7017366	65	7	
64	442325	7017389	88	9	
65	442336	7017395	85	9	
66	442328	7017413	175	17	
67	442323	7017396	169	20	
68	442319	7017390	163	18	
69	442306	7017400	167	19	
Ravine Dam Area					
70	440153	7016299	88	7	
71	440179	7016318	138	8	

72	440210	7016331	142	7	
73	440262	7016289	195	14	
74	440265	7016247	99	7	
75	440222	7016194	131	9	
76	440260	7016132	202	18	
77	440313	7016151	161	11	
78	440343	7016228	101	8	
79	440312	7016267	132	15	
80	440269	7016335	48	5	
81	440226	7016375	132	12	
82	440152	7016421	91	10	
83	440151	7016372	56	9	
84	440164	7016248	207	19	
Dry-stack Area / Valley Flat					
85	441357	7016724	101	10	
86	441328	7016736	121	11	
87	441257	7016733	108	11	
88	441174	7016757	132	14	
89	441095	7016768	180	19	
90	441040	7016775	98	10	
91	441027	7016729	85	8	
92	441074	7016711	83	8	
93	441141	7016697	95	11	
94	441233	7016680	66	6	
95	441345	7016643	132	16	
96	441398	7016601	87	9	
97	441457	7016598	125	13	
98	441567	7016592	149	19	
99	441619	7016553	150	19	
100	441710	7016464	124	12	
101	441739	7016393	159	19	
102	441769	7016423	106	2	
103	441633	7016459	165	20	
104	441565	7016510	202	23	
105	441467	7016523	130	13	
106	441333	7016530	129	13	
107	441258	7016571	48	4	
108	441210	7016525	68	6	
109	441270	7016496	131	14	
110	441358	7016465	200	20	
111	441468	7016437	132	13	

112	441552	7016429	150	16	
113	441608	7016393	150	15	
114	441670	7016340	125	11	
115	441731	7016293	144	15	
116	441773	7016236	169	17	
117	441774	7016158	138	14	
118	441728	7016096	149	14	
119	441669	7016072	140	14	
120	441694	7016148	146	15	
121	441686	7016224	143	14	
122	441637	7016259	168	17	
123	441574	7016207	146	15	
124	441556	7016163	145	14	
125	441494	7016198	202	18	
126	441448	7016157	132	13	
127	441373	7016196	138	15	

b) Provide accurate and defensible precipitation data for the Mactung site, whether determined through on-site measurement or other conservative estimations approved by Environment Canada. This information is critical to an accurate site water balance discussed below.

Measurement of precipitation at the Mactung site has not been undertaken. The Macmillan Pass meteorological station was therefore used to estimate yearly precipitation at the Mactung Property in the project proposal. However, as the Macmillan Pass station is located on the lee-side of the mountain and 481 m lower than the Mactung site, the precipitation could be underestimated due to orographic effects.

As a result, a regional precipitation analysis was conducted to assess the orographic effects on the precipitation in this mountainous region. There are no other nearby climate stations, so a radius of 200 km from the Mactung site was searched and four climate stations with relatively long periods of record were selected. The properties of the selected climate stations are listed in Table 5.3-3.

TABLE 5.3-3: REGIONAL CLIMATE STATIONS

Station	Latitude	Longitude	Period	Elevation	Mean Annual Precipitation (m)
Macmillan Pass	63.24	-130.04	2003-2005	1379	627
Ross River	61.98	-132.45	1994-2005	698	229
Tungsten	61.95	-128.25	172-1990	1143	595
Farp	62.21	-133.38	1987-2009	717	316

The station elevation was plotted against the Mean Annual Precipitation (MAP) as shown in Figure 5.3-2. A good correlation (R^2 equal to 0.91) results. The MAP for the Mactung site is estimated to be 1036 mm by extrapolating to the site elevation of 1860 m using the equation shown in Figure 5.3-2.

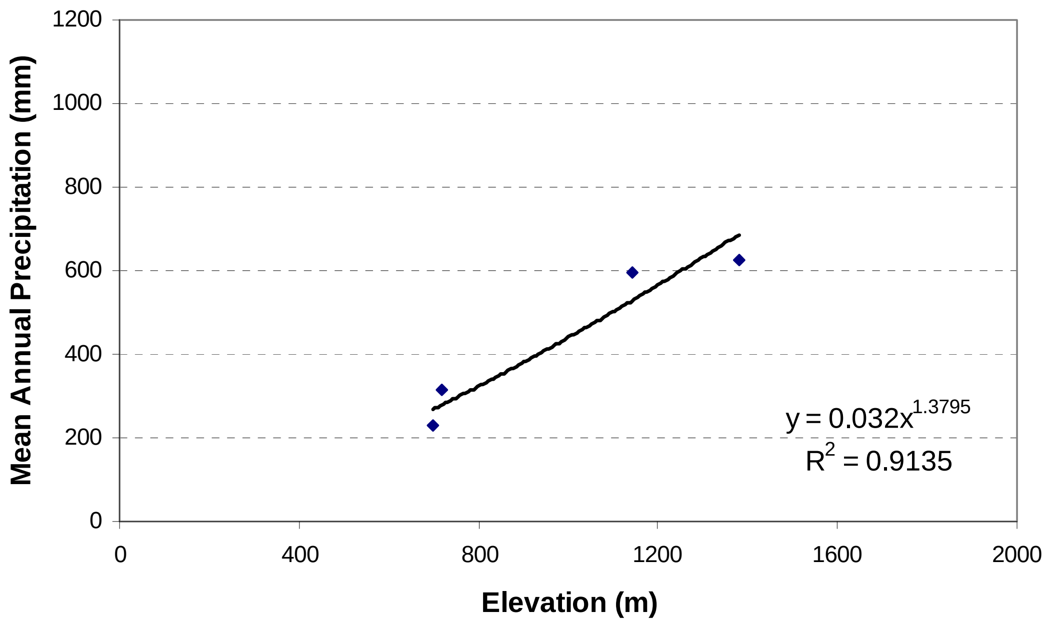


Figure 5.3-2
Mean Annual Precipitation (MAP) Correlation

An empirical equation developed by Aur Resource Inc. (1997) was also used to check the accuracy of the regional precipitation analysis. The equation, as provided below, was developed based on the extensive precipitation analysis experiences gained in the Yukon interior and central BC. E is the elevation of the ungauged point in metres.

$$MAP = 645 + 0.5\ (E-1143)$$

The estimated MAP for the Mactung site using this empirical equation is 1004 mm. The difference between the two methods is 3%, which provides a high level of confidence in the precipitation estimation. The average MAP of the two methods was calculated to be 1020 mm, which represents the annual precipitation in the Mactung site.

The estimated MAP for the Mactung site was distributed over a twelve-month period according to the Macmillan Pass climate station, which is in close vicinity to the project site. The monthly precipitation is provided in Table 5.3-4.

TABLE 5.3-4: ESTIMATED MEAN MONTHLY PRECIPITAION (mm) AT THE MACTUNG SITE													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation	39	88	97	112	46	106	85	118	67	93	73	96	1020

It should be noted that the above two methods considered elevation as the principal variable influencing precipitation at the Mactung site. However, the spatial distribution of the precipitation may be influenced by other factors such as watershed slope and aspect, which are not accounted for in this analysis. It should also be noted that this site is at a topographic divide which in itself can complicate local weather due to boundary layer effects and main valley wind patterns.

c) Based upon the information collected above, discuss and detail the implications to proposed activities and requirements, including but not limited to infrastructure, mitigation measures, and snow management strategies.

The management of runoff, especially snowmelt runoff, will be addressed in the detailed design stage of the project. The site precipitation and runoff data will be helpful for developing return period floods, which are necessary for the drainage structure design. Diversion structures, culverts, and bridges will be designed to standard return periods. Inspection and maintenance programs will be in place to ensure that snow and ice do not compromise drainage systems. Lining of ditches will be provided in steep areas to prevent erosion. All project infrastructure except for access roads and the H. Tributary pumping station are located upstream of the ravine dam. In general, as the infrastructure is located away from the creeks, flooding of camp, mill, and truckshop is unlikely. A total precipitation gauge will be established by NATC at the site during construction and maintained through operations to provide year round precipitation data. This data will be useful for refinement of the water balance in addition to providing important winter precipitation data for use in the avalanche hazard management program.

Snowpack has been shown to be variable in the mine site area with wind drifting contributing to overall snowpack distribution. Snow clearing will be required for infrastructure components during construction and operations. Grading and sanding of roadways during winter months will be conducted as required. Buildings will be designed according to relevant building code standards which incorporate snow loading into the design. NATC will implement programs during construction and operations that allow the company to better understand and adaptively manage operations under complex climatic conditions. Snowcourses for monitoring snowpack will be established during construction and operations in order to provide better information for operational planning purposes related to snow.

5.4 MINE SITE WATER BALANCE

The project proposal indicates various water withdrawal values from the Hess River Tributary and Tributary C over various phases of the project. However, these values are not presented clearly within the report, making it difficult to gain a clear understanding of the total water withdrawal requirements for the project. Please provide the following information.

a) A concise description of the maximum water withdrawal and usage from the Hess River Tributary and Tributary C over the various phases and seasons of the proposed project.

The withdrawal rate from the H. Tributary will be approximately 32 m^3/hour (8.9 L/s or 0.0089 m^3/s). The withdrawal will be at a continuous steady rate during periods of mill operation. Withdrawals, lower than the indicated rate, would occur when the mill is not operating at maximum capacity.

Approximately 2.5 km^2 of the upper 5.0 km^2 drainage area of Tributary C is being affected by the proposed development. Natural run-off in the affected area is intercepted and the outflow controlled by the Ravine dam reservoir discharge rate. The management of the reservoir requires that water inflows equal outflows on approximately a monthly basis during months with active discharge. Active discharge from the reservoir is expected to occur for the period from May to October. Water is retained in the reservoir during the period from November to April, which will potentially reduce baseflow in Tributary C during these months.

This reduction in baseflow will be offset if groundwater seepage from the reservoir is of sufficient quality to allow for discharge into the receiving environment. Tables 5.4-1 to 5.4-9 show ravine dam discharge to Tributary C for dry, average, and wet conditions. A comparison between the rows containing the undiverted catchment run-off and the adjusted discharge to Tributary C allow for an understating of changes to the natural flow regime.

An understanding of the site water balance throughout all the phases of the project is critical to the assessment. An accurate understanding of the water balance will validate the design of on-site mine infrastructure and aid in the determining the appropriateness of mitigation measures.

The project proposal provided information regarding site water characteristics such as baseline climate, hydrology, and hydrogeology data. Potential effects related to these values were also characterized providing some indication as to the water balance for the site. A general water balance diagram and information was provided for the ravine dam reservoir during the operation phase (Figure 5.4.3-9 and Tables 5.4.3-4 and 6.2.8-2). However, some information in the project proposal complicates the understanding of the water balance at the mine site. For example, the project proposal indicates that seepage volumes from the DSTF are estimated to be 74 000 m^3/year (pages 427 and 541) while Tables 5.4.3-4 and 6.2.8-2 indicate that DSTF seepage inflow into the reservoir will be approximately 9 461 m^3/year.

The information provided relating to the site water balance does not clearly indicate all water inputs and outputs such as water withdrawals/discharges, surface and groundwater interactions, and climatic variables such as precipitation and evaporation. Full characterization of the interaction between water flow, mine site infrastructure, and accessory activities during each phase of the project has not been clearly presented.

Based on information provided in the proposal, there is not an adequate understanding the site water balance. The information provided does not present the Executive Committee with a complete and concise understanding of the water balance in the area over all phases of the proposed project. Please provide the following information.

b) A clear and defensible understanding of water balance for all of the mine site infrastructure and accessory activities during each phase of the project including pre-construction baseline, construction, operation, decommissioning, and post-closure. This information should be presented in a clear and concise format and should include but is not limited to:

   i. total anticipated water withdrawals and water discharges including any seasonal demands on the affected water resource;
   ii. site input and output locations including surface water flow, groundwater flow, pumping, etc.;
   iii. an understanding of how climatic variables (precipitation and evaporation) and their associated seasonal variability are considered;
   iv. consideration of all site infrastructure such as underground workings, infrastructure pads, waste rock piles, DSTF, water diversion and retention structures, including the ravine dam and reservoir; and,
   v. consideration of dry, wet, and average years.

Tables 5.4-1 to 5.4-9 contain the revised water balance for the proposed Mactung Mine. The water balance has been revised to show different flow scenarios (dry, average, wet) during Year 1, 6, and 11 of the proposed operations. The water balance tables show a "no pumpback scenario" for groundwater seeping from the reservoir. This scenario assumes that groundwater quality at the control point meets Water License standards and that there is no need to recycle back into the reservoir. The influence of pumping into the reservoir would be an increase in reservoir inflows and a corresponding reduction in the adjusted Tributary C discharge values. The change in Tributary C discharges would be equal to the difference in the groundwater return pumping rate of 10 L/s and the reservoir groundwater seepage rate. Pumping back at 10 L/s during the Year 1 scenario (Tables 5.4-1 to 5.4-3) when reservoir groundwater seepage is estimated at 6.6 L/s would result in a decrease in Tributary C discharge of –3.4 L/s.

Figure 5.4-1 contains a conceptual diagram showing the various infrastructure components that are part of the water balance. The project proposal (p.577) indicates that the groundwater pumpback wells will be located approximately 100 m downstream of the reservoir. The outfall location for discharge from the reservoir will be located downstream of the pumpback wells as is the outflow location for the discharge from the diversion channel.

TABLE 5.4-1: Water Balance (1:10 Dry) - Year 1 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inflow	5.02	3.47	2.95	3.72	66.72	170.01	107.42	63.32	48.12	28.43	12.37	7.38	**Inflows**
Precipitation	0.75	1.86	1.85	2.21	0.88	2.09	1.63	2.26	1.32	1.78	1.44	1.84	
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	
Underground Dewatering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Inflow to Reservoir	53.17	52.73	52.21	53.33	115.30	219.81	156.74	113.27	97.14	77.91	61.21	56.62	
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	**Outflows**
Groundwater Outflow	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	
Discharge to Trib C	0.00	0.00	0.00	0.00	-80.00	-120.00	-110.00	-80.00	-60.00	-40.41	0.00	0.00	
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	
Total Outflow from Reservoir	-51.30	-51.30	-51.30	-51.30	-131.59	-171.85	-161.75	-131.69	-111.45	-91.71	-51.30	-51.30	
Groundwater Return	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	6.60	6.60	6.60	6.60	86.60	126.60	116.60	86.60	66.60	47.01	6.60	6.60	
Reservoir Inflow Monthly Volume (m^3)	5,002	3,461	2,428	5,266	-43,627	124,305	-13,403	-49,341	-37,090	-36,946	25,700	14,246	
Beginning of Month Reservoir Volume (m^3)	159,945	164,947	168,409	170,836	176,102	132,475	256,780	243,377	194,036	156,946	120,000	145,700	
End of Month Reservoir Volume (m^3)	164,947	168,409	170,836	176,102	132,475	256,780	243,377	194,036	156,946	120,000	145,700	159,945	
End of Month Reservoir Elevation (m)	1507.5	1507.5	1507.5	1507.5	1506.5	1509.0	1509.0	1508.0	1507.0	1506.0	1507.0	1507.0	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.

