Tyhee NWT Corp

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APPENDIX L

APPENDIX L TAILINGS ALTERNATIVES ASSESSMENT

April 11, 2011

REPORT ON

Tailings Alternative Assessment Yellowknife Gold Project

Submitted to:
Tyhee Gold Inc.
#401 - 675 West Hastings Street
Vancouver, BC
V6B 1N2

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REPORT

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1.0 INTRODUCTION

This report presents a pre-feasibility level evaluation of options for a tailings containment area at the Yellowknife Gold Project, NWT.

Golder Associates Ltd. was retained by Tyhee NWT Corp (Tyhee) to produce a detailed assessment for selection of a tailings containment area. The assessment is required for submission as part of the Developers Assessment Report to the Mackenzie Valley Environmental Impact Review Board, and to satisfy Fisheries and Oceans (DFO) requirement for a detailed assessment of tailings alternatives before a waterbody is approved for a listing application for the designation of a Tailings Impoundment Area under the Metal Mining Effluent Regulations (MMER) Schedule 2.

This report includes the following:

- A summary description of the project including the mine plan and physical setting.
- A description of methods used to select the tailings containment area.
- Pre-screening assessment of 10 areas and 5 tailings technologies for a total of 50 options.
- Multiple accounts analysis method of evaluation of four options with respect to environmental, technical, social and economic indicators.

A preliminary assessment of tailings containment area selection was previously presented in the Tyhee NWT Corp's Yellowknife Gold Project 2008 Project Description Report (Tyhee 2008).

2.0 PROJECT DESCRIPTION

The project site is located approximately 90 km north of Yellowknife (Figure 1.1), near the historic Discovery Mine site. The Discovery mine was permanently closed in 1969 and the site is now managed by the Contaminants and Remediation Directorate of the Indian and Northern Affairs Canada (INAC). Remediation efforts by INAC included placement of a cover on the Discovery tailings in 1998-2000. The Yellowknife Gold Project (YGP) site is currently accessed by air to an airstrip constructed on the Discovery tailings cover.

2.1 Mine Plan

The Yellowknife Gold Project (YGP) mine plan is based on mining two deposits, namely Ormsby and Nicholas Lake. The Nicholas Lake deposit is approximately 10 kilometres north of the Ormsby Deposit. Two mining methods have been investigated for the Ormsby Zone; surface (open pit) and underground. These investigations indicate that, based on current information, both open pit mining and underground are viable options. For the Ormsby Zone, standard open pit mining is suggested for the upper portions of mineralized zones and underground bulk mining methods are expected to be utilized for the lower portions. It is planned to mine the Nicholas Lake resource by underground methods only.

The Ormsby site will host a 79 Mt (5 Mt ore and 74 Mt waste) conventional open pit followed by a 1.4 Mt underground operation. The Nicholas Lake site will host a 1.3 Mt underground operation. The open pit at Ormsby will provide the bulk of the feed to the mill, accounting for approximately 75% of mill feed for the first 4 years while Nicholas Lake is in operation. Underground operations will begin development during year 3 at the Ormsby site (ramp access will be established near the bottom of the pit to recover the underground resources) and will start producing ore at the end of year 4. The Ormsby open pit has a mine life of 5.5 years excluding stockpiles. The open pit mine will be developed to excavate the majority of the Ormsby reserve. Due to increasing strip ratios as the depth of the pit increases, it is more economical to mine the lower sections of the deposit using underground mining techniques. The Ormsby open pit will produce ore at a rate of 2,250 tpd, while the Ormsby and Nicholas Lake underground operations will produce ore at a rate of 750 tpd for a total combined rate of 3,000 tpd.

A detailed mine plan and schedule will be developed by a professional engineer prior to commencement of the mining activities and maintained on site by Tyhee NWT Corp technical staff during operations. This will include mine design plans, mining sequence and scheduling.

Development of the Ormsby open pit will require construction of a dam to isolate and dewater the north part of Winter Lake. The use of the north portion of the lake is temporary, and the lake would be allowed to re-flood following mine closure. The south end of Winter Lake is one of the tailings alternatives discussed in more detail below. The plan described here is subject to revision during detailed engineering.

This study considers that a total of 7.7 Mt of tailings will be produced over a 7 year mine life. Approximately 74 Mt of waste rock will be produced at the Ormsby site. The majority of waste rock will be produced during open pit development in the first 5.5 years of mine life. Mine wastes will be stored on site over the long term.

Mine waste geochemistry is currently under study. Available geochemistry testing to date indicates that the waste rock is both potentially acid generating (PAG) and non potentially acid generating (NPAG), and that whole tailings are PAG (Golder 2011). Some non-potentially acid generating (NPAG) waste rock may be available for use for construction. Testing to date indicates that the tailings and waste rock will be prone to metal leaching (ML). Arsenic is the principal element of environmental interest in all ore processing wastes and waste rock because of its enrichment in and around the mineralized rock and because of its leachability under neutral pH conditions. Arsenic is mobile under neutral conditions and thus measures to control or prevent ARD generation (other than underwater submergence) and leaching of associated metals could effectively control arsenic release. Drainage from waste rock and tailings should be captured, monitored and treated if necessary, prior to discharge to the receiving environment. (Golder 2011).

2.2 Site Description

This description of the site includes details on environmental setting, geology, seismicity, climate, and surface hydrology. Further studies for geotechnical and hydrogeological site characterization, ground thermal characterization and archaeology are planned for detailed design stages.

Figure 2.1 shows the site layout, including proposed infrastructure and drainage catchments with the exception of a TCA. There are approximately 90 to 100 m of topographic relief in the area, with numerous lakes and outcropping rock ridges. Regional drainage in the area east of Ormsby flows from Round Lake to Winter Lake, and then Narrow Lake. Drainage in the area west of Ormsby flows to Narrow Lake in the south and to Brien Lake in the north.

2.2.1 Environmental Setting

The environmental setting of the site, as described in the 2008 Project Description Report (Tyhee 2008) is as follows.

The YGP lies within the Taiga Shield Ecozone and the Coppermine River Uplands Eco-Region (Environment Canada 2000). This ecozone lies on either side of Hudson Bay. The eastern segment occupies the central part of Quebec and Labrador, and the western segment occupies portions of northern Manitoba, Saskatchewan, Alberta, and the NWT. Two very large biophysical features, the Taiga Forest and the Canadian Shield, define this ecozone. The world's oldest rocks are found on the Taiga Shield north of Great Slave Lake.

The Coppermine River Uplands Ecoregion extends from the McTavish Arm of Great Bear Lake to Howard Lake in the central district of Mackenzie in the Canadian Shield. It is marked by short, cool summers and very cold winters. The mean annual temperature is approximately -7.5°C. The mean summer temperature is 9 C and the mean winter temperature is -24.5°C. The mean annual precipitation ranges 200 mm to 300 mm. The ecoregion is classified as having a predominantly high subarctic eco-climate.

The area is part of the tundra and boreal forest transition, where the latitudinal limits of tree growth are reached. The predominant vegetation consists of open, very stunted stands of black spruce and tamarack, with secondary quantities of white spruce and a ground cover of dwarf birch, willow, ericaceous shrubs, cottongrass, lichen, and moss. Poorly drained sites usually support tussocks of sedge, cottongrass and sphagnum moss. Low shrub tundra, consisting of dwarf birch and willow, is also common.

This ecoregion includes the western half of the Bear-Slave Upland, which consists mainly of massive Archean rocks that form broad, sloping uplands, plateaus, and lowlands. The surface is typical of the bare rock parts of the Shield. Numerous lakes fill the lowlands, and rounded rocky hills reach 490 m above sea level (masl) in elevation. Bare rock outcrops are common, and Dystric Brunisols with some Turbic, Static, and Organic Cryosols are the dominant soils in the ecoregion. The soils have formed on discontinuous veneers and blankets of hummocky to rolling, sandy morainal, fluvioglacial, and organic deposits. Permafrost ranges from continuous in the east to extensive discontinuous in the west half of the ecoregion, with low to moderate ice content and sparse ice wedges.

Characteristic wildlife includes caribou, moose, grizzly and black bear (though no grizzly bears are known in the YGP area), snowshoe hare, fox, wolf, beaver, muskrat, osprey, raven, spruce grouse, and waterfowl.

Lakes within the region contain a variety of fish species, including Northern Pike, Lake Whitefish, Lake Trout, Burbot, Cisco and Slimy Sculpin, with the species composition of each individual waterbody dependent on the habitat available and conditions in the lake. Eclipse Lake and Nicholas Lake were observed to support a complex diversity of habitat types, including steep and vegetated shorelines, rocky shoals and islands, deep water, boulder fields and multiple embayments. Both lakes provided important habitat attributes for the spawning, rearing and over-wintering of Northern Pike, Lake Trout, Burbot, and Lake Whitefish. Brien Lake and Narrow Lake were limited in their habitat availability for fish and were primarily comprised of a single elongated basin supporting a single deep lake section and extensive shed wetland vegetation, at both ends of each of the lakes. Brien Lake and Narrow Lake both support populations of Northern Pike, and Narrow Lake supports an extensive population of Lake Whitefish, as well as populations of Slimy Sculpin. Fish have not been collected from Round Lake, likely due to its shallow depth (most of the lake would freeze to the bottom in winter) and poor water quality (effects from the Discovery Mine, as well as low dissolved oxygen levels). Winter Lake supports limited use by juvenile Northern Pike, which likely move into the lake from Narrow Lake during the open water period to feed on invertebrates. Winter Lake is considered to have limited habitat suitability to support fish due to shallow depth (most of the lake would freeze to the bottom in winter) and anoxic conditions that develop under ice, making over-winter survival of fish unlikely.

Land uses include hunting and trapping, fishing, and tourism. Diamond exploration is a more recent activity along the northern boundary of the region.

2.2.2 Geology

Geology at the site, as described in the 2008 Project Description Report (Tyhee 2008) is as follows:

Soils

Soils at the site include stony, sandy glacial till and fluvial deposits, within the zone of discontinuous permafrost. Bedrock is generally at or near ground surface.

Bedrock

The Yellowknife Gold property is situated about 2 km south of the Nardin Complex and the high metamorphic grade correlatives of the Burwash Formation. The property straddles the cordierite-in isograd separating the low and medium grade regions of the Basin. The Discovery and Nicholas Lake prospects are hosted in the medium grade rocks, whereas the Ormsby prospect lies within the low metamorphic grade region. Granitoids intrude most medium grade regions of the Burwash Formation; but none appear to intrude the low grade regions. Granitoids on the property are undated and unclassified but are considered to most likely be assignable to the Hidden-Prosperous Lake intrusive suite. Northwest-striking and roughly east-striking mafic dykes of unknown age intrude both metamorphic regions, and the latter set also intrudes the figure-8 shaped granitoid north of Thistlethwaite Lake.

Ormsby

Rocks of the Yellowknife Supergroup underlie the Discovery Property, which consists of two large metabasaltic bodies surrounded by predominantly metasedimentary rocks. Three rock units are present on the Discovery Property: (1) the Burwash Formation composed of metamorphosed sandstone and siltstone turbidites; (2) the Transition Unit composed of metamorphosed sandstone, siltstone, (now graphitic) mudstone, and volcanic components; and (3) amphibolite composed of pillowed, brecciated and massive metabasalt. The amphibolite and Transition units are interpreted as occurring collectively within the Banting Group based on rock associations and U-Pb age. One of the amphibolite bodies is termed the Ormsby Member, and hosts Ormsby gold mineralization. It contains a significant brecciated or fragmental component. The derivation of the breccia as a primary or secondary effect is not resolved. It does appear to be a controlling feature on the distribution of gold mineralization.

The more northerly amphibolitic body contains pillows, more limited breccias or fragmentals and is referred to as the Discovery Member.

All the rocks are deformed and metamorphosed at greenschist to amphibolite facies conditions. Nonetheless, their protoliths are recognizable based on preserved textures. Four generations of ductile deformation are preserved on the property, exposed as near vertical dipping foliations, folds and a composite lineation. Retrograde metamorphism and gold mineralization overprint ductile deformation. Faulting and jointing are the youngest observed deformation on the property. The metabasalt bodies are more competent and susceptible to brittle deformation and extensional veining than the surrounding metasedimentary rocks.

Nicholas Lake

Turbiditic metasedimentary rocks of the Burwash Formation predominate the Nicholas Lake region, and are intruded by granite and granodiorite, which host mineralization. Numerous dykes and irregular masses of granodiorite are present in the area southwest of the main granodiorite intrusion. Burwash Formation metasedimentary rocks are tightly folded with remnant bedding striking generally north westerly and dipping steeply. A strong, parallel to sub-parallel axial planar foliation is preserved in the rocks. Regional metamorphic grade is lower amphibolites facies (Northwest Territories Geosciences Office Detailed Showing Report of Nicholas Lake). The granodiorite is medium-grained, beige to weakly pink, commonly silicified and contains common quartz veins and stringers as well as sheeted quartz vein zones.

2.2.3 Seismicity

The project site is within a zone of low seismicity. National Building Code of Canada (2005) indicates a peak ground acceleration of 0.06 g.

2.2.4 Climate

Climate at the site, as described in the 2008 Project Description Report (Tyhee 2008) is as follows. Winds at the YGP site are predominantly from the east with winds blowing from the ENE, E and ESE 30% of the time. Wind speeds are relatively calm with a 95% occurrence of winds under 6 m/s (22 km/h).

Mean relative humidity during winter months is between 80% and 90%. Relative humidity decreases in late February, with levels of 50% to 60% by June and July, then increases in early August to winter normals in October. Variation is between 15% in winter and on the order of 40% in summer.

Temperature norms for the YGP site vary from average temperatures of -24°C in January to 16°C in July.

Tables of climate normals for the site and for the Yellowknife airport are included in Appendix A.

2.2.5 Hydrology

Hydrology at the site, as described in the 2008 Project Description Report (Tyhee 2008), is as follows. Hydrology drainage basins are illustrated in Figure 2.1. Drainage through the area is from Round Lake to Winter Lake to Narrow Lake, and then Morris Lake. From measurements in 2005, 2006, and 2007, the maximum volumes flowing through the lake outlets included 0.024 Mm^3 from Round Lake, 0.16 Mm^3 from Winter Lake, and 0.75 Mm^3 from Narrow Lake. Detailed summaries of basin areas and flows are included in Appendix A.

3.0 TAILINGS AREA ASSESSMENT METHODOLOGY

The tailings containment area site selection methodology included the following:

- Identification of potential tailings storage areas and technologies.
- Pre-screening and selection of options for detailed evaluation.
- Multiple accounts analysis (MAA) evaluation of selected options.
- Sensitivity analyses.

Methods and criteria are described in the following sections.

3.1 Identification of Potential Tailings Containment Areas and Technologies

A total of 10 possible TCAs were identified within a 10 km radius of the proposed mill site. Areas were selected to avoid larger lakes with good fish habitat and included six areas that were largely on-land and four with lakes. Two of the areas including lakes were previously impacted by the historic Discovery mine tailings, and two included water bodies that were relatively close to the proposed mill site.

A total of 5 potential tailings disposal technologies were identified for the project including slurry, thickened tailings, paste, filtered/dry stack and co-disposal with waste rock.

Areas and technologies were then pre-screened to identify options for detailed assessment, with each option including both an area and a tailings technology.

3.2 Pre-Screening

A total of 50 TCA options were pre-screened against the following criteria:

- Must store the life-of-mine tailings production.
- Must allow for possibility of increased storage capacity should the ore reserve increase.
- Must accommodate mine expansion - for example, the facility should not fall on the strike of the deposit.
- Area is within the same sub-catchment as the pit in order to limit the area impacted by mining activities.
- Must have a low consequence of failure.
- Avoids direct impact to water bodies.

Options that failed two or more of the pre-screening criteria were eliminated. Of the remaining options, those with different technologies in the same area were further compared to select the single best option for the area. Selection of the optimum technology within an area involved comparison of different tailings technologies for the area. Technologies were compared for construction, operation and closure phases of the mine life. Benefits were judged against additional costs for each technology, with slurry tailings as the base case. The remaining options were compared using a multiple accounts analysis method.

3.3 Multiple Accounts Analysis Method

Options selected from pre-screening were assessed using a multiple accounts approach that was developed to aid in decision making.

The process of evaluation involved the following:

- Each option was evaluated for environmental, economic, social, and technical indicators that are further divided into sub-indicators.
- Each option was measured or rated against each sub-indicator.
- For each sub-indicator, each option was then assigned a relative score using a ranking scheme based on comparison with the other options.
- Weightings were assigned to each sub-indicator.
- Relative scores were multiplied by assigned weightings to produced weighted sub-indicator scores.
- Sub-indicator scores were summed to provide indicator scores.
- Total option scores were calculated by summing the indicator scores, with the higher score meaning a better option.

Judgement and perception of the individuals conducting the analyses is inevitably part of any such decision making system, both in the assignment of qualitative scores and of weighting factors. Quantitative methods were therefore used to assign relative scores where possible. However, some sub-indicators required the use of qualitative judgement.

Indicators and sub-indicators used in the decision matrix method are described in the following sections, along with a description of use of relative ratings and weightings.

3.3.1 Environmental Indicators

The European Commission (2004) published a Report on Best Available Techniques (BAT) reference document for 'Management of Tailings and Waste-Rock in Mining Activities'. This document was developed in a follow-up action to tailings dam bursts that occurred in Aznalcollar and Baia Mare. The follow-up measures included an elaboration of the BAT Reference Document based on an exchange of information between European Union's Member States and the mining industry. The following key environmental issues or impacts associated with tailings facilities were listed in this document:

- Site specific issues relating to option location and relative land take.
- Potential emissions of dust and effluents during operation (to air, land, and water) and their impact.
- Potential emissions of dust and effluents after closure (to air, land, and water) and their impact.
- ARD and metal leaching, release, and impact.
- Potential releases due to failures of facilities (*i.e.,* burst or collapses of tailing management facilities).
- Site rehabilitation and aftercare to minimize environmental impacts.

In accordance with the intention to use BAT to respect environmental considerations, a list of sub-indicators was developed and used to evaluate the various options. These sub-indicators are presented in Table 5-1 and are described briefly in subsequent sections. The site rehabilitation is considered as a technical sub-indicator.

Table 3-1: Environmental Sub-Indicators

	Sub-Indicators
Environmental	Sub-catchment area
	Number of Sub-catchments Impacted
	Surface flow path length to nearest control point
	Lakes along flow path to nearest control point
	Number of lakes impacted
	On-land footprint area (considers habitat)
	Potential for dust generation during operation
	Potential for Acid Rock Drainage (ARD)
	Potential for Metal Leaching (ML)
	Potential for seepage to groundwater
	Potential for geotechnical hazards with risk to the environment[1]
	Impact on Fish and Fish Habitat

Note: [1] Includes consideration of nature of structure, foundation conditions, impact of seismicity, and height of structure.

Sub-Catchments

A catchment is an area of land bounded by natural high points (hills, ridges, and mountains). Surface water (rainfall and runoff) flows down through the catchment area and into one low point (a creek, river, or bay). Catchment areas may be further divided into sub-catchments; typically each sub-catchment area will have homogeneous physical characteristics.

For the purpose of this evaluation, sub-catchment area was defined as the primary portion of the watershed that would be impacted by the deposited tailings. The total sub-catchment area (hectares) and number of sub-catchments impacted were used to assign relative scores and determine the impact of each option. Options having lower sub-catchment areas are preferable to those with greater areas, and hence were assigned relatively higher scores.

Surface Flow Path

The length of flow path from the nearest point of the TCA option to the hydrology control point through surface water flow in natural channels was measured in plan. A greater distance results in a higher score because the impact of the receptor water body is reduced.

Number of Lakes Impacted

The number of lakes within each area is counted as an indication of habitat that would potentially be impacted.

The number of lakes that each option would impact was tallied and used to assign the relative scores for this sub-indicator. An option that does not impact a lake would receive a relative higher score than an option that impacted a lake.

On-Land Footprint Area

The on-land footprint area of the TCA is defined as the area covered by the deposited tailings and dams. The total footprint area minus the lake area, in hectares, was used to assign the relative scores and judge the impact of each option. The site having the smallest footprint area was given the highest relative score, and the other options were assigned a lower score, relative to their footprint area.

Potential for Generating Dust during Operations

The relative potential for each option to generate dust during mine operation was qualitatively judged, and a value of low, medium, or high was assigned. This sub-indicator is dependent on the method of tailings deposition selected and the relative exposure of the site to wind. In assessing this sub-indicator, a TCA having the lowest topographic profile, or within an area of low topographic relief, would have a high relative value assigned representing a more desirable option. A TCA with a high topographic profile, and located in an area exposed to wind, would be assigned a low relative value, representing a less desirable option.

A facility located topographically as low as possible would be preferable in that the potential for on-going dust generation and down-wind dispersion over water and land would be reduced. Dust can affect vegetation and subsequently affect forage availability and wildlife species such as caribou.

Potential for Acid Rock Drainage (ARD)

For the present analysis, it is assumed that the combined tailings stream is potentially acid generating (PAG). The potential for the tailings deposited in each option to generate ARD during mine operation was qualitatively judged and a value of low, medium, or high was assigned. This sub-indicator is primarily dependent on the method of tailings deposition and the planned method of operation that may minimize the generation of ARD. Options with lower potential for ARD generation are assigned higher relative scores than options with higher potential for ARD.

Potential for Metal Leaching (ML)

For the present assessment, it is assumed that tailings generated at YGP will have potential to leach metals. The impact of metals released into the environment may be toxic, but depends on many factors including concentration, pH, temperature, and water hardness (European Commission 2004). The relative potential for each option to generate metal leaching (ML) during mine operation was qualitatively judged, and a value of low, medium, or high was assigned. This sub-indicator is primarily dependent on the method of tailings deposition and the planned method of operation that may minimize the generation of ML. Facilities that reduce or eliminate the generation and/or transmission of soluble metals to the environment (*i.e.,* hydraulic containment) would receive a high relative score, in comparison to facilities that do not control metal leaching.

Metals may leach from tailings irrespective of the pH; therefore, controlling the flux of water through and out of the tailings facility may have the greatest effect on reducing the release of metal constituents. Consequently, management strategies that limit infiltration of water into the tailings facility, and limit the ability for tailings to come into contact with natural water sources such as groundwater, surface water, and precipitation through the use of low permeability cover systems, containment berms, and diversion ditches, are preferable. Tailings dewatering or thickening at the mill will reduce the volume of water in contact with the tailings, and gets a higher score.

Potential for Seepage to Impact Groundwater

The relative potential for seepage from each option to impact groundwater resources during operation was qualitatively judged and a value of low, medium, or high was assigned. This sub-indicator is primarily dependent on the method of tailings deposition, the planned method of operation, including any steps that will be taken to control groundwater discharges, and groundwater flow paths and flow rates off the site (*i.e.,* groundwater discharge or recharge area). Facilities that produce low rates of seepage and seepage with low levels of contamination would receive a high relative score in comparison to facilities that are expected to generate high quantities of seepage with a high concentration of contaminants (including metals and low pH).

One method of reducing the potential for groundwater impact may be achieved by controlling the flux of water through the tailings. During operation, water flow through the tailings may be controlled by the surrounding berms and liner or low permeability boundary. Facility liners may be man-made or natural, such as low permeability rock, till, clay, or synthetic materials (*i.e.,* high density polyethylene). Materials such as sands and gravels, or highly fractured rock, are highly conductive and would not reduce the flux through the facility.

Options with a low potential for impact to groundwater were assigned higher scores relative to options with a higher potential for impact to groundwater.

Potential for Geotechnical Hazards

The relative potential for geotechnical hazards to exist at each option was qualitatively judged and a value of low, medium, or high was assigned. The assessment considered foundation conditions, seismic activity, and height and type of structure. Tailings facilities may have high dams, and / or long perimeter dams. These facilities may contain large quantities of tailings that can be released to the environment if the retaining structures fail either through the man-made perimeter dams or failure through the foundation materials due to low strength. Unconsolidated tailings stored as slurry with a water cover have the potential to be much more mobile than tailings stored as a dewatered paste.

