APPENDIX D TAILINGS STORAGE FACILITY

PROJECT N^{O}: 141-12598-00

Tailings Storage Facility Alternatives Assessment

GOLIATH PROJECT

Treasury Metals Incorporated

141-12598-00

Report 1, Rev. 0

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1 INTRODUCTION

1.1 GENERAL

Treasury Metals Incorporated (TM) owns mining rights to the Goliath Project (Project) and is in the process of completing preliminary engineering assessments for the site. The Goliath Project site is located adjacent to the village of Wabigoon, Ontario, approximately 20 km east of Dryden, Ontario and is approximately 330 km west of the city of Thunder Bay, Ontario. The geodetic coordinates of the proposed Project are approximately centered on 49°45’25” N by 92°36’30” W and the Project Site Location and Key Plan is shown on Figure 1.1. The Goliath site contains gold and silver deposits and consists of 137 unpatented mining claims and 20 patented mining claims within an area of 4,064 hectares. The site is located partially within both the Hartman and Zealand townships and includes a total area of approximately 4,976 hectares. The general elevation is approximately 400 metres above sea level (masl), has an average annual temperature of 2.1°C and experiences 0.7 metres of precipitation annually with approximately 24% of the annual total falling as snow.

The site is currently accessible year round from Highway 17 and multiple public secondary roads that extend north from Hwy 17 consisting of Anderson Road, Maggrah Road and Tree Nursery Road. Power supplies are close to the site and there is a natural gas pipeline proximal to the site.

The November 2011 National Instrument 43-101 (NI 43-101) Mineral Resource report by A.C.A. Howe indicates an approximate resource of 1.6 million ounces of gold including an additional 5 million ounce silver by-product resource. Future drilling is planned for the site that could identify additional resources that would be available to be mined.

1.2 BACKGROUND INFORMATION

The Goliath site will be a new development as the area has no historic mining activities completed to date. The site was previously used by the Ministry of Natural Resources (MNR) as a tree nursery and the existing infrastructure at the site consists primarily of buildings that were used for the tree nursery.

Limited documentation is available prior to 1989 for site exploration activities. Work done by Teck Exploration (now Teck Resources) after 1989 identified a poorly exposed, broad area of weak mineralisation and anomalous gold extending through parts of lots 3 through 8 of

Concession IV of Zealand Township. Site exploration commenced in 1990 and concluded in 1998 that consisted of approximately 78,000 metres of diamond drilling, after which the project was suspended. A bulk sample of 2,375 tonnes was collected in 1998 from an underground drift at a depth of approximately 250 m accessed from an underground ramp that runs north into the main zone of the ore body and splits off in the east-west direction (on strike) for approximately 100-150 metres in either direction. The portal to the underground ramp was closed as per a closure plan by Teck in 1998.

The current Project site primarily consists of two historic properties consisting of the Thunder Lake Property, previously owned by Teck-Corona, and the Laramide Property. TM obtained the mining rights to the site in 2008 and since that time has been active at the site completing site exploration activities. Site exploration is currently on-going, at the time of this report, which includes in-fill and condemnation drilling activities.

Operations for the Project will consist of an onsite crusher, mill and processing plant, ore stockpile, warehouse and other office buildings. Mining activities will consist of an open pit followed by an underground operation. The open pit can be used for storage of mine waste rock once underground mining activities commence. Mine waste, consisting of waste rock and tailings will be stored on-site. The processing is anticipated to consist of 2,700 dry tonnes per day (dtpd) throughput over the mine life which is currently estimated at 12 years.

TM completed a Project Description Report (PD Report) entitled “Project Description – Goliath Gold Project, Treasury Metals Incorporated” dated November 26, 2012. The PD Report was submitted to the Canadian Environmental Assessment Agency (EAA) and the Ministry of Northern Development and Mines (MNDM) for consideration.

1.3 PROJECT SCOPE OF WORK

TM is in the process of completing the Environmental Impact Statement (EIS) for the Goliath Project Site. An Alternatives Assessment for the tailings storage location and deposition technology has been identified for completion to support the EIS. The scope of work identified for this project consists of completion of the Alternatives Assessment and identification of the preferred location for tailings storage and the deposition technology. This report presents a comprehensive summary of the work undertaken to complete the Alternatives Assessment and the identification of the preferred alternative. The information presented in this report will be included with the EIS for the project.

2 SITE CHARACTERISTICS

2.1 SITE LOCATION

The Goliath property is located approximately 20 km east of the city Dryden, Ontario, adjacent to the village of Wabigoon, which is approximately 330 km west of the city of Thunder Bay, Ontario. The property is located within the Arctic Watershed for general global site runoff and specifically within the Wabigoon River Watershed. The area has moderate to flat topography with elevations ranging from approximately 360 masl to 500 masl. The area has been generally identified as having hardwood boreal forests consisting of black spruce, white spruce, balsam fir, jack pine and tamarack and incudes an abundance of wetlands including bogs, fens and marshes. A plan showing the existing conditions of Project Site is provided as Figure 2.1.

Access to the site is from Highway 17 and multiple public secondary roads that extend north from Hwy 17 consisting of Anderson Road, Maggrah Road and Tree Nursery Road. Road travel is accessible year round with snow clearing completed on the municipal roads by the City of Dryden and the mining roads maintenance including snow clearing being the responsibility of TM.

Dryden is a community of more than 7,000 people and has services such as an airstrip, a hospital, schools, restaurants, grocery stores and hotels. Dryden is primarily accessible from the west and east via Highway 17, from the North via Hwy 72 and from the South via 594.

2.2 HABITAT AND LAND USE

Previous studies and a field programs completed during the 2010-2011 field season were used by TM to identify the local habitat. A total of 20 mammal species were previously identified that included moose, white-tailed deer, black bear, grey wolf, and small furbearers. A total of 120 bird species were previously observed with 101 of those known to nest, or suspected to nest in the area. A total of seven species of amphibians were observed, and five were previously recorded during the 2011 field season that was limited to one toad, three tree frogs, two true frogs and one mole salamander. The tetraploid gray tree frog and eastern American toad were observed in most of the suitable habitats. Two (2) reptile species, the western painted turtle and the eastern garter snake, were observed during the 2011 field program. Four (4) species of butterflies and eighteen species of dragonflies and damselflies (Odonates) have been observed in the study area. Two of the species, the Pronghorn Clubtail and Horned Clubtail are provincially rare.

The surrounding area of the Goliath Project site has a varied land use. The project site is located in close proximity to the village of Wabigoon and the city of Dryden. Snowmobiling, hunting, fishing and camping are popular recreational activities in the area, and both forestry and the pulp industries have played a large part in the local economy.

2.3 GEOLOGICAL SETTING

The Goliath Project site is situated within the volcano-plutonic Eagle-Wabigoon-Manitou Greenstone belt in the Wabigoon Subprovince, just north of the large-scale regional Wabigoon fault. This Subprovince is part of the Archean Superior Province and located in northwestern, Ontario. The greenstone belt is 150 kilometres wide, with an exposed strike length of 700 kilometres. The Wabigoon fault is a large-scale regional structure that is separated into a northern and southern domain. The northern domain generally consists of southward-facing panels of alternating metavolcanic and metasedimentary rocks. North of the Wabigoon fault the geology primarily consists of metasedimentary rocks that are assumed to be predominant. The southern domain is generally composed of northward-facing, volcanic rocks. The Wabigoon fault is observed at surface just north of the village of Wabigoon.

The majority of the project area is underlain by the Thunder Lake Assemblage, an upper greenschist to lower amphibolite metamorphic grade volcanogenic-sedimentary complex of felsic metavolcanic rocks and clastic metasedimentary rocks. The assemblage comprises quartz-porphyritic felsic to intermediate metavolcanic rocks represented by biotite gneiss, mica schist, quartz-porphyritic mica schist, a variety of metasedimentary rocks and minor amphibolites. Compositional layering is present in metasedimentary rocks strikes ~70° to 90° and dips from 70° to 80° south to southeast. The Thunder River Mafic Metavolcanic rocks underlie the south part of the Property. The mafic rocks are generally massive flows but are pillowed locally and include amphibolite and mafic dykes, which are characterised as chlorite schists. Some rocks have been described as ultramafic in character. The regional geology and lithology is included as a Figure 2.2.

2.4 SURFICIAL MATERIALS

The surficial geotechnical materials at the Goliath site generally consist of outwash plain, valley terrain, Glaciolacustrine plain, organic terrain, Kame, kame field, kame terrace, kame moraine and bedrock knobs. They occur in varying thickness depending on the topography in which they are deposited and the process by which they settled. The soils deposits are described as being clay or clayey, silt to silty, sands and also gravels and organic peat. A Ground Moraine located to the north of the project site is described as being predominantly till material. Relief at the site is low to moderate of undulating to rolling variety. Drainage is described as being predominantly dry with wet conditions in areas consisting of organic terrain.

A site investigation (SI) was completed in late March to early April, 2013 for the purpose of investigating the in situ soil conditions at the proposed plant site and potential TSF areas, consisting of Location 1 and Location 6. The information collected during the SI will be used to support the engineering design phase as the project is advanced. The factual soils information from the SI is provided as Appendix A.

2.5 CLIMATE CONDITIONS

The climate in the Dryden and Goliath project site area is characterized by moderately long, cold winters and shorter, warm summers typical of continental conditions. The area experiences a wide variation in temperature throughout the year. In winter months, the temperature can drop below -20°C for extended periods. In the summer, the maximum daily temperature may reach over 30°C for extended periods. The daily mean temperatures typically fall below freezing from November through March.

Two meteorological stations are close to the project site and are identified as “Dryden” and “Dryden A”. Review of Climate Normals for 1970 – 2000 for the Dryden A station indicates that precipitation in the region is characterized as moderate and is generally distributed throughout the year with some seasonal trends. However, the wettest months generally occur in the summer, from June to September. The average annual total precipitation at the Dryden A station based on Climate Normals (1971-2000) is 701 mm, with 536 mm falling as rain and 165 mm falling as water equivalent to snow. The Report “Goliath Gold Project Baseline Study – November 2010 to November 2011” by Klohn Crippen Berger, Ref. No. M09706A01, dated September 21, 2012 (Environmental Baseline Study) for the site assessed longer ranges of data for the Dryden A, Dryden Station as well as the Sioux Lookout A station. The results of the assessment for Dryden A station indicated values of 536 mm rainfall, 170 mm was water equivalent snow with a total precipitation of 706 mm. These values compare with the 1970-2000 Climate Normals and have therefore been adopted for this project. The Environmental Baseline report also identified daily average temperature ranges from -18.2 C in January to +18.5 C in July.