TABLE 5.4-2: Water Balance (1:2) - Year 1 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inflow	6.05	4.18	3.56	4.48	80.37	204.78	129.38	76.27	57.96	34.25	14.90	8.89	Inflows
Precipitation	1.00	2.50	2.49	2.97	1.18	2.81	2.18	3.02	1.77	2.38	1.93	2.46	
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	
Underground Dewatering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Inflow to Reservoir	54.45	54.07	53.44	54.85	129.25	255.29	179.26	126.99	107.44	84.33	64.24	58.75	
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	Outflows
Groundwater Outflow	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	
Discharge to Trib C	0.00	0.00	0.00	0.00	-100.00	-150.00	-120.00	-100.00	-80.00	-53.17	0.00	0.00	
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	
Total Outflow from Reservoir	-51.30	-51.30	-51.30	-51.30	-151.59	-201.85	-171.75	-151.69	-131.45	-104.47	-51.30	-51.30	
Groundwater Return	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	6.60	6.60	6.60	6.60	106.60	156.60	126.60	106.60	86.60	63.17	6.60	6.60	
Reservoir Inflow Monthly Volume (m^3)	8,433	6,711	5,736	9,190	-59,847	138,512	20,131	-66,171	-62,254	-53,936	33,531	19,964	
Beginning of Month Reservoir Volume (m^3)	173,494	181,927	188,638	194,374	203,564	143,717	282,229	302,360	236,190	173,936	120,000	153,531	
End of Month Reservoir Volume (m^3)	181,927	188,638	194,374	203,564	143,717	282,229	302,360	236,190	173,936	120,000	153,531	173,494	
End of Month Reservoir Elevation (m)	1507.5	1508.0	1508.0	1508.0	1507.0	1509.5	1510.0	1509.0	1507.5	1506.0	1507.0	1507.5	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.

TABLE 5.4-3: Water Balance (1:100) - Year 1 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inflow	8.12	5.60	4.77	6.01	107.82	274.73	173.58	102.32	77.76	45.95	19.99	11.93	Inflows
Precipitation	1.41	3.17	3.50	4.04	1.66	3.82	3.07	4.26	2.42	3.35	2.63	3.46	
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	
Underground Dewatering	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Inflow to Reservoir	56.92	56.18	55.67	57.45	157.18	326.26	224.34	154.27	127.88	97.00	70.03	62.79	
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	Outflows
Groundwater Outflow	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	-6.60	
Discharge to Trib C	0.00	0.00	0.00	0.00	-140.00	-160.00	-160.00	-140.00	-115.00	-109.80	0.00	0.00	
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	
Total Outflow from Reservoir	-51.30	-51.30	-51.30	-51.30	-191.59	-211.85	-211.75	-191.69	-166.45	-161.10	-51.30	-51.30	
Groundwater Return	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	6.60	6.60	6.60	6.60	146.60	166.60	166.60	146.60	121.60	116.40	6.60	6.60	
Reservoir Inflow Monthly Volume (m^3)	15,057	11,799	11,699	15,937	-92,171	296,536	33,744	-100,234	-99,993	-171,693	48,538	30,782	
Beginning of Month Reservoir Volume (m^3)	199,320	214,377	226,176	237,875	253,812	161,641	458,176	491,920	391,686	291,693	120,000	168,538	
End of Month Reservoir Volume (m^3)	214,377	226,176	237,875	253,812	161,641	458,176	491,920	391,686	291,693	120,000	168,538	199,320	
End of Month Reservoir Elevation (m)	1508.5	1508.5	1509.0	1509.0	1507.5	1512.0	1512.5	1511.0	1509.5	1506.0	1507.5	1508.0	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.

TABLE 5.4-4: Water Balance (1:10 Dry) - Year 6 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inflow	5.02	3.47	2.95	3.72	66.72	170.01	107.42	63.32	48.12	28.43	12.37	7.38	**Inflows**
Precipitation	0.75	1.86	1.85	2.21	0.88	2.09	1.63	2.26	1.32	1.78	1.44	1.84	
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	
Underground Dewatering	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Total Inflow to Reservoir	54.17	53.73	53.21	54.33	116.30	220.81	157.74	114.27	98.14	78.91	62.21	57.62	
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	**Outflows**
Groundwater Outflow	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	
Discharge to Trib C	0.00	0.00	0.00	0.00	-90.00	-140.00	-110.00	-90.00	-70.00	-45.54	0.00	0.00	
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	
Total Outflow from Reservoir	-47.70	-47.70	-47.70	-47.70	-137.99	-188.25	-158.15	-138.09	-117.85	-93.24	-47.70	-47.70	
Groundwater Return	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	3.00	3.00	3.00	3.00	93.00	143.00	113.00	93.00	73.00	48.54	3.00	3.00	
Reservoir Inflow Monthly Volume (m^3)	17,323	14,589	14,748	17,189	-58,091	84,388	-1,082	-63,804	-51,087	-38,363	37,623	26,566	
Beginning of Month Reservoir Volume (m^3)	184,189	201,512	216,101	230,850	248,039	189,948	274,337	273,254	209,450	158,363	120,000	157,623	
End of Month Reservoir Volume (m^3)	201,512	216,101	230,850	248,039	189,948	274,337	273,254	209,450	158,363	120,000	157,623	184,189	
End of Month Reservoir Elevation (m)	1508.0	1508.5	1508.5	1509.0	1508.0	1509.5	1509.5	1508.0	1507.0	1506.0	1507.0	1508.0	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.
Yr 6 scenario includes underground dewatering and reductino in groundwater seepage from 6.6 L/s to 3 L/s to reflect sedimentation

TABLE 5.4-5: Water Balance (1:2) - Year 6 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inflow	6.05	4.18	3.56	4.48	80.37	204.78	129.38	76.27	57.96	34.25	14.90	8.89	Inflows
Precipitation	1.00	2.50	2.49	2.97	1.18	2.81	2.18	3.02	1.77	2.38	1.93	2.46	
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	
Underground Dewatering	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Total Inflow to Reservoir	55.45	55.07	54.44	55.85	130.25	256.29	180.26	127.99	108.44	85.33	65.24	59.75	
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	Outflows
Groundwater Outflow	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	
Discharge to Trib C	0.00	0.00	0.00	0.00	-110.00	-150.00	-130.00	-110.00	-90.00	-67.65	0.00	0.00	
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	
Total Outflow from Reservoir	-47.70	-47.70	-47.70	-47.70	-157.99	-198.25	-178.15	-158.09	-137.85	-115.35	-47.70	-47.70	
Groundwater Return	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	3.00	3.00	3.00	3.00	113.00	153.00	133.00	113.00	93.00	70.65	3.00	3.00	
Reservoir Inflow Monthly Volume (m^3)	20,754	17,840	18,056	21,113	-74,311	150,435	5,668	-80,634	-76,251	-80,410	45,454	32,284	
Beginning of Month Reservoir Volume (m^3)	197,739	218,493	236,332	254,389	275,502	201,191	351,627	357,295	276,661	200,410	120,000	165,454	
End of Month Reservoir Volume (m^3)	218,493	236,332	254,389	275,502	201,191	351,627	357,295	276,661	200,410	120,000	165,454	197,739	
End of Month Reservoir Elevation (m)	1508.5	1509.0	1509.0	1509.5	1508.0	1510.5	1510.5	1509.5	1508.0	1506.0	1507.5	1508.0	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.
Yr 6 scenario includes underground dewatering and reductino in groundwater seepage from 6.6 L/s to 3 L/s to reflect sedimentation

TABLE 5.4-6: Water Balance (1:100) - Year 6 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inflow	8.12	5.60	4.77	6.01	107.82	274.73	173.58	102.32	77.76	45.95	19.99	11.93	
Precipitation	1.41	3.17	3.50	4.04	1.66	3.82	3.07	4.26	2.42	3.35	2.63	3.46	
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	Inflows
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	
Underground Dewatering	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Total Inflow to Reservoir	57.92	57.18	56.67	58.45	158.18	327.26	225.34	155.27	128.88	98.00	71.03	63.79	
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	
Groundwater Outflow	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	
Discharge to Trib C	0.00	0.00	0.00	0.00	-160.00	-165.00	-160.00	-160.00	-120.00	-114.29	0.00	0.00	Outflows
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	
Total Outflow from Reservoir	-47.70	-47.70	-47.70	-47.70	-207.99	-213.25	-208.15	-208.09	-167.85	-161.99	-47.70	-47.70	
Groundwater Return	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	3.00	3.00	3.00	3.00	163.00	168.00	163.00	163.00	123.00	117.29	3.00	3.00	
Reservoir Inflow Monthly Volume (m^3)	27,378	22,927	24,019	27,860	-133,418	295,499	46,064	-141,482	-101,029	-171,382	60,461	43,103	
Beginning of Month Reservoir Volume (m^3)	223,564	250,942	273,869	297,889	325,748	192,330	487,829	533,893	392,411	291,382	120,000	180,461	
End of Month Reservoir Volume (m^3)	250,942	273,869	297,889	325,748	192,330	487,829	533,893	392,411	291,382	120,000	180,461	223,564	
End of Month Reservoir Elevation (m)	1509.0	1509.5	1510.0	1510.0	1508.0	1512.5	1513.0	1511.0	1509.5	1506.0	1507.5	1508.5	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.
Yr 6 scenario includes underground dewatering and reductino in groundwater seepage from 6.6 L/s to 3 L/s to reflect sedimentation

TABLE 5.4-7: Water Balance (1:10 Dry) - Year 11 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inflow	5.02	3.47	2.95	3.72	66.72	170.01	107.42	63.32	48.12	28.43	12.37	7.38	Inflows
Precipitation	0.75	1.86	1.85	2.21	0.88	2.09	1.63	2.26	1.32	1.78	1.44	1.84	Inflows
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	Inflows
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	Inflows
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	Inflows
Underground Dewatering	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	Inflows
Total Inflow to Reservoir	54.17	53.73	53.21	54.33	116.30	220.81	157.74	114.27	98.14	78.91	62.21	57.62	Inflows
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	Outflows
Groundwater Outflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Outflows
Discharge to Trib C	0.00	0.00	0.00	0.00	-100.00	-140.00	-110.00	-100.00	-75.00	-56.02	0.00	0.00	Outflows
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	Outflows
Total Outflow from Reservoir	-44.70	-44.70	-44.70	-44.70	-144.99	-185.25	-155.15	-145.09	-119.85	-100.72	-44.70	-44.70	Outflows
Groundwater Return	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	0.00	0.00	0.00	0.00	100.00	140.00	110.00	100.00	75.00	56.02	0.00	0.00	
Reservoir Inflow Monthly Volume (m^3)	25,358	21,847	22,784	24,965	-76,840	92,164	6,953	-82,553	-56,271	-58,408	45,399	34,602	
Beginning of Month Reservoir Volume (m^3)	200,000	225,358	247,205	269,989	294,954	218,115	310,279	317,232	234,679	178,408	120,000	165,399	
End of Month Reservoir Volume (m^3)	225,358	247,205	269,989	294,954	218,115	310,279	317,232	234,679	178,408	120,000	165,399	200,000	
End of Month Reservoir Elevation (m)	1508.5	1509.0	1509.5	1510.0	1508.5	1510.0	1510.0	1508.5	1507.5	1506.0	1507.5	1508.0	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.
Yr 11 scenario is for fully sealed reservoir with no groundwater seepage. Groundwater return pumps could be used to offset low flow effects during winter months

TABLE 5.4-8: Water Balance (1:2) - Year 11 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inlfow	6.05	4.18	3.56	4.48	80.37	204.78	129.38	76.27	57.96	34.25	14.90	8.89	**Inflows**
Precipitation	1.00	2.50	2.49	2.97	1.18	2.81	2.18	3.02	1.77	2.38	1.93	2.46	
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	
Underground Dewatering	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Total Inflow to Reservoir	55.45	55.07	54.44	55.85	130.25	256.29	180.26	127.99	108.44	85.33	65.24	59.75	
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	**Outflows**
Groundwater Outflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Discharge to Trib C	0.00	0.00	0.00	0.00	-120.00	-150.00	-130.00	-120.00	-100.00	-73.30	0.00	0.00	
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	
Total Outflow from Reservoir	-44.70	-44.70	-44.70	-44.70	-164.99	-195.25	-175.15	-165.09	-144.85	-118.00	-44.70	-44.70	
Groundwater Return	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	0.00	0.00	0.00	0.00	120.00	150.00	130.00	120.00	100.00	73.30	0.00	0.00	
Reservoir Inflow Monthly Volume (m^3)	28,789	25,097	26,092	28,889	-93,060	158,211	13,703	-99,383	-94,395	-87,494	53,230	40,320	
Beginning of Month Reservoir Volume (m^3)	213,550	242,339	267,436	293,528	322,417	229,358	387,569	401,272	301,889	207,494	120,000	173,230	
End of Month Reservoir Volume (m^3)	242,339	267,436	293,528	322,417	229,358	387,569	401,272	301,889	207,494	120,000	173,230	213,550	
End of Month Reservoir Elevation (m)	1509.0	1509.5	1509.5	1510.0	1508.5	1511.0	1511.5	1510.0	1508.0	1506.0	1507.5	1508.5	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.
Yr 11 scenario is for fully sealed reservoir with no groundwater seepage.
Groundwater return pumps could be used to offset low flow effects during winter months