Tailings are deposited behind dams that are engineered structures constructed with processed materials. The performance and stability of these structures will depend on the foundation conditions, foundation preparation, fill materials, and quality of the construction. The risk increases with the length of the dam structure and, more importantly, the height of the structure. It is desirable from an environmental perspective to optimize the reliance on well constructed engineered structures.

Options with a low potential for geotechnical hazards were assigned higher scores relative to options with a higher potential for geotechnical hazards.

Impact on Fish and Fish Habitat

The expected quality (*i.e.*, low, medium, high) of fish habitat impacted by each of the tailings facilities (tailings deposition and reclaim water) was used to assign relative scores as a measure of the impact of each option. An option impacting high quality fish habitat would receive a lower score than an option that impacts low value fish habitat. Because of the greater relative importance of this metric, a maximum weighting factor was applied.

3.3.2 Economic Indicators

The Economic indicators influencing each of the tailings options were considered. One Economic sub-indicator (Table 3-2) was used to evaluate the options under consideration based on an assessment of the present value of costs.

Table 3-2: Economic Sub-Indicators

	Sub-Indicator
Economic	*Net present value of total costs (capital expenditure + closure costs)*

Evaluation of relative costs was based on:

- Volume of dam fill required;
- Length of tailings distribution pipeline;
- Length of water reclaim pipeline;
- Tailings cover at closure based on a cover over the total tailings area in plan; and
- Process requirements for dewatering.

The approach is simplified, and does not consider risks, operational and sustaining costs, water treatment, monitoring, dam raise scheduling, or gold production schedule. Fish habitat compensation agreements had not been negotiated at the time of this report and costs are therefore not included. Discount rate is assumed at 7%. The economic evaluation is an order-of magnitude relative comparison of specific partial costs that should not be used for any other purpose.

3.3.3 Social Indicators

A list of Social sub-indicators was developed and used to evaluate the various options. Social sub-indicators are presented in Table 3-3 and are described briefly in subsequent sections. It is expected that the assessment of Social indicators will be updated upon completion of socio-economic studies and stakeholder consultation.

Table 3-3: Social Sub-Indicators

	Sub-Indicator
Social	Risk to Human Health
	Risk to Public Safety
	Risk to Worker Safety
	Economic Advantages to the Local Community
	Local Job Creation and Diversity
	Quality of Life
	Use for the Public
	Landscape
	Cultural Heritage
	Management Practices and Innovation

Risk to Human Health

Potential adverse impacts on human health, including dust generation and potential to contaminate drinking water were included in the assessment. At the Yellowknife Gold Project site the prevailing wind direction is from the east (Tyhee 2008). A tailings facility with the potential for on-going dust generation during operations and during closure could potentially impact areas down wind of the source. For example, if the tailings facility was located to the east of the proposed mill location. Risks were first evaluated by multiplying the likelihood of an event by the rated severity of the consequence of exposure, and then rated as insignificant, low, medium, high, or very high based on a format shown in Table 3-4. Scores were then assigned based on the maximum assessed risk with low risk options receiving a higher score.

Table 3-4: Risk Evaluation Framework

Likelihood	Consequence	Risk = Likelihood x Consequence
Almost Certain = 5	Insignificant = 1	Insignificant = 0 to 4
Likely = 4	Minor = 2	Low = 5 to 9
Moderate = 3	Moderate = 3	Medium = 10 to14
Unlikely = 2	Major = 4	High = 15 to 19
Rare = 1	Catastrophic = 5	Very High = 20 to 25

Risk to Public Safety

Potential adverse impacts on public safety include creation of uneven or steep topography, soft tailings deposits or ponds with thin ice. Risks were first assessed based on the format in Table 3-4. Scores were then assigned based on the maximum assessed risk with low risk options receiving a higher score.

Risk to Worker Safety

Potential adverse impacts on the safety of corporation and contractor staff (accidents, time off, illness, etc.) were assessed for construction, operations and closure phases. Risks were first assessed based on the format in Table 3-4. Scores were then assigned based on the maximum assessed risk with low risk options receiving a higher score.

Economic Advantages to the Local Community

Economic benefits to the local community and regional first nations. Economic benefits are realized through an increase in trade and local business, such as supply of materials, expediting and transport of persons and goods and through increase in tax revenue. Options were rated as low, medium, or high based on relative perceived differences, with options providing more economic advantages receiving higher scores.

Local Job Creation and Diversity

Job creation and diversity includes creation of opportunities for northern first nations and other local communities. For example, jobs can be created directly at the mine, and also in local communities to service mine activities, such as supply of materials, transport, healthcare, social work, and education. Options were rated as low, medium, or high based on relative perceived differences, with options requiring more manpower receiving higher scores.

Quality of Life

Quality of life includes both benefits and adverse impacts on the daily life of community members. Examples of benefits include new infrastructure, better access to healthcare, education and training. Examples of adverse impacts include noise, dust, traffic, and road closures. Options were rated as low, medium or high based on a qualitative assessment of relative perceived differences, with better options receiving higher scores.

Use for the Public

Potential for post-closure land use of mine facilities by the public, *e.g.,* roads, recreation areas. Options were rated in terms of low, medium and high based on a qualitative assessment of relative perceived differences. Scores were then assigned with higher scores where there is a greater potential for the facility area to be used by the public.

Landscape

The relative visual impact for each option was qualitatively judged and a value of low, medium, or high was assigned. This sub-indicator considered such items as height, shape, and contrast with the surrounding terrain. An option with a low profile that would blend in with the surrounding area would have a lower impact and receive a higher relative score than an option with a high topographic relief that did not blend into the surrounding terrain.

Cultural Heritage

Cultural heritage includes overall impacts of the option on the cultural attributes of the site (historical, preservation, archaeological, First Nations) in terms of operations and end land use. As examples, the larger lakes in the area can be used for fishing. Options were rated in terms of low, medium and high based on a qualitative assessment of relative perceived differences. Scores were then assigned with higher scores meaning a greater potential for the facility area to become part of cultural heritage.

Management Practices and Innovation

Integration of best management practices is based on perceived environmental and social performance including criteria such as minimal use of natural resources and water, renewable energy and energy efficiency, treatment surpassing the applicable criteria, promotion of reduce, re-use, re-cycle, transparency and stakeholder engagement. The sub-indicator provides a measure of innovation. Options were qualitatively assessed and assigned values of low, medium or high, with higher value options receiving higher scores.

3.3.4 Technical Indicators

Table 3-5 presents a list of the technical sub-indicators that were used to evaluate the options under consideration. The following subsections briefly describe each of these sub-indicators and how they were evaluated.

Table 3-5: Technical Sub-Indicators

	Sub-Indicators
Technical	Pond depth available at startup
	Length of reclaim pipeline
	Length of tailings pipeline
	Maximum height of dams
	Pond management during winter conditions
	Potential for operational delays due to freezing
	Volume water stored (Mm^3)
	Capping Volume assuming 2 m thickness over plan area at closure (Mm^3)
	Ease of decommissioning/closure
	Construction Risk
	Permitting Risk: Disposal system has precedent in arctic environment

Pond Depth Available on Start-up

The depth of pond available at mill start-up was evaluated based on topographic contour information. Without sufficient depth for a reclaim pond, water management is complicated by siltation of intakes with tailings. Options that do not require ponds, such as co-disposal, automatically receive the highest score. For options requiring a water reclaim pond, such as slurry tailings, options with deeper ponds receive higher relative scores.

Length of Pipelines

The nominal length of pipelines for tailings distribution and water reclaim were determined. Values were used to assign a relative score for each option based on the proximity to the mill. Shorter pipelines receive the highest relative score, and facilities requiring long pipelines receive the lowest relative score. Increased distance results in higher pumping power requirements, higher risk of pipe blockage either due to freezing or sanding, and increased pipe maintenance. It is also recognized that reduced distance from the mill allows more frequent inspections and facilitates maintenance.

Maximum Height of Dams

Maximum height of dams provides a quantitative measure for relative comparison of risks between different options. For a given location, dams which are higher require more construction effort and carry more risk than shorter dams. Options with lowest height of retaining structures are assigned the highest relative score.

Pond Management during Winter Conditions

Pond management during winter conditions is considered difficult. Options with reduced water handling requirements during winter conditions, such as those using thickened tailings where water is reclaimed in the mill, received higher scores.

Potential for Delays due to Freezing

The relative potential for delays to be caused due to freezing that would impact mining processing operations was qualitatively judged, and a value of low, medium, or high was assigned. This considered various factors including deposition method, tailings transport method, requirement for operation of a water reclaim system, and pond depth. Facilities that were judged as being more susceptible to freezing that could then cause delays within other portions of the plant received a low score, whereas facilities that were less subject to freezing received a higher score.

For example, an option that required multiple pumping stations or a longer pipeline for transport of tailings uphill with a reclaim water pipeline would likely be more susceptible to freezing and therefore to potential for delays or spills or accidents than a system using a short gravity flow system for paste tailings without a water reclaim.

Volume of Water Stored

Operation of tailings impoundments in cold climates can result in entrapment of water as ice in the deposit. The volume of water stored permanently in the TCA was evaluated based on assumed dry density and total volume of the deposit. Lower volume of water stored receives a higher score.

Closure and Cover Capping Volume / Ease of Decommissioning

Closure relates to the ease of closing the option with respect to the progress of tailings consolidation. For example, if covers can be installed in a progressive manner during operations then ease of closure will be higher. Higher density deposits receive a higher score. Total volume of fill required for cover construction is listed separately, with lower volume receiving a higher score.

Construction Risk

The relative potential for delays or problems to occur during construction was qualitatively judged, and a value of low, medium, or high was assigned. Various factors, including type of construction, amount of construction and construction season, schedule and dependencies, and site conditions were taken into account. For the co-disposal option, tailings production is tied to waste rock production by deposition in the same facility, which adds risk that must be managed. Facilities that require significant construction effort are more subject to delays. By comparison, facilities that require less construction are perceived to have less construction risk and are assigned a higher relative score.

Disposal System has Precedent in Arctic Environment

The precedent for use of each of the proposed tailings deposition methods was qualitatively judged based on the evaluators' experience and published literature, and a value of low, medium, or high was assigned. Facilities that have been successfully built and operated in arctic climates received higher scores relative to facilities that have not been built or rarely built in arctic climates. A list of various tailings management systems used in Arctic or cold climate regions are shown in Table 3-6. The list is not comprehensive but is intended to provide the reader with additional background as to which management strategies are commonly used in the north.

Table 3.6
Tailings Deposition Methods in Arctic or Cold Climates - DRAFT

Mine Name	*Owner*	*Location*	*Tailings Disposal Method*	*Notes*
Ruttan Mine	Hudson's Bay Mine & Smelting	Northern Manitoba	Sub-aqueous slurry	
Thompson Mine	Vale Inco	Manitoba	Sub-aqueous slurry	
Nanisivik Mine	Breakwater Resources Ltd	Nunavut	Sub-aqueous slurry	- initial deposition in lake until filled
Red Dog Mine	Teck Cominco	Alaska	Sub-aqueous slurry	
Voisey's Bay	Vale Inco	Newfoundland (Labrador)	Sub-aqueous slurry	
Doris North Project	Miramar Hope Bay Ltd.	Nunavut	Sub-aqueous slurry	- planned
Key Lake	Cameco	Northern Saskatchewan	Sub-aqueous slurry	- initially in on land containment facility now in mined out flodded pit
Rabbit Lake	Cameco	Northern Saskatchewan	Sub-aerial slurry, will be sub-aqueous at closure	- in open pit with a drainage layer surrounding tailings (wall and base)
Copper Cliff Mine	Vale Inco	Sudbury	Sub-aerial slurry	
FlinFlon	Hudson's Bay Mine & Smelting	Northern Manitoba	Sub-aerial slurry	
Kidd Creek Mine	Xstrata	Timmins	Sub-aerial slurry	- Thickened to 60-65% deposited from center in a cone
Nanisivik Mine	Breakwater Resources Ltd.	Nunavut	Sub-aerial slurry	- later stage deposition in cells above lake - permafrost encapsulation
Fort Knox and True North	Kinross Gold Corporation	Alaska	Sub-aerial slurry	- in dammed valley, closure will be; sub-aqueous using engineered wetlands
Rankin Inlet	Asamera Minerals Inc.	Nunavut	Sub-aerial slurry in pit	as remediation, permafrost encapsulation
Meadowbank Gold Mine	Agnico-Eagle Mines Limited	Nunavut	Sub-aerial slurry in de-watered lake	Mill start-up 2010
Lupin Mine	Echo Bay Mines Ltd. (Kinross Gold)	Nunavut	Sub-aerial slurry	- deposited in cells, saturated final cover, and paste for underground backfill, permafrost encapsulation
Ekati Mine	BHP Billiton Diamonds Inc	Northwest Territories	Thickened tailings (50%) - sub aerial and sub-aqueous	- in dammed lake with lake level raised - non acidic generating
Polaris Mine	Teck Cominco	Cornwallis Island, Nunavut	Thickened tailings	- deposition in lake
Greens Creek Mine	Kennecott Greens Creek Mining Company and Hecla Mining Company	Alaska	Sub-aerial dry stack	
Raglan Mine	Xstrata	Quebec	Sub-aerial dry stack	- permafrost encapsulation
La Coipa	Kinross Gold	Chile	Sub-aerial dry stack	- Tailings are filtered to recover excess water as well as residual cyanide and metal credits
Pogo Gold Mine	Teck Cominco and Sumitomo Metal Mining	Alaska	Sub-aerial dry stack in valley impoundment and underground paste backfill	- final permitting and construction
Mineral Hill Mine	TVX Gold Inc	Montana	Sub-aerial dry stack	- in the planning stages
Met Site, Kidd Creek Mine	Xstrata	Timmins	Sub-aerial paste (thickened)	- radius of the conical pile is 1.2km and the height of the cone is 25m. The height of the cone increases by 0.2m/y and by closure the height is expected to be 29m
Colstrip power plant	LLC, Portland General Electric Company, Puget Sound Energy, PacifiCorp, AVISTA Corporation and NorthWestern Energy LLC	Montana	Sub-aerial paste	- for fly ash disposal
Snap Lake	De Beers S.A.	Northwest Territories	Sub-aerial paste and paste backfill underground	- non acidic generating are placed on land
Kubaka Mine	Magadan Silver and Gold Company	Russia	Tailings facility as consisting of two levels; Partially dry tailings in the upper level, and lower level holding the liquid tailings	- permafrost as containment
Colomac Mine	Government of Canada	Northwest Territories	Sub-aqueous slurry	
Illinois Creek	Government of Alaska	Alaska	Tailings slurry	final closure
Ryan Lode	Sera Bartholome	Alaska	Lined earthen Dam with reclaimed water system	final closure
Nixon Fork	Pacific Northwest Capital Corp.	Alaska	Lined earthen Dam with reclaimed water system	inactive
Julietta	Omsukchansk Mining and Geological Company	Russia Far east	Paste tailings 85-90% solids in to surface facility	
Kumtor	Centerra Gold Inc.	Kyrgyzstan	Sub- aerial	
Con	Newmont Mining Corp.	Yellowknife	Sub aerial	
Giant	Diand (formerly Royal Oak)	Yellowknife	Sub aerial	
Pogo	Sumitomo Metal Mining Company Ltd	Alaska	Dry Stack	
Kemess	Northgate Minerals Corporation	BC	De-watered slurry	
Huckleberry	Imperial Metals Corporation	BC	De-watered slurry	
Mount Polley	Imperial Metals Corp.	BC	Tailings slurry	
Diavik	DDMI, Rio Tinto	NWT	Fine PK as sub-aerial slurry into HDPE and coletanche bitumenous lined containment, Coarse PK trucked moist and dumped (stacked) in till lined containment	
Snap lake	De Beers S.A.	NWT	Paste tailings on surface into cells	- under construction

3.3.5 Weighting and Scoring

Each indicator (*e.g.,* Environment) was evaluated by assigning relative scores and weightings to sub-indicators. A weighted score was then calculated for each sub-indicator by multiplying relative score by weighting for each sub-indicator. Indicator scores were then calculated by summing the weighted scores of the sub-indicators. The overall score of each option is taken as the sum of the indicator scores. The highest score indicates the best option.

Score

To separate the best alternatives from the worst, a relative scaling, or score was applied (S_{IND}) to each sub-indicator. Each sub-indicator was assigned a score between 1 and 9 points, similar to the system described by Robertson and Shaw (1999). The scores provide a relative ranking between the options with the 'best' option receiving a score of nine. All subsequent options were then compared to the 'best' option and assigned a lower relative score.

An example of the scoring method is presented in Table 3-7.

Table 3-7: Example of Scoring System used in the Decision Matrix

Option	Distance to Mill	Points	Notes
A	*1 km*	*9*	*9 points awarded for the facility located closest to the mill (BEST)*
		8	
		7	
		6	
B	*2 km*	*5*	*9 points x 1 km (BEST)/2 km = 5 points*
		4	
C	*3 km*	*3*	*9 points x 1 km (BEST)/3 km = 3 points*
		2	
		1	

Weighting

Sub-indicators were assigned a relative weighting (W_{IND}) to introduce a value bias between the individual sub-indicators. The value bias is based on the relative subjective importance of one sub-indicator versus another. A higher weighting factor indicates a perceived greater relative value or importance between sub-indicators.

Calculations

The cumulative score for each of the options was determined as the sum of the products of the sub-indicator weightings and scores, based on the following equation.

$$OptionScore = \sum(W_{IND} \times S_{IND})_{Environment} + \sum(W_{IND} \times S_{IND})_{Economic} + \sum(W_{IND} \times S_{IND})_{Social} + \sum(W_{IND} \times S_{IND})_{Technical}$$

The resulting option score is based on qualitative and quantitative inputs and provides a means to evaluate the relative ranking of the various options considered. The method is transparent, and allows stakeholders the opportunity to assess the relative weightings and scorings based on personal preference. A significant aspect of the decision matrix methodology is that it requires all indicators be weighed in the final decision, rather than allowing a single indicator to dictate the overall outcome.

Table 3-8 presents the weightings selected for the sub-indicators as well as the maximum possible indicator scores.

Table 3-8: Weighting for Sub-Indicators

Indicator	Sub-Indicator	Weighting	Maximum Possible Score	Maximum Weighted Sub-Indicator Score	Max Possible Indicator Score
Environmental	Sub-catchment area (ha)	4	9	36	711
	No. Sub-catchments Impacted	4	9	36	
	Surface flow path length to nearest control point	5	9	45	
	Lakes along flow path nearest control point	2	9	18	
	Number of lakes impacted	8	9	72	
	On-Land Footprint Area (considers habitat)	7	9	63	
	Potential for dust during operation	5	9	45	
	Potential for ARD generation	10	9	90	
	Potential for ML	10	9	90	
	Potential for seepage to groundwater	7	9	63	
	Potential for geotechnical hazards[1]	7	9	63	
	Impact on Fish and Fish Habitat	10	9	90	
Economic	Net Present Value of Selected Total Costs	10	9	90	90

Indicator	Sub-Indicator	Weighting	Maximum Possible Score	Maximum Weighted Sub-Indicator Score	Max Possible Indicator Score
Social	Risk to Human Health	10	9	90	459
	Risk to Public Health	10	9	90	
	Risk to Worker Safety	10	9	90	
	Economic Advantages to the Local Community	3	9	27	
	Local Job Creation and Diversity	3	9	27	
	Quality of Life	3	9	27	
	Use for the Public	3	9	27	
	Landscape / Visual Impact	3	9	27	
	Cultural Heritage	3	9	27	
	Management Practices and Innovation	3	9	27	
Technical	Pond depth available at start-up	3	9	27	423
	Length of reclaim pipeline	5	9	45	
	Length of tailings pipeline	5	9	45	
	Maximum height of dams	6	9	54	
	Pond management during winter conditions	6	9	54	
	Potential for delays due to freezing	5	9	45	
	Volume water stored (m^3)	2	9	18	
	Capping volume, assuming 2 m thickness (m^3)	2	9	18	
	Ease of decommissioning/closure	4	9	36	
	Construction Risk	5	9	45	
	Disposal system has precedent in arctic environment	4	9	36	
TOTAL					**1683**

Note: [1] Includes consideration of foundation conditions, impact of seismicity, and height of structure.

3.4 Sensitivity Analysis

The baseline scores generated by the MAA method were examined in a sensitivity analysis to determine the outcome based on the following cases:

Base Line Case – options are scored directly.

1) Sensitivity Case 1 - Non-Weighted Scoring – options are scored with all sub-indicator weightings set to 1.

2) Sensitivity Case 2 - Normalized Scoring – scores for each indicator are normalized.

3) Sensitivity Case 3 - Fish and Fish Habitat - Weightings for economic indicators are set to zero and weightings of indicators for impacts to lakes, fish and fish habitat are set to the maximum possible value.

Sensitivity Case 1 was evaluated to allow comparison without bias introduced by weighting factors. As noted above, the weighting of sub-indicators introduces an intentional bias based on perceived relative importance of sub-indicators. For example, the sub-indicator "Impact on Fish and Fish Habitat" may be perceived as more important than "Sub-catchment Area" and is therefore given a higher weighting.

Sensitivity Case 2 was evaluated to allow comparison between sub-indicators without the bias introduced by differences in maximum possible indicator scores. Indicators have different maximum scores partly because of applied weightings, but mainly because of differences in numbers of sub-indicators. As an example, the Environment indicator has 12 sub-indicators and a maximum possible score of 711, while the Economic indicator has 1 sub-indicator and a maximum possible score of 90. The resulting contributions to maximum possible score are 42% for Environment and near 6% for Economics. The effect of the bias makes comparison between indicators difficult. In order to eliminate the bias and allow direct comparison of indicators, the indicator scores can be normalized. The effect is demonstrated in Table 3-9.

Table 3-9: Effect of Normalizing Scoring

	Direct Scoring		Normalized Scoring	
Indicator	**Maximum Possible Score**	**Contribution to Total Score**	**Maximum Possible Normalized Score**	**Contribution to Total Score**
Environmental	711	42%	25	25%
Economic	90	6%	25	25%
Social	459	27%	25	25%
Technical	423	25%	25	25%
Total	1683	100%	100	100%

Normalized indicator scores are calculated by dividing scores by the maximum possible scores for each indicator, and then multiplying by 25%, giving a maximum possible score of 25 for each indicator. When summed, the maximum number of points that an option can receive is 100, with each sub-indicator contributing a maximum of 25 points.

Sensitivity Case 3 included elimination of Economics from the decision process and setting maximum weighting for sub-indicators influencing lakes, fish and fish habitat.

4.0 PRE-SCREENING ASSESSMENT

Pre-screening considered 10 potential tailings containment areas (TCA's) and five potential tailings technologies.

4.1 Potential Tailings Containment Areas

Potential TCA's identified for pre-screening are shown in Figure 4.1 and further described in the results section.

Exclusions of other areas were based on obvious fatal flaws including:

1) Distances greater than approximately 10 km from the proposed mill were excluded in order to limit the number of watersheds and sub-catchments impacted or exposed to potential spills of mine wastes and to limit costs associated with transport.

2) Areas with large lakes that would be considered good fish habitat were purposefully excluded. These areas included:

   a) The area to the east and south east of the proposed mill site was excluded because the area contains large lakes with potential for good fish habitat such as Giauque Lake, the area includes several different sub-catchments, and has few large on-land areas.

   b) The area to the west and northwest of the proposed mill site was generally excluded because it contains a number of larger lakes, includes different sub-catchments, has few potential sites for on-land TCA's and is also higher than the proposed mill location and would require pumping of tailings uphill.