TM has installed a meteorological station at the site. The station became operational on July 18, 2012 and collects wind, precipitation, barometric and humidity data. Data from the meteorological station is anticipated to be utilized throughput the operations at the site.

Evaporation data is not collected at the local meteorological stations. The Environmental Baseline Report indicated that mean annual lake evaporation ranges from 500 mm to 600 mm. This result compares to the PD Report that indicted annual lake and pond evaporation estimated at the site for the year 2011 was in the range to 500 mm to 600 mm. Environment Canada recommended that (TML) use the EC lake evaporation data observed at Rawson Lake station (ID: 6036904, 49.65°N, 93.72°W), which is located approximately 80 km southwest of the project site. The total yearly evaporation identified at the Rawson Lake station is approximately 537 mm, which corresponds to the values presented in the Environmental Baseline Report. The monthly evaporation data from the Rawson Lake station is provided below.

Month	**Evaporation, (mm)**
May	115
June	123
July	127
Aug	109
Sept	63
Total	**537**

Extreme rainfall depths for the project were investigated to determine 24-hr storm depths for various return periods. The amount of rainfall for the various extreme rainfall return periods was calculated using the following equation (Hogg and Carr, 1985):

- $X(T) = X_m + K\ (m_{24})\ x\ S$, where:
- X = Total Rainfall for Event (mm)
- X_m = Mean Precipitation (mm)
- S = Standard Deviation (mm)
- T = Return Period (years)
- $K\ (m_{24})$ = Return Period Constant

Based on Figures D1 and D2 in the "Rainfall Frequency Atlas For Canada" (Hogg and Carr, 1985), the mean precipitation (X_m) and the standard deviation (S) for the Dryden Area have been taken to be 46 mm and 16 mm, respectively. The resultant storm depths are provided below:

Return Period (Years)	Storm Depth (mm)
2	43
10	67

25	79
50	87
100	96
200	105
1,000	125
PMP	320

The Environmental Baseline Study that was previously completed for the Goliath Project included an assessment of potential storm depth for various return periods as well as storm durations (i.e. 5-min, 1-hr, 12-hr, etc.), that also included the rainfall depth (storm depth) for the 24-hr storm. Selected resultant storm depths as presented in the Environmental Baseline Report are as per the following table:

Return Period (Years)	Storm Depth (mm)
2	44
10	62
25	90
50	101
100	113
200	-
1,000	-
PMP	-

Comparison of the Environmental Baseline study values shows a slight increase when compared to the storm depths resulting from the Hog and Carr method. Therefore the storm depths from the Environmental Baseline Study have been adopted for this project. However, storm depth for the 1:200, 1:1,000 and PMP were not provided in the Environmental Baseline Study and therefore storm depths from the Hogg and Car method have been adopted for these 24-hr return periods.

2.6 TOPOGRAPHY

Topography in the general area of the Goliath Property is described as having low slopes, rolling hills and is marked by a low occurrence of streams, ponds, and marsh lands. The approximate elevation of the proposed plant site is El. 395 masl and elevation differences within 20 km of the Goliath Site range from El. 360 to 500 masl. The highest elevations are found 9 km to the north and the lowest elevations at 17 km north-west of the Goliath Site. In the immediate area where infrastructure is planned topography is generally noted as increasing to the north and north-east and moderately to the south-east of the Goliath Site. Topography decreases to the west and south-west towards bodies of water identified as Thunder Lake to the west and Wabigoon Lake to the south-west.

2.7 SURFACE DRAINAGE

Surface water drainage in the area of the Goliath Site will generally occur in a West to South-west direction within two (2) main catchments and smaller sub-catchments. The main catchments route surface water runoff to the south-west towards Wabigoon Lake and to the west towards Thunder Lake. Several seasonal and permanent streams are present within sub-catchments that route surface water runoff to Wabigoon and Thunder Lake. The area of the proposed open pit mine and potential tailings storage locations are anticipated to be within areas of surface water runoff to Wabigoon Lake. The existing facilities at the Goliath Site, located to the north of the proposed open pit mine, are within surface water runoff areas that will be directed to Thunder Lake.

2.8 SEISMICITY

The project site is located within the Interior Platform Seismic Zone. This zone spans from the Cordilleran Deformation Front to the Eastern Northern Ontario region that begins east of Thunder Bay at 88°W longitude.

Seismicity within the interior platform is defined as a “Low” relative hazard region by Natural Resources Canada and is shown on Figure 2.3.

Seismic activity in this zone is very low, with the exception of an area in Southern Saskatchewan. The largest earthquake ever recorded in this area was a magnitude 5.5 event in 1909 near the Canadian-American border. Other than this small area, the entire Interior

Platform at the centre of the North American plate is a stable craton area, is the lowest Seismic Hazard Zone of Canada and is considered a seismically inactive zone.

The Geological Survey of Canada (GSC) publishes the seismic hazard model for Canada, most recently as the GSC Open File 5913 (2008) that forms the basis for Seismic Hazard Calculation. This 4th generation seismic hazard model is the basis for seismic design provisions in the 2005 National Building Code of Canada (NBCC). The 4th generation model included updated seismic source zones, magnitude-recurrence relations and ground motion attenuation relations. The 2005 code uses median ground motion on firm soils sites for a probability of exceedance of 2% in 50 years, with the ground motion being described by seismic hazard values for five parameters; spectral acceleration at 0.2, 0.5, 1.0 and 2.0 second period and peak acceleration (PA). The values of the five parameters are tabulated for more than 200,000 grid points over Canadian territory and surrounding areas. The four spectral parameters allow the construction of approximate uniform hazard spectra for all locations in Canada to provide improved earthquake resistant design.

For the central “stable” craton region of Canada, the ‘F’ model is used, as the source zone model. As this area has had too few earthquakes recorded to define reliable source zone and rates, the ‘F’ model is based on earthquake activity rates for three separate regions: central Canada, the portion of North America that is geologically similar to central Canada, and global regions that are geologically similar to central Canada. These regions have an overall activity rate that is a combined weighting of 0.2, 0.4 and 0.4 respectively. The ‘F’ model is the lowest level of ground motion for seismic design of buildings in Canada. However, although the seismic hazard and related seismicity levels are too low to allow for reliable estimation based on historical seismicity, international examples suggest that large (greater than Magnitude 6 Richter) can occur anywhere, however, the probability is extremely low (Johnston et al., 1994).

Consistent with current design philosophy for structures such as embankment dams, the Maximum Design Earthquake (MDE) will be selected to represent extreme earthquake loading conditions (ICOLD, 1995). Values of maximum ground acceleration and design earthquake magnitude will be determined for the MDE.

The appropriate design earthquake for the Goliath Site tailings dam can be selected on the basis of the Hazard Potential Classification (HPC) criteria taken from the CDA Guidelines (2007) and is discussed later in this report. The MDE for design purposes will be determined in accordance with the HPC as the design is advanced. Probabilistic seismic risk parameters were calculated for the site by the Canadian Geological Survey based on the NBCC and analyses of the earthquake data for the region are presented in Table 2.1.

2.9 EXISTING FACILITIES

The Goliath Project site was not been previously developed as a mining operation. There are existing buildings at the site that consist of the Tree Nursery Buildings. The existing facilities will be used as project management and mine administration offices as the project is advanced. New infrastructure is anticipated to consist of the mill, shop and administration offices to support the mining activities. There are existing roads that are currently used to access the site for the current operations, consisting of exploration drilling and environmental monitoring to support baseline data. An existing overhead utility power line is present at the site that diagonally crosses the site in a north-west direction. An existing gravel pit is present, outside of the TM property boundary, to the south near Anderson Road. A Figure showing the existing conditions site, including current property boundaries, is provided on Figure 2.1.

3 ALTERNATIVES ASSESSMENT - DESIGN PARAMETERS AND ASSUMPTIONS

3.1 GENERAL

Previous work and studies at the Goliath Project site have primarily been related to mining exploration and environmental baseline studies. As a result, design work related to tailings storage and management as well as ore processing, mine design and site water handling have been limited. Design work related to ore processing and mine designs are understood to be progressing in parallel to the tailings storage Alternatives Assessment and therefore limited information is available for inclusion with the assessment. Design parameters and assumptions have been developed to advance the Alternatives Assessment that are based on the information that is currently available, as well as previous experience with similar projects. The Alternatives Assessment includes different types of tailings disposal technologies that have required assumptions to advance their assessment. The design parameters are therefore preliminary and will need to be refined and/or confirmed, as well as the assumptions, as the project is advanced to subsequent levels of design. The subsequent levels of the design are understood to include the Feasibility and Detailed Design levels. The following is a summary of the design parameters and assumptions that have been adopted for the completion of the Alternatives Assessment.

3.2 PROCESSING

The following processing information has been provided for use in the Alternative Assessment. It has been used to determine total tailings volume that will require on land storage. The ore/tailings processing has also been used to identify water management requirements related to water flows directed to the tailings storage facility as well as water reclaim requirements for use in processing.

- Processing of 2,700 dry tonnes per day;
- Operations of 365 days per year for 12 years; and
- 11,826,000 total tonnes of dry tailings solids produced over the expected 12 year life of mine.

3.2.1 TAILINGS PARAMETERS AND VOLUMES

Laboratory testing to determine the potential in situ density of tailings solids has not been completed for the project at this stage and therefore assumptions have been made to estimate the total tailings volume to be stored within the on land tailings facility to complete the Alternatives Assessment. The assumptions of in situ density are based on current known parameters, published historic information as well as previous experience with similar projects. The following tailings parameters have been used to complete the Alternatives Assessment.