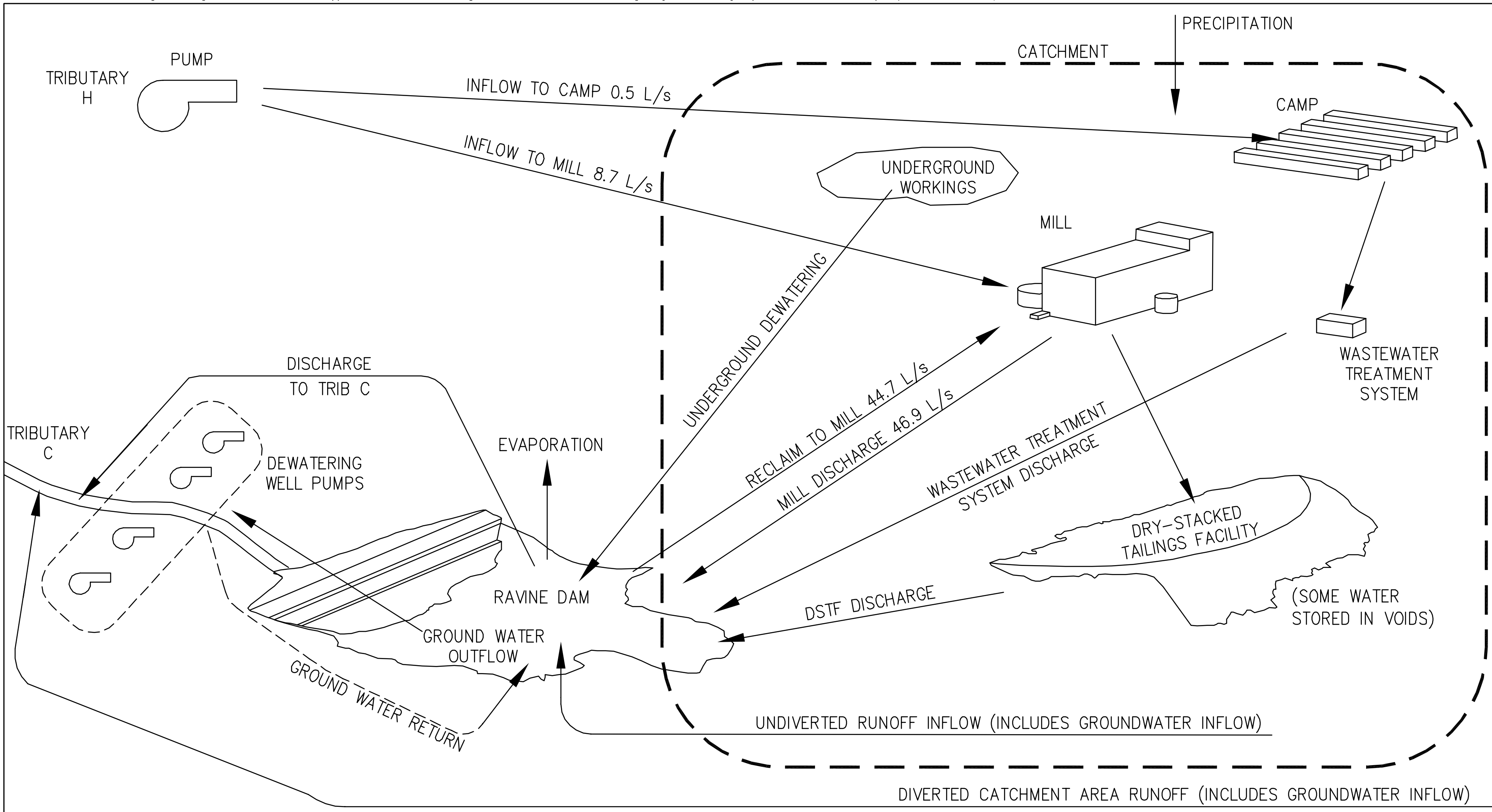
TABLE 5.4-9: Water Balance (1:100) - Year 11 (L/s)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Undiverted Runoff Inlfow	8.12	5.60	4.77	6.01	107.82	274.73	173.58	102.32	77.76	45.95	19.99	11.93	**Inflows**
Precipitation	1.41	3.17	3.50	4.04	1.66	3.82	3.07	4.26	2.42	3.35	2.63	3.46	
Mill Discharge	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	46.90	
Wastewater Treatment Discharge	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
DSTF Discharge	0.00	0.00	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.00	
Underground Dewatering	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Total Inflow to Reservoir	57.92	57.18	56.67	58.45	158.18	327.26	225.34	155.27	128.88	98.00	71.03	63.79	
Reclaim to the Mill	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	-44.70	**Outflows**
Groundwater Outflow	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Discharge to Trib C	0.00	0.00	0.00	0.00	-170.00	-170.00	-170.00	-170.00	-140.00	-95.42	0.00	0.00	
Evaporation	0.00	0.00	0.00	0.00	-0.29	-0.55	-0.45	-0.39	-0.15	0.00	0.00	0.00	
Total Outflow from Reservoir	-44.70	-44.70	-44.70	-44.70	-214.99	-215.25	-215.15	-215.09	-184.85	-140.12	-44.70	-44.70	
Groundwater Return	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Adjusted Discharge to Trib C	0.00	0.00	0.00	0.00	180.00	180.00	180.00	180.00	150.00	105.42	0.00	0.00	
Reservoir Inflow Monthly Volume (m^3)	35,413	30,185	32,055	35,636	-152,167	290,315	27,315	-160,231	-145,093	-112,803	68,237	51,138	
Beginning of Month Reservoir Volume (m^3)	239,375	274,788	304,973	337,028	372,663	220,496	510,811	538,127	377,896	232,803	120,000	188,237	
End of Month Reservoir Volume (m^3)	274,788	304,973	337,028	372,663	220,496	510,811	538,127	377,896	232,803	120,000	188,237	239,375	
End of Month Reservoir Elevation (m)	1509.5	1510.0	1510.5	1511.0	1508.5	1512.5	1513.0	1511.0	1508.5	1506.0	1508.0	1509.0	

Notes:

Current scenario assumes groundwater meets discharge criteria. Groundwater return pumps not in operation.
Groundwater return pumping rate estimated at 10L/s when system is operational.
Yr 11 scenario is for fully sealed reservoir with no groundwater seepage.
Groundwater return pumps could be used to offset low flow effects during winter months

Q:\Whitehorse\Data\0201drawings\MacTung\W23101211.002 Yesaa Supplemental\W23101211.002 Figure 5.4-1 WATER BALANCE rev 1.dwg [FIGURE 5.4-1] September 03, 2009 - 4:14:56 pm (BY: KEN TOMCZYK)



ISSUED FOR USE

NOTE:

NUMBERS SHOWN IN FIGURE REPRESENT FIXED VARIABLES.

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

CONCEPTUAL WATER BALANCE

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	PLR	1
OFFICE	DATE		
WHSE	September 3, 2009 - REVISED		

Figure 5.4-1

The water balance for the reservoir during operation provided in Tables 5.4.3-4 and 6.2.8-2 indicates an overall positive water balance on an annual basis. A positive water balance may have several potential adverse effects if not properly mitigated or if infrastructure is not sized accordingly. Furthermore, the table presented also appears to contain some discrepancies regarding water balance in the reservoir. Key discrepancies with the water balance table include:

- Groundwater discharge (inflow) has been provided as 6.6 L/s each month of the year, and was calculated as 208 138 m^3/year. Groundwater seepage (outflow) has been provided as -6.6 L/s each month of the year, and was calculated as -129 298 m^3/year. Given that the discharge and seepage of groundwater have both been calculated at 6.6 L/s, the total yearly volume should be equal. Furthermore, there has been no evidence to suggest that groundwater flows would remain constant throughout the year.
- DSTF seepage into the reservoir has been provided as 0.3 L/s each month of the year. However, given the distance between the DSTF and the reservoir and the cold temperatures during winter months, it is possible that seepage from the facility may be seasonally affected.

Table 1 (Appendix A) presents the calculations of the reservoir water balance data and is based upon Table 6.2.8-2 from the project proposal. A water balance column has been added to indicate the water balance using the values within that month/year. Based upon the data submitted by the proponent, a positive water balance of 109,927 m^3/year is anticipated to occur. This reworked table has been provided in order to highlight some of the outstanding discrepancies that are discussed below.

In order to understand the water balance for the reservoir during operation as provided in Tables 5.4.3-4 and 6.2.8-2, please provide the following information.

c) Details on how the positive water balance will be dealt with. A discussion on monthly values as well as yearly values may be useful. Information should include, but is not limited to:
   i. methods for positive water management;
   ii. potential effects related to the release of positive water; and,
   iii. appropriate mitigation measures to deal with positive water balance.

A positive water balance will be addressed through regulating the discharge rate from the reservoir. The water balance Tables 5.4-1 to 5.4-9 show the discharge rate from the reservoir. During the later summer and fall months the discharge rate is greater than the inflow rate to the reservoir, which allows for excess water to be discharged from the reservoir. The early spring discharges from the reservoir are higher than the natural inflows to the reservoir to allow for discharge of water accumulated in the reservoir during winter months.

d) Provide a discussion on why the yearly groundwater discharge into the reservoir exceeds the yearly groundwater seepage out of the reservoir when the monthly discharge and seepage are the same.

The original water balance contained an error in the calculation of groundwater flow volumes. The revised water balance Tables 5.4-1 to 5.4-9 contain the corrected groundwater information. Groundwater inflows to the reservoir are included with the estimates of the undiverted catchment inflows. Undiverted catchment inflows includes both surface water and groundwater inputs based on the regional hydrological model.

e) Provide a description of how groundwater discharge and seepage estimates were derived. Additionally, provide rationale as to why there is no seasonal fluctuation of groundwater discharge and seepage rates, or, update water balance tables with appropriate seasonal considerations.

Groundwater discharge from the reservoir is based on a two dimensional groundwater flow model and the results of hydraulic testing conducted in that area (refer to page 573 of the project proposal). Please refer to the updated water balance Tables 5.4-1 to 5.4-9 for the revised groundwater values. Groundwater discharge rates in the water balance were set at the initially calculated value of 6.6 L/s and then reduced over time (3.0 L/s at year 6 and 0 L/s at year 11) to simulate sedimentation and "sealing up" of groundwater flowpaths on the bottom of the reservoir.

f) Provide a discussion on DSTF seepage throughout each month of the year. If seasonal freezing is expected, please discuss how it will be managed for and how it may affect spring seepage into the reservoir.

Seepage from the DSTF is expected to occur during the months from May to October, and is expected to be zero during other months due to freezing conditions. Seepage rates from the DSTF have been estimated based on the tailings properties and the moisture content of the materials during placement. The seasonal nature of the seepage from the DSTF has been incorporated into the water balance tables. The volume of seepage from the DSTF is not significant compared with other spring inflows to the reservoir and as a result DSTF seepage only has a minor affect on spring seepage.

5.5 RAVINE DAM AND RESERVOIR

The project proposal indicates that water will be released from the mine site to the environment through groundwater seepage from the reservoir and ravine dam discharge. Currently the proponent expects that water will meet discharge compliance. If water quality does not meet discharge compliance, the project proposal indicates that downstream groundwater wells will pump most of the groundwater seepage back into the reservoir. A water treatment system will be designed and purchased to treat reservoir water prior to discharge to the environment. The reservoir and dam is capable of storing water for a period of seven months.

Although water treatment may be an appropriate mitigation it may not be feasible to design, purchase, and commission a water treatment system within the time frame indicated by the proponent (i.e. 7 months). Given the constraints of the proposed project it may be difficult to design and implement a water treatment system based on various factors including: the limited amount of time until the reservoir fills to capacity; the isolated nature of the project location; and, the climate in the area which may make construction difficult during winter and spring. Furthermore, there has been no conclusive evidence showing that water within the reservoir will not need treatment during the operation and possibly the closure phase of the mine.

Additional information is required in order to determine if groundwater seepage and ravine dam discharge may have significant adverse effects. Please provide the following information.

a) Details on a potential reservoir water treatment system that will be implemented in the event that reservoir water does not meet discharge compliance. Details should include, but are not limited to:
   i. type of water treatment system that would be installed at the site;
   ii. location of the water treatment system on-site including inflow and outflow locations;
   iii. how sludge from the water treatment system will be disposed of;
   iv. with consideration of the site characteristics and constraints, the timeframe required from the point when water requires treatment until the water treatment system is in operation at the site. Include in this a discussion of how this would be mobilized in the winter months if required;
   v. consideration to alternative methods of monitoring and treating water. For example, collecting and treating water from mine-site infrastructure (e.g., DSTF seepage, underground mine water, waste rock runoff, etc.) prior to discharge to the reservoir. If such alternatives are considered, substantially less volume of water may need to be treated.

Please refer to response 3.12(b).

b) Discuss and include a rationale as to whether there would be any anticipated geotechnical issues associated with pumping from interceptor wells and potentially dewatering soil materials at the toe of the dam.

The groundwater recovery wells are 100 m downstream of the toe of the dam. Pumping from these wells will lower the local groundwater table in the adjacent area, and may also lower the groundwater table in the vicinity of the toe of the dam. Included in the design of the ravine dam is a geocomposite drain which will be dissipating any porewater behind the dam's liner. Pumping at recovery wells will not effect the groundwater elevation within the dam structure.

However, it may still lower the groundwater elevation in the foundation soils. Typically, lowering the groundwater elevation at the toe of an embankment or dam will improve the stability of the structure, so long as foundation soils can dissipate the porewater pressure quicker or at the same rate as the pump rate. The foundation soils of the ravine dam are expected to be well drained sand and gravels overlying shale bedrock that are able to dissipate the pressures satisfactorily.

Lowering the groundwater table at the toe of a dam will increase the hydraulic gradient through the dam. This can possibly create piping issues in a dam if it is not properly designed. The design of the ravine dam includes both upstream and downstream filters to minimize the potential for piping.

In conclusion, there should be minimal adverse geotechnical effects on the ravine dam generated by pumping from the groundwater recovery wells.

Page 540 of the project proposal indicates the design flood volume for the reservoir has been estimated to be approximately 520,000 m^3. However, on page 542 of the project proposal, it is stated that the reservoir will have an operating volume between 120,000 m^3 and 620,000 m^3. In light of the discrepancy between these values, please provide the following information.

c) Clarify the total volume of the reservoir.

The maximum operating volume of the reservoir is 540,000 m^3. This volume was determined by assuming a 1.5 m deep excavation across the area of the proposed reservoir since this material is expected to be used in construction of the ravine dam and that maximum operating level is 1.0 m below the spillway elevation. Therefore the volume of water that the reservoir will contain before overtopping is about 612,000 m^3.

d) Provide the anticipated volume and available storage of the reservoir on a monthly basis throughout the life of the mine (this may be included in the response to the mine site water balance questions).

This information is provided with the water balance in the Tables 5.4-1 through 5.4-9.

e) Provide details on calculations and design of the proposed flood volume.

Details of calculation methods are provided in the project proposal on page 368 in addition to information presented in responses 5.1.1(k) and 5.1.1(m).

5.6 DRY-STACKED TAILINGS FACILITY

The project proposal (p.541) indicates that seepage from the DSTF is estimated to be 74,000 m^3/year. However, calculations derived from Tables 5.4.3-4 and 6.2.8-2 and Figure 5.4.3-9 indicated that seepage will be approximately 9 467 m^3/year. These values are substantially different. Please provide the following information.

a) Clarify, with appropriate assumptions and data, the total volume of seepage expected from the DSTF annually during operations.

To fully understand the forces governing seepage from the DSTF, first there must be a general understanding of a soil phase diagrams, saturation, void ratio, moisture content, and moisture density relationships. Soils are composed of three phases, solids (minerals), liquids (water), and gases (air). Soil voids are defined as the volume occupied by water and air. Saturation is defined as the ratio of volume of water to the volume of voids (i.e. 100% saturation means there is no air in the soil). The void ratio is defined as the ratio of the volume of voids to the volume of solids. Moisture content is defined as the mass of water divided by the mass of solids.

The moisture density relationship of a soil is a complex topic and is extremely generalized here. The term maximum dry density used here refers to the maximum dry density as determined by ASTM D698. ASTM D698 is a test that uses a constant force to determine the maximum dry density of a soil at that standard force. As the moisture content of a soil increases towards the optimum moisture content the dry density that a soil can be compacted to (using the same standard applied force) also increases. The dry density of a soil (using the same standard applied force) will reach a maximum at its optimum moisture content. Increasing the moisture content past its optimum moisture content and continuing to apply the same standard force will cause the dry density of the soil to decrease. This is because the majority of the voids in the soil are filled with water, which is an incompressible fluid. Typically the optimum moisture content of a fine-grained soil corresponds to a saturation of 80% (Coduto, 1999).

As described above, when soil is compacted the total volume of the soil is decreased by decreasing the volume of air in the soil. If the volume of air is decreased then the volume of voids is also decreased. If the volume of voids is decreased but the volume of water is constant then by definition the saturation increases. Experience shows that water may seep from a soil during compaction when it is over its optimum moisture content (especially when a vibratory compactor is used).

The expected gradation and optimum moisture content of the tailings at Mactung will be similar to those at Minto. The optimum moisture content for the Minto tailings is approximately 16%. Since the tailings at Mactung are expected to be only slightly over the optimum moisture content, the seepage from compaction is considered to be negligible. For the purposes of this calculation, however, EBA has conservatively estimated the seepage at 10% of the total porewater, and the total volume of seepage water will depend on the volume of tailings placed. It is not expected that water will seep from the DSTF during the winter months as porewater that might seep out will freeze and be covered by tailings before it has a chance to thaw. In perpetuity this ice is expected to melt and the tailings in the DSTF are expected to be unfrozen. The tailings are not expected to be over 100% saturation so this water should stay in voids of the tailings over the long term. This ice formation has been accounted for in the short-term stability analysis of the DSTF. The associated minor surface settlement has been accounted for in the long-term stability analysis and closure planning of the DSTF.