3) It is noted that the historic Discovery tailings area was purposefully excluded, as it has been covered for closure by INAC and a portion of the area is currently being used as an airstrip for access to the Yellowknife Gold Project site.

Each potential TCA was evaluated for dam construction requirements and available storage volume using models of existing topography, lake bathymetry and a simplified typical dam section with 3 horizontal to 1 vertical side slopes and a 10 m crest width. Volume of dam fill was estimated for a typical dam section, illustrated in Figure 4.2, to a crest elevation within one metre of the required storage volume for tailings and does not account for stripping of dam footprints, areas of liners, filters or instrumentation requirements, or freeboard requirements. The approach is considered appropriate for a relative comparison of construction requirements for the potential TCA's at the pre-screening level of assessment. Further development and optimization of the dam section and alignments for the selected TCA will be completed during later stages of design. The quantities presented should not be used to determine absolute costs.

Storage capacity for each area was determined based on struck level storage volumes contained within the modelled dams. Struck level volume provides an indication of the maximum volume that can be stored, but does not account for loss of storage due to freeboard requirements, to reclaim ponds or to the slope of the tailings surface. The storage volume estimate may be further refined during later stages of design. The use of struck level volumes is therefore a simplifying assumption that is considered useful for relative comparison of options at the pre-screening level of assessment.

4.2 Potential Tailings Disposal Technologies

Tailings disposal technologies considered for use at the Yellowknife Gold Project include slurry, thickened, paste, filtered/dry stack, and co-disposal, which are described in the following sections. The technologies vary by the degree of dewatering and method of deposition.

It is noted that tailings deposits in cold climates may have reduced density relative to deposits in warm climates due to ice content. For tailings deposited as slurry, ice contents in cold climates have been observed to increase the total volume of a deposit by 15 to 30%, depending on how the facility is operated. A factor of 20% bulking for ice storage is applied here for a tailings deposit formed by sub-aerial slurry discharge. A factor of 0% is applied to thickened tailings, paste tailings, filtered/dry stack, and co-disposal.

4.2.1 Slurry

Transport and deposition of tailings as a slurry is commonly used in combination with wet ore mineral processing techniques. Slurries typically have solids contents between 20% and 40%, but may range between 5% and 50%. Tailings slurries are typically transported in pipelines or open channels to the containment area and may be deposited from a single point or multiple discharge locations. Discharge is typically into a body of water that may consist of a natural lake, or other body of water, such as a reclaim pond within an on-land flooded containment facility, or within a flooded mine pit.

Engineered containment structures are built to control the area over which tailings are placed and to prevent uncontrolled release of water from the tailings impoundment to the environment. As part of engineered embankment types of tailings management facilities, diversion structures are commonly constructed to redirect natural surface water away from the TCA.

Sub-aqueous deposition implies that all tailings are deposited under water. This is primarily used when tailings have a high potential to produce ARD or severe dust problems, or to limit ice entrapment. After slurry deposition, solids settle out and the supernatant water can then be decanted and recycled for use within the mill. The following are examples of mines that use or have used sub-aqueous slurry deposition: Hudson's Bay Ruttan Mine, Manitoba; Vale Inco's Thompson Mine, Manitoba; Nanisivik Mine (initial deposition), Nunavut; Polaris Mine Nunavut; and the Red Dog Mine, Alaska.

Sub-aerial slurry deposition is similar to sub-aqueous deposition, but tailings are discharged overland and run down hill to the water pond. The coarser fraction of tailings drop out near the discharge to form a beach and the finer fraction is carried to the pond. In general, the density of the tailings deposited sub-aerially is greater than for sub-aqueous methods because settlement of the deposited tailings is promoted through drainage and evaporation from the tailings beach. The following are examples of mines that use sub-aerial tailings deposition: the historic Discovery Mine adjacent the site; Giant Mine, Yellowknife; Copper Cliff Mine, Ontario; Hudson's Bay Flin Flon, Manitoba; Kidd Creek Mine, Ontario; and Nanisivik Mine (later stage), Nunavut. The Meadowbank Gold Project is currently using sub-aerial deposition and operation of a reclaim pond.

4.2.2 Thickened Tailings

Thickening of tailings involves placing slurry tailings in a tank, allowing the solids to settle, then drawing off the tank underflow for pumping to storage in the tailings impoundment. Chemical additives called flocculants are often added to increase the solids content above 50% (typically 50% – 60%), thus improving storage efficiency. Thickened tailings will bleed some water when deposited, but the majority is retained in the mill. Thus, a full time water reclaim system is not required at the impoundment. A secondary facility for re-circulation of water may still be required, but could be operated on a seasonal basis.

Examples of thickened tailings discharge include Kidd Creek Mine, Timmons Ontario; the Peak Mine, Australia; Century zinc mine, Australia; Osborne Mine, Australia; Falconbridge Strathcona Mill, Sudbury Ontario, Canada; and the Porgera Gold Mine, Papua New Guinea.

4.2.3 Paste

Paste tailings have less water than thickened tailings and are achieved by using chemical additives, or a combination of mechanical devices (such as deep cone thickeners) with chemical additives including flocculants and hydrating agents (*i.e.,* Portland cement, fly ash), to create a paste that will not separate. Pastes typically consist of approximately 60% solids for fine grained tailings and up to 80% solids for coarse tailings.

Paste tailings are frequently used for backfilling underground mine workings but surface disposal of paste tailings is also possible. Above ground use of paste technology still requires the use of containment facilities, although due to the increased density (lower moisture content) and increased slope of deposition of the tailings, the size and/or height of the facilities may be reduced compared to slurry type methods of disposal. Paste tailings can be transported using high pressure pipelines to the storage area. These facilities require surface water runoff and seepage management systems. Ditches to redirect non-contact water away from the facility and ditches to collect runoff from the tailings deposit are used. A secondary facility for re-circulation of water may still be required, but could be operated on a seasonal basis.

Examples of mines that use the paste method technology for tailings deposition include Bulyanhulu, Tanzania; Myra Falls, on Vancouver Island; and Cobriza mine, Peru. Snap Lake, NWT was working on implementation of a paste plant.

4.2.4 Filtered / Dry Stack

An alternative to pumped tailings deposition systems is called filtered tailings. The method uses mechanical devices (such as high capacity vacuum and pressure belt filters), often in combination with chemical additives, to further dewater the tailings. The resulting tailings have about 50% to 70% solids, and are too thick to pump. Instead they are transported by truck or conveyor system and then "dry stacked." It is important to note that filtered tailings that are dry stacked are not truly "dry", but rather have moisture contents several percentage points below saturation.

Typically, filtered tailings are dry stacked by placing, spreading, and compacting to form an unsaturated dense and stable mound. No additional containment structures, such as dams, are required to retain the tailings. These facilities may result in a smaller footprint area due to their increased density.

Dry stack facilities may require surface water runoff and seepage management systems. Ditches or berms to redirect non-contact water away from the facility and to collect runoff from the stack are used. Additionally, methods to collect seepage and prevent groundwater contamination may be required. A series of under drains, groundwater cut-off walls, or liners may be used. A closure cover is required to prevent erosion, prevent dust generation, and to provide an appropriate media for re-vegetation. Potentially acid generating tailings may require an infiltration barrier to reduce ARD generation.

This type of facility may be advantageous if the mine is:

- Located in an arid region, where water conservation is a driving factor, or where subsequent saturation by precipitation is not an issue;
- Located in a high seismic area;
- In a region where water handling is difficult; and
- Limited by available space for disposal of tailings.

The nature of the tailings produced, both the grain size and mineralogy, can play an important role in determining the effectiveness of filter processing. Tailings with a high percentage of clay-sized particles and also clay mineralogy may negate the effectiveness of a filtering system.

Examples of dry stack tailings facilities are Greens Creek Mine, Alaska; Raglan, Quebec; Mineral Hill, Montana; La Coipa, Chile; Pogo mine, Alaska.

4.2.5 Co-Disposal

Co-disposal is the disposal of tailings and waste rock in one facility. There are many different forms of co-disposal, which vary by degree of mixing, physical arrangement, and mixture ratio of tailings to waste rock.

Co-disposal has been implemented as waste rock and tailings disposed in the same open pit (Kidston Gold Mine, Australia), and has been used for coal washery wastes in Australia, Indonesia, and in the USA. Co-disposal has also been proposed at the Shakespeare Project, Ontario, and Cerro de Maimon Mine, Dominican Republic (Wisleski and Li 2008). The Snap Lake mine, NWT has adopted a co-disposal concept where tailings are deposited into flow-through containment berms composed of waste rock, with supernatant collected in ditches surrounding the facility.

The form of co-disposal considered for the YGP is placement of thickened, non-segregating tailings within waste rock containment berms, similar to the Snap Lake concept. The waste rock production is tied to the mine development sequence of open pit development for several years associated with the production of the majority of waste rock followed by an underground operation with production of a minor amount of waste rock. The tailings are produced at a relatively constant rate. The mine plan therefore does not provide the opportunity for homogeneous mixing or co-mingling in specific proportions without significant effort and expense to re-handle the waste rock during the later stages of mine life. Forms of co-disposal involving homogeneous mixing or alternating layers of waste rock and tailings are therefore excluded as more expensive than the preferred option, with no additional benefit. Thickened tailings offer a reduced capital cost for thickeners relative to the infrastructure required to produce paste and filtered tailings, but require less water management than slurry tailings, *i.e.,* a water reclaim pond is not required because water is largely reclaimed at the mill.

For the proposed co-disposal concept considered for the YGP, waste rock scheduled to go to the Ormsby waste rock storage facility would instead be placed as berms in the TCA. A haul road would therefore be required to access the TCA. Thickened flotation tailings would be discharged within the berms. The inside of the berms would be lined with geotextile filter to allow water drainage, but retain tailings solids. A perimeter water collection system would be required outside the berms and these would be lined to intercept any water exiting the facility. Water from the seepage collection system would be temporarily stored in sumps or collection ponds and released to the environment or pumped to the mill for treatment on a seasonal basis, as required.

The co-disposal concept was evaluated at a pre-screening level for each area shown in Figure 4.1 by modeling a shape including 3 horizontal to 1 vertical sides slopes and a flat top surface.

4.2.6 Underground Backfill

The decision to use paste backfill generally depends on the type of deposit and mining method. The backfill process involves dewatering tailings in a paste plant, addition of cement (though in some cases cement may be omitted) and then pumping of the mixture to fill underground mine workings. Paste backfill will flow to fill underground mine workings and is considered to offer more flexibility than other fills, such as cemented rockfill.

For the YGP, the use of underground storage, such as paste backfill, as an alternative for tailings storage would not eliminate the requirement for a surface TCA because of the mine schedule, mining methods, and the physical separation of ore bodies.

The mine plan for the YGP includes development of an open pit at Ormsby for the first five years, with underground mining at Ormsby during the last three years. Underground workings at Ormsby will therefore only be available during the latter stages of mine life, while tailings are produced during the whole of mine life. Nicholas Lake underground workings will come available during the first years of mine life, but would require transport of tailings from the mill to Nicholas Lake. However, storage available underground will be insufficient to store the total volume of tailings. As a rule of thumb, as much as half of the volume removed from an underground mine can be replaced as paste backfill. The open pit produces the majority of ore (5 Mt), while the Ormsby underground workings will produce approximately 1.4 Mt ore, and Nicholas Lake will only produce 1.3 Mt ore. The volume of storage available in underground workings will be too small to store the total volume of tailings and a surface TCA is therefore required.

4.3 Results of Pre-Screening

Results of pre-screening of TCA options are summarized in Table 4-1. Descriptions of pre-screening options are presented in Tables 4-2 through 4-6.

Options failing two or more of the pre-screening selection criteria were eliminated for reasons shown in Table 4-1 and described in the following sections. The remaining options were further reduced to one preferred option per area based on selection of the best tailings technology for the area.

Options selected for further assessment include:

- Area A Winter Lake with sub-aerial slurry discharge;
- Area B Narrow Lake with sub-aerial slurry discharge;
- Area C Ormsby with co-disposal as thickened tailings with waste rock; and
- Area F South with sub-aerial slurry discharge.

Table 4-1:
Pre-Screening of Options Summary

	Area A Winter Lake	Area B Narrow Lake	Area C Ormsby	Area D Round Lake	Area E East	Area F South	Area G South West	Area H West	Area I North	Area J North East
Slurry	Selected for Assessment	Selected for Assessment	Impacts additional sub-catchment(s). Consequence of failure associated with pond on hill above open pit. Impacts waste rock storage.	Limited potential for increase of storage capacity. Impacts Round Lake and air strip. Potential liability for historic Discovery tailings deposit.	Impacts additional sub-catchment(s). Consequence of failure associated with potential impact to Giauque Lake. Impacts small water body.	Selected for Assessment	Impacts additional sub-catchment(s). Consequence of failure associated with distance from mill.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.
Thickened	Requires additional capital and operational costs for thickener with limited benefit relative to Area A slurry option.	Requires additional capital and operational costs for thickener with limited benefit relative to Area B slurry option.	Co-disposal option in Area C has additional benefits at lower cost. Impacts waste rock storage.	Limited potential for increase of storage capacity. Impacts Round Lake and air strip. Potential liability for historic Discovery tailings deposit.	Impacts additional sub-catchment(s). Consequence of failure associated with potential impact to Giauque Lake. Impacts small water body.	Requires additional capital and operational costs for thickener with limited benefit relative to Area F slurry option.	Impacts additional sub-catchment(s). Consequence of failure associated with distance from mill.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.
Paste	Requires additional capital and operational costs for thickener with limited benefit relative to Area A slurry option.	Requires additional capital and operational costs for thickener with limited benefit relative to Area B slurry option.	Co-disposal option in Area C has additional benefits at lower cost. Impacts waste rock storage.	Limited potential for increase of storage capacity. Impacts Round Lake and air strip. Potential liability for historic Discovery tailings deposit.	Impacts additional sub-catchment(s). Consequence of failure associated with potential impact to Giauque Lake. Impacts small water body.	Requires additional capital and operational costs for paste plant with limited benefit relative to Area F slurry option.	Impacts additional sub-catchment(s). Consequence of failure associated with distance from mill.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.
Filtered/Dry Stack	Requires additional capital and operational costs for filter plant with limited benefit relative to Area A slurry option.	Requires additional capital and operational costs for filter plant with limited benefit relative to Area B slurry option.	Higher cost and similar benefits to Area C co-disposal option. Impacts waste rock storage.	Limited potential for increased capacity. Impacts Round Lake and air strip. Potential liability for historic Discovery tailings deposit.	Impacts additional sub-catchment(s). Consequence of failure associated with potential impact to Giauque Lake. Impacts small water body.	Requires additional capital and operational costs for filter plant and 7 km haul road with limited benefit relative to Area F slurry option.	Impacts additional sub-catchment(s). Consequence of failure associated with distance from mill.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.
Co-Disposal with Waste Rock	Requires additional capital and operational costs with limited benefit relative to Area A slurry option.	Requires additional capital and operational costs with limited benefit relative to Area B slurry option.	Selected for Assessment	Insufficient storage capacity. Limited potential for increased capacity. Impacts Round Lake and air strip. Potential liability for historic Discovery tailings deposit.	Impacts additional sub-catchment(s). Consequence of failure associated with potential impact to Giauque Lake. Impacts small water body.	Requires additional capital and operational costs for thickener and additional 7 km haul for waste rock with limited benefit relative to Area F slurry option.	Impacts additional sub-catchment(s). Consequence of failure associated with distance from mill.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.	Impacts additional sub-catchment(s). Consequence of failure associated with crossing of sub-catchments. Directly impacts water bodies.

Table 4-2:
Pre-screening by Area with Slurry Tailings

	Area A Winter Lake	Area B Narrow Lake	Area C Ormsby	Area D Round Lake	Area E East	Area F South	Area G South West	Area H West	Area I North	Area J North East
Crest Elevation to store 5.9 Mm^3 (m) [1]	292	294	333	304	287	292	292	321	319	325
Dam Fill (m^3) [2]	102,000	193,000	1,803,000	782,000	458,000	1,491,000	840,000	1,009,000	290,000	631,000
Maximum Dam Height at Centreline (m) [3]	9	14	17	16	15	20	17	19	10	15
Area (ha)	158	159	86	61	218	184	124	127	208	374
Storage Efficiency Ratio (Storage m^3 / Dam Fill m^3)	63	33	3.3	8	13	4	8	7	22	10
Distance from Mill (km)	2.0	2.5	1.5	0.6	1.8	7.2	6.3	3.2	2.5	6.7
Construction	Dam across Winter Lake and dewatering of north portion to south. Single or multiple stage construction of additional perimeter dams. Insulated pipelines for tailings distribution and water reclaim.	Staged construction of dams across the ends of Narrow Lake. Insulated pipelines for tailings distribution and water reclaim. Dam across Winter Lake and north portion dewatering. Dewatering of part of Narrow Lake to provide tailings storage capacity.	Staged construction of perimeter dams. Insulated pipelines for tailings distribution and water reclaim. Dam across Winter Lake and north portion dewatering. Water from north Winter Lake dewatering pumped to form reclaim pond. Requires re-location of mine rock storage area.	Staged construction of perimeter dams. Insulated pipelines for tailings distribution and water reclaim. Dam across Winter Lake and north portion dewatering. Water from north Winter Lake dewatering pumped to form reclaim pond. Must adjust airstrip location and other site infrastructure.	Staged construction of perimeter dams. Insulated pipelines for tailings distribution and water reclaim. Dam across Winter Lake and north portion dewatering. Water from north Winter Lake dewatering pumped to form reclaim pond. Includes potential borrow areas.	> 7 km all weather road. Insulated pipelines for tailings distribution and water return. Staged construction of sidehill dam. Dam across Winter Lake and north portion dewatering. Water from north Winter Lake dewatering pumped to form reclaim pond.	> 6 km all weather road. Insulated pipelines for tailings distribution and water return. Staged construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Water from north Winter Lake dewatering pumped to form reclaim pond.	> 3 km all weather road. Insulated pipelines for tailings distribution and water reclaim. Staged construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Water from north Winter Lake dewatering pumped to form reclaim pond.	> 2.5 km all weather road. Insulated pipelines for tailings distribution and water reclaim. Single or multiple stage construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Water from north Winter Lake dewatering pumped to form reclaim pond.	> 6.5 km all weather road. Insulated pipelines for tailings distribution and water return. Staged construction of sidehill dam. Dam across Winter Lake and north portion dewatering. May require additional water to build up reclaim pond at start-up.
Operation	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings flow downhill from mill El. 320 m.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings may require pumping from mill El. 320 m. Operate flow through diversion.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings require pumping uphill from mill El. 320 m over a distance of > 1.5 km.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings flow downhill from mill El. 320 m.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings flow downhill from mill El. 320 m.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings require pumping over a distance of > 7 km.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings require pumping over a distance of > 6 km.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings require pumping from mill El. 320 m over a distance of > 3 km.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings require pumping over a distance of > 2.5 km.	Subaerial/ Subaqueous deposition of tailings slurry, operate reclaim pond and insulated pipelines for tailings distribution and water reclaim. Tailings require pumping uphill from mill El. 320 m over a distance of > 6.5 km.
Closure	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Permanent flow-through diversion required for flow from Round and Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration. Manage minor amount of water from upper part of sub-catchment.	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Draw down reclaim pond. Cover over tailings to minimize infiltration.
Pre-Screening Indicators										
Storage for life-of mine tailings production	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Potential for increased capacity	Yes	Yes	Yes	Limited	Yes	Yes	Yes	Yes	Yes	Yes
Location enables mine expansion	Yes	Possible Impact	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area is within same sub-catchment as pit	Yes	Yes	No	Yes	No	Yes	No	No	No	No
Low consequence of failure	Yes	Yes	No	Yes	No	Yes	No	No	No	No
Avoids direct impact to water body	No	No	Yes	No	No	No	Yes	No	No	No

Notes

1. 5.9 Mm^3 volume based on 7.7 Mt tailings at in place density of 1.3 t/m^3 and includes 20% bulking for ice.
2. Containment dams are based on a typical section of 3H:1V slopes, 10 m crest, and do not consider stripping for foundation preparation.
3. 5.9 Mm^3 storage volume is for pre-screening comparison of options only and does not consider freeboard requirements, reclaim pond storage, or the slope of the tailings surface.
   - Additional dam height will be required for these aspects but are not considered at this pre-screening level of assessment.