- Total tailings solids of 11,826,000 dry tonnes

- Tailings specific gravity of 2.7 (provided by process design)

- Conventional Tailings:
    - 43% solids content in tailings stream (provided by process design)
    - Estimated In situ dry density of 1.1 t/m^3
    - Tailings solids volume 10,750,909 m^3

- Thickened Tailings:
    - Estimated 65% solids content in Tailings Stream
    - Estimated In situ dry density of 1.4 t/m^3
    - Tailings solids volume 8,447,143 m^3

- Dry Stack Tailings:
    - Assumed Moisture Content 15%
    - Estimated dry density 1.6 t/m^3
    - Tailings solids volume 7,391,250 m^3

Co-Disposal of Tailings into the Mine Workings will consist of initial disposal in the tailings facility during the initial years of operations followed by removal of percentage of the tailings solids from the stream. The portion of the tailings removed will be used as paste backfill in the underground mine workings. This concept assumes that disposal of tailings solids into underground mine workings can occur after Year 5 of operations and that an assumed 40% can be removed from the tailings stream (directed to the on land tailings facility after Year 5) and directed to the underground mine workings. Tailings solids directed to the underground mine are assumed to be thickened to a paste prior to being routed back to the underground mine workings. Total tailings requiring storage on-land with 40% removal after Year 5 is 8,243,000 m^3.

The tailings solids have been assumed to be Potential Acid Generating (PAG), based on the Draft Report “Geochemical Evaluation of the Goliath Gold Project” by EcoMatrix Inc., Ref. No. 12-1938 dated September, 2013. The results of the Draft Report indicated that tailings materials should be treated as PAG. Water in the tailings stream is anticipated to be generally inert (based on preliminary indications from processing design)

3.3 DAM CROSS-SECTION AND MATERIALS

Several potential tailings storage locations and tailings technologies will be assessed as part of the Alternatives Assessment and therefore preliminary assumptions have been established to develop preliminary construction material volume estimates related to embankment construction. The assumptions are preliminary at this stage of the project and can be optimized as the project is advanced to subsequent levels of design when additional information is available related to the sub-surface soil conditions at the site as well as material parameters of potential fill materials and volumes. The preliminary estimate of materials and volumes has been developed in order to estimate costs as inputs to the Alternatives Assessment. Similar assumptions have been applied to the impoundments at all locations for the purpose of maintaining consistency in completing of the Alternatives Assessment. It is anticipated that the assumptions adopted for the completion of the Alternatives Assessment will be confirmed and optimised as the project is advanced during subsequent levels of design. The following assumptions have been adopted for the dam cross sections and potential fill materials to complete the Alternatives Assessment.

- Dams required for tailings containment (based on tailings technology) will be initially established with a starter dam for 4 years of operations utilizing local borrow materials and/or from materials from local pits.

- Raising of the dams post Year 4 can be completed with NAG mine waste rock and has been conservatively assigned as a downstream raise. This assumption will be dependent on the results of the mine design and planning, sufficient availability of mine waste rock and also TM ability to effectively sort NAG and PAG rock at the source.

- The style of dam raise will be dependent on the foundation conditions that will be determined as the project is advanced.

- Basin areas in locations anticipated to consist of low permeable materials (i.e. clay) can be constructed with low permeable soil embankments (clay) with graded internal geotechnical filters and that the basin area can use the in situ low permeable geotechnical materials to achieve containment.

- Basin areas in locations anticipated to consist of higher permeable sands and gravels will utilize engineered liner products for the basin and upstream embankments for containment.

- Embankment slopes:

  - Fine grained fill:
    - Upstream 2.5H:1V
    - Downstream 2.25H:1V
  - Downstream Mine Waste Rock – 1.5H:1V
  - Upstream Slopes with Liner – 3H:1V

- Foundation Parameters – Based on available Site Investigation data

- Construction fill materials consisting of low permeable clay have been assumed to be provided from borrow sources at the mine site. The proposed open pit mine area has clay overburden that will require stripping in preparation for mining activities that may be used in the construction of the impoundment dams.

- Fill materials for internal graded filters can be supplied from potential borrow sources at the mine site or alternatively from local gravel pits in the Dryden area.

- Fill materials to construct the proposed starter dam, for the initial years of operations, can be supplied form borrow sources at the site or alternatively form local gravel pits.

- Topsoil from basin and foundation preparation activities will be stockpiled on site for use in closure activities.

3.4 OPERATIONAL AND STORMWATER MANAGEMENT

Limited information related to the site water handling was available as input for the Alternatives Assessment and will become available as the project is advanced. The following inputs and assumptions have been adopted to complete the Alternatives Assessment.

- Water reclaim to plant for conventional tailings – 140 m^3/hr (provided by processing design);

- Mine dewatering that will be routed to the on land tailings storage facility can range from 540 m^3/day to 1,600 m^3/day. The larger mine dewatering rate has been utilized for the Alternatives Assessment to identify potential surplus water, for this stage of the project, that would be accumulated in the tailings area. A methodology to address the surplus water collected at the tailings area is ongoing and being developed by TM.

- Average precipitation that will be reporting to the on-land tailings facility is 706 mm per year with approximately 550 mm per year of evaporation.

Additional water inputs to the on land tailings facility may become apparent as the project is advanced and the water management design will incorporate these additional inputs, as required.

The following assumptions related to water management have been adopted to complete the Alternatives Assessment:

- Impoundments established for conventional tailings and thickened storage can be used for temporary storage of surplus water, if necessary. Yearly surplus water, after process reclaim, will be directed to a water treatment plant prior to release.

- Dry stack storage will require a secondary water collection pond for temporary storage of surplus water prior to being directed to treatment. The potential for utilizing a future secondary containment structure for water collection for thickened tailings disposal may be required and would be dependent on the use of a central tailings discharge. This would be determined as the project is advanced to subsequent levels of design. The Alternatives Assessment has been completed assuming a single impoundment for tailings and water storage with scoring reflecting the potential of utilizing a future secondary containment facility for water collection.

- All dam impoundments will be required to contain an Environmental Design Storm (EDS) resulting from the 1:1,000 yr, 24-hr storm event.

- All dam impoundments will include sufficient embankment heights to provide adequate normal and minimum freeboards.

- A water cover will be used for conventional tailings storage to minimise the potential for acid generation of the tailings solids.

- Dry stack tailings will require a foundation collection system to collect potential seepage water from the tailings to prevent ARD. Perimeter runoff collection ditching would also be used to collect surface water runoff form the storage area. Seepage and runoff water would be routed to a collection pond for containment and potential treatment.

- A perimeter seepage collection ditch with pump back system will be used to intercept seepage from the impoundment area and return it to the facility.

- All dam impoundments will include a spillway designed to accommodate the required Inflow Design Flood (IDF) based on the Hazard Classification Potential (HPC). The HPC has been estimated for each dam impoundment as part of the Alternatives Assessment. The HPC will be adopted for the water collection pond for the Dry Stack Option.

3.5 OPERATIONAL AND CAPITAL COSTS

Preliminary cost ranking has been completed, at a high level, to provide inputs for the purpose of completing the Alternatives Assessment based on the available design input parameters and assumptions outlined above. Cost estimating will be developed and optimized for the project once the design commences for the preferred alternative. Cost ranking for this stage of the project has been estimated to provide a direct comparison of economic account inputs for the Alternatives Assessment. Relative cost rankings were developed for construction, operation and closure, for each alternative advanced past the pre-screening step of the Alternatives Assessment. The cost rankings have been compared (at this stage of the project) on a relative scale and have been factored based on the lowest cost alternative (lowest anticipated cost assigned as 1 and other alternatives assigned a relative rank based cost increase). This allows for cost comparisons by ranking as economic inputs to be scored as part of the Alternatives Assessment process. The lowest anticipated cost was assigned the highest score (as being favourable) with the higher cost Alternatives assigned an incremental lower score to provide the required comparison for the assessment. The following assumptions have been adopted to estimate cost ranking for the Alternatives Assessment.

- Cost rankings for construction represent the anticipated final embankment stage and include allowances for contractor mobilization and demobilization, as a percentage of the construction costs, as well as inclusion of a construction contingency.

- Processing of conventional tailings was taken as the base case. Operational cost increases associated with the processing of thickened and dry stack tailings have been included with the operational costs for the individual tailings technology.

- Operational cost rankings associated with hauling dry stack tailings have been considered to include site and foundation preparation activities as well as the costs associated with establishing a secondary water collection pond.

- Closure cost rankings have been included associated with closure of the facilities. The closure concept consists of capping the tailings with clay and providing a soil water shedding cover.

The cost ranking for each Alternative is provided in the Alternatives Assessment, as discussed below in Section 4.0.

4 ALTERNATIVES ASSESSMENT

4.1 GENERAL

Assessment of potential alternatives for tailings storage and tailings disposal technology is required under Environment Canada’s Guidelines for the Assessment of Alternatives for Mine Waste Disposal (Environment Canada 2013) when potential alternative locations are within bodies of water or streams. This requires an assessment of mine waste disposal alternatives, and specifically an assessment of tailings deposition technology and tailings management facility locations.

All projects require an assessment of mine waste disposal alternatives if the Tailings Management Facility (TMF) or the Waste Rock Management Facility (WRMF) is placed in natural water bodies frequented by fish. If this is the case, the facilities are then designated as Tailings Impoundment Areas (TIA’s), as specified by Schedule 2 of the Metal Mining Effluents Regulations (MMER).

The alternatives assessment for the tailings management facility and the tailings disposal technology builds on previously issued documentation for the Project including:

- Goliath Gold Project Description (Treasury Metals Incorporated, December 2012);
- Metallurgy Test Work Technical Report (September, 2012);
- National Instrument 43-101 Preliminary Economic Analysis of the Goliath Gold Project (A.C.A. Howe International Limited, August 2012);
- Geochemical Evaluation of the Goliath Gold Project (EcoMetrix Incorporated, June 2013); and
- Technical Report and National Instrument 43-101 Preliminary Economic Assessment on the Goliath Gold Project (A.C.A. Howe International Limited, August 2010).

4.2 ASSESSMENT APPROACH

Environment Canada’s Guidelines for the Assessment of Alternatives for Mine Waste Disposal (Guidelines), has identified a seven step process, which is as follows:

- Step 1: Identify Candidate Alternatives
- Step 2: Pre-screening Assessment
- Step 3: Alternative Characterization
- Step 4: Multiple Accounts Ledger
- Step 5: Value-Based Decision Process
- Step 6: Sensitivity Analysis
- Step 7: Document Results

This process has been followed as several streams are present at the site so as to ensure that the location selected for the on-land tailings storage facility will have the least impact. The most suitable or preferred tailings alternative is selected from an environmental, technical and socio-economic perspective.