The mill is expected to produce 717,600 dry tonnes of tailings a year at a moisture content ranging from 15% to 20%. Only 50% of the total tailings are placed in the DSTF – the other 50% are backfilled underground so the total mass tailings placed in the DSTF per year is 358,800 dry tonnes. The total volume of water entering the tailings facility per year is 71,760 tonnes. The density of water is 1 tonne per cubic metre, so the total volume of water entering the DSTF is 71,760 m^3. If 10% of that water seeps from the facility all year round then the total volume of water seeping from the DSTF is 7,176 m^3 per year or 0.228 L/s (which was rounded up to 0.3 L/s for Figure 5.4.3-9 and Tables 5.4.3-4 and 6.2.8-2). For the initial water balance it was also assumed that this flow would be year round (worst case for water quality) however, in the revised water balance this flow will only be shown as active in May, June, July, August, September, and October to better reflect expected operating conditions. Using an average rate of seepage of 0.228 L/s over 6 months it is expected that the seepage from the DSTF will be 3,650 m^3 per year.

Experience at the Minto Mine shows that there is no seepage from the DSTF; however, the foundation soils of the DSTF at the Minto mine are frozen, and this may be hindering seepage. The tailings at the Minto mine are leaving the mill at a moisture content just above optimum, similar to what can be expected at Mactung.

b) Provide a description of the long-term water balance for the DSTF post closure.

DSTF will be compacted and have a moisture content at or slightly above 16%. This means that water will be retained within the available pore space due to matrix suction (negative pressures). As a result, following installation of the cover onto the surface of the DSTF, there is expected to be no drainage of water from within the facility. As a result the contribution to the long-term water balance for the DSTF, once covered, is only the run-off from the surficial materials placed on top of the synthetic liner. Please also refer to response 5.6(a) above.

Access Road

The proposed 34.5 km access road requires 28 stream crossings, three of which will require bridges and the remainder will require culverts. Single lane bridges will be used to cross the South Macmillan River, Tributary E, and Tributary A. The remainder of stream crossings will use culverts sized to accommodate a minimum 1:50 year peak flow while the roadway will be designed for an overtopping scenario. Maximum instantaneous flow data has been provided for Tributaries A, B, and C as well as the South Macmillan River. However, there has been no stream flow data provided for the remaining stream crossings.

More detailed flow data for streams that require crossing is required in order to predict the potential effects associated with proposed activities and the success of proposed mitigations. Therefore, please provide the following information.

c) The project proposal indicates that peak flows calculated for Tributaries A, B, and C were used to develop design flood estimates for road crossings. These tributaries are located along the access road between the mine site and the pump house as well as along the last 6.5 km of the 34.5 km access road. In the absence of flow data or flood flow estimations along remainder of the access road, indicate how the culverts will be designed for a 1:50 year peak flow. Furthermore, provide sufficient detail and reasoning for the use of culverts designed for 1:50 year storm events, versus the use of culverts that are designed to withstand and accommodate more substantial storm events, particularly given the length of time the road will be in operation.

Using a regression from the flows recorded at Tributaries A and C, and estimates of the drainage areas along the proposed access road, predictions of the expected flow at stream crossings can be determined.

As stated on page 342 of the project proposal, culverts will be sized to accommodate at least a 1:50 year peak flow event with culverts being at least 900 mm in size (A Government of Yukon standard). This means that if a larger culvert is required, it will be used or additional culverts will be installed. Given the maximum length of time the road will be used (17 years) this approach will be adequate for managing peak flow events.

d) In the project proposal, it is stated that some of the approximately 28 streams and rivers that will be crossed during the construction of the access road are fish-bearing. Given that the proponent has identified that some of the waterway crossings could present some risk to fish, it is important to fully understand the erosion control measures and practices that are to be followed during the construction and operation of the road. Therefore, provide a detailed description of the erosion control measures and practices that will be implemented during the construction and use of the road (e.g. environmental monitors, silt control devices, run-off, and drainage control).

Erosion control measures for waterway crossings were discussed on page 593 of the project proposal under Section 6.2.9 Aquatic Ecosystems and Fisheries Resources. Also, mitigation measures regarding the construction of bridges are discussed under Section 3.5 of this response document. Standard Operating procedures for Road Construction Including Culvert Installation (Appendix A), also includes details of standard mitigation measures to be followed regarding road construction, including erosion control measures at waterway crossings.

6.0 MINE ENGINEERING ISSUES

6.1 MINE WORKER SAFETY – UNDERGROUND ACCESS

The proposal indicates that there will be one decline developed from the adit, 520 m down at a 13 percent grade to the crusher station underground. This decline will house two conveyor systems, one for transporting crushed ore to the surface and a second system for transporting tailings underground, as well as serve as the only underground access for workers and equipment.

Experts retained by the Executive Committee have identified that there could be health and safety issues related to workers and equipment passing underneath the conveyor systems.

Additional questions were raised regarding sufficient space around the hanging conveyors to allow for the passage of equipment and regular repair and maintenance of the conveyors.

It is important that these potential concerns have been accounted for in the proposed design and operations of the underground workings. With this information the Executive Committee will have a better understanding of potential adverse effects that may result from underground operations and hence be able to determine if the design and proposed mitigations will be successful.

Please provide the following information.

a) An explanation as to how the health and safety of mine workers and equipment has been considered with respect to the design of two conveyor systems carrying ore and tailings operating along the roof of the decline.

b) Identify and explain how the conveyor systems are designed to minimize potential injuries to workers or equipment, and what procedures are to be followed by equipment operators to minimize accidents between equipment and conveyor systems.

c) Explain how the design of the decline is sufficient to accommodate regular maintenance and repair of the conveyor systems, given that workers and equipment will be also using the decline on a regular basis.

General Safety

The conveyor design shall be guided by following standards and regulations:

- ANSI/ASME B20.1 – 2006 – Safety Standards for Conveyors and Related Equipment
- ANSI B11.10 – 2003 - Performance Criteria for Safeguarding
- CSA Z432-04 - Safeguarding of Machinery
- WorkSafe – Occupational Health & Safety Regulation – General Hazard Requirements – Part 12 – Tools, Machinery, and Equipment

"Safeguarding of Conveyors" shall be implemented in parallel with the following guidance related to moving parts and machinery:

- Reach up:

The safety distance when reaching up shall be 2500 mm.

- Rotating hazard:

Pinch points and rotating parts such as shafts, couplings and collars, set screws and bolts, keys and keyways, and projecting shaft ends, exposed to contact with workers shall be guarded.

- Falling Materials:

Conveyors shall have guards or sideboards to prevent material from falling from conveyors into areas occupied by workers or equipment if the falling material presents a hazard of impact injury or damage.

- Lockout:

Unless conveyors have been locked out a worker must not be in or on the conveyor, and a guard or safety device must not be removed.

- Emergency stopping devices:

Conveyors shall have an emergency stopping system. The stopping system shall be designed to be activated manually by pulling a safety trip cord installed along side the conveyor. The stopping system shall be designed that after an emergency stop, manual resetting is required before the conveyor can be restarted. The conveyor must not be restarted after an emergency stop until a qualified operator has determined it can be operated safely.

Accident Prevention

Contact with conveyor prevention:

Access to low parts of conveyor will be restricted to reduce the risk of workers or equipment making contact with any part of moving conveyor system.

All designated areas for workers passing under the conveyor will be protected by spill trays that will collect any fugitive material falling from conveyors.

Drive-through areas for equipment will be designed to protect the conveyor, and prevent the equipment from coming in contact with any parts of conveyors. Spill trays shall contain any falling fugitive material to ensure the safe protection of personnel and equipment.

Design of loading to stabilize material on the belt:

The design of the loading zone of the ore conveyors will be such that fine material will be placed on the conveyors first, followed by larger material. This loading design will help prevent the rolling motion of larger material down the decline conveyor.

Maintenance Friendly Design

The maintenance friendly design is reflected in methods such as:

- bolted connections as opposed to welded,
- wear-liner bolt-on installation,
- loading zone design without moving parts (idlers),
- long lasting skirting,

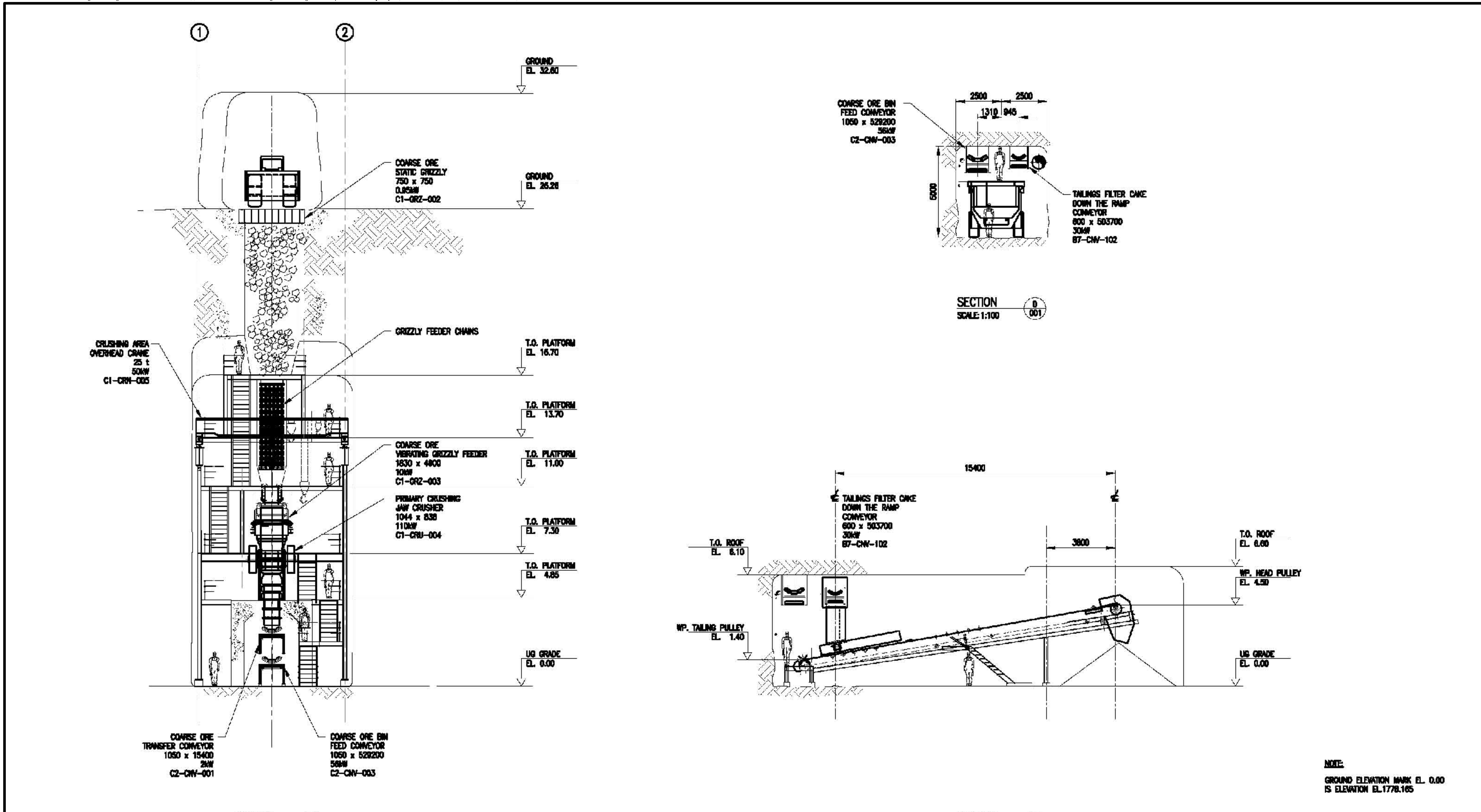
- RMA grade of belt covers for longevity,
- specifying idlers with long lifespan L10 – 60,000 hours prorated for 500 rpm,
- minimizing material impact to prolong belt life, and
- material delivery onto the belt that matches the belt direction and speed, to minimize wear and tear of belts.

For the necessary regular/preventive maintenance access, the design and clearance shall be according to the Conveyor Equipment Manufacturers Association (*CEMA)* Sixth edition; Second Print; Chapter Two; Design Considerations; Maintenance; Access Requirements.

Minimum maintenance access will be as follows:

Pulley replacement	762 mm
Idler replacement - carry side	762 mm
Idler replacement – return side	610 mm
Clearance under conveyor for cleaning	610 mm
Belt cleaner service – removal	belt width
Belt cleaner service – inspection	610 mm
Personnel passage	762 mm
Skirtboard replacement heights	229 mm
Skirtboard adjustment	152 mm
Personnel access opening heights	610 mm
Personnel access opening width	610 mm
Targeted overhead clearance (where practical)	1220 mm

As can be seen from Figure 6.1-1, there is enough clearance to accommodate regular maintenance and repair of the conveyor system.



NOTES:

DRAWING ADAPTED FROM ORIGINAL PROVIDED BY WARDROP ENGINEERING INC.

0 — 5
Scale: 1: 100 (metres)

ISSUED FOR USE

Client: NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

MACTUNG

Primary Crusher Ore Bin Feed Conveyor
Plan and Elevations

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	GMR	0
OFFICE: EBA-WHSE	DATE: JULY 2009		

Figure 6.1-1

6.2 SILICA DUST

Experts retained by the Executive Committee identified that drilling and mucking activities will be dry, and that there could be health and safety issues associated with hazardous dusts (e.g. silica). Please provide the following information.

a) Clarify whether or not drilling and mucking operations will be dry.

b) Clarify whether or not there is the potential for the generation of silica dusts through drilling and mucking operations.

c) If there is the potential for silica dust to be generated, identify how health and safety concerns have been addressed in the effects assessment with respect to worker health and safety. Identify appropriate mitigations measures that will be undertaken to minimize or negate these hazards.

Drilling operations will be carried out using a hot water misting system (with a hot water tank on the drill equipment) to avoid freeze ups and dust production. Drilling dust will be controlled with air/water mist using water from a hot water tank on the equipment. Dust collector systems will be installed in all drilling units to prevent potential effects to worker health and safety.

6.3 VENTILATION SYSTEMS FOR THE MINE

Experts retained by the Executive Committee identified that there is insufficient information provided to understand how the ventilation system for the underground workings will function. Ventilation is paramount to the effective and safe operation of the mine. Please provide the following information.

a) Detailed schematic(s) of the mine ventilation system that will be installed. Please provide diagrams that show the location of the fans, the raises that will provide a return path for exhaust air and the locations of any auxiliary equipment associated with the ventilation system.

b) Explain how the design of ventilation system which is to be located in the main decline/drift underground has taken into account the fact that conveyor systems, equipment and workers will also be using the decline, and as a result, the air quality in the ventilation system could be compromised (e.g. vehicle exhaust). Please explain how this potential adverse effect on air quality in the mine was taken into account in the effects assessment of mine worker health and safety as well as the operation of the mine.