Table 4-3:
Pre-screening by Area with Thickened Tailings

	Area A Winter Lake	Area B Narrow Lake	Area C Ormsby	Area D Round Lake	Area E East	Area F South	Area G South West	Area H West	Area I North	Area J North East
Crest Elevation to store 5.1 Mm^3 (m) [1]	291	292	332	302	287	291	291	320	318	324
Dam Fill (m^3) [2]	80,000	127,000	1,526,000	517,000	458,000	1,295,000	712,000	850,000	222,000	506,000
Maximum Dam Height at Centreline (m) [3]	8	12	16	14	15	19	16	18	9	14
Area (ha)	158	159	86	61	218	184	124	127	208	374
Storage Efficiency Ratio (Storage m^3 / Dam Fill m^3)	67	42	4	10	13	4	8	7	24	10
Distance from Mill (km)	2.0	2.5	1.5	0.6	1.8	7.2	6.3	3.2	2.5	6.7
Construction	Dewater Winter Lake. Single or multiple stage construction of perimeter dams. Pipeline for tailings. Thickening plant.	Dewatering of Narrow Lake. Water diversion works. Staged construction of dams across the ends of Narrow Lake. Pipeline for tailings. Dam across Winter Lake and north portion dewatering. Thickening plant.	Staged construction of perimeter dams. Pipeline for tailings. Dam across Winter Lake and north portion dewatering. Thickening plant. Requires re-location of mine rock storage area.	Staged construction of perimeter dams. Pipeline for tailings. Dam across Winter Lake and north portion dewatering. May dewater Round Lake prior to deposition to prevent capture of ice. Thickening plant. Must adjust airstrip location.	Staged construction of perimeter dams. Pipeline for tailings. Dam across Winter Lake and north portion dewatering. May remove standing water to reduce water treatment or capture of ice. Thickening plant.	> 7 km all weather road. Pipeline for tailings. Staged construction of sidehill dam. Dam across Winter Lake and north portion dewatering. Thickening plant.	> 6 km all weather road. Pipeline for tailings. Staged construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Thickening plant.	> 3 km all weather road. Pipeline for tailings. Staged construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Thickening plant.	>2.5 km all weather road. Pipeline for tailings. Single or multiple stage construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Thickening plant.	> 6.5 km all weather road. Pipeline for tailings. Staged construction of sidehill dam. Dam across Winter Lake and north portion dewatering. Thickening plant.
Operation	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings may require pumping from mill. Water reclaimed seasonally by truck or temporary lines.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings may require pumping from mill. Water reclaimed seasonally by truck or temporary lines. Operate flow through diversion.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings require pumping uphill from mill El. 320 m. Seasonal reclaim of water by truck or temporary lines.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings flow downhill from mill El. 320 m. Water reclaimed seasonally by truck or temporary lines.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings may require pumping from mill. Water reclaimed seasonally by truck or temporary lines.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings require pumping over a distance of > 7 km. Water reclaimed seasonally by truck or temporary lines.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings require pumping over a distance > 6 km. Water reclaimed seasonally by truck or temporary lines.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings require pumping over a distance of > 3 km. Water reclaimed seasonally by truck or temporary lines.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings require pumping over a distance of > 2.5 km. Water reclaimed seasonally by truck or temporary lines.	Thickener with subaerial deposition of thickened tailings by insulated pipeline. Tailings require pumping uphill over a distance of > 6.5 km. Water reclaimed seasonally by truck or temporary lines.
Closure	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Permanent flow-through diversion required for flow from Round and Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.
Pre-Screening Indicators										
Storage for life-of mine tailings production	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Potential for increased capacity	Yes	Yes	Yes	Limited	Yes	Yes	Yes	Yes	Yes	Yes
Location enables mine expansion	Yes	Possible Impact	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area is within same sub-catchment as pit	Yes	Yes	No	Yes	No	Yes	No	No	No	No
Low consequence of failure	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No
Avoids direct impact to water body	No	No	Yes	No	No	No	Yes	No	No	No

Notes

1. 5.1 Mm^3 volume based on 7.7 Mt tailings at in place density of 1.5 t/m^3.
2. Containment dams are based on a typical section of 3H:1V slopes, 10 m crest, and do not consider stripping for foundation preparation.
3. 5.1 Mm3 storage volume is for pre-screening comparison of options only and does not consider freeboard requirements, temporary water storage, or the slope of the tailings surface.
   - Additional dam height will be required for these aspects but are not considered at this pre-screening level of assessment

Table 4-4:
Pre-screening by Area with Paste Tailings

	Area A Winter Lake	Area B Narrow Lake	Area C Ormsby	Area D Round Lake	Area E East	Area F South	Area G South West	Area H West	Area I North	Area J North East
Crest Elevation to store 4.8 Mm^3 (m) [1]	291	292	332	302	287	290	290	319	318	324
Dam Fill (m^3) [2]	80,000	127,000	1,526,000	517,000	458,000	1,115,000	600,000	714,000	222,000	506,000
Maximum Dam Height at Centreline (m) [3]	8	12	16	14	15	18	15	16	9	14
Area (ha)	158	159	86	61	218	184	124	127	208	374
Storage Efficiency Ratio (Storage m^3 / Dam Fill m^3)	67	42	4	10	13	5	8	7	24	10
Distance from Mill (km)	2.0	2.5	1.5	0.6	1.8	7.2	6.3	3.2	2.5	6.7
Construction	Dewater Winter Lake. Single or multiple stage construction of perimeter dams. Pipeline for tailings. Paste plant.	Dewatering of Narrow Lake. Water diversion works. Staged construction of dams across the ends of Narrow Lake. Pipeline for tailings. Dam across Winter Lake and north portion dewatering. Paste plant.	Staged construction of perimeter dams. Pipeline for tailings. Dam across Winter Lake and north portion dewatering. Paste plant. Requires re-location of mine rock storage area.	Staged construction of perimeter dams. Pipeline for tailings. Dam across Winter Lake and north portion dewatering. May dewater Round Lake prior to deposition to prevent capture of ice. Paste plant. Must adjust airstrip location.	Staged construction of perimeter dams. Pipeline for tailings. Dam across Winter Lake and north portion dewatering. May remove standing water to reduce water treatment or capture of ice. Paste plant.	> 7 km all weather road. Pipeline for tailings. Staged construction of sidehill dam. Dam across Winter Lake and north portion dewatering. Paste plant.	> 6 km all weather road. Pipeline for tailings. Staged construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Paste plant.	> 3 km all weather road. Pipeline for tailings. Staged construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Paste plant.	>2.5 km all weather road. Pipeline for tailings. Single or multiple stage construction of perimeter dams. Dam across Winter Lake and north portion dewatering. Paste plant.	> 6.5 km all weather road. Pipeline for tailings. Staged construction of sidehill dam. Dam across Winter Lake and north portion dewatering. Paste plant.
Operation	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings may require pumping from mill. Water reclaimed seasonally by truck or temporary lines.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings require pumping from mill. Water reclaimed seasonally by truck or temporary lines. Operate flow through diversion.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings require pumping uphill from mill El. 320 m over a distance of > 1.5 km. Seasonal reclaim of water by truck or temporary lines.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings flow downhill from mill but may require pumping. Seasonal reclaim of water by truck or temporary lines.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings may require pumping from mill. Seasonal reclaim of water by truck or temporary lines.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings require pumping from mill over a distance of > 7 km. Seasonal reclaim of water by truck or temporary lines.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings require pumping from mill over a distance of > 6 km. Seasonal reclaim of water by truck or temporary lines.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings require pumping from mill over a distance of > 3 km. Seasonal reclaim of water by truck or temporary lines.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings require pumping from mill over a distance of > 2.6 km. Seasonal reclaim of water by truck or temporary lines.	Paste plant with sub aerial deposition of paste tailings by insulated pipeline. Tailings require pumping from mill over a distance of > 6.5 km. Seasonal reclaim of water by truck or temporary lines.
Closure	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Permanent flow-through diversion required for flow from Round and Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.
Pre-Screening Indicators										
Storage for life-of mine tailings production	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Potential for increased capacity	Yes	Yes	Yes	Limited	Yes	Yes	Yes	Yes	Yes	Yes
Location enables mine expansion	Yes	Possible Impact	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area is within same sub-catchment as pit	Yes	Yes	No	Yes	No	Yes	No	No	No	No
Low consequence of failure	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No
Avoids direct impact to water body	No	No	Yes	No	No	No	Yes	No	No	No

Notes

1. 4.8 Mm^3 volume based on 7.7 Mt tailings at in place density of 1.6 t/m^3.
2. Containment dams are based on a typical section of 3H:1V slopes, 10 m crest, and do not consider stripping for foundation preparation.
3. 4.8 Mm^3 storage volume is for pre-screening comparison of options only and does not consider freeboard requirements, temporary water storage, or the slope of the tailings surface.
   - Additional dam height will be required for these aspects but are not considered at this pre-screening level of assessment

Table 4-5:
Pre-screening by Area With Filtered/Dry Stack Tailings

	Area A Winter Lake	Area B Narrow Lake	Area C Ormsby	Area D Round Lake	Area E East	Area F South	Area G South West	Area H West	Area I North	Area J North East
Crest Elevation to store 4.5 Mm^3 (m) [1]	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only	Berms for Surface Drainage Control Only
Dam Fill (m^3) [2]	<10,000	<10,000	<10,000	<10,000	<10,000	<10,000	<10,000	<10,000	<10,000	<10,000
Dam Height (m)	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2	1 to 2
Area (ha)	158	159	86	61	218	184	124	127	208	374
Storage Efficiency Ratio (Storage m^3 / Dam Fill m^3)	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
Distance from Mill (km)	2.0	2.5	1.5	0.6	1.8	7.2	6.3	3.2	2.5	6.7
Construction	Haul road for tailings transport. Water diversion berms around perimeter plus sump(s). Dewater Winter Lake. Filter plant.	Haul road for tailings transport. Dewater Narrow Lake. Water diversion berms around perimeter. Dam across Winter Lake and north portion dewatering. Filter plant.	Haul road for tailings transport. Water diversion berms around perimeter plus sump(s). Dam across Winter Lake and north portion dewatering. Filter plant. Requires re-location or integration of mine rock storage area.	Haul road for tailings transport. Dewater Round Lake. Water diversion berms around perimeter plus sump(s). Dam across Winter Lake and north portion dewatering. Filter plant. Must adjust airstrip location.	Haul road for tailings transport. Dewater area. Water diversion berms around perimeter plus sump(s). Dam across Winter Lake and north portion dewatering. Filter plant.	Haul road for tailings transport. Water diversion berms around perimeter plus sump(s). Dam across Winter Lake and north portion dewatering. Filter plant.	> 6 km all weather haul road for tailings transport. Water diversion berms around perimeter plus sump(s). Dam across Winter Lake and north portion dewatering. Filter plant.	> 3 km all weather haul road for tailings transport. Water diversion berms around perimeter plus sump(s). Dam across Winter Lake and north portion dewatering. Filter plant.	> 2.5 km all weather haul road for tailings transport. Water diversion berms around perimeter plus sump(s). Dam across Winter Lake and north portion dewatering. Filter plant.	> 6.5 km all weather haul road for tailings transport. Water diversion berms around perimeter plus sump(s). Dam across Winter Lake and north portion dewatering. Filter plant.
Operation	Filter plant with trucked transport and deposition of tailings. Water reclaimed seasonally by truck or temporary lines.	Filter plant with trucked transport and deposition of tailings. Water reclaimed seasonally by truck or temporary lines. Operate flow through diversion.	Filter plant with trucked transport and deposition of tailings. Water reclaimed seasonally by truck or temporary lines. May co-dispose with waste rock in same facility.	Filter plant with trucked transport and deposition of tailings. Water reclaimed seasonally by truck or temporary lines.	Filter plant with trucked transport and deposition of tailings. Water reclaimed seasonally by truck or temporary lines.	Filter plant with trucked transport and deposition of tailings > 7 km. Water reclaimed seasonally by truck or temporary lines.	Filter plant with trucked transport and deposition of tailings > 6 km. Water reclaimed seasonally by truck or temporary lines.	Filter plant with trucked transport and deposition of tailings > 3 km. Water reclaimed seasonally by truck or temporary lines.	Filter plant with trucked transport and deposition of tailings > 2.5 km. Water reclaimed seasonally by truck or temporary lines.	Filter plant with trucked transport and deposition of tailings > 6.5 km. Water reclaimed seasonally by truck or temporary lines.
Closure	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Permanent flow-through diversion required for flow from Round and Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings to minimize infiltration.
Pre-Screening Indicators										
Storage for life-of mine tailings production	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Potential for increased capacity	Yes	Yes	Yes	Limited	Yes	Yes	Yes	Yes	Yes	Yes
Location enables mine expansion	Yes	Possible Impact	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area is within same sub-catchment as pit	Yes	Yes	No	Yes	No	Yes	No	No	No	No
Low consequence of failure	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No
Avoids direct impact to water body	No	No	Yes	No	No	No	Yes	No	No	No

Notes

1. 4.5 Mm^3 volume based on 7.7 Mt tailings at in place density of 1.7 t/m^3.
2. Only minor berms are required to direct surface drainage to sumps.

Table 4-6:
Prescreening by Area with Co-disposal of Tailings with Waste Rock

	Area A Winter Lake	Area B Narrow Lake	Area C Ormsby	Area D Round Lake	Area E East	Area F South	Area G South West	Area H West	Area I North	Area J North East
Crest Elevation to store 42.1 Mm^3 (m) [1]	318	328	373	Insufficient Storage	308	320	342	356	342	340
Approximate Height (m) [2]	36	44	61	Insufficient Storage	37	47	69	58	33	29
Area (ha)	158	159	86	61	218	184	124	127	208	374
Distance from Mill (km)	2.0	2.5	1.5	0.6	1.8	7.2	6.3	3.2	2.5	6.7
Construction	Haul road. Pipeline for tailings. Perimeter ditches and sump(s). Dewater Winter Lake. Thickening plant.	Haul road. Pipeline for tailings. Water diversion works. Dewater Narrow Lake. Winter Lake dam and north portion dewatering. Thickening plant.	Haul road. Pipeline for tailings. Perimeter ditches and sump(s). Winter Lake dam and north portion dewatering. Thickening plant.	Haul road. Pipeline for tailings. Perimeter ditches and sump(s). Dewater Round Lake. Winter Lake dam and north portion dewatering. Thickening plant. Must adjust airstrip location.	Haul road. Pipeline for tailings. Perimeter ditches and sump(s). Remove standing water. Winter Lake dam and north portion dewatering. Thickening plant.	> 7 km haul road. Pipeline for tailings. Perimeter ditches and sump(s). Winter Lake dam and north portion dewatering. Thickening plant.	> 6 km haul road. Pipeline for tailings. Perimeter ditches and sump(s). Winter Lake dam and north portion dewatering. Thickening plant.	> 3 km haul road. Pipeline for tailings. Perimeter ditches and sump(s). Winter Lake dam and north portion dewatering. Thickening plant.	> 2.5 km haul road. Pipeline for tailings. Perimeter ditches and sump(s). Winter Lake dam and north portion dewatering. Thickening plant.	> 6.5 km haul road. Pipeline for tailings. Perimeter ditches and sump(s). Winter Lake dam and north portion dewatering. Thickening plant.
Operation	Haul waste rock by truck for berm construction. Thickener operation with tailings pumped from mill at El. 320 m through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.	Haul waste rock by truck for berg construction. Thickener operation with tailings pumped uphill from mill at El. 320 m through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines. Operate flow through diversion.	Haul waste rock by truck for berm construction. Thickener operation with tailings pumped uphill from mill El. 320 m over a distance of 1.5 km through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.	Haul waste rock by truck for berm construction. Thickener operation with tailings pumped uphill from mill at El. 320 m through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.	Haul waste rock by truck for berm construction. Thickener operation with tailings flowing downhill from mill at El. 320 m through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.	Haul waste rock by truck for > 7 km for berm construction. Thickener operation with tailings pumped from mill at El. 320 m through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.	Haul waste rock by truck for > 6 km for berm construction. Thickener operation with tailings pumped uphill from mill at El. 320 m over a distance of > 6 km through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.	Haul waste rock by truck for > 3 km for berm construction. Thickener operation with tailings pumped uphill from mill El. 320 m over a distance of > 3 km through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.	Haul waste rock by truck for > 2.5 km for berm construction. Thickener operation with tailings pumped uphill from mill El. 320 m over a distance of > 2.5 km through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.	Haul waste rock by truck for > 6.5 km for berm construction. Thickener operation with tailings pumped uphill from mill El. 320 m over a distance of > 6.5 km through insulated pipeline for subaerial deposition within waste rock berms. Water reclaimed seasonally by truck or temporary lines.
Closure	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration. Operate permanent flow-through diversion.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.	Re-flooding of north portion of Winter Lake. Cover over tailings and waste rock to minimize infiltration.
Pre-Screening Indicators										
Storage for life-of mine tailings production	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Potential for increased capacity	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Location enables mine expansion	Yes	Possible Impact	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Area is within same sub-catchment as pit	Yes	Yes	No	Yes	No	No	No	No	No	No
Low consequence of failure	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No
Avoids direct impact to water body	No	No	Yes	No	No	No	Yes	No	No	No

Notes

1. 42.1 Mm^3 volume based on 7.7 Mt tailings at in place density of 1.5 t/m^3 plus 74 Mt waste rock at 2.0 t/m^3.
   - 42.1 Mm^3 storage volume is for pre-screening comparison of options only and does not consider storage of tailings within the voids of the waste rock.
2. Concept based on thickened tailings pumped to containment dams of waste rock with typical section of 3H:1V slopes, 10 m crest, and do not consider stripping for foundation preparation, or requirements for filters.
   - Waste rock berms would be flow-through to allow drainage and runoff collection in ditches and then collection in sumps.

Results of the pre-screening are summarized and include a description of each area.

4.3.1 Area A: Winter Lake

Area A Winter Lake with sub-aerial slurry discharge was selected for detailed assessment as Option A.

Area A includes the south half of Winter Lake. Bathymetry for Winter Lake has been measured. Winter Lake has an approximate surface elevation of 285 masl with water depths of 5 to 6 m in the north and less than 2 m in the south. Dissolved oxygen profiles indicate that Winter Lake would not support a fish population over the winter period (dissolved oxygen has been measured at less than 0.62 mg/L during winter sampling). Winter Lake is therefore not considered good fish habitat.

Development of the Ormsby Pit requires temporary dewatering of the north part of Winter Lake. A dewatering dam is proposed across the narrows to divide the lake north to south, shown in Figure 2.1. Total water volume is approximately 1.5 Mm^3 and the divide results in approximately 0.7 Mm^3 water in the north and 0.8 Mm^3 in the south. As part of mine closure, the north basin of the lake would be re-flooded.

While the dam at the narrows of Winter Lake is required to allow pit development for all options, the dam allows isolation of the south end of the lake for tailings storage. Additional minor dams are also required at low areas around the perimeter of the south part of the lake to retain tailings above the lake surface elevation, illustrated in Figure 4.3.

Area A is best suited to sub-aerial discharge of tailings as slurry with operation of a water reclaim pond. Limited water depth will preclude sub-aqueous deposition after a short period. Further effort to dewater or thicken the tailings provides some benefit to increase the tailings density and reduction in water handling, but the capital costs for thickeners is much greater than savings in dam construction. Dewatering the tailings and the lake to use the basin does not provide any significant benefit over slurry placed into water. All tailings technologies require the permanent use of the south part of the lake for long term tailings storage in Area A.

4.3.2 Area B: Narrow Lake

Area B Narrow Lake with sub-aerial slurry discharge was selected for detailed assessment as Option B.

Area B is an in-lake option that includes Narrow Lake. Bathymetry for Narrow Lake has been measured. Narrow Lake has a surface elevation of approximately 282 m, corresponding to 1.3 Mm^3 of water, and includes two pockets with water depths greater than 10 m. Narrow Lake contains high quality habitat for Lake Whitefish and Northern Pike.

Drainage from the Winter Lake, Round Lake and Narrow Lake basins flows through Narrow Lake, and any use of Narrow Lake would have to account for managing water flow-through during operations and in the long term. Total annual flows at the lake outlet have been measured at 0.3 to 0.75 Mm^3. Narrow Lake is on-strike for the Ormsby deposit and the use of Narrow Lake may impact future mine expansion.

Use of Narrow Lake for tailings storage would require dams at the entry and exit, illustrated in Figure 4.4.

The area is best suited to sub-aerial discharge of tailings as slurry with operation of a water reclaim pond. Further effort to dewater or thicken the tailings provides some benefit to increase the tailings density and reduction in water handling, but the capital costs for thickening are much greater than savings in dam construction.

4.3.3 Area C: Ormsby

Area C Ormsby with co-disposal of thickened tailings with waste rock was selected for detailed assessment as Option B.

Area C is an on-land option that includes the Ormsby Valley, located in the upland area to the west of the proposed Ormsby pit. Brien Lake is located parallel to the northwest edge of the Area C.

Use of Area C for conventional storage of slurry, paste, or thickened tailings storage would require engineered, water retaining dams with poor storage efficiency. Little storage volume is available in natural depressions in Area C, so near continuous perimeter dams would be required. Should expansion of the TCA be required, there is space to the southwest. Area C drains to the north and south west to Brien Lake and also south to the Winter Lake / Narrow Lake system.

Filtered tailings and co-disposal carry lower risks and costs due to lack of a retained head of water and requirement for engineered dams that retain water. Filtered/dry stack tailings would offer the operational flexibility of trucked tailings deposition and would not require significant retaining dams, but would require significantly higher capital and operational expenditures than the co-disposal option considering thickened tailings.

The co-disposal option with thickened tailings reduces the requirement for water management and eliminates engineered water retaining dams. The area is also suited to co-disposal because it is adjacent the Ormsby pit and haul distance for waste rock is therefore limited. The co-disposal option would replace the proposed waste rock dump.

The optimum tailings technology selected for co-disposal with waste rock is thickened non-segregating tailings that may be pumped. Co-disposal of waste rock with thickened tailings will eliminate the need for a water reclaim pond, as required with tailings slurry, because water is reclaimed at the mill. Production of thickened tailings has a reduced cost relative to production of paste or filtered tailings. The difference in final water content between thickened tailings and paste is not that large, but the cost and effort to produce paste is significantly greater.

4.3.4 Area D: Round Lake

Area D is an in-lake option that includes Round Lake, a small non-fish bearing lake that contains tailings from the historic Discovery mine. Sediments from the lake bottom have indicated high values for arsenic, copper, nickel, zinc, and phosphorous in comparison with other lakes and a noticeable gradient in metals concentrations has been noted in the downstream lakes (Tyhee 2008). Bathymetry of Round Lake has been measured. Round Lake has a surface elevation of approximately 288 masl, a depth of less than 1 m, and approximate total water volume of 0.086 Mm^3. Round Lake is located in the upper part of the sub-catchment and drains to Winter Lake.

Use of Area D for tailings storage would require continuous perimeter dams.

Area D Round Lake was not selected for detailed assessment because of the limited potential for increase in storage capacity, use of the area would impact the airstrip and proposed site infrastructure including the plant site and diesel storage, stockpiles, and temporary lay down areas. Use of the area would also incur liability for a portion of the historic Discovery tailings.

4.3.5 Area E: East

Area E is located between Giauque Lake and Winter Lake and contains a small water body. Bathymetry for the water body has not been measured. Area E generally has low relief and drains directly to Giauque Lake.

Use of Area E for tailings storage would require continuous perimeter dams.

Area E East was not selected for detailed assessment because it would impact a drainage outside the Ormsby pit area and poses a direct risk to Giauque Lake. The area has some natural advantage because it contains a minor basin.

4.3.6 Area F: South

Area F with sub-aerial deposition of tailings slurry was selected for detailed assessment as Option F.

Area F is located approximately 7 km to the south of the proposed mill location. Area F is an on-land area located in the same drainage but downstream of the proposed Ormsby pit, in the upper end of its sub-catchment. Area F includes two streams and small water bodies and is located downhill from the mill.

Use of Area F for tailings storage would require a side hill dam along the north and western perimeter marked on Figure 4.6.

Use of Area F will require significant dam construction and transport of tailings over a distance of greater than 7 km. The optimum tailings technology selected for Area F is sub-aerial discharge of tailings as slurry with operation of a water reclaim pond. Further effort to dewater or thicken the tailings provides some benefit to increase the tailings density and reduction in water handling, but the capital expenditure for thickening is greater than for dams associated with tailings slurry. Co-disposal is rejected because of the requirement for hauling of waste rock an additional 7 km from the Ormsby pit.

4.3.7 Area G: South West

Area G is an on-land option located approximately 6 km to the south west of the proposed mill location. Area G does not contain any major water bodies. Area G is downhill from the mill and drains to the south west into a sub-catchment that is separated from the Ormsby Pit sub-catchment. Use of Area G for tailings storage would require three cross valley dams in the early stages of mine operation.

Area G was not selected for detailed assessment as a TCA because of impact to additional sub-catchments outside the pit area and risks associated a tailings containment failure.

4.3.8 Area H: West

Area H is an on-land option located to the west of the proposed mill location at the south west end of Brien Lake. Area H contains several small streams and drains to Brien Lake, to Narrow Lake and to the south west. The area was identified for pre-screening because it does not contain major water bodies. Use of Area H for tailings storage would require several dams.

Area H was not selected for detailed assessment as a TCA because it drains to sub-catchments outside the Ormsby pit area, use of the area would impact several small water bodies, and distance from the proposed mill location and would require pumping of tailings.

4.3.9 Area I: North

Area I is located to the north of the proposed mill location. Area I contains two small water bodies and drains mainly to the west and also north. The area was identified for pre-screening because it does not contain major water bodies and topography is relatively favourable for storage efficiency, *i.e.,* it contains a valley area. Use of Area I for tailings storage would require several cross valley dams.

Area I was not selected for detailed assessment as a TCA because it drains to two sub-catchments outside the pit area, use of Area I would impact several small water bodies, and distance from the proposed mill location would require pumping of tailings.

4.3.10 Area J: North East

Area J is located approximately 6.5 km north east of the proposed mill site, closer to the Nicholas lake site. Area J is an elevated on-land area and contains several small water bodies and streams draining to the north east, to the south, to the south west and to the west. Use of Area J for tailings storage would require a side hill dam across the south west perimeter of the area.

Area J was not selected for detailed assessment as a TCA because it drains to several sub-catchments outside the pit area, impacts several small water bodies, carries risks impacting several different water bodies, is uphill from the proposed mill location, and would require pumping of tailings over a distance greater than 7 km. The area was identified for pre-screening because it is primarily on-land and does not contain major water bodies.

5.0 MULTIPLE ACCOUNTS ANALYSIS

Options selected for multiple accounts analysis are described with key advantages and disadvantages and results of the MAA are presented and discussed.

For detailed assessment, options considering slurry deposition were evaluated for dam construction requirements and available storage volume using the same method as used for pre-screening, but included an additional 5 m dam height to account for reclaim pond volume, slope of the tailings surface and freeboard requirements. The approach is considered appropriate for a relative comparison of construction requirements for the potential TCA's. Further development and optimization of the dam section and alignments for the selected TCA will be completed during later stages of design. The quantities presented should not be used to determine absolute costs.