4.3 IDENTIFICATION OF CANDIDATE ALTERNATIVES

A total of seven (7) candidate locations for potential on-land tailings storage were selected for consideration in the Alternatives Assessment. The assessment also included potential tailings disposal technologies at each of the candidate locations. A potential dry location was included as Location 7, as recommended by the guidelines. The Goliath project area does have natural streams that are present at the site and care has been taken to avoid or minimise contact with streams for the placement of candidate alternative locations. On-land waste management facilities for mining operations can be relatively large to meet storage requirements. This area also has existing streams that would make it difficult if not impossible to identify consistent dry land candidate alternatives that would provide sufficient storage capacity while maintaining a stable and aesthetic impoundment area.   The degree of impact is evaluated in the assessment for each candidate alternative. A list of the candidate locations, tailings technologies and potential alternatives that were assessed are provided on Table 4.1.

Tailings deposition technology and locations are assessed together in order to determine mutual interactions and effects. A figure showing the locations of the alternatives is provided on Figure 4.1.

A set of threshold criteria has been established in order to determine the regional boundaries for selecting candidate alternatives. The threshold criteria were determined to include:

- Exclusion based on distance;
- Exclusion based on the presence of protected areas;
- Exclusion based on legal boundaries; and
- Exclusion based on corporate policy.

4.3.1 POTENTIAL TAILINGS MANAGEMENT FACILITY LOCATIONS

Seven (7) unique sites were identified within the site boundaries. The topography of all options is of a similar flat nature, and hence will require similar containment designs using perimeter embankments.

LOCATION 1 – NORTHEAST OF MINE SITE

This location has minimal fish habitat within the footprint and very little water flow. The water flow for the Blackwater Creek Tributary #2 has been determined to be seasonal, and only present during the spring. Topography is gently sloping towards the west. The process plant is less than 500 metres away and minimal access roads will be required for development and operation. This option for the tailings storage will ensure constant monitoring due to its close proximity to the plant, and the project access road (Tree Nursery Road). Fish habitat is present directly downstream of the proposed tailing storage area and any environmental spillage incident may be more complex to mitigate than other options.

LOCATION 2 – EAST OF MINE SITE

This location is located to the north and east of Location 1. Within the footprint of this location option, are the headwaters of tributaries of the Blackwater Creek and Hughes Creek. Both of these creeks drain into Wabigoon Lake. The topography is very rolling, with elevation changes of up to 40 metres. The process plant is located over 3 kilometers to the west, and significantly farther when travelling by on site road access. The only access to Location 2 is via a logging road, of unknown condition that runs north of the community of Wabigoon landfill site (closed) towards the southeast corner of Location 2. The east side of Location 2 has recently been harvested for logging purposes. This location has the largest footprint of all the options.

LOCATION 3 – FAR EAST OF MINE SITE

Location 3 is located on the far southeast of the TM property boundary and northeast of extents of Anderson Road. There are no known creeks, rivers or water bodies within the boundaries of the Location 3 Option. Topography is generally fairly flat, with the exception on the east side of the property, which is elevated in excess of 10 metres. Road access exists within 100 metres on the west side off Anderson Road. This option is slightly smaller than Location 2 with respect to area.

LOCATION 4 – SOUTHEAST CORNER OF NORMANS ROAD AND NURSERY ROAD

This alternative is similar to Location 1, in that the footprint has minimal fish habitat, little water flow, is also close to the process plant (about 500 metres), requires few roads to be built and has similar topography. Two headwaters for tributaries flowing into Blackwater Creek, and eventually to Wabigoon Lake, commence within the footprint of Location 4. This location has significant elevation changes and topography (in excess of 30 metres) and has rolling terrain. The site is within 200 meters of the frequently travelled Normans Road. Location 4 is not within the TM land position holdings.

LOCATION 5 – SOUTHEAST OF SITE AND NORTH OF POWER LINE

Location 5 has ideal topography for the site as it is a large flood plain with easy access from both Normans Road and Anderson Road. However, this option involves the destruction of fish habitat within the Hughes Creek System. This option widens the affected area and watershed impacts of the tailing storage, and substantially spreads out the project footprint. Location 5 requires a tailings pipeline in excess of 3,000 metres with associated road construction for monitoring purposes and corresponding increase in risk from other options due to monitoring and footprint. The topography is mostly flat, with sections around the exterior having hilly terrain. Portions of location 5 are not within the Goliath Project Property boundaries.

LOCATION 6 – SOUTH OF SITE

The sixth alternative is located adjacent to the site operations (<250 metres), and directly south of the open pit and Normans Road. This location has the smallest footprint area of the seven options. This location is bisected by a tributary of Blackwater Creek, with headwaters in the vicinity of the open pit. The terrain within this option is hilly with a ridge dissecting the footprint. Location 6 is directly south of Normans Road and adjacent to planned on site infrastructure.

LOCATION 7 – SOUTH OF ANDERSON ROAD

Location 7 is located south of Anderson Road. This location is in between two tributaries of Hughes Creek. The footprint of Location 7 is coincident with the surface projection of the Wabigoon Fault, of unknown geological and geotechnical characteristics. The mill and plant facilities are approximately 3 kilometers from the confines of this location. The topography is very hilly, with elevations changes in excess of 40 metres over the proposed site location. Location 7 is not on property currently owned by Treasury Metals.

4.3.2 POTENTIAL TAILINGS DISPOSAL TECHNOLOGIES

Four (4) different mine tailings waste disposal technologies were considered for use at the Goliath Gold Mine Project site. The four options consist of conventional slurry tailings, thickened tailings, filtered/dry stack tailings and co-disposal.

The various types of tailings waste disposal technologies are defined in the following sections.

CONVENTIONAL SLURRY TAILINGS

Conventional Slurry or hydraulic fill tailings are an un-thickened product of wet ore mineral processing and are transported via pipeline and deposited. Typical slurry solids content range from 5% to 50%, with the normal range between 20 to 40%. Slurry depositional systems can be via a single point discharge or at multiple locations (spigots) and can be discharged in the open air or sub-aqueous. The later method is utilized when the tailings have the potential to produce ‘Acid Rock Drainage or Metal Leachates” (ARD/ML). Water will continue to decant from the tailings over time and consolidation within the tailings will occur.

THICKENED TAILINGS

Thickened tailings are similar to conventional slurry tailings, except that they contain less water with a typical solids content of 60 to 80%. Thickened tailings involve the mechanical process of dewatering low solids concentrated slurry by using compression thickeners or a combination of thickeners and filter presses. The tailings are typically dewatered to form a homogenous non-segregated mass when depositing from the end of a pipe. Little solid/liquid separation results in less oxygen ingress which will reduce oxidations and subsequent acid generation from sulphur bearing tailings. In addition, water requirements for thickened tailings are smaller compared to conventional slurry tailings.

Paste tailings are thicker and denser than thickened tailings and have a chemical additive resulting in the elimination of bleed water and separation from the tailings. Paste tailings have an increased strength and subsequent slope within a tailings management facility resulting in a smaller footprint compared to conventional slurry methods. Potential slope angles of 1 to 3.5 degrees can be achieved to form a self-draining reclaimable shape.

Thickened tailings and paste tailings are transported via high pressure pipelines and positive displacement pumping systems.

FILTERED/DRY STACK TAILINGS

Filtered or dry stack tailings vary from the above-mentioned technologies as it does not require a pumped system to transport the tailings for deposition. Tailings are mechanically filtered using vacuum or high pressure filtration systems with chemical additives to dewater the tailings. Filtered tailings have a typical solids content of 50 to 70% and cannot be pumped. The water requirements for filtered tailings are the lowest of all methods. Tailings are deposited via conveyor or truck followed by spreading and compaction of the tailings to produce a dense stable arrangement. These systems are often cost prohibitive due to the increased capital costs of the filter systems and associated operating costs (electrical consumption, filters and transport costs). Containment structures are not required for tailings storage. These systems have a smaller associated footprint, but do require surface water and seepage management systems to ensure that contamination does not occur.

CONVENTIONAL SLURRY TAILINGS WITH FUTURE CO-DISPOSAL OF A PORTION OF TAILINGS INTO UNDERGROUND MINE WORKINGS

Co-disposal occurs when waste rock and tailings are disposed of within a single facility. Co-disposal methods vary widely and depending upon quantities and qualities of waste, physical arrangement, and degree of mixing. Co-disposal can occur in surface tailings impoundment areas, in underground voids or within a mined-out area of an open pit.

For the purposes of this analysis, conventional slurry tailings surface disposal following by future partial stream co-disposal of tailings and waste rock into the underground mine openings was considered as an alternative for this assessment.

4.4 DESCRIPTION OF ALTERNATIVES

For each of the alternative locations, some or all the disposal technologies were applied for this assessment. The co-disposal option was only assessed for Location 1 as this was determined to be the optimum location due to proximity to the open pit and underground operations while minimizing travel distance and environmental harm. This stage of the assessment is very high level and determination of specific depositional regimes and operating conditions were not detailed. Each of the locations, combined with the disposal technologies will be subjected to the next stage, the pre-screening assessment.

4.5 PRE-SCREENING ASSESSMENT

The purpose of the pre-screening assessment, as defined by the Guidelines, is to exclude alternatives that are "non-compliant", in that they do not meet the minimum specifications which have been developed for the project. The pre-screening process filters out alternatives that exhibit a fatal flaw, are non-compliance with regulatory requirements, or unable to achieve economic or environmental targets.

Pre-screening criteria were formulated such that only a simple "Yes" or "No" response to whether the alternative complies with the set criteria is required. The criteria that each alternative were subjected to are detailed below:

- **Criterion 1:** Would the tailings impoundment area sterilize a potential resource?
- **Criterion 2:** Is any part of the tailings disposal technology unproven at the proposed throughput?
- **Criterion 3:** Is any part of the tailings disposal technology unproven for the climate at the site?
- **Criterion 4:** Does the life-of-mine tailings production exceed the available storage of the alternative?
- **Criterion 5:** Does the disposal site exceed a practical distance from the mill?
- **Criterion 6:** Is the location topography favourable for the potential tailings deposition technology?
- **Criterion 7:** Does the increased cost of the alternative exceed a reasonable threshold for the viability of the project?
- **Criterion 8:** Does the alternative present an unacceptable environmental liability?

- **Criterion 9:** Does the alternative exceed the risk threshold for failure of engineering containment?

- **Criterion 10:** Does the footprint of the Alternative exceed the land holding currently held by Treasury Metals Incorporated?