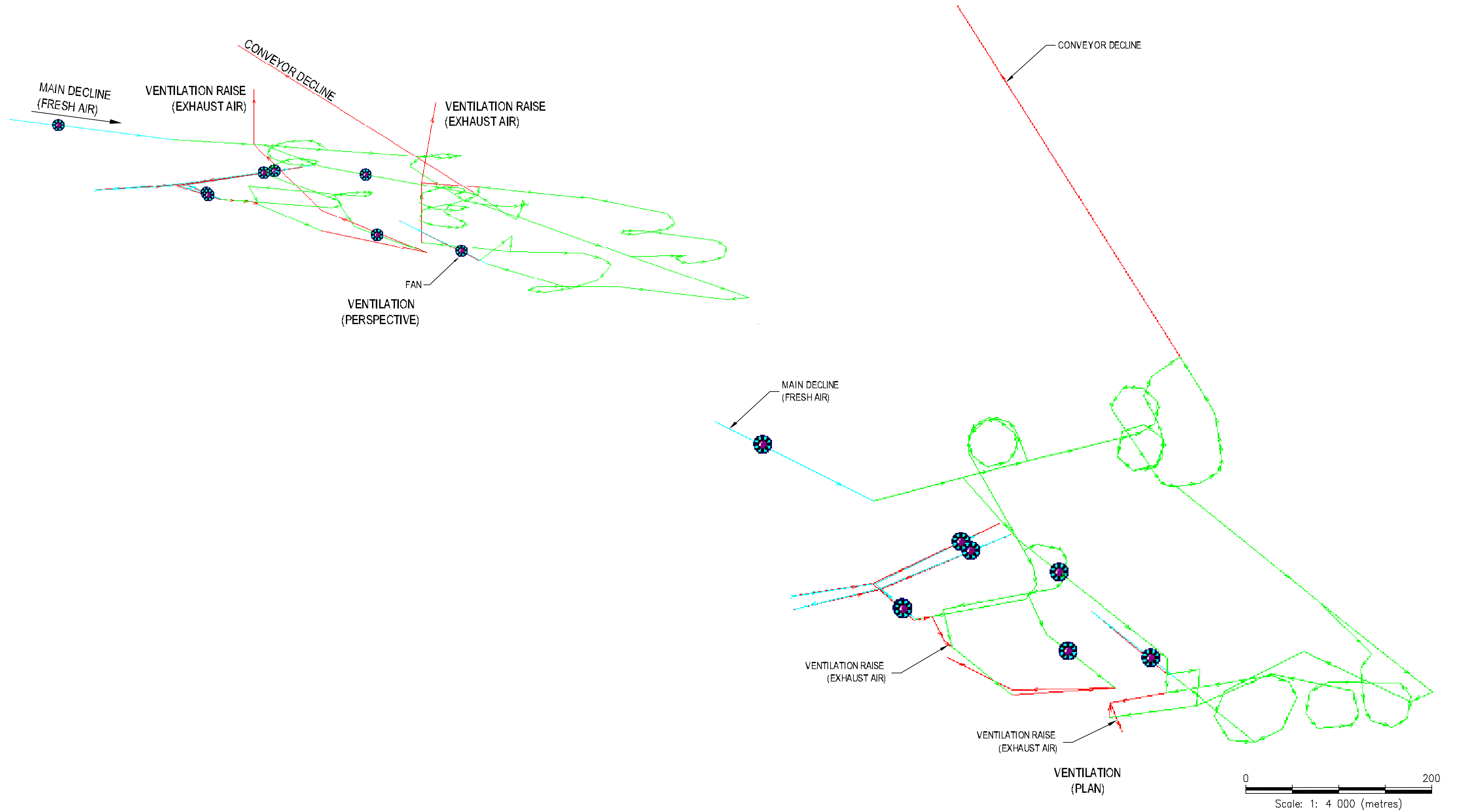
The ventilation system designed for the Mactung underground mine meets the Yukon Mine Safety Regulations for ventilation and follows general practices employed throughout

Canadian underground mines (Figure 6.3-1). The following is a summary of the ventilation limits:

TABLE 6.3.1: DESIGN VENTILATION STANDARDS		
Description	Unit	Value
Ventilation air requirements per kW	m^3/s	0.06
Ventilation air requirements per kW	cfm	127.13
Ventilation air requirements per hp	m^3/s	0.05
Ventilation air requirements per hp	cfm	100.00
Minimum air velocity (haulage)	m/s	0.25
Maximum air velocity (haulage)	m/s	6.00
Maximum air velocity (ventilation shaft)	m/s	12.00
Maximum air velocity (hoisting shaft)	m/s	8.00

The design basis for the ventilation system at Mactung is the air required to dilute and remove exhaust gases produced by underground diesel equipment. Equipment utilization factors were used to represent the diesel equipment in use at any time (Table 6.3.2).

Lower emissions from engines with DDEC systems have not been considered in the ventilation system design. The lower emissions will lower the ventilation air requirement to less than 0.06 m^3/s per installed Kw.



ISSUED FOR USE

CLIENT: NORTH AMERICAN TUNGSTEN CORPORATION LTD

MACTUNG

VENTILATION SYSTEM

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
W23101211.002	KJT	GMR	0
OFFICE: EBA-WHSE	DATE: JUNE 2009		

Figure 6.3-1

TABLE 6.3.2: MINE VENTILATION REQUIREMENTS FOR PRODUCTION PHASE							
Item	Equipment Detail	Units	Typical Type	Qty	hp	Utilization	Total hp
1	Development Jumbo (2 boom)	ea.	Tamrock DD420-40C	2	149	10%	29.8
2	Long-hole DTH Drill	ea.	Tamrock DL310-7	2	99	10%	19.8
3	Secondary Breaking System	ea.	Maclean SB-6 Blockholer	1	150	10%	15
4	Rockbolter	ea.	Tamrock DS 310	2	200	20%	80
5	Exploration Drill	ea.	Diamec 252/1600U4PHC	1	61	0%	0
6	Development Load-Haul-Dump (5.0)	ea.	TORO LH410	1	295	60%	177
7	Production Load-Haul-Dump (5.0)	ea.	TORO LH410	2	295	75%	442.5
8	Haulage Truck (30 t)	ea.	EJC 30 SX	4	315	75%	945
9	Grader/D7 Dozer	ea.	GR 12 H	1	200	40%	80
10	ANFO Loader	ea.	Toyota HZJ79	1	125	50%	62.5
11	Mechanics Truck	ea.	Toyota HZJ79	1	125	50%	62.5
12	Supervisor Vehicle	ea.	Toyota HZJ79	2	125	20%	50
13	Electrician Vehicle – Scissor Lift	ea.	Toyota HZJ79	1	125	50%	62.5
14	Survey Vehicle	ea.	Toyota HZJ79	1	125	50%	62.5
15	Mine Engineering Vehicle	ea.	Toyota HZJ79	1	125	30%	37.5
16	Scissor Lift	ea.	Maclean SL-3	2	149	50%	149
17	Cassette Carrier	ea.	Maclean CS-3 Carrier	2	200	50%	200
18	Rockbreaker	ea.	Mobile (Caterpillar)	1	150	0%	0
Total hp							**2475.6**
Total Utilization							**100%**
Ventilation Requirements 2.83 m^3/min/HP		m^3/min					7,005.948
20% Losses							1,401.1896
Total Ventilation Requirements		**m^3/min**					**8,407.1376**
Total Ventilation Requirements		**m^3/s**					**140.1**
Conversion Faction From m^3/ft^3		m^3/ft^3					0.0283
		Cfm					29,7072

6.4 MINE AIR HEATING SYSTEMS

Experience at Ekati Mine (and similar arctic-type mine operations) indicates that as mining progresses below the permafrost, groundwater is encountered. In the winter months this groundwater freezes and causes safety conditions in the work places, particularly the ramps where ice is formed which affects mobile equipment travel. Based on current design practice, Ekati Mine has included mine air heating systems to prevent freezing when developing and mining below the permafrost in the winter months. It is also noted that in the winter months (with unheated air and groundwater present) the gradual build-up of ice in the lower portion of the ventilation raises restricts airflow, increases resistance, causes operational difficulties with the fans, and results in a shortage of ventilation air volumes to the underground workings. Please provide the following information.

a) Explain how this issue of groundwater freezing was addressed and incorporated into the design and operation of the underground workings and identify any mitigation measures that the proponent intends to put in place to minimize this effect.

Comparison of the groundwater inflows into the underground portions of the EKATI mine and the proposed Mactung Mine are not applicable. The underground portions of the EKATI mine are less than 15 km away from and likely hydraulically connected to Lac De Gras. Whereas the proposed Mactung mine is less than 500 m in elevation from the peak of Mt. Allan, and is essentially the headwater of the groundwater table of the region and thus the groundwater inflows into the Mactung mine are expected to be minimal.

Furthermore, the method in which mining is occurring at EKATI and the method in which mining is proposed at Mactung are different. EKATI is mining in a constant decline following a cone-shaped ore body effectively plunging straight down making their ramp one long helical decline. The ore body at Mactung is on a modest dip (20º maximum) towards the northwest and the length of steep ramp below the groundwater table is limited to a portion of the Lower North Ramp and a portion of the Lower 2B Mining Zone (see Figure 5.4.3-4 in the project proposal for locations).

Moreover, the rock types at EKATI and Mactung are very different. The orebody in which the stopes at EKATI are developed into is kimberlite, a soft porous rock; whereas at Mactung it is hornfels, limestone, and shale – these rocks have significantly lower hydraulic conductivities than kimberlite.

If freezing of groundwater on the ramps becomes an issue it will be mitigated by the placement of select crushed waste rock, which is common practice in underground mines and currently in place at Cantung.

b) If the project intends to install a mine air heating system, provide an appropriate level of explanation detailing how this system will operate. Please provide a discussion, details and diagrams on any associated infrastructure that may be required for a mine air heating system to operate (e.g. heaters, compressors, cement pads).

No mine air heating system will be installed. The mine air temperature will remain below freezing due to the ambient air temperature and its location in a permafrost environment. This practice was successfully used at both the Polaris and Nanisivik Mines. All mine equipment will have heated cabins for worker comfort and safety.

6.5 EQUIPMENT MAINTENANCE AND REPAIR

Experts retained by the Executive Committee identified that there is the possibility for the maintenance and repair of equipment and vehicles to occur underground. Not only would this be required for some equipment (e.g. crusher), but in some situations, it could serve as a time and cost saving measure. However, there is no mention within the proposal as to whether any such activities will occur underground. If they are, it is unclear as to whether the underground design includes sufficient space to allow such activities to occur. Please provide the following information.

a) Will any repair or maintenance activities of vehicles and equipment be occurring underground?

b) If so, will there be designated locations/areas underground to allow for these activities to occur? If these locations are going to be built as part of the underground design, please provide diagrams detailing their dimensions and a map showing their location. Indicate whether or not the waste rock from the excavation and development of these rooms has been taken into account throughout mine site design (e.g. predicted amounts in the waste rock pile).

c) Indicate whether or not the underground locations for equipment that will not be repaired above-ground (e.g. crusher, remote mucking vehicles, etc.) are being sized to accommodate repair/maintenance activities that will occur around the equipment, and whether or not equipment will be able to move past the equipment while it is being repaired?

There will be a surface warehouse/maintenance shop which includes indoor truck bays, a waste oil system, an exhaust system, lube-oil systems, water systems, coolant systems, a machine shop and equipment, a welding bay and tire-change area. The building will include offices for maintenance and warehouse personnel.

Underground maintenance and repairs will be limited to running repairs of underground equipment and NATC will ensure that design clearances will accommodate these types of activities.

6.6 APPROPRIATE EQUIPMENT FLEET AND MAINTENANCE FACILITIES

Experts retained by the Executive Committee also identified that the proposed underground equipment fleet and planned maintenance facilities for this fleet may in fact be understated for the size of the proposed project. It is important that the proponent has a realistic idea of all infrastructure requirements prior to operations such that all potential project effects are accounted for. Please provide the following information.

a) Confirm whether or not the size of the fleet is appropriate for the operations that are planned, and whether or not the planned maintenance facilities and staff will be able to accommodate the fleet size.

The equipment estimates were based on 80% mechanical availability.

A list of major mine equipment operating parameters and productivity is shown in Table 6.6-1. The effective work time per shift is 6.9hrs out of 10hrs. Table 6.6-2 details the pre-production equipment requirements.

TABLE 6.6-1: MINE EQUIPMENT OPERATING PARAMETERS AND PRODUCTIVITY

Ore Production Input Factors	Unit	Quantity Ore	Development Waste Quantity	Backfill Quantity
Rock Characteristics				
Situ Density	t/m³	3.14	2.99	-
Swell Factor	%	60	60	-
Average Loose Density	t/m³	1.96	1.87	1.70
Schedule				
Shifts per Day	ea.	2	2	2
Shift Length	h	10	10	10
Travel, Setup Time	h	0.75	0.75	0.75
Lunch Break	h	0.75	0.75	0.75
Equipment Inspection	h	0.25	0.25	0.25
Subtotal Non-Productive Time	h	1.75	1.75	1.75
Usable Work Time per Shift	h	8.25	8.25	8.25
Shift Efficiency Factor	%	82.5	82.5	82.5
Usable Minutes per Hour	min	50	50	50
Hour Efficiency Factor	%	83.3	83.3	83.3
Effective Work Time per Shift	h	6.9	6.9	6.9
Total Tonnage per Day	t/d	2,000	199	847

TABLE 6.6.2: PRE-PRODUCTION DEVELOPMENT MINE EQUIPMENT		
Equipment	Typical Model	No. Req'd
Drilling Equipment		
Development Jumbo (2 boom) Unit	Tamrock DD420-40C	2
Components - 16 ft feed	Tamrock	2
- Autolube	Tamrock	2
- Ansul Fire Suppression	Tamrock	2
- Enclosed Cabin	Tamrock	2
- Jumbo Power Plug	Misc.	10
Cable Bolter Unit	Misc	1
Rock Bolter Unit	Tamrock DS 310	2
Jackleg Unit	PHQ250JHML	4
Stoper Unit	PHQ250SMCSR	4
Exploration Drill Unit	Diamec 252/1600U4PHC	1
Total Drilling Equipment		
Loading & Hauling Equipment		
Development Load-Haul-Dump Unit 5.0 m^3	TORO LH410	1
Production Load-Haul-Dump Unit , 5.0 m^3	TORO LH410	2
Components - Enclosed Safety Cabin	Sandvik	3
- Autolube	Sandvik	3
- Ansul Checkfire	Sandvik	3
- RRC Recovery Hook	Sandvik	2
Haulage Truck Unit , 30 t	EJC 30 SX	4
Components - Enclosed Cabin	Sandvik	4
- Autolube	Sandvik	4
- Ansul Checkfire	Sandvik	4
Total Loading & Hauling Equipment		
Service Vehicles		
Grader/Dozer Unit	GR 12 H	1
ANFO Loader	Toyota HZJ79	1
- 85 cfm diesel compressor	Toyota	1
Mechanics Truck	Toyota HZJ79	1
Supervisor Vehicle	Toyota HZJ79	2
Electrician Vehicle - Scissor Lift	Toyota HZJ79	1
Survey Vehicle	Toyota HZJ79	1
Mine Engineering Vehicle	Toyota HZJ79	1
- Fire Suppression System	Toyota	4
Scissor Lift	Maclean SL-3	1
Cassette Carrier	Maclean CS-3 Carrier	2

TABLE 6.6.2: PRE-PRODUCTION DEVELOPMENT MINE EQUIPMENT		
Equipment	Typical Model	No. Req'd
- Flat Deck Cassette	Maclean CS-3 Flat Deck	1
- Hiab 095 Boom/Deck Cassette	Maclean CS-3	1
- Fuel/Lube Cassette	Maclean CS-3	1
- Personnel Cassette	Maclean CS-3	2
- Enclosed Cab	Maclean	3
- Ansul Fire Suppression	Maclean	3
- Lincoln Autolube	Maclean	03
- Pneumatic Tire Spare	Maclean	3
- 20 lb. Fire Extinguisher	Maclean	3

Mine Operation Equipment

Table 6.6.3 provides a list of the operation-phase equipment, which includes all pre-production equipment and additional loading and trucking units, and equipment used for ground support and long-hole drilling.