5.1 Description of Options

5.1.1 Option A Winter Lake Sub-Aerial Slurry

Construction for Option A includes a dam built across Winter Lake to allow dewatering of the north portion of the lake and thus allow for pit development. The water from the north portion of the lake would be pumped to the south portion, and this would raise the water level by approximately 1.5 m, resulting in a total water depth of about 3.5 m. Additional water may be required from another source to raise the water level to permit winter operation of a reclaim pond without siltation or sanding of the reclaim line under a 2 m thick ice cover. Perimeter dams would also be built during the construction phase to accommodate the increase in water level and future tailings discharge. Pre-construction raising of the water level will provide a measure of the water retention of the dams without the presence of tailings supernatant. For example, if the dam section includes a liner on the upstream face, the liner may be placed without a cover to allow inspection for damage during the construction period, then covered with either fill or tailings for operations. Water management works, including diversion ditches, seepage collection ditches, sumps and pumps can all be tested prior to mill start-up. Water reclaim lines and tailings pipelines are constructed and commissioned prior to mill start-up.

During start-up, tailings will be discharged into water, and limited water depth will be available to allow settlement of the tailings. During operations, tailings would be pumped from the mill through a pipeline to discharge points located around the perimeter of the Winter Lake area. The tailings would be pumped as slurry, with sub-aerial discharge to build beaches against the dams. Following settlement of the solids out of the tailings stream, water collects in the pond and is pumped back to the mill for use in process make-up. The cold conditions at the site require insulated, heat traced water reclaim lines, tailings lines, and housing for valves. The deposition of tailings slurry is sequenced to build a tailings surface slope that facilitates closure of the facility.

For closure, the water over the tailings would be pumped out and the tailings may be contoured and covered to promote consolidation and run-off and to limit infiltration of precipitation. Some period of time will be required to allow the tailings to consolidate, during which time periodic water treatment may be required. At the end of mining, the north end of the Winter Lake would be allowed to flood and would return as part of the natural surface water drainage system.

Risks during construction include in-water construction, and construction of engineered water containment dams. Risks during operation include operation of water reclaim lines and tailings pipelines during cold conditions, possible dam failures resulting in tailings release to the environment, and potential flooding of the Ormsby open pit. Risks that may occur during closure and post-closure include long-term settlement and consolidation of the tailings deposit resulting in changes to the anticipated closure activities.

Key advantages to Option A include the following:

- Low volume of fill required for dam construction.
- Drainage is well defined, and located in the upper portion of a basin, which will limit flow-through and contact of water with the tailings.
- Downhill from the mill – no pumping would be required.
- Dewatering dam to isolate the north basin of the lake is required for all options; Option A uses the dam over the long term.
- Anoxic conditions in winter limits fish use of the lake only during the open water period, and this use appears to be limited to use by a small number of juvenile Northern Pike. The deeper north part of the lake which does not freeze to the bottom every year is flooded at mine closure and returns to the natural drainage course.

Key disadvantages to Option A include the following:

- Loss of low quality, seasonal fish habitat, which will require listing under MMER Schedule 2.
- Failure of the north dam could potentially flood the Ormsby mine.
- Dust generation from tailings beach areas.
- Less than 5 m water depth in existing south portion of the lake will make operation of a water reclaim pond difficult.
- Operation of a water reclaim system in winter.

5.1.2 Option B Narrow Lake Sub-Aerial Slurry

Construction for Option B includes dams built across both ends of Narrow Lake. Water reclaim lines and tailings pipelines would be constructed and commissioned prior to mill start-up. Water management works, including diversion ditches, seepage collection ditches, sumps, and pumps would all be built and tested prior to mill start-up. Narrow Lake holds approximately 1.3 Mm^3 of water and partial dewatering of the lake may be required prior to start-up to make room for tailings to be added to the basin.

During operations, tailings would be pumped from the mill through a pipeline to discharge points located around the perimeter of the Narrow Lake area. The tailings would be pumped as slurry, with sub-aerial discharge to build beaches against the dams. A water reclaim barge would be operated in one of the deep pockets of the lake, with water pumped back to the mill for use in process make-up. The cold conditions at the site require insulated, heat traced water reclaim lines, tailings lines, and housing for valves. The deposition of tailings slurry would be sequenced to build a tailings surface slope that facilitates closure of the facility.

For closure, either a water cover could be maintained, or the water would be pumped out of the facility and the tailings surface contoured and covered to promote run-off and limit infiltration of precipitation. Water diversion works would be required to manage the flow-through from the Winter Lake and Round Lake drainage basins, measured as high as 0.75 Mm^3 per year. Some period of time will be required to allow the tailings to consolidate, during which time periodic water treatment may be required. The greater depth of Narrow Lake would result in a smaller area requiring cover, but also an extended time for tailings consolidation and water treatment during closure.

Risks during construction include in-water construction and construction of water containment dams. Risks during operation include operation of water reclaim lines and tailings pipelines during cold conditions, possible catastrophic dam failure resulting in some tailings release to the environment and possible partial flooding of the Ormsby open pit and/or underground mine. Risks during closure and post-closure include long term settlement and consolidation of the deposit resulting in changes to the anticipated closure activities.

Key advantages of Option B include the following:

- Deeper water pockets facilitate operation of water reclaim in cold conditions.
- Reduced total footprint of tailings due to lake depth and natural confinement.

Key disadvantages of Option B include the following:

- Impacts to high quality fish habitat, which would require listing of the waterbody under MMER Schedule 2 as well as greater fish habitat compensation requirement for the loss of fish habitat.
- Failure of the northeast dam could potentially flood the Ormsby mine.
- Must manage water flow through (measured values indicate 0.25 to 0.75 Mm^3/year).
- Pumping of tailings may be required.
- Requires water treatment or lake dewatering at start-up.
- Dust generation from beach areas (though less than for Option A).
- May complicate future mine expansion to south west.

5.1.3 Option C Ormsby Co-Disposal Waste Rock and Thickened Tailings

Construction for Option C includes hauling waste rock from the Ormsby pit development to an on-land area for building perimeter berms. The berms would be constructed with PAG and NPAG rock, with the base being NPAG. The outer batters of the berms would be covered with low permeability soil to limit water infiltration and promote run-off, and the inner batters lined with geotextile to retain tailings solids. Waste rock berms would be constructed with side slopes of 3 horizontal to 1 vertical for stability over the long term.

Water management works, including diversion ditches, seepage collection ditches, sumps and pumps would be constructed prior to waste rock placement and mill start-up. The layout of the facility can be optimized in cells to limit the catchment of precipitation requiring management. A tailings pipeline would be constructed to the facility, and will require heat tracing and insulation. High density thickening tanks would be required in the mill area, such as deep cone thickeners. Several tanks will allow capacity to store tailings at the mill prior to pumping to the tailings area.

The operation would include pumping of thickened flotation tailings to the west side (back) of the storage area to allow downhill seepage flow towards the waste rock berms. Thickened tailings are dewatered at the mill to reclaim water and thereby limit the discharge of tailings supernatant water to the facility. Some decant water from the tailings deposited in the facility and also precipitation in the facility area would flow through the waste rock berms and to the seepage collection system. Water would be stored in ponds for periodic management during warm conditions or pumped back over the berms to collect in the pond nearest the mill or in the pit.

Planning for closure of the facility would anticipate that the tailings would be covered with a soil cover to limit infiltration. Operation of the facility in cells would allow progressive closure of the cells during operations. Thickened tailings have a density that is greater than slurry upon deposition. Greater density will limit the total amount of consolidation and will also increase the rate of consolidation of thickened tailings deposits relative to slurry tailings deposits. Still, consolidation of the deposit will produce pore water requiring management for several years following closure. The facility would be covered to limit infiltration and promote surface run-off.

Construction of waste rock berms is generally considered to be low risk, but care would need to be taken to prepare the downhill toe area of the berms to limit possible failure in the foundation and care would be taken to build seepage collection and storage works down slope of the facility. The main risks during operation are freezing of the tailings line, inability to complete thickening of the tailings and management of seepage, and mobility of wastes downhill towards the open pit. Risks during closure include long term acid generation and metal leaching from the facility.

Key advantages of Option C include the following:

- Tailings are not deposited in a fish-bearing lake.
- Minimized total mine waste storage footprint due to integrated storage. Eliminates separate waste rock storage facility.
- Significantly reduced dam construction cost and effort. Berms of waste rock with filters are required but an impermeable layer or liner is not required.
- Reduced water handling requirements.
- Design can allow progressive closure during operations.
- Less risk in construction and closure.

Key disadvantages of Option C include the following:

- Heavy reliance on perimeter seepage and runoff collection system and temporary water storage system.

- Tailings must be transported uphill from mill.
- Crosses drainage divide boundaries; require drainage control works to limit impact on Brien Lake, Bruce Lake, Narrow Lake and Winter Lake. May impact mine freshwater intake.
- Loss of terrestrial wildlife habitat and native plant cover, though this is offset by use of the area otherwise designated for tailings storage.
- Increased dust generation affects vegetation cover and quality, subsequently affecting forage availability and quality for wildlife (*e.g.,* caribou). Could be mitigated by progressive closure or sequencing.
- Increased potential for acid rock drainage and metal leaching of waste rock portion of the facility over the long term. This potential exists for all options because they store waste rock in the Ormsby facility. Waste rock will be covered at closure, but co-disposal of the waste rock with tailings will result in a greater footprint area for the waste rock portion that will catch more precipitation than the stand-alone waste rock piles associated with Options A, B, or F.

5.1.4 Option F South Sub-Aerial Slurry

Construction for Option F includes an all weather road and staged construction of a side hill dam. Pipelines for tailings distribution and water reclaim would be constructed and commissioned prior to mill start-up. As part of commissioning, water from north Winter Lake dewatering would be pumped to Option F to form the reclaim pond.

During operations, tailings would be transported downhill from the mill through a pipeline to discharge points located on the retaining dam. The tailings would be pumped as slurry, with sub-aerial discharge to build beaches against the dams and train the pond against natural topography in a central location. A water reclaim barge would be operated in the pond, with water pumped back to the mill for use in process make-up. The cold conditions at the site require insulated, heat traced water reclaim lines, tailings lines, and housing for valves. The deposition of tailings slurry would be sequenced to build a tailings surface slope to facilitate closure of the facility.

For closure, either a water cover could be maintained, or the water could be pumped out of the facility and the tailings surface contoured and covered to promote run-off and limit infiltration of precipitation. Water diversion works would be required to manage a minor amount of drainage from the upper part of the catchment. Some period of time will be required to allow the tailings to consolidate, during which time periodic water treatment may be required.

Risks during construction include length of construction season and the large amount of infrastructure required. Option F may require construction over more than one season. Risks during operation include operation of water reclaim lines and tailings pipelines during cold conditions, and possible catastrophic dam or tailings line failure resulting in tailings release to the environment. Risks during closure and post-closure include long term settlement and consolidation of the deposit resulting in changes to the anticipated closure activities, as well as tailings dam failure.

Key Advantages of Option F include the following:

- No major water bodies are impacted. Anticipated impact to fish habitat is low.
- Area F is downstream but in the same catchment as the Ormsby pit.

Key Disadvantages of Option F include the following:

- Greater than 7 km pipelines are required for tailings distribution and water reclaim.
- Tailings must be pumped to reach the facility.
- Relatively inefficient and expensive– a 25 m high dam with a relatively low storage efficiency is required.

6.0 RESULTS AND SENSITIVITY ANALYSIS

The multiple accounts evaluation matrix results and sensitivity analysis are presented in the following sections.

6.1 Base Line Analysis

Results of assessment are summarized in Table 6-1 and presented in detail in Table 6-2.

Table 6-1: Summary of Base Line Results for Multiple Accounts Analysis

		Option A	Option B	Option C	Option F
Indicator	Weight	Winter Lake - Sub-aerial Slurry	Narrow Lake - Sub-aerial Slurry	Ormsby - Co-Disposal	South – Sub-aerial Slurry
Environmental	42%	483	425	501	331
Economic	6%	80	90	47	23
Social	27%	423	393	341	447
Technical	25%	305	287	316	228
Total Score	100%	1290	1195	1205	1029

The option with the highest total score is Option A Winter Lake with sub-aerial slurry deposition. Option A did not receive the highest score for any one indicator, but had the second highest scores in all indicators. Use of Winter Lake will result in the loss of low value fish habitat but the tailings would be stored in a single sub-catchment with the lowest dam construction requirements. For Option A, the dewatering dam required for mining of the Ormsby pit becomes a higher structure for retaining tailings.

Option C Ormsby with co-disposal of waste rock and thickened tailings had the next highest total score, with the highest overall scores for Technical and Environmental indicators. However, Option C had only the third highest Economic indicator score, due primarily to the high capital cost requirement for a tailings thickening plant. Option C will create a larger on-land structure than the waste rock facility alone, but the overall waste storage footprint would be smaller. Option C does not remove a lake from the ecosystem but is located on higher ground across a watershed boundary and therefore has the potential to impact several lakes in different sub-catchments over the long term.

Option B Narrow Lake with sub-aerial slurry deposition had the third highest total score. Option B had the highest Economic Indicator score. The key advantages to Option B are greater water depth and storage in a natural basin that allows for efficient storage in a smaller footprint. However, Option B permanently removes high quality fish habitat and requires management of water flow through the Narrow Lake area over the long term.

Option F South with sub-aerial slurry deposition had the lowest total score. Option F had the highest score in the Social Indicator. However, Option F also had the lowest score in the Environment Indicator because of impact to two sub-catchments, and risks associated with higher dams and longer tailings and water reclaim pipelines. Option F had the lowest Economic indicator score because of poor storage efficiency / dam construction requirements, and also the requirement to build long pipelines for tailings distribution and water reclaim.

Table 6-2:
Tailings Storage Options Matrix

TAILINGS STORAGE OPTIONS MATRIX				Options A	Option B	Option C	Option F	Sub-Indicator Score				Sub-Indicator Weighted Scores			
				Winter Lake	Narrow Lake	Cemetery	South	A	B	C	F	A	B	C	F
				Sub-aerial Slurry	Sub-aerial Slurry	Co-Disposal Waste Rock and Thickened Tailings	Sub-aerial Slurry								
				Construction - Dam across Winter Lake, staged construction of perimeter dams, dewater of north Winter Lake to south, tailings and water reclaim pipelines.	Construction - Staged construction of tailings dams across ends of Narrow Lake, water and tailings pipelines. Dam and dewatering of north part of Winter Lake.	Construction - Continuous construction of waste rock berms. Pipeline for tailings deposition. Dam and dewatering of north part of Winter Lake.	Construction - Staged construction of tailings dams. Water and tailings pipelines and +7 km all weather road. Dam and dewatering of north part of [illegible]								
				Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline.	Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline.	Operation - Spigot discharge of thickened non-segregating tailings. Operate tailings pipeline. Place waste rock and cover as available. Seasonal water management for bleed and runoff.	Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline.								
Key Indicators	Sub-Indicators	Relative Weighting *Factor*	Maximum Possible Score	Closure – Decant pond, place capping layer over tailings to shed water to minimize infiltration and control surface drainage, re-flood north Winter Lake.	Closure – Decant pond, place capping layer to limit infiltration, operate surface water diversion works to prevent erosion of tailings deposit.	Closure – Place capping layer to limit infiltration, shed water.	Closure – Decant pond, place capping layer over tailings to shed water to minimize infiltration and control surface drainage.								
Key Details	Dam fill construction volume required[1] (Mm³)			0.32[(2)]	0.44	-	2.78								
	Area of Tailings Facility (ha)			147	93	124	152								
	Length of tailings pipeline (km)			3.6	3.3	2.3	8.8								
	Volume Tailings (Mm³)			5.9	5.9	5.1	5.9								
	Maximum Dam Height (m)			15	19	61	25								
	Number of Dams			5	2	-	1								
	Length of Dams (km)			2.1	1.0	-	2.8								
	Length of reclaim pipeline (km)			2.1	3.0	0.0	8.2								
	Location of water pond			south end of lake	near southwest end of lake	none	central/western								
Environmental	Sub-catchment area (ha)	4	9	430	360	1130	415	[illegible]	[illegible]	3.0	[illegible]	21.6	36.0	12.1	[illegible]
	No. Sub-catchments impacted	4	9	1	1	2	2	9.0	9.0	4.5	4.5	36.0	36.0	18.0	18.2
	Surface flow path length to nearest control point (km)	5	9	2.3 to end of Narrow Lake	0 to end of Narrow Lake	0.37 to end of Brian Lake	1.0 to main drainage in area	9.0	0.0	1.4	[illegible]	45.0	0.0	7.2	[illegible]
	Lakes along flow path to nearest control point (km)	2	9	1	0	1	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Lakes impacted	8	9	1	1	0	2	[illegible]	5.0	9.0	3.0	40.0	40.0	72.0	24.0
	On-land footprint area[4]	7	9	90	38	25	140	2.5	[illegible]	[illegible]	[illegible]	17.7	[illegible]	[illegible]	[illegible]
	Potential for dust during operation	5	9	medium	low	high	high	[illegible]	[illegible]	1.0	1.0	[illegible]	[illegible]	[illegible]	5.0
	Potential for ARD generation	10	9	low	low	medium	medium	[illegible]	[illegible]	4.0	4.0	[illegible]	[illegible]	40.0	40.0
	Potential for ML	10	9	high	high	medium	high	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Potential for seepage to groundwater	7	9	low	low	medium	medium	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Potential for geotechnical hazards with risk to environment[3]	7	9	high	high	low-medium	high	4.0	4.0	[illegible]	4.0	[illegible]	[illegible]	[illegible]	[illegible]
	Impact on Fish and Fish Habitat	10	9	low	high	nil	low	[illegible]	1.0	[illegible]	[illegible]	[illegible]	10.0	90.0	[illegible]
	Sum of Environmental Weightings	79	711									482	428	505	331
Economic	Net Present Value of Select Total Costs[5] (Millions of CAD)	10	9	12 to 21	11 to 19	18 to 39	40 to 77	8.0	9.0	4.7	2.3	79.8	90.0	46.8	22.7
	Sum of Economic Weightings	10	90									80	90	47	23
Social	Risk to Human Health	10	9	insignificant	low	low	insignificant	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	80.0	90.0
	Risk to Public Safety	10	9	insignificant	insignificant	insignificant	insignificant	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	90.0	90.0
	Risk to Worker Safety	10	9	low	low	medium	low	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Economic Advantages to the Local Community	3	9	low	low	low	medium	5.0	5.0	5.0	9.0	[illegible]	[illegible]	15.0	27.0
	Local Job Creation and Diversity	3	9	low	low	low	medium	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.0	27.0
	Quality of Life	3	9	low	low	low	low	[illegible]	[illegible]	[illegible]	[illegible]	27.0	27.0	27.0	[illegible]
	Use for the Public	3	9	low	low	low	low	[illegible]	[illegible]	[illegible]	[illegible]	27.0	27.0	27.0	27.2
	Landscape	3	9	low	low	high	medium	[illegible]	[illegible]	1.0	[illegible]	27.0	27.0	3.0	[illegible]
	Culture Heritage	3	9	low	low	low	low	[illegible]	[illegible]	[illegible]	[illegible]	27.0	27.0	27.0	[illegible]
	Management Practices and Innovation	3	9	low	low	medium	medium	[illegible]	[illegible]	[illegible]	[illegible]	15.0	15.0	27.0	27.0
	Sum of Social Weightings	51	459									423	390	348	447
Technical	Pond depth available at start-up (m)	3	9	3.5	10	0	8	2.5	7.0	[illegible]	[illegible]	7.4	21.0	27.0	16.8
	Length of reclaim pipeline (km)	5	9	2.1	3.0	0	8.2	7.0	4.9	[illegible]	1.8	35.0	24.5	45.0	9.2
	Length of tailings pipeline (km)	5	9	3.6	3.3	2.3	8.8	[illegible]	6.3	[illegible]	2.4	28.8	31.4	45.0	11.8
	Maximum dam height (m)	6	9	15	19	61	25	9.0	7.1	2.2	5.2	54.0	42.7	12.8	31.5
	Pond management during winter conditions	6	9	yes	yes	no	yes	[illegible]	5.0	[illegible]	5.0	30.0	30.0	54.0	30.0
	Potential for delays due to freezing	5	9	high	high	medium	high	[illegible]	5.0	[illegible]	[illegible]	25.0	25.0	45.0	25.0
	Volume of water stored (Mm³)	2	9	3.1	3.1	2.3	3.1	6.7	6.7	9.0	6.7	13.4	13.4	18.0	13.4
	Capping volume, assuming 1 m thickness over plan area (Mm³)	2	9	2.9	1.7	2.5	3.0	5.1	9.0	6.0	4.9	10.2	18.0	12.0	9.8
	Ease of decommissioning/closure	4	9	low	low	medium	low	[illegible]	5.0	[illegible]	5.0	20.0	20.0	36.0	20.0
	Construction Risk	5	9	low	medium	high	medium	9.0	5.0	1.0	5.0	45.0	25.0	5.0	25.0
	Disposal system has precedent in arctic environment	4	9	yes	yes	one case in implementation phase	yes	9.0	9.0	4.0	9.0	36.0	36.0	16.0	36.0
	Sum of Operational Weightings	47	423									305	287	318	228
TOTAL SCORE			1683	1290	1195	1205	1029					1290	1195	1205	1029

Notes:

1. Dams are sized to store 5.9 Mm3 tailings plus 5 m allowance for freeboard, slope of tailings surface and reclaim pond. Co-disposal concept considers total volume of 42.1 Mm³.
2. Winter Lake dewatering dam is common to all options and therefore not considered.
3. Includes consideration of nature of structure, foundation conditions, impact of seismicity, and height of structure.
4. Option C land use considers total on-land footprint area less the waste rock dump footprint area.
5. Relative capital cost of select items for comparison only. Interest rate assumed as 7%.

6.2 Sensitivity Case 1 - Non-Weighted Scoring

To remove bias introduced by relative weightings, the options were scored by setting all weighting factors to 1 in Sensitivity Case 1 – Non-Weighted Scoring. Results are summarized in Table 6-3 and presented in detail in Table 6-4.

Table 6-3: Summary of Multiple Accounts Analysis – Sensitivity Analysis Case 1 Non-Weighted Scoring

		Option A	Option B	Option C	Option F
Indicator	**Weight**	**Winter Lake - Sub-aerial Slurry**	**Narrow Lake - Sub-aerial Slurry**	**Ormsby - Co-Disposal**	**South – Sub-aerial Slurry**
Environmental	35%	73	64	67	54
Economic	3%	8	9	5	2
Social	29%	78	75	67	86
Technical	32%	69	70	76	56
Total Score	100%	228	218	215	198

Option A had the highest overall non-weighted score, with highest scores for the Environmental indicator. Option A had the second highest non-weighted Economic indicator score.

Option B had the second highest non-weighted score, with the highest Economic Indicator score, the second highest scores in the Environmental and Social Indicators. Option C had the third highest non-weighted score including the highest Technical indicator score. Option F had the lowest overall score, with the highest Social indicator score.

The second and third ranked options differ for the non-weighted case relative to the baseline case, whereby Option B is ranked second, followed by Option C. The change in ranking is due to removal of heavier weighting factors for indicators biased towards fish and fish habitat.