- **Criterion 11:** Does the footprint of the Alternative occur above a geo-hazard, or a structural geological feature(s)?

Each candidate was screened based on each of the criteria detailed above. The criteria were structured such that a Yes response indicates that the alternative fails to pass one of the screening criteria and indicates a fatal flaw in the alternative, thus eliminating the alternative.

4.5.1 PRE-SCREENING ASSESSMENT RESULTS

The Pre-screening resulted in the elimination of 14 alternatives, resulting in a reduction of the possible alternatives from 22 to 8 as described below.

- Alternative 2C failed to pass screening Criterion 7 due to the excessive distance from the proposed mine site for transportation of dry stack tailings material.
- Alternatives 3A, 3B and 3C failed to pass screening Criterion 5 due to exceeding a practical distance from the mill for operational and cost purposes. In addition, option 3C does not meet Criterion 7 (economic viability) due to the excessive distance from the operational facilities.
- Alternatives 4A, 4B and 4C failed to pass screening Criterion 10 as the footprint of the proposed tailings impoundment area exceeds the land position currently held by Treasury Metals Inc.
- Alternatives 5A, 5B and 5C failed to pass screening Criteria 8 and 10. It was determined that location 5 presented an unacceptable environmental liability (wetlands, ponds and existing water courses within footprint). In addition, the footprint of option 5 extends beyond the property boundary of Treasury Metals. Option 5C also does not pass Criterion 5 and 7 (practical distance and economic viability) due to distance from the operating facility.
- Alternative 6B failed to pass screening Criterion 6 due to the extreme rolling topography of the area and the technical and operational difficulties resulting from paste deposition.
- Alternative 7 failed to pass screening Criterion 8 and 10. The footprint of location 7 is completely outside of the property boundary.
- Alternative 1A, 1B, 1C, 2A, 2B and 6A and 6C passed all screens and will be carried forward into the detailed multiple accounts analysis (MAA).

The following alternatives have been put forward for further MAA:

- Location 1 – Conventional Slurry Tailings
- Location 1 – Thickened Tailings (1A)
- Location 1 – Filtered/Dry Stack Tailings (1B)
- Location 1 – Co-disposal (1C)
- Location 2 – Conventional Slurry Tailings (2A)
- Location 2 – Thickened Tailings (2B)
- Location 6 – Conventional Slurry Tailings (6A)
- Location 6 – Co-disposal (6C)

A summary table of the Pre Screening Assessment has been provided as Table 4.2.

4.6 ALTERNATIVE CHARACTERIZATION

Additional detailed characterization and assessment is completed upon completion of the pre-screening assessment to further define the preferred alternative. A description of each of the alternatives is provided below as well as a description of accounts, sub accounts and indicators to which each alterative is assessed and is based on available information for the site.

4.6.1 DESCRIPTIONS OF SELECTED OPTIONS

Each of the selected tailings management options are further described below detailing construction considerations, operational considerations, water management features and other physical features.

LOCATION 1 – CONVENTIONAL SLURRY TAILINGS

Location 1 is located 400 metres to the northwest of the proposed operational facilities. Minimal road construction will be required as existing roads can be used for access and pipeline alignments. The approximate footprint area is 88 hectares. In terms of possible fish habitat, 3.7 ha of the Blackwater Creek may be impacted. No additional bodies of open water are directly impacted. Some diversion of excess water from seasonal runoff will be required.

This tailing storage facility will be a clay lined zoned earthfill dam and will be contained by an assumed natural clay basin with an internal drain system with a secondary downstream seepage and pump-back system. The remediation requirements for this option will be the most complex, requiring stabilization of slopes and surface water management.

LOCATION 1 – THICKENED TAILINGS

Location 1 is located directly to the northwest of the operational facilities within 400 metres. Minimal road construction will be required and existing roads can be primarily used for access and pipeline alignments. The approximate footprint area is 88 hectares. In terms of possible fish habitat, 3.7 ha of the Blackwater Creek may be impacted. No additional bodies of open water are directly impacted. Some diversion of excess water from seasonal runoff will be required.

The topography in this area is favourable for paste tailings. Local topography can be utilized to minimize dam embankments. A zoned earthfill dam with a low permeability clay liner or liner material has been conceptualized with the foundation material favourable for key-in. The dam can be raised during operations. A lower dam embankment height is required than for conventional slurry due to the greater density of the tailings. The tailings and water will be stored within a single containment facility.

LOCATION 1 – FILTERED/DRY STACK TAILINGS

Location 1 is located directly to the northwest of the operational facilities within 400 metres. Existing road infrastructure will be used to haul the dry tailings waste. The approximate footprint area is 100 hectares including the tailings storage facility and the water collection pond. In terms of possible fish habitat, 3.7 ha of the Blackwater Creek may be impacted. No additional bodies of open water are directly impacted. Some diversion of excess water from seasonal runoff will be required.

Tailings waste will be stockpiled on surface. Runoff will be collected by perimeter collection ditches and routed to a separate facility for containment and reclaim. Dust entrainment and emissions are very likely, especially during the summer months. With respect to remediation requirements, this alternative has the lowest complexity, as it only requires capping of the facility and provision of stable final surfaces to achieve closure.

LOCATION 1 – CO-DISPOSAL

Location 1 is located directly to the northwest of the operational facilities within 400 metres. Existing road infrastructure will be used to haul waste rock for co-disposal purposes and can also be used for pipeline alignment, although additional road infrastructure will be required for depositional and monitoring purposes. The approximate footprint area is estimated to be 88 hectares including the tailings storage facility and the water collection pond. In terms of possible fish habitat, 3.7 ha of the Blackwater Creek may be impacted. No additional bodies of open water are directly impacted. Some diversion of excess water from seasonal runoff will be required.

Tailings waste will be contained by the assumed natural clay basin and a clay lined dam with an internal drain system with secondary downstream seepage collection and a pump-back system. It is anticipated that local topography will be used to reduce embankment heights. It is anticipated that underground co-disposal will occur during the underground operational phase that will result in a decrease of tailings to be impounded on surface and subsequent lower height for the tailings impoundment structures. The water reclaim system has a low level of complexity, consisting of containment within facility and reclaim for processing with surplus water being directed to treatment. Closure will be highly complex, requiring facility closure, long term stability of embankments, potential grading of slopes, addressing remaining contained water within the facility and capping of the final tailings surface. This location is favourable to expansion for additional tailings storage through embankment raising.

LOCATION 2 – CONVENTIONAL SLURRY TAILINGS

Alternative 2A (Location 2 and conventional slurry tailings) is approximately 2,200 metres from the plant and will require development of access roads and pipeline alignments that will disturb existing land and vegetation. The footprint area of this option is 246 ha. New access routes also require crossing of existing streams and water features. Both Hughes Creek and Blackwater Creek may be permanently affected due to hydrological changes associated with dam and infrastructure development. It is estimated that 5.8 ha of stream habitat will be impacted by this option.

The tailings containment foundation conditions consist of sands and gravels, which are generally not suitable for basin containment. Local topography can be used to establish embankment layouts and sloping topography will assist with seepage collection. The dam has been conceptualized as a zoned earthfill with a low permeable clay layer or liner material. The location is not proximal to local borrow sources, mine waste rock and other supplied materials that will be required for construction. All tailings solids and water management will be contained within the perimeter embankments. Water will be reclaimed from the facility and will be supplied to the operations for use as process water while surplus will be treated and released. Closure is anticipated to consist of grading and capping tailings with a low permeable liner or clay material and vegetation to prevent water infiltration.

LOCATION 2 – THICKENED TAILINGS

Alternative 2B (Location 2 and thickened tailings) is approximately 2,200 metres from the plant and will require extensive development of access roads and pipeline alignments that will disturb existing land and vegetation. The footprint area of this option is 246 ha. Access routes will also require crossing of existing streams and water features. Both Hughes Creek and Blackwater Creek may be permanently affected due to hydrological changes associated with dam and infrastructure development. It is estimated that 5.8 ha of stream habitat will be impacted by this option.

The tailings will be stored in a zoned earthfill dam with a clay layer or liner system in the basin and dam structure with an internal drain system and secondary downstream seepage collection and pump-back system. Local topography can be used to establish embankment layouts. The dam can be raised during operations if required. The location is not adjacent to local borrow sources, mine waste rock and other supplied materials that will be required for construction. Tailings and water storage will be contained within a single containment facility with potential requirements for further containment for water management. Closure is anticipated to consist of grading and capping tailings with low permeable liner or clay material and vegetation to prevent water infiltration.

LOCATION 6 – CONVENTIONAL SLURRY TAILINGS

Alternative 6A (Location 6 and conventional slurry tailings) is located approximately 1.4 km from the process site and will require additional access roads and pipeline alignments to be constructed. The proposed storage facility is close to the open pit and may be visible from cottages around Thunder Lake. The footprint area of this option is 54 ha. A portion of the existing Tree Nursery Road can be used as part of the access road and pipeline alignment. It is likely that Blackwater Creek and approximately 3.3 ha of land position will be permanently affected due to hydrological changes associated with dam and infrastructure development. The area is thought to consist of clay and bedrock knobs. While this undulating topography can be used to establish perimeter embankments, bedrock may hinder establishment of perimeter ditches.

The dam would be designed as a zoned earthfill with a low permeable clay layer or liner. The rock foundation will require a complex and detailed design for the key-in or anchor for the basin liner. A higher dam hazard classification is anticipated due to proximity to Highway 17 and Wabigoon Lake. This location has a closer proximity to local borrow material, mine waste rock and externally supplied materials than Locations 1 and 2. The tailings solids and water management will be contained within perimeter embankments with water reclaim from the facility. Closure will require regrading of tailings and slopes, and capping the final tailings surface with a low permeable liner or clay and revegetation.

LOCATION 6 – DRY STACK TAILINGS

Alternative 6C (Location 6 and dry stack tailings) is located approximately 1.4 km from the process site and will require additional access roads, and subsequent truck traffic and tailings haulage. The footprint of this alternative is 60 ha including the tailings storage and water collection pond. The proposed storage facility is close to the open pit and may be visual from Thunder Lake communities. The dry stack technology is expected to result in increased dust generation. A portion of the existing Tree Nursery Road can be used as an access road. It is likely that Blackwater Creek and approximately 3.3 ha of land position will be permanently affected due to hydrological changes associated with tailings storage area infrastructure. The area is thought to consist of clay and bedrock knobs. While this undulating topography can be used to establish perimeter embankments, bedrock may hinder establishment of perimeter ditches.