TABLE 6.6.3: OPERATION EQUIPMENT LIST		
Equipment	Typical Model	No. Req'd
Drilling Equipment		
Development Jumbo (2 boom)	Tamrock DD420-40C	2
- 16 ft feed	Tamrock	2
- Autolube	Tamrock	2
- Ansul Fire Suppression	Tamrock	2
- Enclosed Cabin	Tamrock	2
- Jumbo Power Switch	Misc	10
Longhole DTH Drill	Tamrock DL310-7	2
Secondary Breaking System	Maclean SB-6 Blockholer	1
Rockbolter	Tamrock DS 310	2
Jackleg	PHQ250JHML	4
Stoper	PHQ250SMCSR	4
Exploration Drill	Diamec 252/1600U4PHC	1
Loading & Hauling Equipment		
Development Load-Haul-Dump, 5.0 m^3	TORO LH410	1
Production Load-Haul-Dump, 5.0 m^3	TORO LH410	3
- LHD Remote Control	Sandvik	3
- Enclosed Safety Cabin	Sandvik	4
- Autolube	Sandvik	4
- Ansul Checkfire	Sandvik	4
- RRC Recovery Hook	Sandvik	2

TABLE 6.6.3: OPERATION EQUIPMENT LIST		
Equipment	Typical Model	No. Req'd
Haulage Truck, 30 t	EJC 30 SX	5
- Enclosed Cabin	Sandvik	5
- Autolube	Sandvik	5
- Ansul Checkfire	Sandvik	5
Service Vehicles		
Grader	GR 12 H	1
ANFO Loader	Toyota HZJ79	1
- 85 cfm Diesel Compressor	Toyota	1
Mechanics Truck	Toyota HZJ79	1
Supervisor Vehicle	Toyota HZJ79	2
Electrician Vehicle - Scissor Lift	Toyota HZJ79	1
Survey Vehicle	Toyota HZJ79	1
Mine Engineering Vehicle	Toyota HZJ79	1
- Fire Suppression System	Toyota	7
Scissor Lift	Maclean SL-3	1
Cassette Carrier	Maclean CS-3 Carrier	2
- Flat Deck Cassette	Maclean CS-3 Flat Deck	1
- Hiab 095 Boom/Deck Cassette	Maclean CS-3	1
- Fuel/Lube Cassette	Maclean CS-3	1
- Personnel Cassette	Maclean CS-3	2
- Enclosed Cab	Maclean	3
- Ansul Fire Suppression	Maclean	3
- Lincoln Autolube	Maclean	3
- Pneumatic Tire Spare	Maclean	3
- 20 lb. Fire Extinguisher	Maclean	3
- "Link One" Manual	Maclean	2
- Training - 1 week	Maclean	1

The estimated size of the fleet is appropriate for the operations and the planned maintenance facilities, and staff will be able to keep the required fleet operational.

6.7 BACKFILL PLACEMENT

As noted by Environment Canada, insufficient information has been presented about placement of backfill in the underground. Information related to this is necessary in order to properly assess this disposal and closure method. Please provide the following information.

a) Provide details related to the procedure and methodology for backfill placement in the underground.

The following additional information is provided with respect to the placement methodology for underground backfill.

The mill tailings will be transported by two conveyor belts down to the underground backfill loading station. One tailings return conveyor will be installed parallel to the crushed ore conveyor in the 5 m x 5 m conveyor decline. The other conveyor will be transversal to the decline conveyor dumping on a pile on the floor of the loading station. An LHD unit will load the backfill tailings into a returning ore truck and transport the tailings a distance of approximately of 1 km up to the backfilling stope. The backfill material will be dumped into a dumping bay in the top crosscut of the stope, transported by another LHD unit up to the sill of the backfilling area, and pushed inside the stope with a remote-controlled bulldozer. When the backfill volume reaches the sill level, the bulldozer will push and level the backfill inside the backfilling stope, finally perch the material against the back of the stope. Due to the dip (angle) of the hanging wall the stopes being backfilled can be accessed and filled from the drill sill of the upper, adjacent stopes, by pushing material through windows in the rib pillars.

7.0 WILDLIFE

7.1 DALL'S SHEEP

As part of baseline data collection for sheep, aerial surveys were flown between 2005 and 2007 over a regional study area around the mine site area. In 2008 these studies were expanded to include the access road. The proponent indicates that limited observations made it difficult to identify key habitat areas, whereas historical data from the Government of Yukon indicates that the mountains in the vicinity of the mine are good winter range for sheep. The Yukon Government (Department of Environment) raised a concern with respect to the presence of winter range within the project study area. Even though the project proposal suggests that this area is not currently used by sheep, the Yukon Government (Department of Environment) retains the opinion that the mountains adjacent to the mine site offers good potential winter range for sheep, and is recommending more detailed sheep surveys be completed. The Executive Committee believes that these will assist in validating the current use of the winter range. Furthermore it is felt that without conducting surveys on this mountain block, the sheep use or disuse of the winter range cannot be verified. Please provide the following information.

a) Additional information related to winter range use by Dall's sheep, in the area within and adjacent to the mine. It is recommended that any surveys that may be undertaken are designed through discussion with the Yukon Government (Department of Environment).

A late-winter aerial sheep survey was conducted on April 7 and 13, 2009 according to the recommendation of Jean Carey, Sheep and Goat Biologist with Yukon Government (Department of Environment). The methods used during this survey were designed by EBA biologists and reviewed by Ms. Carey. The survey methods and results have been provided in the Letter Report dated May 29, 2009 and included in Appendix C. In summary, one sheep (ram) was observed approximately 4 km from the proposed mine site and no other sheep or sheep signs were observed (e.g. tracks, scat).

b) Once complete, indicate whether or not this information affects the project as currently proposed (e.g. new mitigations, changes to project design), supported by appropriate rationale.

The information collected from the late-winter aerial sheep survey conducted in April 2009 confirms that although some suitable winter habitat for sheep may be present in the area; sheep abundance is very low. Ewes or family groups have not been observed overwintering in the area, and no observations of lambing have been recorded. Based on this latest survey and from baseline studies conducted between 2005 and 2008, NATC does not foresee the need for further surveys as part of the assessment process. As the data from the 2009 late-winter survey are consistent with other recent data, they do not affect the project as currently proposed. Additional mitigation measures and/or changes to the project design are not required at this time. Mitigation measures for sheep should be implemented as per the project proposal.

7.2 GRIZZLY BEARS

Grizzly bears have been considered in the proposal as a valued component, and an effects assessment has been completed with respect to all phases and activities associated with the project. Input from the Yukon Government (Department of Environment) suggests that the existing survey data is not as comprehensive as it should be, largely due to the fact that it is based upon incidental observations and dated references. Typically, baseline surveys for grizzly bears are more rigorous in nature, and provide a stronger understanding of local populations, survivability, gender, family groups, and localized habitat use.

The information provided in the proposal does indicate continued use of the study area by grizzly bears, and the presence of den sites and areas within close proximity of project activities and infrastructure. Environment has indicated that grizzly bears tend to aggregate den sites in particular habitat types and the availability of these sites are often a limiting factor to survivability, health and condition of bear populations.

Of particular concern is that, as stated in the proposal, bears may avoid denning in areas that are affected or influenced by construction activities or noise (p.488). Given that even with incidental observations the proponent has identified several potential den sites close to project infrastructure, it is the opinion of the Executive Committee that a more comprehensive and detailed understanding of den sites and their current and ongoing use is required. Any project activity or infrastructure that limits access or use to den habitat could have significant adverse effects on localized grizzly bear populations. Please provide the following information.

a) Identify current and ongoing use of denning areas adjacent to the project. Particular attention should be paid to those potential denning areas that are proximal to project activities or infrastructure. The proponent should also attempt to identify landscape features and/or habitat types in the area that are likely to be suitable for this use, so that the impacts of the project can be understood. It is recommended that any surveys that may be undertaken are designed through discussion with the Yukon Government (Department of Environment).

b) Once complete, indicate whether or not this information affects the project as currently proposed (e.g. new mitigations, changes to project design), supported by appropriate rationale.

NATC and NATC's consultants (EBA) have reviewed the information request regarding grizzly bear information. Following previous correspondence with both YESAB and Environment Yukon, Government of Yukon, a letter dated July 3 and addressed to both YESAB and Environment Yukon is appended to this document (Appendix D). This letter is submitted as a formal response to Section 7.2(a) and (b) of YESAB's Adequacy Review Report dated March 30, 2009.

7.3 MINERAL LICK

Baseline studies identify a mineral lick located within one kilometre of the junction between the proposed access road and the road from the mine to the Hess River tributary. Past surveys indicate that animals make use of this lick, and there is sufficient evidence in the area that supports current use by a variety of ungulates (e.g. numerous trails, tracks, antler sheds). The Yukon Government (Department of Environment) has indicated that such mineral licks may be of regional importance to ungulate populations for replenishing bone growth in the spring, as well as fetal development and lactation. However, it is the opinion of the department that there is not enough baseline data about the mineral lick at this location in order to determine its regional importance. There is a concern that the project, as proposed, may affect the usage of this mineral lick by local ungulate populations. Please provide the following information.

a) Describe and detail the use of this mineral lick by local ungulate populations. Any studies required to provide additional baseline information should be developed in cooperation with Yukon Government (Department of Environment).

There is evidence from the baseline studies completed in the area of the proposed road route that the mineral lick in question is used by ungulates. Rather than potentially disturb local populations of ungulates by carrying out further monitoring of the mineral lick, which in turn may adversely affect the results of any monitoring due to the presence of humans and/or equipment, the following information is provided in lieu of any future new data being provided on the use of the mineral lick.

- The service road that passes nearest the mineral lick is not a haul road but a smaller road that will be used by smaller and generally quieter maintenance vehicles, not by haul trucks (used to haul concentrate).

- The volume of traffic along the route will be low as the route is a spur road separate from the main haul road and will only be used for the inspection and service of the water intake infrastructure and water line.
- The mineral lick is surrounded by trees and shrubs that will provide a noise and visual barrier between the mineral lick and the proposed service road.
- NATC will ensure that all mine roads and mine activities are at least 600 m from the mineral lick.
- Placing the road further than 600 m from the mineral lick would cause the road to be moved up hill, increasing the potential for any noise and visual effects on wildlife using the mineral lick.

7.4 INCORRECT DATA IN TABLE 4.1.9-20

Table 4.1.9-20 (p.183) is titled Special Management Requirements and Ongoing Studies – Small Mammals, but the column headings and data shown do not relate to the table heading.

a) Clarify whether or not the Table is titled correctly, or provide the appropriate column headings and relevant data.

Table 4.1.9-20 was titled correctly but the information in the table was incorrect. The following table replaces Table 4.1.9-20 in the project proposal.

TABLE 4.1.9-20: SPECIAL MANAGEMENT REQUIREMENTS AND ONGOING STUDIES – SMALL MAMMALS[1]

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

8.0 MISCELLANEOUS

8.1 AVALANCHE HAZARD MANAGEMENT PLAN

The project proposal identifies avalanche hazards throughout the study area, in particular along the proposed access road. A large component of the mitigation efforts for avalanche hazards on-site and along the road are an avalanche hazard management plan (p.420) and an avalanche safety program (p.423). Even though the proponent indicates that both of these are yet to be developed, it is important that the Executive Committee has a better understanding of how avalanche hazards will be predicted, assessed, and mitigated. Avalanches may pose a significant adverse effect to human safety along the road and on the mine site. Furthermore, avalanches may pose a risk to infrastructure such drainage ditches and diversion channels resulting in potential environmental effects. In order to determine whether or not these hazards will be effectively mitigated, the Executive Committee requires more details of the plan and the program. Please provide the following information.

a) A copy of the avalanche hazard management plan. If a full plan is not yet available, at a minimum provide an outline of the plan that describes the goals, objectives, monitoring and recording efforts, potential list of procedures that could be employed, and a list of resources that will be used to manage and respond to avalanche hazards.

An avalanche hazard management plan will be developed during the permitting phase of the project and a completed prior to construction. The Mactung Mine avalanche hazard management plan will be based on similar management programs that have been successfully implemented at mines in British Columbia.

Forecasting of avalanche hazard for minesite infrastructure will be conducted using periodic snowcourse measurements in addition to review of climate data (precipitation and temperature) collected at the site. A qualified avalanche forecaster/control expert will be utilized for avalanche forecasting.

The goal and objective of an avalanche hazard management plan is to ensure safe operations in avalanche prone terrain during periods of heightened avalanche risk. Safe operations are obtained through active management of avalanche hazards in addition to employing a trained workforce or training a workforce that is supported by proper procedures and protocols.

The hazard management plan for the Mactung mine will include:

- An avalanche path atlas for the road and minesite area detailing the location of avalanche paths. This atlas is used to record natural avalanche activity on a path by path basis in addition to recording the results of avalanche control activities at the site.;
- Establishment of a snow course program for snow stability assessment during winter months;
- Establishment of an avalanche reporting protocol to assist with forecasting efforts;
- Avalanche hazard signage along the access road and signage indicating safe turnout areas;
- A Detailed Emergency Response Procedure for avalanche response including a list of external specialists (RCMP, SAR, avalanche specialists) that may be contacted to provide additional support during avalanche response.;

- Details on recommended amount and type of avalanche response equipment that should be maintained for an emergency situation;
- Annual avalanche hazard and response training program for Emergency Response Team members; and,
- Development of Road Closure and Avalanche Control protocols for avalanche blasting activities associated with the project. Avalanche control is typically performed by helicopter deployment of explosives in order to reduce the mass of snow within starting zones. Avalanche control using the avalauncher (nitrogen charged cannon) may also be used to deliver explosives to potential starting zones. Control work will be performed by a qualified avalanche technician with a blasting certificate valid in the Yukon.

b) An explanation or details on the avalanche safety program including information on the training and resources that are involved, and how it will be disseminated to on-site workers.

Annual avalanche training will be provided to emergency response workers at the Mactung Mine. The training program will cover area specific avalanche hazards and areas, snow stability assessment, and emergency response procedures. The emergency response procedure training will include scenarios involving the use of avalanche transceivers and probes in order to facilitate realistic training. Training for Mactung personnel will be conducted by a qualified avalanche professional with appropriate Canadian Avalanche Association Certification.

An avalanche equipment cache will be maintained for emergency response. The contents of the emergency response cache (transceivers, probes, shovels, stretcher, first aid kits, etc) will be based on current industry standards for this type of operation. The contents of the cache will be inventoried and kept in an accessible location to allow for rapid response.

Contractors utilizing the access road during winter months will be required to undertake avalanche hazard training and to ensure that vehicles traveling the road have the appropriate radio frequencies. Signage along the access road will indicate avalanche areas and also safe turnout areas in order to reduce the exposure of equipment and personnel to avalanche hazard. Contractors will also be required to undertake annual training on the Road Closure and Avalanche Control protocols.

8.2 WASTE STREAMS IN THE DRY-STACKED TAILINGS FACILITY

The project proposal describes the DSTF as being the primary method of dealing with mine tailings. The function of the facility is to provide a long term storage area for tailings, and to facilitate the channelling of tailings drainage. However, throughout the proposal, the proponent indicates that other waste streams will also be directed into the facility including non-combustible wastes (Table 5.4.2-1, p.378) and large waste items (Section 6.3.5.1, p.664), as well as ashes from the solid waste incinerator (including incinerated sewage sludge). As no other mention of this practice is made in the proposal, it is unclear what sort of items will be disposed of in the DSTF, or how they will influence its function.

Comments from an independent review of the project proposal indicate that the proposed liner system (upon closure) will not be adequate in preventing seepage from the DSTF after closure. Furthermore, once the reservoir is removed, there is the real possibility that unknown or unaccounted for contaminants could enter the downstream aquatic environment beyond the life of the project. Please provide the following information.

a) A description and understanding of the types of waste items that will be disposed of in the DSTF including a rationale and understanding as to why these waste streams are being disposed of in the DSTF. Provide examples, if available, of where this practice currently exists and evidence that it is an acceptable practice at operational mine sites.

The dry-stacked tailings facility will not be used for the disposal of waste. Instead, NATC proposes to develop and use an on-site landfill for the duration of the project. The proposed landfill will be located within the polygon presented in Figure 3.7-1, adjacent to the land treatment facility. Development and use of the facility will be conducted in accordance with the (Yukon) *Solid Waste Regulation*.