Table 6-4:
Tailings Storage Options Matrix - Sensitivity Case 1 Non-Weighted Scoring

								Sub-Indicator Score				Sub-Indicator Weighted Scores			
TAILINGS STORAGE OPTIONS MATRIX				Option A	Option B	Option C	Option F	A	B	C	F	A	B	C	F
				Winter Lake	Narrow Lake	Dimsky	South								
				Sub-aerial Slurry	Sub-aerial Slurry	Co-Disposal Waste Rock and Thickened Tailings	Sub-aerial Slurry								
				Construction - Dam across Winter Lake, staged construction of perimeter dams, dewater of north Winter Lake to south, tailings and water reclaim pipelines. Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline	Construction - Staged construction of tailings dams across ends of Narrow Lake, water and tailings pipelines. Dam and dewatering of north part of Winter Lake. Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline	Construction - Continuous construction of waste rock berms. Pipeline for tailings deposition. Dam and dewatering of north part of Winter Lake. Operation - Spigot discharge of thickened non-segregating tailings. Operate tailings pipeline. Place waste rock and cover as available. Seasonal water management for bleed and runoff.	Construction - Staged construction of tailings dams. Water and tailings pipelines and +7 km all weather road. Dam and dewatering of north part of Winter Lake to form startup pond. Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline.								
Key Indicators	**Sub-Indicators**	**Relative Weighting Factor**	**Maximum Possible Score**	Closure - Decant pond, place capping layer over tailings to shed water to minimize infiltration and control surface drainage, re-flood north Winter Lake	Closure - Decant pond, place capping layer to limit infiltration, operate surface water diversion works to prevent erosion of tailings deposit	Closure - Place capping layer to limit infiltration, shed water.	Closure - Decant pond, place capping layer over tailings to shed water to minimize infiltration and control surface drainage.								
Key Details	Dam fill construction volume required[1] (Mm³)			0.32[2]	2.44	-	2.75								
	Area of Tailings Facility (ha)			147	83	124	152								
	Length of tailings pipeline (km)			3.6	3.3	2.3	8.8								
	Volume Tailings (Mm³)			5.8	5.8	5.1	5.8								
	Maximum Dam Height (m)			55	19	41	25								
	Number of Dams			3	2	-	1								
	Length of Dams (km)			2.1	1.0	-	2.8								
	Length of reclaim pipeline (km)			2.1	3.0	0.0	8.0								
	Location of water pond			south end of lake	near southwest end of lake	none	central/western								
Environmental	Sub-catchment area (ha)	1	9	430	380	1130	415	8.0	9.0	3.0	8.2	8.0	9.0	3.0	8.2
	No. Sub-catchments impacted	1	9	1	1	2	2	9.0	9.0	4.5	4.5	9.0	9.0	4.5	4.5
	Surface flow path length to nearest control point (km)	1	9	2.3 to end of Narrow Lake	0 to end of Narrow Lake	0.37 to end of Brien Lake	1.0 to main drainage in area	9.0	0.0	1.4	3.9	9.0	0.0	1.4	3.9
	Lakes along flow path to nearest control point (km)	1	9	1	4	1	3	3.0	9.0	3.0	9.0	3.0	9.0	3.0	9.0
	Lakes impacted	1	9	1	1	0	2	5.0	5.0	9.0	3.0	5.0	5.0	9.0	3.0
	On-land footprint area (ha)(considers habitat)[4]	1	9	80	58	35	149	2.5	3.5	9.0	1.5	2.5	3.9	9.0	1.5
	Potential for dust during operation	1	9	medium	low	high	high	5.0	9.0	1.0	1.0	5.0	9.0	1.0	1.0
	Potential for ARD generation	1	9	low	low	medium	medium	9.0	9.0	4.0	4.0	9.0	9.0	4.0	4.0
	Potential for ML	1	9	high	high	medium	high	5.0	5.0	9.0	5.0	5.0	5.0	9.0	5.0
	Potential for seepage to groundwater	1	9	low	low	medium	medium	9.0	9.0	5.0	5.0	9.0	9.0	5.0	5.0
	Potential for geotechnical hazards with risk to environment[3]	1	9	high	high	low-medium	high	4.0	4.0	8.0	4.0	4.0	4.0	8.0	4.0
	Impact on Fish and Fish Habitat	1	9	low	high	nil	low	5.0	1.0	9.0	5.0	5.0	1.0	9.0	5.0
	Sum of Environmental Weightings	12	108									72	64	67	54
Economic	Net Present Value of Select Total Costs[5] (millions of CAD)	1	9	12 to 21	11 to 19	18 to 39	40 to 77	8.0	9.0	4.7	2.3	8.0	9.0	4.7	2.3
	Sum of Economic Weightings	1	9									8	9	5	2
Social	Risk to Human Health	1	9	insignificant	low	low	insignificant	9.0	5.0	5.0	9.0	9.0	5.0	5.0	9.0
	Risk to Public Safety	1	9	insignificant	insignificant	insignificant	insignificant	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	Risk to Worker Safety	1	9	low	low	medium	low	9.0	9.0	3.0	9.0	9.0	9.0	3.0	9.0
	Economic Advantages to the Local Community	1	9	low	low	low	medium	5.0	5.0	5.0	9.0	5.0	5.0	5.0	9.0
	Local Job Creation and Diversity	1	9	low	low	low	medium	5.0	5.0	5.0	9.0	5.0	5.0	5.0	9.0
	Quality of Life	1	9	low	low	low	low	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	Use for the Public	1	9	low	low	low	low	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	Landscape	1	9	low	low	high	medium	9.0	9.0	1.0	5.0	9.0	9.0	1.0	5.0
	Cultural Heritage	1	9	low	low	low	low	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	Management Practices and Innovation	1	9	low	low	medium	medium	5.0	5.0	9.0	9.0	5.0	5.0	9.0	9.0
	Sum of Social Weightings	10	90									75	75	67	86
Technical	Pond depth available at start-up (m)	1	9	3.5	10	0	8	2.5	7.0	9.0	5.6	2.5	7.0	9.0	5.6
	Length of reclaim pipeline (km)	1	9	2.1	3.0	0	8.0	7.0	4.9	9.0	1.8	7.0	4.9	9.0	1.8
	Length of tailings pipeline (km)	1	9	3.6	3.3	2.3	8.8	5.8	6.3	9.0	2.4	5.8	6.3	9.0	2.4
	Maximum dam height (m)	1	9	55	19	41	25	9.0	7.1	2.2	5.2	9.0	7.1	2.2	5.2
	Pond management during winter conditions	1	9	yes	yes	no	yes	5.0	5.0	9.0	5.0	5.0	5.0	9.0	5.0
	Potential for delays due to freezing	1	9	high	high	medium	high	5.0	5.0	9.0	5.0	5.0	5.0	9.0	5.0
	Volume of water stored (Mm³)	1	9	3.1	3.1	2.3	3.1	6.7	6.7	9.0	6.7	6.7	6.7	9.0	6.7
	Capping volume, assuming 2 m thickness over plan area (Mm³)	1	9	2.9	1.7	2.5	3.0	5.1	9.0	6.0	4.9	5.1	9.0	6.0	4.9
	Ease of decommissioning/closure	1	9	low	low	medium	low	5.0	5.0	9.0	5.0	5.0	5.0	9.0	5.0
	Construction Risk	1	9	low	medium	high	medium	9.0	5.0	1.0	5.0	9.0	5.0	1.0	5.0
	Disposal system has precedent in arctic environment	1	9	yes	yes	one case in implementation phase	yes	9.0	9.0	4.0	9.0	9.0	9.0	4.0	9.0
	Sum of Operational Weightings	11	99									66	70	76	58
TOTAL SCORE			306	228	218	215	198					228	218	215	198

Notes:
1. Dams are sized to store 5.8 Mm3 tailings plus 5 m allowance for freeboard, slope of tailings surface and reclaim pond. Co-disposal concept considers total volume of 42.1 Mm³.
2. Winter Lake dewatering dam is common to all options and therefore not considered.
3. Includes consideration of nature of structure, foundation conditions, impact of seismicity, and height of structure.
4. Option C land use considers total on-land footprint area less the waste rock dump footprint area.
5. Relative capital cost of select items for comparison only. Interest rate assumed as 7%.

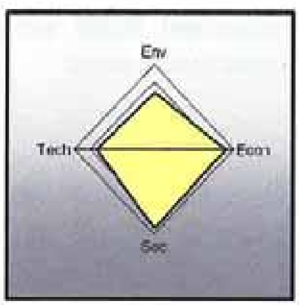
6.3 Sensitivity Case 2 - Normalized Scoring

Sensitivity Case 2 involves comparison of normalized scores presented for the base line analysis. Normalized scores for the options examined are presented in Table 6-5, where each indicator has a maximum 25 of 100 possible points. Normalized scores allow comparison of total scores without a bias towards options that score higher in indicators with greater maximum possible scores. Indicators may also be compared within each option.

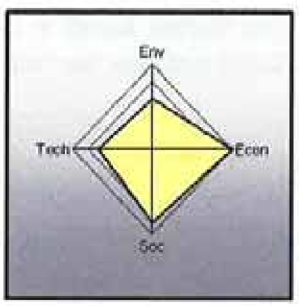
Table 6-5: Summary of Multiple Accounts Analysis – Sensitivity Case 2 Normalized Scoring

		Option A	Option B	Option C	Option F
Indicator	Weighting	Winter Lake - Sub-aerial Slurry	Narrow Lake - Sub-aerial Slurry	Ormsby - Co-Disposal	South – Sub-aerial Slurry
Environment	25%	17	15	18	12
Economic	25%	22	25	13	6
Social	25%	23	21	19	24
Technical	25%	18	17	19	14
Total Score	100%	80	78	68	56

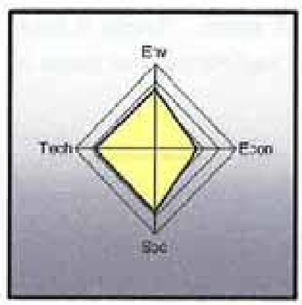
Option A



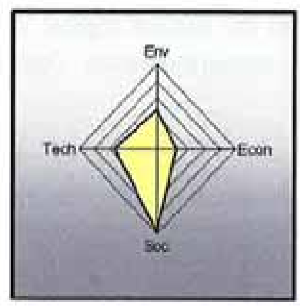
Option B



Option C



Option F



Note: Larger areas on the plots indicate higher normalized scores. Indicator scores are plotted on different axes, with the maximum on each axis of 25 and divisions marking 5 point increments.

Results presented in Table 6-5 indicate that Option A has the highest normalized score. The second and third ranked options differ from the base case, with Option A having the highest score, followed by Options B, C, then D.

Option A did not receive the highest normalized score in any one indicator had the second highest normalized scores for all indicators. Highest scores for Option A are for Social and Economic indicators. Option B was had a similar, but lower, normalized score, and received the highest score in the Economic Indicator. Option B also scored highly in the Social indicator. Option C had the highest normalized Technical Indicator score but a significantly lower overall score compared to Options A and B due to a poor normalized Economic indicator score. Option F had the highest normalized Social Indicator score, but also had the lowest normalized scores in all other indicators.

6.4 Sensitivity Case 3 – Fish and Fish Habitat

Results of Sensitivity Case 3, where Economic indicators are not considered and weightings of sub-indicators that could impact lakes, fish and fish habitat are set to the maximum weighting, are summarized in Table 6-6 and presented in detail in Table 6-7.

Table 6-6: Summary of Multiple Accounts Analysis – Sensitivity Case 3 Fish and Fish Habitat

		Option A	Option B	Option C	Option F
Indicator	**Weighting**	**Winter Lake - Sub-aerial Slurry**	**Narrow Lake - Sub-aerial Slurry**	**Ormsby - Co-Disposal**	**South – Sub-aerial Slurry**
Environment	48%	517	435	543	409
Economic	0%	0	0	0	0
Social	27%	423	393	341	447
Technical	25%	305	287	316	228
Total Score	100%	1244	1115	1200	1085

Option A has the highest overall score for Sensitivity Case 3, followed by Option C, then Option B and finally Option F. Option A had the second highest scores in Environment, Social, and Technical Indicators, producing the highest overall score. Option C had the highest scores for the Environment and Technical Indicators and had the second highest overall score. Option B had the third highest scores in the Environment, Social, and Technical Indicators. Option F had the highest score in the Social Indicator, but had the lowest overall score.

Table 6-7:
Tailings Storage Options Matrix - Sensitivy Case 3 Fish and Fish Habitat

TAILINGS STORAGE OPTIONS MATRIX

Key Indicators	Sub-Indicators	Relative Weighting Factor	Maximum Possible Score	Option A	Option B	Option C	Option F	Sub-Indicator Score A	Sub-Indicator Score B	Sub-Indicator Score C	Sub-Indicator Score F	Sub-Indicator Weighted Scores A	Sub-Indicator Weighted Scores B	Sub-Indicator Weighted Scores C	Sub-Indicator Weighted Scores F
				Winter Lake	Narrow Lake	Ormsby	South								
				Sub-aerial Slurry	Sub-aerial Slurry	Co-Disposal Waste Rock and Thickened Tailings	Sub-aerial Slurry								
				Construction - Dam across Winter Lake, staged construction of perimeter dams, dewater of north Winter Lake to south, tailings and water reclaim pipelines.	Construction - Staged construction of tailings dams across ends of Narrow Lake, water and tailings pipelines. Dam and dewatering of north part of Winter Lake.	Construction - Continuous construction of waste rock berms. Pipeline for tailings deposition. Dam and dewatering of north part of Winter Lake.	Construction - Staged construction of tailings dams. Water and tailings pipelines and +7 km all weather road. Dam and dewatering of north part of Winter Lake to form startup pond.								
				Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline	Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline	Operation - Spigot discharge of thickened non-segregating tailings. Operate tailings pipeline. Place waste rock and cover as available. Seasonal water management for bleed and runoff.	Operation - Spigot tailings slurry. Operate tailings pipeline, water reclaim pond and pipeline								
				Closure – Decant pond, place capping layer over tailings to shed water to minimize infiltration and control surface drainage, re-flood north Winter Lake.	Closure – Decant pond, place capping layer to limit infiltration, operate surface water diversion works to prevent erosion of tailings deposit.	Closure – Place capping layer to limit infiltration, shed water.	Closure – Decant pond, place capping layer over tailings to shed water to minimize infiltration and control surface drainage.								
Key Details	Dam fill construction volume required[1] (Mm³)			0.32 [2]	0.44	-	2.75								
	Area of Tailings Facility (ha)			147	85	126	182								
	Length of tailings pipeline (km)			3.6	3.3	2.3	8.8								
	Volume Tailings (Mm³)			5.9	5.9	5.1	5.9								
	Maximum Dam Height (m)			15	19	41	25								
	Number of Dams			5	2	-	1								
	Length of Dams (km)			2.1	1.9	-	2.8								
	Length of reclaim pipeline (km)			2.1	3.0	0.0	8.0								
	Location of water pond			south end of lake	near southwest end of lake	none	central/western								
Environmental	Sub-catchment area (ha)	4	9	430	360	1130	415	8.0	9.0	3.0	8.2	31.8	36.0	12.1	33.0
	No. Sub-catchments impacted	4	9	1	1	2	2	9.0	9.0	4.5	4.5	36.0	36.0	18.0	18.0
	Surface flow path length to nearest control point (km)	5	9	2.3 to end of Narrow Lake	0 to end of Narrow Lake	0.3? to end of Brian Lake	1.0 to main drainage in area	9.0	0.0	1.4	3.9	45.0	0.0	7.2	19.6
	Lakes along flow path to nearest control point (km)	10	9	1	0	1	3	3.0	0.0	3.0	9.0	30.0	0.0	30.0	90.0
	Lakes impacted	10	9	1	1	0	2	9.0	9.0	9.0	3.0	90.0	90.0	90.0	30.0
	On-land footprint area (ha)(considers haul...)[4]	7	9	90	58	25	149	2.5	3.9	9.0	1.5	17.7	27.0	63.0	10.7
	Potential for dust during operation	5	9	medium	low	high	high	5.0	9.0	1.0	1.0	25.0	45.0	5.0	5.0
	Potential for ARD generation	10	9	low	low	medium	medium	9.0	9.0	4.0	4.0	90.0	90.0	40.0	40.0
	Potential for ML	10	9	high	high	medium	high	5.0	5.0	9.0	5.0	50.0	50.0	90.0	50.0
	Potential for seepage to groundwater	7	9	low	low	medium	medium	9.0	9.0	5.0	5.0	63.0	63.0	35.0	35.0
	Potential for geotechnical hazards with risk to environment[3]	7	9	high	high	low-medium	high	4.0	4.0	9.0	4.0	28.0	28.0	63.0	28.0
	Impact on Fish and Fish Habitat	10	9	low	high	nil	low	5.0	1.0	9.0	5.0	50.0	10.0	90.0	50.0
	Sum of Environmental Weightings	89	801									517	435	542	469
Economic	Net Present Value of Select Total Costs[5] (Millions of CAD)	0	9	12 to 21	11 to 19	18 to 39	40 to 77	8.0	9.0	4.7	2.3	0.0	0.0	0.0	0.0
	Sum of Economic Weightings	0	0									0	0	0	0
Social	Risk to Human Health	10	9	insignificant	low	low	insignificant	[illegible]	[illegible]	[illegible]	[illegible]	90.0	90.0	90.0	90.0
	Risk to Public Safety	10	9	insignificant	insignificant	insignificant	insignificant	[illegible]	[illegible]	[illegible]	[illegible]	90.0	90.0	90.0	90.0
	Risk to Worker Safety	10	9	low	low	medium	low	[illegible]	[illegible]	[illegible]	[illegible]	90.0	90.0	50.0	90.0
	Economic Advantages to the Local Community	3	9	low	low	low	medium	[illegible]	[illegible]	[illegible]	[illegible]	15.0	15.0	15.0	27.0
	Local Job Creation and Diversity	3	9	low	low	low	medium	[illegible]	[illegible]	[illegible]	[illegible]	15.0	15.0	15.0	27.0
	Quality of Life	3	9	low	low	low	low	[illegible]	[illegible]	[illegible]	[illegible]	27.0	27.0	27.0	27.0
	Use for the Public	3	9	low	low	low	low	[illegible]	[illegible]	[illegible]	[illegible]	27.0	27.0	27.0	27.0
	Landscape	3	9	low	low	high	medium	[illegible]	[illegible]	1.0	[illegible]	27.0	27.0	3.0	15.0
	Cultural Heritage	3	9	low	low	low	low	[illegible]	[illegible]	[illegible]	[illegible]	27.0	27.0	27.0	27.0
	Management Practices and Innovation	3	9	low	low	medium	medium	[illegible]	[illegible]	[illegible]	[illegible]	15.0	15.0	27.0	27.0
	Sum of Social Weightings	51	459									423	389	341	447
Technical	Pond depth available at start-up (m)	3	9	3.5	10	0	8	2.5	7.0	9.0	5.6	7.4	21.0	27.0	16.8
	Length of reclaim pipeline (km)	5	9	2.1	3.0	0	8.0	7.0	4.9	9.0	1.8	35.0	24.5	45.0	9.2
	Length of tailings pipeline (km)	5	9	3.6	3.3	2.3	8.8	5.8	6.3	9.0	2.4	28.8	31.4	45.0	11.8
	Maximum dam height (m)	6	9	15	19	41	25	9.0	7.1	2.2	5.2	54.0	42.7	12.9	31.5
	Pond management during winter conditions	6	9	yes	yes	no	yes	5.0	5.0	9.0	5.0	30.0	30.0	54.0	30.0
	Potential for delays due to freezing	5	9	high	high	medium	high	5.0	5.0	9.0	5.0	25.0	25.0	45.0	25.0
	Volume of water stored (Mm³)	2	9	3.1	3.1	2.3	3.1	6.7	6.7	9.0	6.7	13.4	13.4	18.0	13.4
	Capping volume, assuming 2 m thickness over plan area (Mm³)	2	9	2.9	1.7	2.5	3.0	5.1	9.0	6.0	4.9	10.2	18.0	12.0	9.8
	Ease of decommissioning/closure	4	9	low	low	medium	low	5.0	5.0	9.0	5.0	20.0	20.0	36.0	20.0
	Construction Risk	5	9	low	medium	high	medium	9.0	5.0	1.0	5.0	45.0	25.0	5.0	25.0
	Disposal system has precedent in arctic environment	4	9	yes	yes	one case in implementation phase	yes	9.0	9.0	4.0	9.0	36.0	36.0	16.0	36.0
	Sum of Operational Weightings	47	423									305	287	356	238
TOTAL SCORE			1683	1344	1513	1209	1085					1244	1115	1250	1085

Notes:
1. Dams are sized to store 5.9 Mm3 tailings plus 5 m allowance for freeboard, slope of tailings surface and reclaim pond. Co-disposal concept considers total volume of 42.1 Mm³.
2. Winter Lake dewatering dam is common to all options and therefore not considered.
3. Includes consideration of nature of structure, foundation conditions, impact of seismicity, and height of structure.
4. Option C land use considers total on-land footprint area less the waste rock dump footprint area
5. Relative capital cost of select items for comparison only. Interest rate assumed as 7%

7.0 SUMMARY AND CONCLUSIONS

This report presents a pre-feasibility level evaluation of options for a TCA at the Yellowknife Gold Project, NWT. The report includes:

- A summary description of the project including the mine plan and physical setting;
- A description of methods used to select the TCA;
- Pre-screening of areas and tailings technologies; and
- Evaluation of tailings options by a multiple accounts analysis method including a description of the model, description of options, and results of the evaluation.

Ten areas within a 10 km radius of the mill were identified that would minimize impacts to fish bearing water bodies if used as a TCA. Five tailings technologies were evaluated for each area including slurry tailings, thickened tailings, paste tailings, filtered/dry stack tailings, and co-disposal with waste rock. For lake areas, dewatering of slurry tailings to a thickened or paste consistency does not appear to provide significant advantage to reducing footprint area, costs, or net environmental impact (*i.e.,* the lake is still impacted). Co-disposal is suitable for the on-land area near the open pit in the form of waste rock berms containing thickened tailings due to limitation of haul distance and re-handle for waste rock.

Options considered in a detailed evaluation by multiple accounts analysis included the following:

- Option A - Winter Lake with sub-aerial slurry tailings disposal.
- Option B - Narrow Lake with sub-aerial slurry tailings disposal.
- Option C - Ormsby area with on-land co-disposal of waste rock with thickened tailings.
- Option F - South with sub-aerial slurry tailings disposal.

The analysis method considered environmental, economic, social, and technical indicators. Evaluation involved assigning relative scores to each option based on measured or rated sub-indicators. Weightings were then assigned to each sub-indicator. Scores were weighted and summed to provide total scores for each option. A sensitivity analysis was conducted determine influence of different indicators and weightings to the selection process.

Results of the analysis indicate that Option A Winter Lake with sub-aerial slurry disposal had the highest total score for base line scoring and also for all sensitivity analysis cases. Option A did not receive highest score for any one indicator, but scored second highest in all of the indicators. The balance of scoring makes Option A the best possible option. Option C Ormsby with co-disposal of waste rock and thickened tailings scored second in baseline analysis and both second and third in sensitivity analyses. Option C has the benefit of not directly impacting a lake, but would impact drainage sub-catchments outside the pit and had greater costs associated with the requirements for a thickening plant. Option B Narrow Lake with sub-aerial slurry had the third highest total score and the highest economic score due to a smaller footprint requiring closure. However, Option B would remove high quality fish habitat from the ecosystem and Option B therefore scored either second or third in sensitivity analyses depending on the weighting of Economic and Environmental Indicators. Option F scored last in all analysis cases. Option F had the highest Social indicator score, but scored poorly in the other indicators. Option F would not directly impact a major lake, but had lower Environmental and Economic indicator scores due to location across two sub-catchments and the risks and costs associated with requirements for high dams and 7 km pipelines from the mill area.

Based on the analysis presented, it is concluded that Option A Winter Lake with tailings deposited as slurry is the best option for tailings disposal at the Yellowknife Gold Project.

8.0 CLOSURE

We trust that this report meets your requirements at this time. If you have any additional questions, please do not hesitate to contact the undersigned.