The tailings will not be required to be contained within perimeter embankments. Tailings will be dewatered at the plant site, but will require collection and treatment of water runoff. A water collection pond would be included with the Dry Stack option to collect seepage and surface water runoff from the storage area as well as other surplus water from the operations. The undulating topography will require operational planning for tailings placement. Closure will require regrading to stabilize the tailings pile slopes for placement of cover material and subsequent revegetation. This location is less favorable to expansion due to local topography, property boundaries, local infrastructure and its proximity to the open pit.

4.7 ALTERNATIVE CHARACTERIZATION ASSESSMENT

The alternative characterization provides a detailed description of the alternatives to ensure that every aspect of an alternative is properly considered and to allow for direct comparison within the remaining alternative set.

The following site specific characterization criteria were developed for the Goliath Gold Project and are categorized into four categories, or “accounts” as defined by Environment Canada, that reflects the entire project life cycle. The four “accounts” are as follows:

- Environmental Account;
- Technical Account;
- Project Economic Account; and
- Socio-Economic Account.

The summaries for each of the accounts (from Environment Canada, Guidelines for the Assessment of Alternatives for Mine Waste, September, 2013) are as follows:

- **Environmental Account -** Characterizing the local and regional environment surrounding the proposed TIA. These include elements such as climate, geology, hydrology, hydrogeology, water quality and potential impacts on aquatic, terrestrial and bird life.

- **Technical Account -** Characterization of the engineered elements of each alternatives such as storage capacity, dam size and volume, diversion channel size and capacity, dumping techniques (if applicable), haul distances (if applicable), sedimentation and pollution control, dam requirements, tailings discharge methods, pipeline grades and routes, closure design, discharge and/or water treatment infrastructure and supporting infrastructure such as access roads.

- **Economic Account -** Characterizes the project life economics. All aspects of the Tailings Management Plan needs to be considered including investigation, design, construction (inclusive of borrow development and royalties where applicable), operation, closure, post closure care and maintenance, water management, associated infrastructure (including transport and deposition systems), compensation payments and land use or lease fees.

- **Socio-Economic Account** – Identifies how a proposed TIA may influence local and regional land users. Elements that are considered here include characterization and valuation of land use, cultural significance, presence of archaeological sites and employment and/or training opportunities.

Each of these subaccounts and indicators were assigned an indicator parameter by which the subaccount could be measured. The Alternative Characterization table is included as Table 4.3.

4.7.1 ENVIRONMENTAL ACCOUNT

The environmental account details a range of issues relating to direct and indirect impacts as a result of the development, construction, operation and closure of a given location and tailings disposal technology.

The environmental account has been subdivided into the following subaccounts with indicators detailed in brackets:

- **Land Use** (*distance from the mine site, pipeline and access road requirements and storage facility and associated infrastructure footprint*)

- **Water Impacts** (*number of watersheds affected, potential impact to surface water availability and potential impacts to water quality*)

- **Aquatic Habitat** (*permanent streams impacted, indirect impacts such as downstream reductions, direct impact to open water, and number of fish bearing lakes impacted*)

- **Terrestrial Habitat** (*area of feeding or shelter loss due to tailings storage facilities or associated structures and existing vegetation, and/or ecosystems that will be lost or impacted by operations*); and

- **Air Quality** (*potential for dust emission contributed by haulage, potential for dust emission contributed by tailings, potential for greenhouse gas emissions and noise emissions)*.

4.7.2 TECHNICAL ACCOUNT

The technical account details the technical advantages and disadvantages during the mine life including development, construction, operation, closure and post closure phases of a given location and tailings disposal technology.

The technical account has been subdivided into the following subaccounts with indicators detailed in brackets:

- **Design** (*foundation conditions, distance from plant, topographic complexity, topography, dam complexity, dam hazard potential classification, construction material availability, slope stability including height and slope angle, and number of watersheds);*
- **Operations** (*distance between storage facility and mill site, operational risks and other uncertainties, water treatment requirements)*;
- **Closure** (*remediation requirements, post closure water treatment requirements, post closure landform stability, post closure chemical stability);*
- **Capacity** (*tailings storage efficiency and tailings storage expansion capacity and probability*); and

- **Water management** (*sensitivity to climate variability, surface water control measures and seepage control measures).*

4.7.3 ECONOMIC ACCOUNT

The economic account and factors consider direct and indirect costs associated with the development of each of the alternatives.

The economic account has been subdivided into the following subaccounts with indicators detailed in brackets:

- **Life of Mine Costs** (*capital, operational, fish habitat compensation, closure and reclamation costs).*

4.7.4 SOCIO-ECONOMIC ACCOUNT

The socio-economic account serves to detail the social, cultural significance, land use and economic indicators of each of the alternatives assessed.

The socio-economic account has been subdivided into the following subaccounts with indicators detailed in brackets:

- **Archaeology** (*archaeological potential);*
- **Health and Safety** (*risk to human health, public safety and worker safety*);
- **Socio-Economic Indicators** (*economic benefits to regional communities, regional job creation and diversity, and indirect employment);*
- **First Nation Impacts** (*potential impacts to identified areas of Aboriginal Rights, extent of Traditional Land use detailed by number of persons and by activity type); and*
- **Recreational and Commercial Land Use** *(visual impact of storage facility, impact to navigable waters, extent of recreational land use and extent of commercial land use).*

4.8 MULTIPLE ACCOUNTS LEDGER FOR CANDIDATE ALTERNATIVES

A multiple accounts ledger was established to evaluate the eight alternatives to provide a basis for scoring and weighting. The multiple accounts ledger consists of the following two elements in accordance with the guidelines:

- Sub-accounts (evaluation criteria), and;
- Indicators (measurement criteria).

The summary table for the each of the sub-accounts within the multiple accounts ledger is provided on Table 4.4.

4.9 VALUE-BASED DECISION PROCESS

A value based decision process is applied for each of the site alternatives upon conclusion of providing the scoring matrix for each of the indicators and accounts. This process entails taking the list of accounts, sub-accounts and indicators and assessing the combined impacts for each of the alternatives under review. This entails scoring of all indicators and also weighting of all indicators, sub-account and accounts and quantitatively determining merit ratings for each alternative. There are three steps to this process (Scoring, Weighting and Quantitative Analysis), which are detailed in the following sections.

4.9.1 SCORING

The indicators determined in the previous step, are a qualitative or quantitative measurement of the impact (that is, a benefit or loss) associated with each alternative or sub-account and are required to be measureable. The multiple accounts ledger and the indicator quantity or quality was assessed.

Upon determination and definition of all of the indicators for the multiple accounts leger, quantitative scoring for each of the indicators has been developed, and as per the Guidelines, a six point scale has been used to address the range for all quantitative scoring. This provides sufficient capacity to differentiate between options.

Scoring is completed by developing a quantitative value scales for every indicator, including those that are easily measureable and assigning an indicator value (S) to each subaccount. The scoring criteria are summarized in Table 4.5.

4.9.2 WEIGHTING

The Value based decision process requires the ability to introduce a value bias between the individual indicators. This was completed by applying a weighting factor to each indicator. As recommended by the Guidelines, the weighting factors range from 1 through 6. An indicator with a weighting factor of 2 is twice as important as an indicator with a weighting factor of 1.

Weighting factors are constant for any given indicator, sub-account or account across all alternatives.

As recommended by the Guidelines, the alternatives assessment was completed using the following weightings factors (W) for accounts:

- Environment Accounts – 6
- Technical Accounts – 3
- Project Economics – 1.5
- Socio-Economic – 3

The weighting factors are summarized in Table 4.6.

4.9.3 QUANTITATIVE ANALYSIS

The Quantitative Analysis serves to determine an indicator merit score for each of the indicators. This is completed by determining the product of Indicator Value (S) developed in the scoring section and multiplying it by the Weighting Factor (W) determined in the weighting section. The formula for this is:

Indicator Value (**S**) x Weighting Factor (**W**) = **Indicator Merit Score**

Indicator Merit Scores were directly compared across alternatives, as were sub-account merit scores (Σ{S x W}) for the Environmental, Socio-Economic, Technical and Project Economics Accounts. In order to compare values of all sub-accounts, the scores were normalized to a six point scale. This was achieved by dividing the sub-account merit score by the sum of the weightings (ΣW) to yield a sub-account merit rating (R_s = (Σ{SxW}/{ΣW)ΣW). This normalization is required to balance out different numbers of indicators and sub-accounts for each account. The results of the Quantitative Analysis and summary table are detailed on Table 4.7.

The same procedure of weighting and normalization is followed to determine account merit scores (Σ{R_sxW}) and account merit ratings (R_a = Σ(R_s x W)/ΣW).

To complete the value-based decision process, an alternative merit score (Σ{R_a x W}), and an alternative merit rating (A = Σ(R_axW)/ΣW) was determined for each of the alternatives and the results are provided on Table 4.8.

The result of the Alternatives Assessment value-based decision process has selected Option 1D consisting of Candidate Location 1 with Co-disposal of tailings as the preferred option for tailings management at the Goliath site. The selection of Option 1D is based on the highest Alternative Merit score that considers all of the input Indicators for the Environmental, Technical, Economic and Socio-Economic Accounts for the project.

4.10 SENSITIVITY ANALYSIS

A sensitivity analysis is recommended for completion as part of the Alternatives Assessment. The sensitivity analysis is completed by adjusting the weightings that are assigned to sub-account and accounts to determine the range of variances within the alternatives and the sensitivity to the Indicator parameters. This part of the analysis is completed to eliminate bias and subjectivity. The sensitivity analysis utilizes the results of the Alternatives Assessment, presented above, with Option 1D as the Base Case with comparison to the scenarios developed to assess sensitivity. The following scenarios were analyzed as part of the sensitivity analysis:

- Scenario 1 – Adjust Weights of Environmental Account from 6 to 9
- Scenario 2 – Increase the Weighting factor for Technical input Indicators from 3 to 6
- Scenario 3 – Adjust all Weighs to 1 for all Accounts
- Scenario 4 – Reduce the Socio-Economic Weighting factors from 3 to 1.5

The results of the sensitivity analysis for the Scenarios presented above as well as the result of the Base Case are provided on Table 4.9. The results of the sensitivity analysis completed for each of the Scenarios presented above maintained the results of the Alternatives Assessment with Option 1D remaining the preferred alternative for tailings management at the Goliath site.