A description of the expected waste streams for operation and decommissioning of the mine has been included within Tables 8.2-1 and 8.2-2 respectively.

Upon decommissioning, the landfill will be covered with overburden and/or treated soils from the land treatment facility and recontoured as required.

TABLE 8.2-1: WASTES GENERATED DURING OPERATIONS PHASE

Waste Type	Description	Volume	Handling Method	Disposal Method
Solid Waste	General waste produced in camp, including food scraps.	1.3 kg/person/day to 325 kg/day (maximum)	Bagged garbage hauled in a truck.	Propane fired incinerator. Ashes will be disposed of with non-combustible waste in the landfill.
Sewage	Human waste, grey water.	Estimated to be the same as water consumption at 200 litres/person/day.	Sewage will be piped to the proposed sewage treatment facility.	Sewage treatment facility will produce two types of waste, treated sewage effluent and sewage sludge waste. Sewage sludge waste will be incinerated with solid waste. Treated sewage effluent is accounted for below.
Treated Sewage Effluent	Liquid effluent exiting the sewage treatment plant.	Estimated to be the same as water consumption at 200 litres/person/day.	Effluent will be pumped in an insulated, heat traced HDPE pipeline. In emergencies the effluent will be hauled in a water truck which is not used to haul fresh	Treated effluent will flow to the ravine dam.

TABLE 8.2-1: WASTES GENERATED DURING OPERATIONS PHASE

Waste Type	Description	Volume	Handling Method	Disposal Method
			water to the camp to the ravine dam.	
Mine Waste	Inert waste produced operation (i.e. bags, bins, scraps for maintenance and repairs).	Estimated to be 3000 kg/year.	Material will be placed in bins around the site and subsequently trucked to the landfill.	Inert mine waste will be contained within the landfill.
Lubricants	Oils used in machinery, glycol, etc.	Estimated at 5% of fuel consumption.	Stored in bulk waste oil containers, specific to waste type.	Waste oil that is usable in a waste oil heater will be used to produce heat, all other wastes in this category will be hauled off site to an approved disposal facility.
Hazardous Specified Waste	Paint, waste from hydrocarbon spill clean-up, aerosol cans, batteries, cleaning chemicals etc.	Estimated to be 16,000 kg/year	Hazardous waste will be separated and stored in approved containers.	Hazardous waste will be hauled off-site and disposed of in an approved facility.
Brush	Wood or woody debris generated from clearing.	Estimated to be very minor during operation.	Trees will be handled in accordance with plan established with Forestry Branch of Energy, Mines and Resources Department.	Depending on plan developed brush will either be stockpiled for use or burned
Vegetation and Overburden	Stripping of topsoil and unused soil.	Estimated to be very minor during operation.	These materials will be stockpiled in or near borrow pits on site	These materials will be used in the reclamation of borrow pits or final reclamation of the site

TABLE 8.2-2: WASTES GENERATED DURING THE DECOMMISSIONING PHASE

Waste Type	Description	Volume	Handling Method	Disposal Method
Solid Waste	General waste produced in camp, including food scraps.	1.3 kg/person/day to 325 kg/day (maximum)	Bagged garbage hauled in a truck.	Propane fired incinerator. Ashes will be disposed of with non-combustible waste in the landfill.

TABLE 8.2-2: WASTES GENERATED DURING THE DECOMMISSIONING PHASE				
Waste Type	Description	Volume	Handling Method	Disposal Method
Sewage	Human waste, grey water.	Estimated to be the same as water consumption at 200 litres/person/ day.	Sewage will be piped the proposed sewage treatment facility.	Sewage treatment facility will produce two types of waste, treated sewage effluent and sewage sludge waste. Sewage sludge waste will be incinerated with solid waste. Treated sewage effluent is accounted for below.
Treated Sewage Effluent	Liquid effluent exiting the sewage treatment plant.	Estimated to be the same as water consumption at 200 litres/person/ day.	Effluent will be pumped in an insulated, heat traced HDPE pipeline. In emergencies the effluent will be hauled in a water truck which is not used to haul fresh water to the camp to the ravine dam.	Treated effluent will flow to the ravine dam.
Mine Wastes	Material remaining after the mine has closed that must be disposed of during decommissioning.	Dependant upon resale value.	All items for reuse or resale will be taken off-site. Remaining waste will be trucked to the landfill.	Inert mine waste will be contained within the landfill or transported to an approved facility.
Lubricants	Oils used in machinery, glycol, etc.	Estimated at 5% of fuel consumption.	Stored in bulk waste oil containers, specific to waste type.	Waste oil that is usable in a waste oil heater will be used to produce heat, all other wastes in this category will be hauled off site to an approved disposal facility.
Hazardous Specified Waste	Paint, waste from hydrocarbon spill clean-up, aerosol cans, batteries, cleaning chemicals etc.	Not applicable as all material has to be removed from the site to appropriate permitted facilities.	Hazardous waste will be separated and stored in approved containers.	Hazardous waste will be hauled off-site and disposed of in an approved facility.

b) Information that shows how these various waste streams have been accounted for in the successful operation of the DSTF, as well as how they have been considered in the treatment of drainage waters downstream of the DSTF.

As stated in 8.2(a) above, the DSTF will be used solely for tailings disposal and a landfill and incinerator will be used for all other non-hazardous wastes.

c) Indicate how the presence of these various waste streams in the DSTF have been considered in the long term closure and decommissioning of the DSTF, as well as in the quality of seepage from the facility over the long term.

As stated in 8.2(a) above, the DSTF will be used solely for tailings disposal and a landfill and incinerator will be used for all other non-hazardous wastes.

d) Identify any mitigations that will be undertaken to minimize adverse effects that these waste streams may have on the functionality, decommissioning, or closure of the DSTF.

As stated in 8.2(a) above, the DSTF will be used solely for tailings disposal and a landfill and incinerator will be used for all other non-hazardous wastes.

8.3 MANAGEMENT PLANS

An important part of the project submission is a clear understanding of the adaptive management plans and planning that the proponent intends to undertake through the life of the project. The proposal includes the Emergency Response Plan and the Spill Contingency Plan, and indicates that the avalanche hazard management plan, further adaptive management plans, and adaptive management planning are yet to be developed. It is important that a clear understanding of the goals, objectives, resources, and strategies of these plans is provided as part of the proposal in order to determine whether or not they are sufficient and effective. Therefore, please provide the following information.

a) A list of these adaptive management plans that will be developed, as well as the goals, objectives, and details for each plan. In several instances throughout the effects assessment component of the proposal, the proponent indicates that monitoring activities and adaptive management will be used to increase the effectiveness of mitigation measures, but no explanation is provided on the adaptive management framework. Such an approach should include guiding goals and objectives, as well as an understanding of how monitoring activities will inform the process. Include any details related to the scheduling of monitoring activities that will be undertaken as part of each plan.

For the proposed Mactung Mine, NATC will create an Adaptive Management Framework (AMF) that outlines the goals and objectives for managing and preventing potentially negative effects associated with development. Further, this framework will provide for the implementation of six individual Adaptive Management Plans (AMPs), including:

- Wildlife;
- Fish and Fish Habitat;
- Vegetation;
- Water Quality;
- Natural Landscape and Soil Stability; and,
- Human Health and Safety.

Each AMP relates to valued components identified within the Project Proposal and for which potentially negative effects have been identified; specifically where temporal and spatial scopes overlap. For this reason, NATC will, prior to construction and after obtaining regulatory approvals, develop a detailed AMP for each of the listed components. Each AMP has been described in Table 8.3-1 below, specifically a delineation of components for inclusion.

The overarching goal of the AMF, and ultimately each AMP will be to minimize and/or eliminate potentially negative effects of mine-related activities for each valued component.

The ongoing monitoring of project activities and their interaction with specified valued components will form the overarching objective of the AMF. Within each AMP this objective will be further be delineated to outline the acceptable levels of change from each of the value's known baseline condition. These objectives cannot yet be delineated as they will be formed through both the assessment and regulatory processes. For instance, the objectives of the Water Quality AMP will be those parameters and associated limits listed within the Water Licence as well as the Environmental Effects Monitoring program established during permitting with Environment Canada.

The AMF monitoring objective is designed to ensure that each AMP contains a monitoring program developed to meet the appropriate licence requirements and is applicable to the baseline conditions established for the specific valued component. As a result it would be premature to establish the monitoring program requirements and the programs monitoring schedule. Further, the purpose and intent of adaptive management is the development of monitoring/management plans that evolve over the course of the project to respond to the conditions experienced at the project site. Through clearly defined objectives the results of monitoring will be used to improve mitigations and ensure that the overarching goal of the AMF, minimizing potentially negative effects, is met. This iterative approach is referred to as the adaptive management feedback cycle and will be activity incorporated into the life of the project.

TABLE 8.3-1: ADAPTIVE MANAGEMENT PLANS	
Adaptive Management Plan	Components anticipated for Inclusion
Wildlife	- Caribou monitoring (outlined in Table 6.2.7-17 of project proposal). - Moose monitoring (outlined in Table 6.2.7-17 of project proposal). - Grizzly bear monitoring program. - Access monitoring. - Hunting management policy.
Fish & Fish Habitat	- Acid rock drainage and metal leaching, specifically managing tailing, storage of rock, operational accidents and malfunctions, ravine dam and reservoir. - Erosion control for management of sedimentation. - Release of deleterious substances from accidents and malfunctions. - Maintaining baseline species presence. - Fishing management policy.
Vegetation	- Seed mixture effectiveness. - Revegetation success. - Prevention of noxious and invasive species.
Water Quality	- Acid rock drainage and metal leaching, specifically managing tailing, storage of rock, operational accidents and malfunctions, ravine dam and reservoir. - Erosion control for management of sedimentation. - Release of deleterious substances from accidents and malfunctions.
Natural Landscape & Soil Stability	- Emergency Response Plan contained within Appendix M2 of the Project Proposal; which contains response planning for operational considerations and project infrastructure as well as waste management. - Spill Contingency Plan contained within Appendix M2 of the Project Proposal. - Avalanche Hazard Management Plan contained within Appendix M2 of the Project Proposal.
Human Health & Safety	- Driving and access policies. - Accidents and malfunctions. - Emergency response.

b) A copy of the Environmental Management Protocol. The proposal makes reference to this protocol (p.490), but no further information is provided.

For clarification, reference to the "Environmental Management Protocols" identified within the project proposal should have appeared in lower case as "environmental management protocols". These protocols will be designed to address issues and/or encounters with bears during the course of the project. These protocols will form part of the Environmental Management Plan for wildlife, and are described in further detail in section 8.3(a) above.

8.4 RIPARIAN RESERVES

In the project proposal, the proponent suggests maintaining clearance limits and riparian reserve areas during construction activities areas in order to minimize adverse effects on fish and fish habitat. It is stated in the proposal (p.595) that the BC Riparian Management Area Guidebook will be followed, however no further references or information are provided. It is unclear at this point how these reserves will be defined and what factors will be used to establish clearing limits. Therefore, please provide the following information.

a) Details on how the clearing limits will be determined, established and delineated during project activities.

The intention in the project proposal was to utilize those limits as defined in the British Columbia Forest Practices Code *Riparian Management Area Guidebook* (1995). Although this resource now falls under the *Forest and Range Practices Act* in BC and does not explicitly pertain to the Yukon, it does provide a professionally acceptable and conservative set of guidelines that can be applied to the land development included in the proposal. NATC will apply Riparian Reserve Zones and Riparian Management Areas according to Table 8.4:

TABLE 8.4: RIPARIAN RESERVE ZONE AND MANAGEMENT AREA CRITERIA

Fish Bearing Status	Average Channel Width (m)	Riparian Stream Class	Riparian Reserve Zone (m)	Riparian Management Area (m)
Fish-Bearing	5 - 20	S2	30	50
Fish-Bearing	1.5 - 5.0	S3	20	40
Fish-Bearing	< 1.5	S4	0	30
Non Fish-Bearing	> 3.0	S5	0	30
Non Fish-Bearing	< 3.0	S6	0	20

The average channel width denoted in the table above refers to the average cross-sectional stream width from average high water mark to average high water mark.

Two types of setbacks have been adopted from the Riparian Management Area Guidebook, Riparian Reserve Zones and Riparian Management Areas. These set backs are detailed below.

Riparian Reserve Zones (RRZ): extend a moderate distance from the top of bank, and represent vegetation areas that are critical to the functioning of the individual watercourse. No project infrastructure or development will be allowed within the RRZ, with the exception of watercourse crossings where unavoidable. These crossings will be planned for the most suitable location, and NATC will ensure that rights-of-way, clearing zones, and construction areas are minimized, and disturbed areas are promptly and effectively re-vegetated to promote riparian functionality (e.g., runoff control, sediment capture, shade, woody debris input, and organic production for watercourse input). Proper mitigation measures for work near watercourses have been included in the information for bridge and culvert construction measures.

Riparian Management Areas (RMA): extend a larger distance back from bank areas, and represent vegetation area that aids in the functioning of the watercourse and helps to mitigate outside effects on those watercourses (e.g. mitigating peak surface flows, allowing sediment in runoff to settle, providing shade to watercourses). The intent is for the RMAs to be zones of protection where no infrastructure is planned unless necessary (e.g. water access, stream realignment, etc.), and that will be delineated and maintained during the planning and development processes as part of responsible development practices. In addition to limiting development, RMAs will be actively re-vegetated following any development activities to help restore their functionality.

Categorizations of RMAs or RRZs will be determined based on baseline environmental data (e.g. fish bearing status), and ongoing survey data (e.g. stream width). NATC environmental and planning personnel will ensure that sites are properly categorized during the planning processes. NATC will ensure that the required information is collected and that this information is properly routed into the planning process prior to construction.

Delineation of RMAs or RRZs is to be conducted prior to construction activities at the planning and survey stages. NATC will be responsible for developing information regarding riparian protected areas in a format that can be used at the appropriate stages of planning or construction, and will be responsible for sharing this information with contractors, consultants, or other third parties.

b) Explain what efforts will be taken to ensure workers are aware of and how they will operate with respect to the reserve areas.

The delineation of riparian areas will be identified and discussed as part of the Environmental Management Plan (EMP) for the proposed mine. The EMP will be developed in accordance with permits and licences. It will address regulatory requirements applicable to each aspect of the proposed mine. Once the EMP is developed worker training will take place through the presentation of the plan to workers, information handouts specific to individual groups of workers, and through periodic updates which could be provided in conjunction with safety meetings. Implementation and education of the EMP and environmental licence requirements will also form the mandate of the mine's Environmental Coordinator. New employees will be made aware of the plan as part of employee orientation. A copy of the plan will be available on site for employees to review.

Adherence to the EMP, and all regulatory requirements by contractors will form a part of the contracts signed between NATC and each contractor. Further, the mine's supervisory staff would be tasked with ensuring that mine construction and operation activities are carried out in a manner that conforms to the EMP and applicable permits and licenses.

8.5 RE-VEGETATION PLANS FOR PROJECT INFRASTRUCTURE

Throughout the construction phase of the project, vegetation and organic soil will be stripped as part of the development of the mine site and the project infrastructure. The proposal acknowledges that such actions could have adverse effects on the identified valued component of natural landscape. The proposal suggests that where erosion is moderate-high, the proponent will re-vegetate with native species (p.421). The proposal goes on to state that all cleared areas will be re-vegetated (p.470). Please provide the following information.

a) Clarify the intention for re-vegetating cleared areas and include details on how different considerations may affect the proposed mitigative approach.

For clarification NATC will carry out revegetation in areas where erosion potential is considered to be moderate to high. Erosion potential will be determined based on criteria, including:

- slope stability (gradient and length);
- site base soils;
- potential for natural revegetation; and/or,
- distance from a watercourse.