GOLDER ASSOCIATES LTD.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 049
GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED AND SEALED

Ben Wickland, Ph.D., P.Eng. (BC, NWT/NU)
Geotechnical Engineer

ORIGINAL SIGNED

John Hull, P.Eng. (BC, NWT/NU, YT)
Principal

BEW/JAH/ja/rs/aw

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REFERENCES

Environment Canada. 2000. Terrestrial Ecozones and Ecoregions of Canada. Website address: www.ec.gc.ca/soer-ree/English/Framework/NarDesc/taishdwe.cfm.

Environment Canada Climate Data and Information Archive. Website address: http://www.climate.weatheroffice.ec.gc.ca/climateData/canada_e.html.

European Commission. 2004. Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities. July.

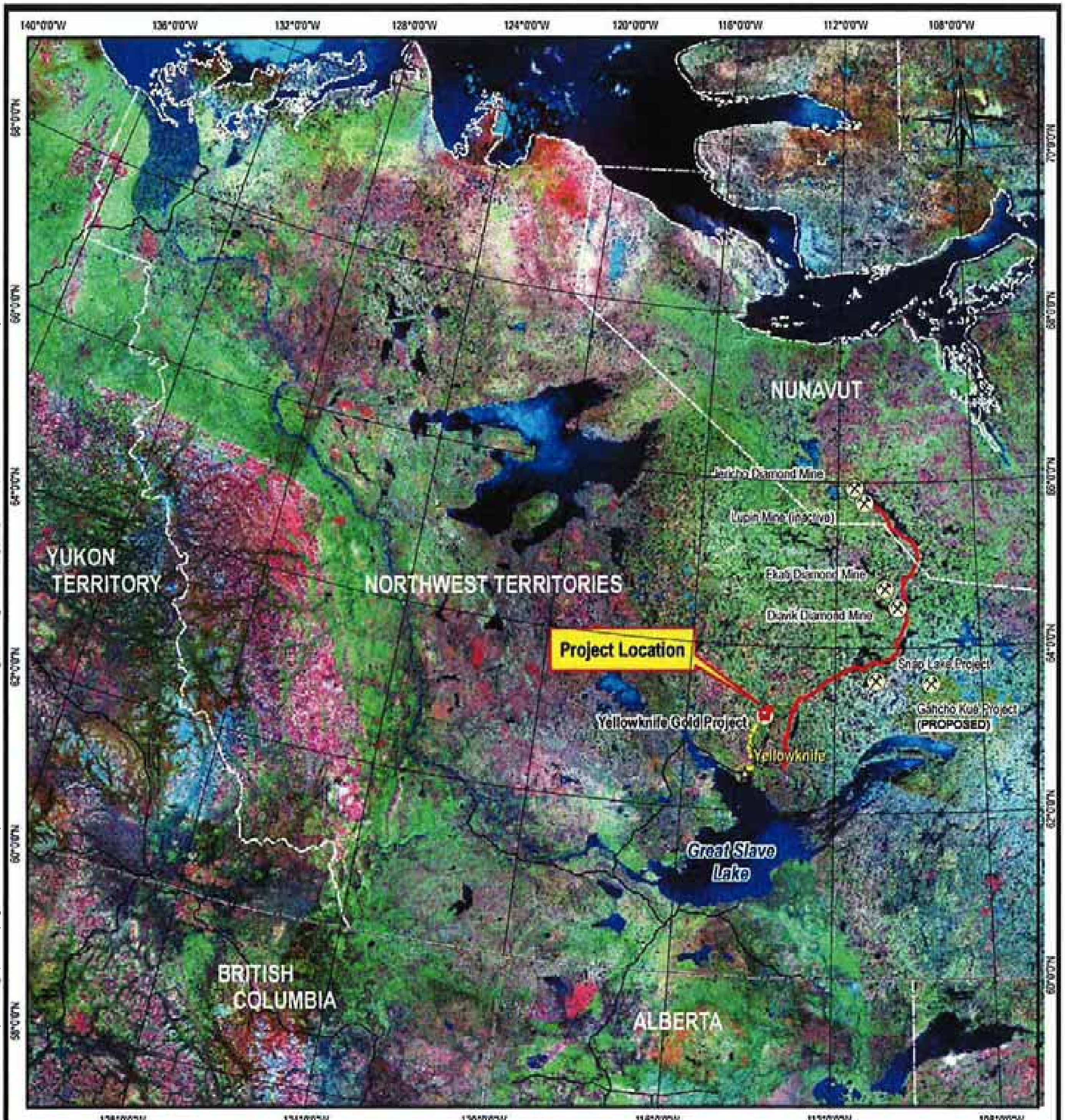
Golder 2011. Draft Report on Geochemical Characterization Geochemical Characterization of Ormsby and Nicholas Lake Waste Rock, Ore, and Tailings, Yellowknife Gold Project, NWT. April.

MESH Environmental Inc. 2009. Update to the Revised Acid Rock Drainage Monitoring and Contingency Plan Yellowknife Gold Project NWT Water License MV2002L2-0017. March.

National Building Code of Canada 2005 Seismic Hazard Assessment. Website address: http://earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index-eng.php.

Tyhee 2008. Tyhee NWT Corp Yellowknife Gold Project 2008 Project Description Report. July.

Wisleski, I. and A. Li. 2008. Innovative mine waste disposal in two distinctly different settings. Proceedings Tailings and Mine Waste '08. October 18-23. Vail Colorado.



0 75 150 225 300 375

SCALE IN KILOMETRES

LEGEND

- Local Study Area
- Existing Mine
- Winter Road to Ormsby
- Tibbitt to Contwoyto Winter Road

REFERENCE

Base map provided by Tyhee 2008.
Base data source:LandSat7 Canada

Tyhee NWT Corp

PROJECT

TYHEE NWT CORP
YELLOWKNIFE GOLD PROJECT
NORTHWEST TERRITORIES

TITLE

PROJECT LOCATION

Golder Associates
Greater Vancouver Office, BC

PROJECT No. 09-1373-1009		
DESIGN	BW	10NOV09
CADD	SRR	13NOV09
CHECK	BW	11APR11
REVIEW	JAH	11APR11

PHASE No. 3000
SCALE AS SHOWN REV. 0

FIGURE 1.1

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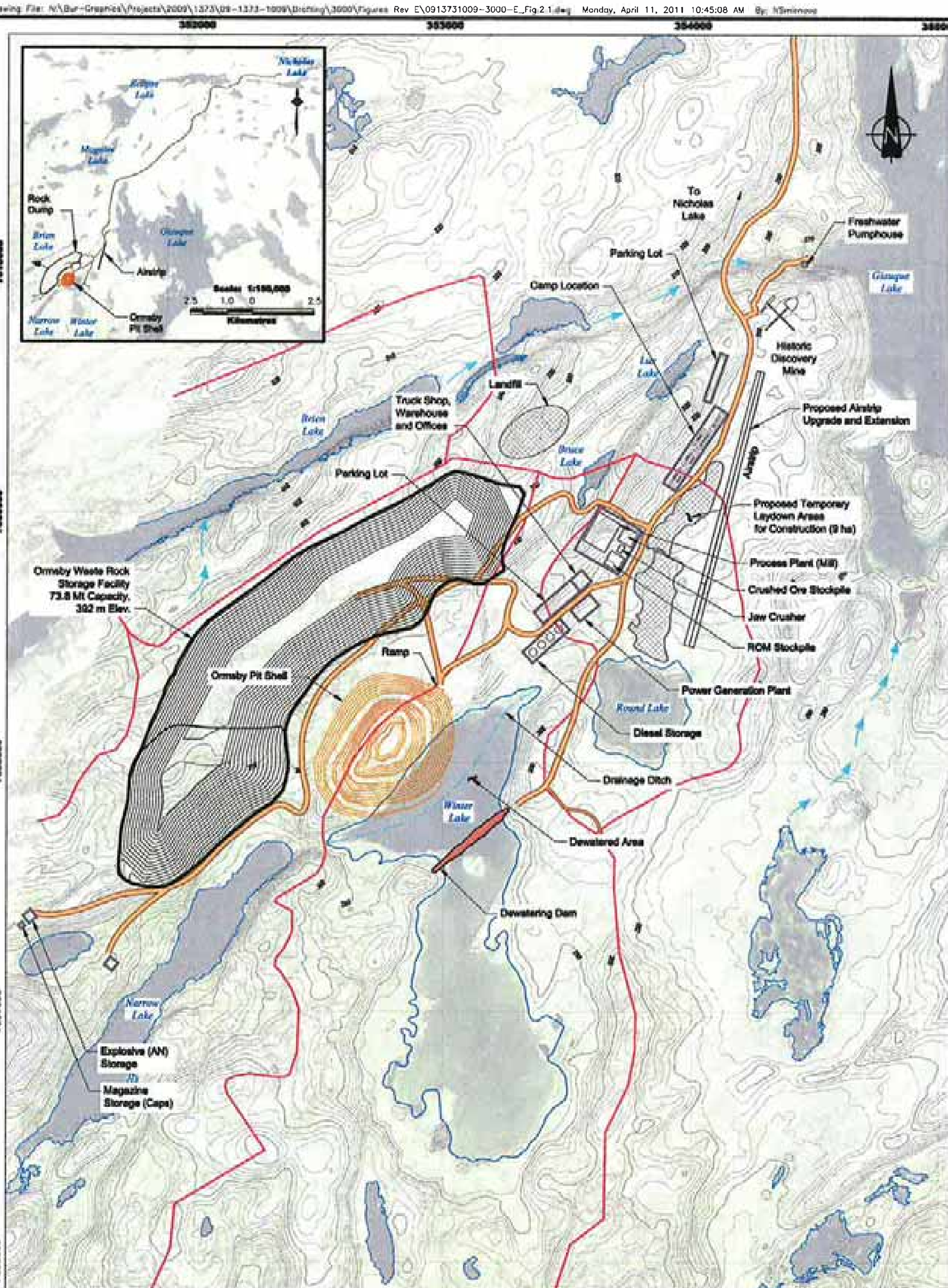

LEGEND

WATERSHED BOUNDARY

0 150 300 450 600 750

SCALE 1:15,000 METRES

NOTES

1. BASE MAPPING FROM WATTS, GRIFFIS AND MCOUAT (DRAWING FILE TDC_07_BASE_INFRASTRUCTURE.DWG)
2. BACKGROUND IMAGERY FROM IKONOS (JULY 27 AND AUGUST 2, 2004) AND LANDSAT TM (AUGUST 11, 2001)
3. EXTRA WATER FEATURES EXTRACTED FROM IKONOS IMAGERY
4. COORDINATES SYSTEM BASED ON NAD 83, UTM ZONE 12
5. TAILINGS IMPOUNDMENT AREA NOT SHOWN

REFERENCES

1. BASE PLAN PROVIDED BY "EBA ENGINEERING CONSULTANTS LTD". CAD FILE: V23201097.006_FIG 4.1-1_R1.dwg DATED: MARCH 14, 2011.

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YELLOWKNIFE GOLD PROJECT
NORTHWEST TERRITORIES

SITE LAYOUT PLAN

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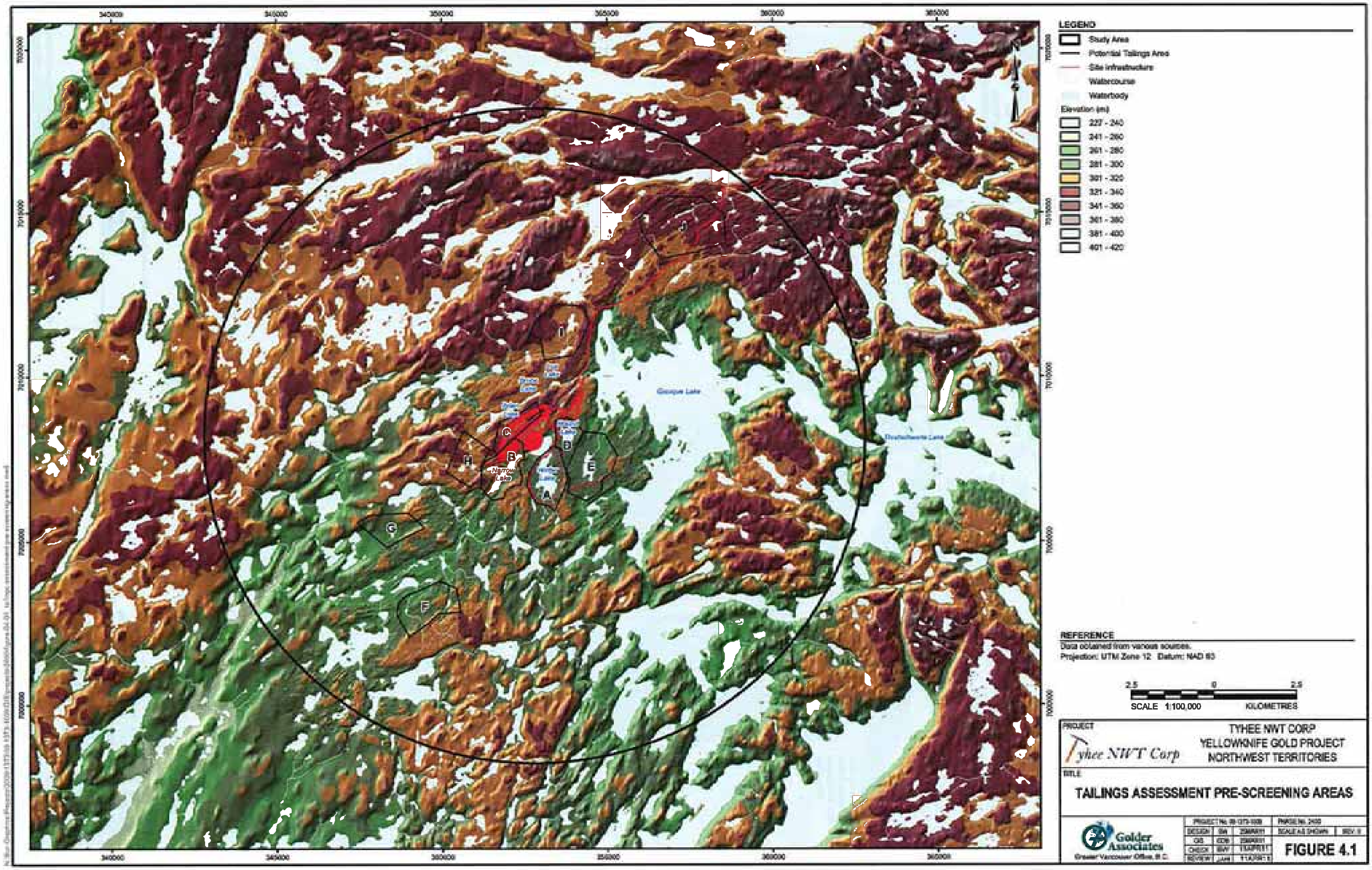
FIGURE 2.1



Gizzard Lake
LEGEND
Study Area
Potential Tailings Area
Site infrastructure
Watercourse
Waterbody
Elevation (m)
227 - 240
241 - 260
261 - 280
281 - 300
301 - 320
321 - 340
341 - 360
361 - 380
381 - 400
401 - 420
REFERENCE
Data obtained from various sources.
Projection: UTM Zone 12 Datum: NAD 83
SCALE 1:100,000
KILOMETRES
PROJECT
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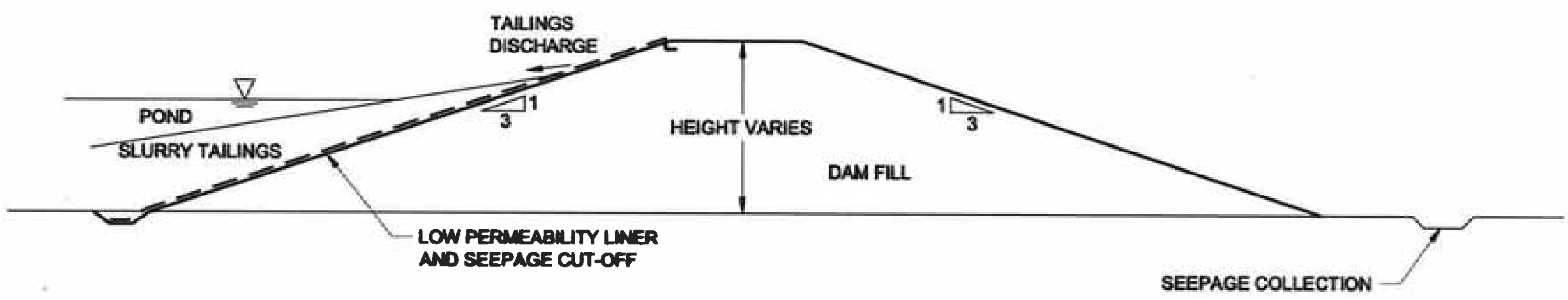
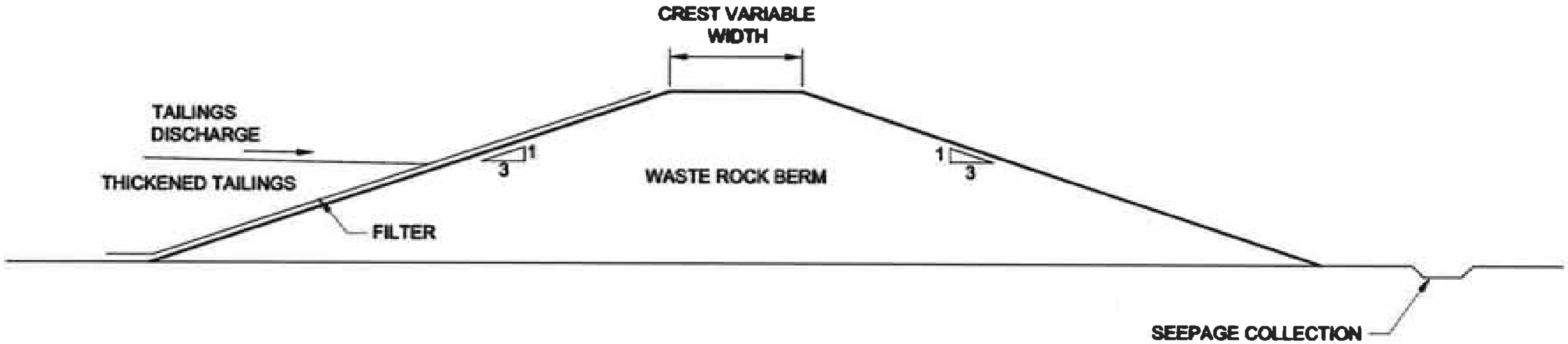
TYHEE NWT CORP
YELLOWKNIFE GOLD PROJECT
NORTHWEST TERRITORIES
TITLE
TAILINGS ASSESSMENT PRE-SCREENING AREAS
Golder Associates
FIGURE 4.1

Drawing File: N:\Bur-Graphics\Projects\2009\1373\09-1373-1009\Drafting\3000\Figures Rev E\0913731009-3000-E_Fig.4.2.dwg Monday, April 11, 2011 10:52:12 AM By: NSmirnova



TYPICAL TAILINGS DAM SECTION



CO-DISPOSAL CONCEPT SECTION

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PROJECT
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NORTHWEST TERRITORIES

TITLE
TYPICAL DAM SECTIONS

Golder Associates
Greater Vancouver Office, BC

PROJECT No. 09-1373-1009		
DESIGN	BW	29MAR11
CADD	SRR	29MAR11
CHECK	BW	11APR11
REVIEW	JAH	11APR11

PHASE No. 3000
SCALE AS SHOWN REV. 0

FIGURE 4.2

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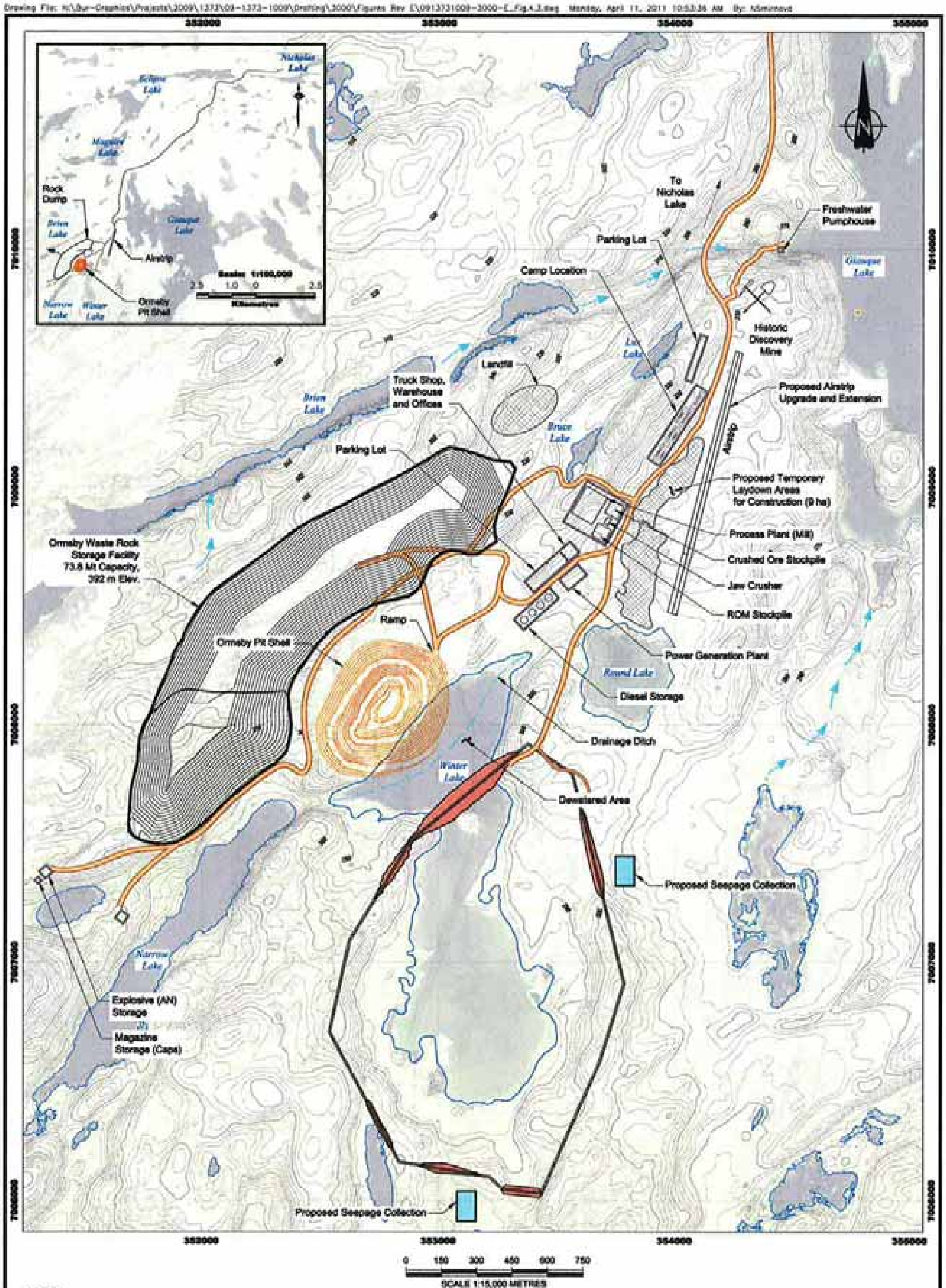

NOTES

1. BASE MAPPING FROM WATTS, GRIFFIS AND MCOUAT (DRAWING FILE TDC_07_BASE_INFRASTRUCTURE.DWG)
2. EXTRA WATER FEATURES EXTRACTED FROM IKONOS IMAGERY.
3. COORDINATES SYSTEM BASED ON NAD 83, UTM ZONE 12

REFERENCES

1. BASE PLAN PROVIDED BY "EBA ENGINEERING CONSULTANTS LTD", CAD FILE: V23201097.006_FIG 4.1-1_R1.dwg DATED: MARCH 14, 2011.