5 PREFERRED ALTERNATIVE

5.1 GENERAL

The results of the Alternatives Assessment and sensitivity analysis completed for the location and tailings disposal technology for the Goliath Site identified that Option 1D, consisting of conventional tailings disposal within Location 1 with future co-disposal of the tailings back into the underground mine workings as the preferred alternative.

Mining activities at the site will involve extraction of ore initially from an open pit mining operation followed by an underground mining operation. The open pit operation is anticipated to be in operation for four (4) years followed by the underground mining operations until the end of planned operations after 12 years. Ore processing will be carried out at the site with recommended disposal of tailings on-land and co-disposed on-land and into the underground mine workings after Year 5 of operations. It was estimated that 40% of the waste tailings solids were removed from the tailings stream and directed to the TSF will be thickened to a paste consistency and directed to the underground mine workings for disposal.

The objective of the Tailings Storage Facility (TSF) for the Goliath Project is to ensure protection of the environment during operations and in the long-term (after closure) and to achieve effective reclamation at mine closure. The design of the TSF will take into account the following requirements:

- Permanent, secure and total confinement of all solid waste materials within an engineered facility
- Maintain a water cover over the tailings beach to minimize potential acid generation of the tailings solids as initial studies have indicated that mine waste can be considered as Potentially Acid Generating (PAG). Excess water directed to the facility will be retained and directed to the plant site as reclaim for use in the operations and any surplus to treatment at a water treatment plant
- The inclusion of monitoring features for all aspects of the facility to ensure performance goals are achieved, and the design criteria and assumptions are met.

The TSF will be initially constructed with a Stage 1 dam embankment height at the pre-production stage to accommodate mine start-up and initial operations. The dam will be raised in stages during the operations to the full height required to accommodate the total required tailings solids scheduled to be deposited into the facility as well as allowances for operational, storm water and additional allowances for freeboard. This approach to the construction and operation of the TSF offers a number of advantages as follows:

- Reduces the initial capital costs and defers a portion of the capital expenditures until the mine is operating fully and Non Acid Generating (NAG) mine waste rock can be utilized for construction and raising the embankments.
- Reduces construction requirements at pre-production
- Provides ability to refine design and construction methodologies as experience is gained with local conditions and constraints, and also allows for monitoring and collection of field data on the deposited tailings to optimize tailings parameters for use in design.
- Provides ability to adjust plans at a future date to remain current with “state-of-the-art” engineering and environmental practices, and
- Allows the observational approach to be utilized in the ongoing design, construction and operation of the facility.

The observational approach is a powerful technique that can deliver substantial cost savings while maintaining a high level of safety. It also enhances knowledge and understanding of site-specific conditions. For this method to be applicable, the character of the project must be such that it can be altered during construction (Peck, 1969).

The construction and staging of the TSF will be scheduled to ensure that sufficient storage capacity is provided in the facility to avoid overtopping and prevent water from exiting through the spillways during operations by providing sufficient freeboard to safely accommodate the supernatant pond and design storm event, combined with wave run-up.

5.2 EMBANKMENT HEIGHT AND CONSTRUCTION STAGING

The required storage capacity of the TSF will be established to accommodate the total anticipated tonnage of tailings solids scheduled to be deposited over the life of the mine with consideration of the portion being directed to the underground mine workings. The available storage capacity of the TSF is based on the site selection of the facility determined from the Alternatives Assessment and the natural ground topography has been used to align the dam embankments to maximise storage capacity while minimizing embankment fill volumes. A figure showing the storage capacity of the TSF alignment is provided in Figure 5.1.

Tailings solids generation for the project has been identified at 2,700 dry tonnes per day (dtpd) for a total of 11,826,000 dry tonnes over the life of the mine. An estimated 4,925,500 dry tonnes will be routed to the TSF up until the end of Year 5 of operations followed, after which approximately 40% will be routed to the underground mine workings from Year 6 to end of the operations in Year 12. An estimated 4,139,600 dry tonnes will be routed to the TSF from Year 6 to end of Year 12 of the operations for a total of approximately 9,066,600 dry tonnes requiring storage within the TSF. The actual fraction of tailings solids that can be directed to the underground mine workings as well as the schedule will be confirmed as the mine design is advanced.

Laboratory testing of the tailings solids or small-scale pilot projects can be used to quantify the tailings in situ density when deposited. At this stage of the project laboratory testing or pilot projects have not been completed and therefore an estimate of the tailings solids in situ density has been used develop to estimate the volume of tailings solids that will require storage within the TSF. An in situ density of 1.1 t/m^3 has been estimated for the project that is based on literature and experience with similar projects. The in situ density of the tailings can be optimized with laboratory testing as the project is advanced as well as monitoring during the operations. Applying the in situ dry density of 1.1 t/m^3 adopted for the design results in a total tailings volume of approximately 8,242,364 m^3 that will be directed to the TSF.

A preliminary stage storage for the TSF has been developed that is based on the embankment layout and has been used to preliminarily identify potential embankment staging and requirements for operational and stormwater management. The embankment heights have been assigned to provide containment of the required volume of tailings as well as an allowance for operational water, the EDS and normal freeboard. A figure showing the potential embankment staging is provided as Figure 5.2. Embankment staging at this time is preliminary and will be revised/optimized as the project is advanced.

Water management and freeboard allowances have been applied to each embankment Stage to ensure that full containment of tailings and water is provided during operations and to protect the dam from overtopping during the occurrence of significant storm events. A Maximum Operating Level has been established to contain runoff as well as water inputs to maintain a water cover over the tailings beach. Water transfer will be required for reclaim to process as well as transfer to treatment of yearly excess volumes.

An allowance for the containment of storm water has also been provided that corresponds to the volume of water resulting from the EDS. The EDS that has been adopted for the TSF is the 1:1,000 yr, 24 hr. storm event that has a storm depth of approximately 125 mm. The catchment area for the TSF is approximately 70.6 ha and the corresponding volume of water resulting from the occurrence of the EDS is approximately 88,250 m^3. A spillway invert for each embankment stage will be assigned to ensure that containment of the volume of water resulting from the EDS is maintained without being released though the spillway.

A freeboard allowance will be included to ensure that water overtopping the dam does not occur in the event that the spillway becomes active. The freeboard will be based on peak water levels occurring within the spillway during the occurrence of the IDF. The IDF will be based on the HPC as identified by the CDA Guidelines and also the MNR Best Management Practices. The freeboard for each embankment stage has been preliminary assigned at 1.5 m above the spillway invert.

5.3 TSF EMBANKMENT

The preliminary embankment cross section for the TSF has been developed with the Alternatives Assessment and will form the basis for advancing to subsequent levels of design. The embankments will be constructed in a staged approach, as discussed above, with the initial stage constructed at pre-production with subsequent embankment raises during the life of mine to accommodate tailings solids storage, operational and stormwater management. The upstream slope of the embankment has been assigned at 2.5H:1V and the downstream slope at 2.25H:1V for the initial embankment. Subsequent raising of the embankments will utilize NAG mine waste rock with downstream slopes of 1.5H:1V while maintaining the upstream slope at 2.5H:1V. The downstream waste rock slopes for embankment raising can be stepped with benches to accommodate covering the Stage 1 downstream embankment. The internal drain and transition zones will be constructed at a slope of 2.5H:1V for Stage 1 and the type of embankment raising will dictate the drain and transition slopes for subsequent raises. The style of embankment raising is envisaged to consist of a centreline style that would utilize vertical drainage and transition zones for subsequent embankment raising. The type or style of embankment raising will be confirmed and optimized as the project is advanced to the subsequent level of design and will be based on stability analysis with inputs from site investigation programs. A figure showing the plan layout of the Stage 1 embankment (pre-production) is provided on Figure 5.3 and for the potential final embankment stage on Figure 5.4. A preliminary embankment cross-section showing the potential embankment staging is provided as Figure 5.5.

The TSF will provide primary and secondary containment of the tailings solids and impounded water as it consists of a zoned earthfill with an upstream low permeable clay zone. The upstream clay zone will be placed on the upstream slope of the embankment and also be keyed into the basin foundation within the key trench. The zoned earthfill section of the dam will provide the secondary containment and also seepage control to maintain dam stability and integrity of the anticipated low seepage flows through the dam.

5.3.1 FOUNDATION PREPARATION

Foundation areas will require clearing of all standing trees and low level shrubs, grubbing and stripping of topsoil and potentially unsuitable materials prior to fill placement for the embankment. Topsoil that is stripped from the embankment footprint area would be hauled and stockpiled for later use in reclamation activities. Zones of soft or highly saturated and unsuitable foundation material would require removal and replacement with compacted fill material.

The main section of the dam will be constructed on a prepared foundation of native materials, anticipated to consist of clay material. The area immediately underlying the upstream clay zone of the embankment would be excavated to form a key trench. The excavation would extend down as far as necessary to provide a suitable cut off against seepage. Clay zone fill would then be placed in horizontal lifts and compacted into the trench. Foundation preparation and key trench excavation, depending on the required depths, may involve measures for dewatering during excavation activities that will require development of a sediment control plan.

A drain network (blanket drain) would be constructed into the base of the embankments, downstream of the clay zone, to drain groundwater from the foundation and also control seepage flows through the dam. Where necessary some trenching may be required for the drains to ensure gravity flow to the downstream toe of the embankment. Seepage flows would be collected in a perimeter collection ditch and routed back (pumped) into the TSF.

Foundation preparation within the basin area would consist of clearing all trees and shrubs and stockpiling at the site. Cleared trees consisting of merchantable timber can be hauled to forestry operations. Non-merchantable timber can be chipped and spread on-site.

5.3.2 EMBANKMENT ZONES

The embankment zones for the TSF have been preliminary established based on available site investigation information and indications of fill materials in potential local borrow sources and also material availability from gravel pits in the Dryden area. The internal drain system will be designed as graded filters so that the individual zones function to control the movement of seepage while maintaining stability of the zone by preventing the migration of finer material into the adjacent zone. A non-woven geotextile can be included with the embankment cross-section, between the upstream clay zone and adjacent drain that can aid in the prevention of migration of fine material into the drain zone. This will be determined with the filter design when material parameters for the fill materials are determined. Local fill will form the main body of the dam for Stage 1 and also the upstream clay zone for Stage 1 and subsequent embankment raises, and can be provided from local borrow sources. Subsequent embankment staging will utilize NAG mine waste rock from the mining operations in the downstream shell of the dam. An additional transition zone may be required after Stage 1, between the transition zone and the mine waste rock, which will be determined once mine waste rock gradations have been established.