Where cleared areas are not revegetated, NATC will recontour or scarify the area to promote natural revegetation as described in the project proposal.

The criteria used for determining erosion potential will also aid in determining the approach for revegetation, as described in section 8.5(b) below.

b) Identify what measures will be undertaken to ensure re-vegetation, in light of the low soil temperatures, short growing season, and slow rates of plant reproduction, organic accumulation, and decomposition as identified on page 57 of the proposal.

Revegetation will be performed as per the Government of Yukon, Department of Environment supported *"Guidelines for Reclamation/Revegetation in the Yukon"* (Kennedy 1993). As stated in the document, revegetation in northern locations must take into consideration factors such as nutrient availability and winter survival. The objective where revegetation measures are required is to develop a self-sustaining vegetative cover that does not require long-term maintenance such as re-seeding or periodic fertilizer applications.

Determination of the appropriate seed mixture for revegetation activities will be based on a combination of species characteristics and existing micro-habitat features (soil nutrients, growth period, altitude, precipitations, etc.). These features will be established for each revegetation unit in order to ensure that each revegetation is successful. Further, each unit will be defined based on the identification of pre-mining microhabitats which is determined by site specific characteristics; for example micro-topography, soil texture, organic aspect, moisture, and slope characteristics. Modifications to these seed mixtures it is expected to occur based on the results of progressive reclamation activities that may occur during mine operations.

Where possible, native seed mixtures will be purchased from a certified commercial supplier and will be ordered in advance to ensure availability. The use of certified suppliers for native seed supply ensures that information on germination and seed contamination has been documented. Plant communities were previously identified during the *"Vegetation and Ecosystem Land Classification (ELC) 2008 Environmental Baseline Studies"* and will also be considered when determining seed mixtures.

The grubbing of organic and finer grained surficial materials will be conducted during infrastructure and access road construction. Grubbing activities will be restricted to identified clearing boundaries and materials will be placed into stockpiles for use in future site reclamation activities. Mixing of organic materials and the upper granular soil horizon is expected occur due to the thin soil thicknesses in the project area.

Fertilizer will be applied during revegetation activities to ensure soil quality is suitable for plant colonization. The rate of fertilizer application will be determined through reclamation research trials described in the Decommissioning and Closure Plan (Appendix M) submitted with the project proposal.

The revegetation of disturbed areas will be conducted by hand or mechanical means depending on the nature of revegetation efforts. Organic amendments (straw or wood mulch, previously salvaged organic soils) and other accepted revegetation aids (enviro-matting, seedling protectors) will be used where required to increase the potential for successful revegetation. Studies into revegetation requirements will be conducted as part of operational Reclamation Research which was identified in the Decommissioning and Closure Plan (Appendix M) included with the project proposal.

Observations of the performance of revegetation activities on different areas will be undertaken to determine the success of germination, seedling survival and the occurrence of invasive species. These observations will also provide important information on whether there is a need for modification of revegetation methods or if additional remedial measures are required to address a specific site.

The described measures will be used to promote successful revegetation to the areas described in 8.5(a) above.

8.6 MISSING SECTION OF PROPOSAL

Portions of Section 5.4.3.10 (p.406) seem to be missing (i.e. the discussion related to equipment maintenance splits off into discussion on water quality monitoring). Also, Tables 5.4.3.1 to 5.4.3.3 associated with this section are missing.

a) Please update Section 5.4.3.10 and the missing tables accordingly.

The following Section is the missing information from Section 5.4.3.10 of the project proposal. The numbering of the missing section fits with that in the project proposal to make it clear where the section begins and ends.

5.4.3.10 Equipment Maintenance Facility Operation

All equipment maintenance will be conducted on the surface in the equipment maintenance facility. The equipment maintenance facility is located near the shifter building as shown in Figure 5.4.2-17. The equipment maintenance facility will have bulk storage capacity for fuels, oils, and lubricants that are required for the operation of the mobile equipment fleet. These liquids will be stored in supplier provided bulk storage containers. It is anticipated that the products listed in Table 5.4.3-1, Table 5.4.3-2, and Table 5.4.3-3 will be stored on site.

TABLE 5.4.3-1 – FUEL, OILS AND LUBRICANTS STORED ON SITE

Chemical/Product	Quantity Stored	Location
Engine Oil	10,000 litres	Equipment maintenance facility
Hydraulic Oil	10,000 litres	Equipment maintenance facility
Gylcol	5,000 litres	Equipment maintenance facility
Transmission Oil	5,000 litres	Equipment maintenance facility
Grease	2,000 kg	Equipment maintenance facility

TABLE 5.4.3-2 – GENERAL CHEMICALS STORED ON SITE

Chemical/Product	Quantity Stored	Location
Detergents	230 kg	Cookhouse
Adhesives	10 kg	Warehouse
Cement	20 tonnes	Warehouse
Muriatic acid	45 litres	Warehouse
Oxygen	50 cylinders	Warehouse
Paint	150 litres	Warehouse
Paint stripper	45 litres	Warehouse
Propane	50 cylinders	Warehouse
Salt	1 tonne	Warehouse
Dynamite and emulsion explosives	30 tonnes	Magazine
Ammonium nitrate	30 tonnes	Designated Site

TABLE 5.4.3-3 – PROCESS CHEMICALS STORED ON SITE		
Chemical/Product	**Quantity Stored**	**Location**
Copper sulphate	500 – 3,000 kg	Reagent Storage Area
Depramin (starch)	500 – 10,000 kg	Reagent Storage Area
DF-250 Dowfroth (frother)	500 – 4,000 kg	Reagent Storage Area
Emcol	500 – 3,000 kg	Reagent Storage Area
Flocculants	500 – 3,000 kg	Reagent Storage Area
Hydrated lime	1,000 – 21,000 kg	Reagent Storage Area
P40 detergent	200 – 1,000 kg	Reagent Storage Area
Pamak (fatty acid)	500 – 10,000 kg	Reagent Storage Area
Quebracho (tree extract)	5,000 – 25,000 kg	Reagent Storage Area
Sodium silicate	2,000 – 30,000 kg	Reagent Storage Area
Xanthate Z-6 (KAX)	500 – 5,000 kg	Reagent Storage Area
Hydrochloric acid	100 – 400 kg	Reagent Storage Area and Assay Lab
Hydrofluoric acid	50 – 200 kg	Reagent Storage Area and Assay Lab
Nitric acid	100 – 400 kg	Reagent Storage Area and Assay Lab
Sodium bicarbonate	500 – 1,000 kg	Reagent Storage Area and Assay Lab
Sulphuric acid	100 – 400 kg	Reagent Storage Area and Assay Lab

Waste oils removed from mobile equipment and those captured in the sumps and processed through the oil/water separator will be stored in the waste oil bulk storage container located adjacent to the equipment maintenance facility. A waste oil burner installed within the equipment maintenance facility will burn waste oil to supplement the propane heating system. All hazardous waste will be properly packaged and hauled to an approved disposal facility.

5.4.3.11 Powerhouse Operation

Site power requirements will be met through an onsite powerhouse consisting of five 2.5 megawatt diesel generators. The peak power demand for the site is estimated to be approximately 10 MW. The generators will operate through an on-demand system; generators will be throttled down or taken off line when power demands are low. Normally only four of the five generators will operate at any one time allowing for the fifth generator to serve as a back-up. This will ensure that maintenance can be conducted without shutting down the power system. Waste heat produced in power generation will be used to supplement the propane heat in the powerhouse itself as well as in the adjacent process plant.

The diesel generators are expected to consume approximately 69,000 litres of fuel a day (at peak demand). Fuel storage for the generators will be adjacent to the powerhouse and the process plant. The bulk fuel storage will be in single-walled fuel tanks within a geomembrane-lined secondary containment facility. The total diesel storage capacity will be approximately 2,070,000 litres of diesel, or 30 days of total use.

5.4.3.12 Reservoir Operation

Water will be stored in the reservoir year round. The depth of water at the dam will be at least 15 m to ensure that water can be pumped from the reservoir throughout the winter. There will be several inflows and outflows associated with the reservoir as demonstrated in the water balance presented in Figure 5.4.3-9 and summarized in Table 5.4.3-4.

TABLE 5.4.3-4: AVERAGE YEAR WATER BALANCE BY MONTH (L/S)

	Process Water	Runoff	DSTF Seepage	GW Discharge	Treated Effluent	UG Mine Dewatering	Process Water Reclaim	Reservoir Discharge	GW Seepage
	Inflow	Inflow	Inflow	Inflow	Inflow	Inflow	Outflow	Outflow	Outflow
January	46.9	6	0.3	6.6	0.5	1.0	-44.7	-10	-6.6
February	46.9	4	0.3	6.6	0.5	1.0	-44.7	-6	-6.6
March	46.9	4	0.3	6.6	0.5	1.0	-44.7	-5.4	-6.6
April	46.9	5	0.3	6.6	0.5	1.0	-44.7	-6	-6.6
May	46.9	81	0.3	6.6	0.5	1.0	-44.7	-87	-6.6
June	46.9	207	0.3	6.6	0.5	1.0	-44.7	-210	-6.6
July	46.9	131	0.3	6.6	0.5	1.0	-44.7	-171	-6.6
August	46.9	77	0.3	6.6	0.5	1.0	-44.7	-81	-6.6
September	46.9	59	0.3	6.6	0.5	1.0	-44.7	-61	-6.6
October	46.9	35	0.3	6.6	0.5	1.0	-44.7	-38	-6.6
November	46.9	15	0.3	6.6	0.5	1.0	-44.7	-18	-6.6
December	46.9	9	0.3	6.6	0.5	1.0	-44.7	-12	-6.6
Total Yearly Volume (m^3)	1479038	1665196	9461	208138	15768	31536	-1307612	-1862300	-129298

TABLE SUPERSEDED BY TABLES 5.4-1 to 5.4-9 SEE SECTION 5.4 of NATC's ADEQUACY RESPONSES

Water quality in the pond will be monitored using monitoring stations. Stations will be located at the end of pipe and at some distance downstream, as determined through the water licensing process. NATC will ensure that the water quality at the end of pipe discharge location will be in compliance with MMER regulations and the downstream monitoring point will be in compliance with the CCME water quality guidelines to receiving waters.

Should the water be out of discharge compliance it will not be allowed to report to the environment but will be held until suitable treatment regimes are applied. In the event that the groundwater quality downstream of the reservoir is noted to be moving towards noncompliant condition there will be pumping wells downstream of the dam to pump groundwater back into the reservoir. These wells will be capable of pumping at a rate that is twice the anticipated groundwater seepage rate and will discharge water back into the reservoir for treatment and subsequent discharge.

Figure 5.4.3-9 has now been updated and superseded by Figures 5.4-1. Please see Section 5.4.

5.4.3.13 Water Diversion Structures

Water diversion structures will be maintained as required. The diversion structure on the north side of the valley and the diversion berms uphill of the DSTF will both require snow clearing in late winter to open an area for runoff water to flow. Spring runoff will flow in the ditches under the snow as is the situation at Cantung. A summer maintenance program to remove spring runoff debris from the ditches is required only. Snow fences may be installed uphill of the diversion structures to keep large pieces of snow and ice from blocking the water flow route along these diversion structures during freshet. The diversion channel will have a sediment control structure at the outfall, e.g., a silt fence, sediment sump.

5.4.3.14 Water Usage

Fresh and makeup water for the operation phase will be pumped from the Hess River Tributary (H. Tributary) to the site for use as process water and will be treated for use as potable water. It is expected that the water usage for the facilities will be approximately 200 litres per person per day or 30,000 litres per day at peak capacity. Water demand for the process is estimated to be 46.9 L/s. The process water demand will consist of approximately 2.2 L/s of fresh water and approximately 44.7 L/s of reclaim water from the reservoir. Other water flows are described throughout the report and summarized in Section 5.4.3.12.

5.4.3.15 Quality Control / Quality Assurance

NATCL will use a combination of external consultants, an internal project management team, and internal mine staff to conduct quality assurance on all aspects of the tailings placement, backfill placement, mine planning, mine operation, ventilation operation, and all other tasks as necessary. Quality assurance will include, but is not be limited to:

- Daily inspections of all ground conditions and ventilation systems,
- Regular reviews of the mine plan,
- Regular compaction testing at the DSTF; and,
- Annual inspections of all dams and water diversion structures.

All required testing and instrumentation monitoring as detailed in design reports, construction specifications, permits, and licences will be conducted.

5.4.3.16 Work Force Requirements

The labour force required for MacTung is summarized in Table 5.4.3-5. With scheduled rotations, there will be approximately 150 people on site at any given time.

TABLE 5.4.3-5: NATCL'S OPERATION PHASE LABOUR FORCE

Position	Number of Employees
Engineers, geologists, technical staff	15
Mine foremen and superintendents	10
Drillers and blasters	19
Equipment operators	32
Miners and labourers	29
Mechanics and skilled trades	26
Plant foremen and superintendents	10
Plant operators	35
Plant maintenance	26
Plant equipment operators and labourers	30
Total	232

5.4.3.17 Waste Rock Disposal

All waste rock will be disposed as described in the Underground Backfill Section.

5.4.3.18 Tailings Disposal

All tailings disposal will be conducted as described in the DSTF and Underground Backfill Sections. The ravine dam design is summarized in the Construction Phase Section.

5.4.3.19 Access and Transportation

Access to the site will be provided by land and air. Access to Ross River from the south will be by the Robert Campbell Highway. A summer barge and a winter road ice bridge will be used to cross the Pelly River at Ross River along the North Canol Highway. Access to site will be along the North Canol Highway to 3 km before the Macmillan Pass Aerodrome where the mine site access road begins. Ground access will be for all bulk supplies, fuel, and groceries.

NATC will have a material laydown near the warehouse that will be used during the operation phase. The staging area will be on the infrastructure pad adjacent to the truckshop. A cover-all building may be constructed if large items need to be stored snow-free during the winter.

During operation, the mine will be serviced by standard 5-axle or 6-axle 40-tonne trucks and 10-tonne "hot-shot" trucks. It is expected that there will approximately 2 to 4 loads a day on average with a possible peak of 10 trucks per day.

Personnel will be transported to site by a combination of aircraft and buses. Workers from local communities such as Ross River and Faro will be transported to site by bus. Workers from outside the Yukon will be flown from locations such as Vancouver to the Macmillan Pass Aerodrome by chartered aircraft. These workers will be picked up from the Macmillan Pass Aerodrome by a bus and taken to the mine site. It is anticipated that there will be three flights per week to site during the construction phase of the project.

NATC will be responsible for maintenance of the Macmillan Pass Aerodrome and the mine access road. The Government of Yukon will be responsible for maintenance of all Yukon Highways used to access the site, including the North Canol Road.

The mine site access road alignment is shown in Figure 5.4.2-5. There will be 28 stream crossings. The stream crossings will use culverts except for three locations. These three major crossings will have bridges.

5.4.3.20 Fuel, Hazardous Materials and Explosives Management

Fuel will be stored as described in the Bulk Fuel Storage section of the Construction Phase description. NATC will have procedures in place for refuelling mobile equipment. Generators and dryers for the final concentrate product will be connected to the fuel tanks by pipelines with the appropriate emergency shutoff systems in place.

Explosives will be used during the underground mining. Both ANFO and Geldyne high explosive will be used. ANFO will be produced onsite at the emulsion plant. It is anticipated that the emulsion plant will produce 1000 kg of explosives per day. Explosives will be hauled underground in a truck equipped for hauling explosives. The explosives will be stored, in accordance with the applicable laws and standards, at both the South Haul Ramp and the North Haul Ramp.

All other hazardous materials will be handled as described in the waste management section above.

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APPENDICES

PLEASE SEE ATTACHED CD