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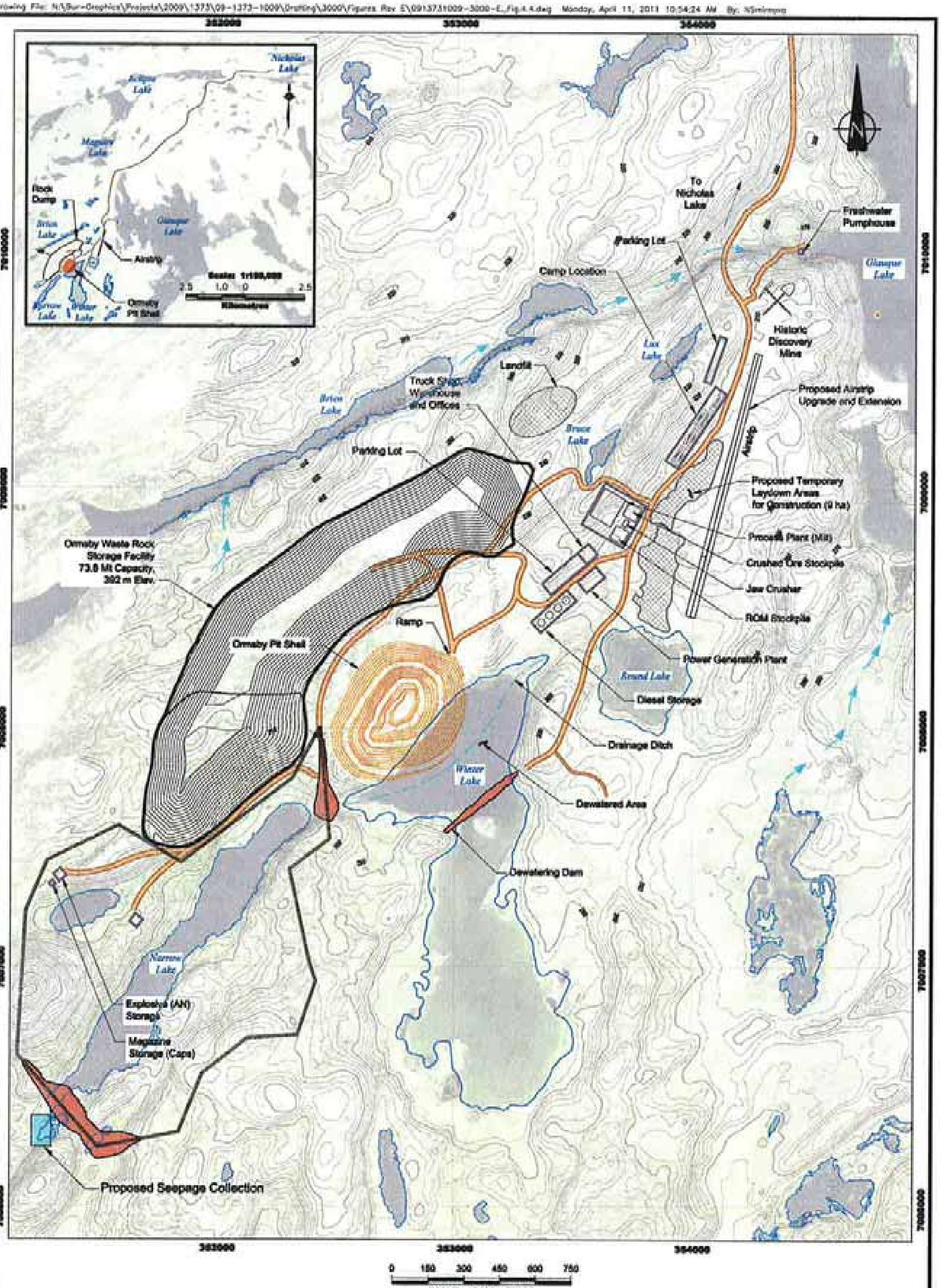
PROJECT
TYHEE NWT CORP
YELLOWKNIFE GOLD PROJECT
NORTHWEST TERRITORIES

TITLE
AREA A WINTER LAKE

Golder Associates

FIGURE 4.3



NOTES

1. BASE MAPPING FROM WATTS, GRIFFIS AND MCOUAT (DRAWING FILE TDC_07_BASE_INFRASTRUCTURE.DWG)
2. EXTRA WATER FEATURES EXTRACTED FROM IKONOS IMAGERY.
3. COORDINATES SYSTEM BASED ON NAD 83, UTM ZONE 12

REFERENCES

1. BASE PLAN PROVIDED BY "EBA ENGINEERING CONSULTANTS LTD". CAD FILE: V23201097.006_FIG 4.1-1_R1.dwg DATED: MARCH 14, 2011.

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NORTHWEST TERRITORIES

AREA B NARROW LAKE

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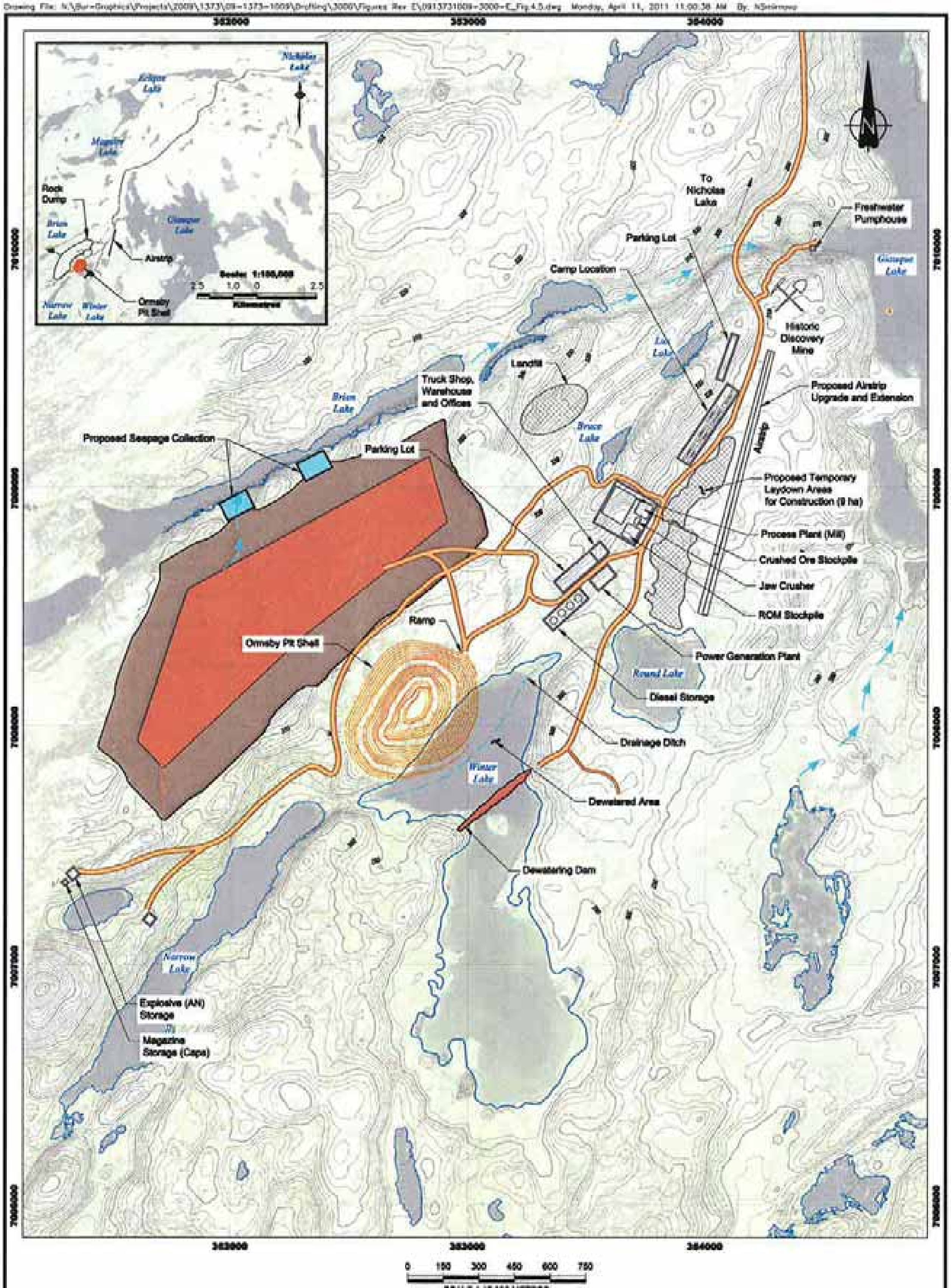
FIGURE 4.4



NOTES

1. BASE MAPPING FROM WATTS, GRIFFIS AND MCOUAT (DRAWING FILE TDC_07_BASE_INFRASTRUCTURE.DWG)
2. EXTRA WATER FEATURES EXTRACTED FROM IKONOS IMAGERY.
3. COORDINATES SYSTEM BASED ON NAD 83, UTM ZONE 12

REFERENCES

1. BASE PLAN PROVIDED BY "EBA ENGINEERING CONSULTANTS LTD". CAD FILE: V23201097.006_FIG 4.1-1_R1.dwg DATED: MARCH 14, 2011.

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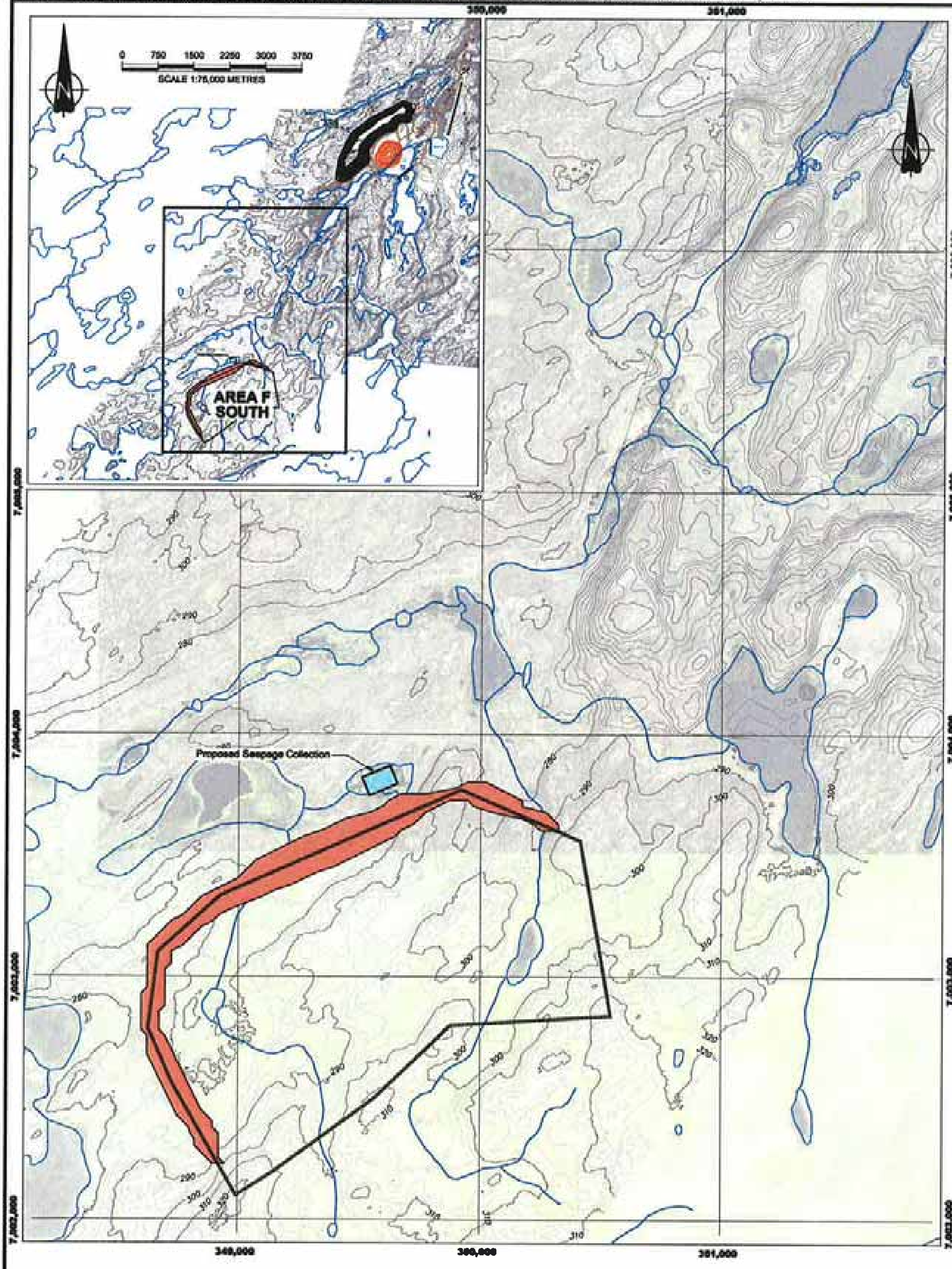
YELLOWKNIFE GOLD PROJECT
NORTHWEST TERRITORIES

AREA C ORMSBY

Golder Associates

FIGURE 4.5

Drawing File: N:\Bur-Graphics\Projects\2009\1373\09-1373-1009\Drafting\3000\Figures Rev E\0913731009-3000-E_Fig.4.6.dwg Monday, April 11, 2011 11:03:12 AM By: NSmirnova



NOTES

1. BASE MAPPING FROM 2010 LIDAR SURVEY
   DRAWING FILE: CONTOURS_LIDAR.DWG
   AND WATTS, GRIFFIS AND MCOUAT
   DRAWING FILE: TDC_07_BASE_INFRASTRUCTURE.DWG
2. EXTRA WATER FEATURES EXTRACTED FROM IKONOS IMAGERY
3. COORDINATES SYSTEM BASED ON NAD 83, UTM ZONE 12

REFERENCES

1. BASE PLAN PROVIDED BY "EBA ENGINEERING CONSULTANTS LTD".
   CAD FILE: V23201097.006_FIG 4.1-1_R1.dwg
   DATED: MARCH 14, 2011.

Tyhee NWT Corp

PROJECT
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YELLOWKNIFE GOLD PROJECT
NORTHWEST TERRITORIES

TITLE
AREA F SOUTH

Golder Associates
Greater Vancouver Office, BC

FIGURE 4.6

APPENDIX A

Climate and Hydrology Data

Detailed summaries of site climate and hydrology data are presented.

1.0 CLIMATE DATA

Temperature norms for the YGP site and for the Yellowknife Airport climate station are presented in Tables I-1 and I-2.

Table I-1: Summary of Yellowknife Gold Project Site Climate (Oct. 2004 – Dec. 2007)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Temperature (°C)													
Average Daily Maximum	-20.3	-17.9	-10.3	1.5	9.1	18.3	20.5	17	8.7	0.2	-11.8	-17.1	-0.2
Average Daily Minimum	-28.3	-26.5	-21.1	-9.4	-1.2	8.1	11.6	8.7	2.8	-4.9	-18.4	-24.2	-8.6
Daily Mean	-24.1	-22.1	-15.9	-4	4	13.3	16	12.7	5.5	-2.4	-14.8	-20.6	-4.4
Extreme Maximum	-3.2	-3.9	4.8	13.4	25.4	30.1	29	26.9	21.6	10.8	1	-2.7	30.1
Extreme Minimum	-42.8	-44.5	-38.7	-27.9	-13	-0.6	4.3	2.1	-7.2	-16.7	-38.3	-41	-44.5

Table I-2: Summary of Yellowknife Airport Climate (1942 – 2007)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Temperature (°C)													
Average Daily Maximum	-23.1	-19.6	-12	-0.7	9.7	17.7	20.9	18.1	10.3	1.3	-10	-19.2	-0.6
Average Daily Minimum	-31.4	-29.1	-23.7	-12.1	-0.4	8	12	10.1	3.7	-1.5	-17.7	-27.2	-9.1
Daily Mean	-27.3	-24.3	-17.8	-6.4	4.7	12.9	16.5	14.1	7	-4.2	-13.9	-23.2	-5.2
Extreme Maximum	3.4	6.2	9.3	20.3	26.1	30.3	32.5	30.9	26.1	19	7.8	2.8	32.5
Extreme Minimum	-51.1	-51.1	-43.3	-40.6	-22.8	-4.4	0.6	-0.6	-9.7	-28.9	-44.4	-48.3	-51.1

Source: Environment Canada Climate monthly data (July 1942 - December 2007)

Precipitation at YGP and the Yellowknife Airport climate station are presented in Tables I-3 to I-8.

Table I-3: Summary of Yellowknife Gold Project Site Precipitation (Oct. 2004 – Dec. 2007)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Precipitation (mm)	16.8	25	7.6	13.5	13.2	23.5	36.5	47.7	28.6	18.6	20.4	9.7	261.1
Extreme Daily Precipitation (mm)	11.2	18	2.8	10.4	4.8	29.5	21.1	17	21.6	5.3	17	6.6	N/A

Table I-4: Summary of Yellowknife Airport Precipitation (1942 - 2007)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Rainfall (mm)	0.1	0.02	0.08	2.1	13.4	21.8	36.1	39.6	28.5	12.6	0.5	0.1	154.9
Snowfall (cm)	17.2	15.9	15.6	9.6	3.8	0.1	-	0.02	3.1	20.4	30.9	22	138.6
Precipitation (mm)	14	12.7	12.7	10.6	17.2	22	36.1	39.6	31.8	31.4	23.7	17.3	269.1

Table I-5: Summary of Yellowknife Airport Extreme Daily Precipitation (1942 - 2007)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Extreme Daily Rainfall (mm)	2.8	0.8	3	14.4	34	33.6	66	82.8	29.7	35.6	7.1	2.2	82.8
Extreme Daily Snowfall (cm)	16.4	23.7	16.2	13	11.2	3	-	1	15.2	16	15	20.2	23.7
Extreme Daily Precipitation (cm)	14.2	17.5	12.4	14.4	34	33.6	33.6	82.8	29.7	35.6	12.2	11.4	82.8
Mean Month-End Snow Cover (cm)	46	51	47	6	-	-	-	-	10	15	31	37	N/A

Source: Environment Canada Climate daily data (July 1942 - December 2007)

Table I-6: Monthly Distribution of Precipitation, Rainfall, and Snowfall - Yellowknife Gold Project Site

Month	Precipitation (%)	Rainfall (%)	Snowfall (%)
January	7	0	12
February	9	0	12
March	3	0	11
April	5	1	7
May	5	9	3
June	8	14	0
July	15	23	0
August	19	26	0
September	10	18	2
October	7	8	14
November	8	0	22
December	4	0	16
Annual	100%	100%	100%

Table I-7: Comparison of Annual Mean Precipitation

	Yellowknife Gold Project Site Annual Precipitation (mm)	Yellowknife Airport Annual Precipitation (mm)
2005	316	389
2006	281	304
2007	169	310
3 - Year Mean	255	334
Correlation Ratio (%)	Project Site/Yellowknife Airport = 76	

Table I-8: Mean and Extreme Annual Precipitation

Yellowknife Airport Precipitation (mm)		Correlation Ratio (%)	Yellowknife Gold Project Site Precipitation (mm)	
Mean Annual	293	76	Mean Annual	222
10-Year Wet	379	76	10-Year Wet	288
10-Year Dry	210	76	10-Year Dry	160

Evaporation data for the site is summarized in Tables I-9 to I-11.

Table I-9: Annual Evaporation Totals - Yellowknife Gold Project Site

	Period of Record			Total Annual Evaporation	
	Start	Finish	# of Days	Total Pan (mm)	Total Lake (mm)
2005	May 26, 11:13	Sep. 13, 19:30	110.3	377	264
2006	June 9, 17.55	Sep. 21, 7:50	103.6	445	312
2007	June 2, 7:30	Sep. 15, 6.55	105	431	302
Average	-	-	106.3	419	293

Table I-10: Lake Evaporation and Monthly Distribution - Yellowknife Gold Project (2005 - 2007)

	Lake Evaporation (mm)					
	May	June	July	August	September	Annual
2005	24	96	64	67	13	264
2006	0	97	110	79	30	316
2007	0	110	113	63	16	302
Mean	8	1001	95	70	20	294
Distribution (%)	3	34	32	24	7	100

Table I-11: Average Daily Evaporation Rates - Yellowknife Gold Project

	2005					2006				2007			
	*May	Jun.	Jul.	Aug.	*Sep.	Jun.	Jul.	Aug.	*Sep.	Jun.	Jul.	Aug.	*Sep.
Pan Evaporation Rate (mm/day)	7	4.5	3.5	3.6	1.6	7.3	5.1	3.6	2.1	6	5.2	2.7	1.7
Lake Evaporation Rate (mm/day)	4.9	3.2	2.5	2.5	1.1	5.1	3.5	2.5	1.5	4.2	3.6	1.9	1.2

Note: A factor of 0.7 has been used to convert pan evaporation to lake evaporation

* May 2005 data based on a period of record of 5 days

* Sep. 2005 data based on a period of record of 13 days

* Sep. 2006 data based on a period of record of 21 days

* Sep. 2007 data based on a period of record of 15 days

2.0 HYDROLOGY TABLES

Basin characteristics and flow data are presented in Tables I-12 to I-15.

Table I-12: Summary of Hydrometric Station General Basin Characteristics

Gauging Station Site ID	Basin Name	*Length (m)	*Width (m)	*Drainage Area (m^2)	Approx. Lake Elevation (m)	Maximum Basin Elevation (m)
Combined Basins						
Site 3+4	Winter - Round Basin	4600	1700	5,500,000	N/A	330
Site 1+3+4	Narrow - Winter - Round Basin	4600	3400	9,300,000	N/A	350
Individual Basins						
Site 1	Narrow Basin	3900	1500	3,800,000	282	350
Site 3	Winter Basin	4300	1400	4,300,000	285	330
Site 4	Round Basin	1800	800	1,200,000	288	330
Site 6	Nicholas Basin	6000	2000	6,280,000	235	370

* Note basin areas, lengths and widths are determined only up to the location of the gauging station

Table I-13: Round Lake Outlet Hydrometric Station Annual Discharge and Runoff Values

Site 4 - Round Lake Outlet (Round Lake Basins)					
Year	Period of Record		Total Station Volume (m^3)	Period Total Runoff (mm)	Average Station Flow (L/s)
	Start	Finish			
2005	Jul 18, 09:32	Sep 12, 09:32	17,768	14.8	3.7
2006	Jun 09, 16:59	Sep 19, 09:15	47,431	39.5	4.7
2007	May 21, 09:30	Sep 28, 09:15	24,449	20.4	2.3

Table I-14: Winter Lake Outlet Hydrometric Station Annual Discharge and Runoff Values

Site 3 - Winter Lake Outlet (Winter + Narrow Lake Basins)					
Year	Period of Record		Total Station Volume (m^3)	Period Total Runoff (mm)	Average Station Flow (L/s)
	Start	Finish			
2005	Jul 14, 14:26	Sep 12, 10:26	82,937	15.1	16.0
2006	Jun 09, 11:10	Sep 19, 13:40	140,052	25.5	15.9
2007	May 21, 09:30	Sep 28, 09:15	155,047	28.2	14.5

Table I-15: Narrow Lake Outlet Hydrometric Station Annual Discharge and Runoff Values

Site 1 - Narrow Lake Outlet (Round + Winter + Narrow Lake Basins)					
Year	Period of Record		Total Station Volume (m^3)	Period Total Runoff (mm)	Average Station Flow (L/s)
	Start	Finish			
2005	May 22, 11:11	Sep 12, 14:59	754014	81.1	77.1
2006	Jun 09, 09:27	Sep 19, 14:12	328611	35.3	37.2
2007	May 21, 09:30	Sep 28, 09:15	302184	38.7	26.8

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Africa	+ 27 11 254 4800
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Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
500 - 4260 Still Creek Drive
Burnaby, British Columbia, V5C 6C6
Canada
T: +1 (604) 296 4200

Golder Associates