Fill zone widths and the final dam width will be confirmed as the project is advanced based on stability, seepage and also graded filter designs based on geotechnical parameters obtained from site investigation activities. The following provides a preliminary summary of the embankment zones for the TSF embankment.

- Low Permeable Upstream Clay Zone (Zone A) – Constructed with native material from the local borrow sources (i.e. stripping form the open pit mine area) will provide primary containment of tailings solids and stored water. The upstream and internal slopes at Stage 1 will be 2.5H:1V and can be raised vertically with embankment raises. At the final embankment height the clay zone width can be between 2 m to 3 m and will be determined from stability and seepage modeling. A geotextiles can be included with the design and placed on the downstream side of the clay zone to prevent migration of fines into the adjacent zone that will be determined with filter grading design as the project is advanced.

- Internal Filter (Zone B) – Will be constructed on the downstream face of the clay zone using screened sand from local borrow sources or local gravel pits in the Dryden area. The filter width will be determined with seepage analysis (typically 0.5 m to 1.0 m width) over the entire downstream face of the clay zone and will have the same upstream and internal slopes as the clay zone. The drain material can be raised vertically utilizing a centreline style of embankment raise. The filter will also serve to heal cracks that may develop in the core zone by retaining fines at the core/filter interface. The filter design will ensure sufficient permeability to drain the downstream face of the clay zone. The internal filter will also be connected to a blanket drain that is located on the downstream shell zone of the embankment.
- Transition (Zone C) – Will be constructed on the downstream side of the Filter (Zone B) and will function to pass seepage and prevent the migration of fines from the adjacent. The transition zone width will be determined similar to the filter zone and can be constructed from screened local material or from a gravel source in the Dryden Area. The width of the zone is anticipated to be about 1 m to 1.5 m. The transition zone will be placed at the same slope as the filter for Stage 1 and subsequent embankment raises.
- General Fill (Zone D) – Will be used to construct the main body, or downstream shell zone, for the Stage 1 embankment. The general fill material will be placed on the downstream side of the transition zone with an upstream slope of 2.5H:1V and downstream slope of 2.25H:1V. The downstream slope will be confirmed with stability assessments as the project is advanced. Materials for the general fill zone can be provided from local borrow sources at the site or alternatively as pit run material from gravel pits in the Dryden area.
- Waste Rock Shell (Zone E) – Will consist of NAG rock and will be provided from the mining operations. The mine waste rock will be used as downstream shell zone material for embankment raises after Stage 1. The material gradation will be determined from the mine design as the project is advanced and be used in the graded filter design. The mine waste rock will require sorting of NAG and PAG to ensure that only NAG material is used in the construction of the TSF. NAG waste rock volumes available for construction will be determined as the project is advanced with the mine design.
- Riprap (Zone F) – Will be placed on the upstream embankment slope and will function to provide protection from potential erosion, wave action and ice damage. Riprap can initially be provided from a local gravel pit for Stage 1 and the construction of future raises can utilize select mine waste rock for subsequent embankment raises. The zone will have the same slope as the upstream embankment at 2.5H:1V.

Other embankment zones will be included with the dam cross section, as required, as the design is advanced and input parameters become available.

Internal Drain System

The presence of the upstream clay zone will contain the tailings and control the movement of water through the dam embankment. The phreatic surface within the embankment and foundation would be controlled with the engineered filters and drains. Two systems are in place to control seepage as secondary containment and control; one behind the core zone (as described above) and one over the prepared foundation of the downstream shell. These systems would collect and control seepage flows that pass through the core and prevent the finer particles from the core or foundation soils from migrating with the seepage flows. All potential seepage water would continue to be contained and would not be discharged from the site as the flows from the filter and drains would be conveyed beneath the shell zone of the embankment to the collection ditch, located along the downstream toe of the embankment, and would then be collected and routed(pumped) back into the TSF.

5.4 SEEPAGE CONTROL

A seepage collection ditch will be located along the downstream toe of the TSF for collection and containment of potential seepage flows through the dam. The ditch will also collect runoff from the downstream embankment of the TSF consisting of Zone E material or NAG waste rock. All water that is collected in the seepage collection ditch will be contained, collected and transferred back into the TSF utilizing a sump, pump and pipeline system. The design of the TSF ditch will include consideration of all potential water inputs as well as seepage estimates, and location, determined from the embankment seepage analysis.

5.5 WATER MANAGEMENT

Water management for the TSF will require management of both operational and storm water. The tailings solids have been classified as PAG and therefore the concept of utilizing a water cover over the tailings beach has been adopted for the project. The water cover will keep the tailings solids submerged to restrict contact with the atmosphere to minimize acid generation.

Water collected in the TSF will consist of runoff from the catchment created by the perimeter embankments as well as operational water delivered to the TSF in the tailings stream that is not locked in the settled tailings. The water inputs into the TSF in addition to tailings have been identified at this stage of the project as consisting of mine dewatering. Other potential inputs may become apparent as the project is advanced and these will be included with the water management design. Surplus water collected in the TSF can be stored and directed to a treatment facility prior to being released. The TSF while in operation will therefore contain all operational water and also provide containment of the Environmental Design Storm (EDS) for stormwater management. An emergency overflow spillway will be included to maintain embankment stability during the occurrence of significant stormwater events.

Water pond levels will be confirmed for each embankment stage for operational and stormwater management as presented below.

- Maximum Operating Level – required to contain runoff from average and wet precipitation conditions considering the volume of water being removed from the facility (evaporation and water transferred to treatment and process) while maintaining a water cover

- Spillway Invert Level – Pond level providing storage capacity between the invert of the spillway and Maximum Operating Water Level to contain an Environmental Design Storm (EDS), currently assigned as the volume of water resulting from the 1:1,000 yr, 24-hr. event
- Embankment Height – Freeboard above the invert of the spillway for each embankment stage to prevent water from overtopping the dam during the occurrence of the prescribed Inflow Design Flood (IDF) that will be determined once the dam's Hazard Potential Classification has been established.

5.5.1 WATER TRANSFER SYSTEM

A water transfer system will be used to transfer water from the TSF to the plant site as reclaim for use in the processing operations as well as potential surplus water for treatment. The transfer to treatment rates, as well as timelines during the year will be determined with the water balance that will be prepared during detailed design as the project is advanced. The water transfer system can consist of a floating pump barge with a HDPE pipeline or alternatively a stationary reclaim system and will be dependent on the detailed water/solids balance modeling as the project is advanced.

5.5.2 WATER/SOLIDS BALANCE

A monthly water/solids balance will be completed as the design is advanced to determine the effect of various precipitation conditions on the overall water management requirements for the TSF and to confirm that the operational and stormwater pond levels will be maintained over the life of the facility. The analyses were completed for the planned 12 years of operations based on the tailings solids volume that is planned for deposition into the TSF with co-disposal occurring into the mine workings.

The water/solids balance will be used to determine the quantity of water that must be transferred to the water treatment plant based on net inputs from precipitation on catchments, process water and other water inputs that includes underground mine dewatering. The analysis will also be used to confirm that the proposed water cover can be maintained during periods of low precipitation conditions. The water/solids balance analyses will utilize a computer add on program called @RISK to statistically determine pond elevations. Water/solids balance modeling utilizing the program @RISK permits cell inputs to be modelled as distributions rather than as single values. The @RISK software has the capability to perform Monte Carlo type simulations and track the various outputs that result from variations in the input. The model can run several iterations (i.e. 1,000 or more) such that 1,000 or more different sequences of monthly precipitation over the year are considered and the resultant pond levels tracked. This analysis will produce the average as well as the high and low pond levels during the planned 12 years of operations. This analysis will be used to establish the required pond operational limits and identify the maximum operating water level.

Tailings Rate of Rise

Tailings deposition into the facility will result in development of a tailings beach that will rise over the operational life and dictate the required embankment heights at each stage to provide containment. A deposition plan will be required for the planned 12 years of operation based on the total volume of tailings that will be deposited into the TSF. Deposition will consist of depositing approximately 8,242,364 m^3 of tailings from the embankment crest by spigotting.

The yearly rate of tailings flow is not consistent over the life of the operations as tailings will be deposited initially into the TSF followed by a portion of the tailings solids being directed to the underground mine workings for disposal. The following yearly tailings flow rates have been used to identify the tailings rate of rise within the TSF basin:

Year of Operation	Dry Tonnes per Year	Total Tailings Volume
1	985,500	895,909
2	985,500	1,791,818
3	985,500	2,687,727
4	985,500	3,583,636
5	985,500	4,479,545
6	591,300	5,017,091
7	591,300	5,554,636
8	591,300	6,092,182
9	591,300	6,629,727
10	591,300	7,167,273
11	591,300	7,704,818
12	591,300	8,242,364

The yearly volumes presented above are based on the design solids content of 43% and a corresponding in situ dry density of 1.1 t/m^3. A figure showing the tailings rate of rise over the 12 years of operation is provided on Figure 5.2 and represents the tailings beach surface over time. The rate of rise in Year 1 will be approximately 10 m as the lower areas of the basin are filled in. The average rate of rise from Years 2 to 5 is approximately 1.4 m per year. A reduction in the tailings rate of rise will occur after Year 5 to approximately 0.7 m per year based on a percentage of tailings being routed to co-disposal. The tailings surface, over time, will be used to confirm and optimize the required embankment heights, pond levels for operations and storm containment and also identify the required embankment freeboard.

Model Inputs and Outputs

Water inputs and outputs for the TSF will be confirmed as the project is advanced with the completion of design work for other aspects of the project, consisting of the mine design, waste rock stockpile design, plant site design, etc. The following identifies the water inputs and outputs that have been identified at this stage of the project for the TSF. The values shown represent the Year 1 to Year 5 operations prior to the start of co-disposal of tailings solids into the underground mine.

TSF Inputs:

- Paste tailings solids (2,700 dtpd)
- TSF Catchment runoff (determined with the analysis)
- Direct pond precipitation (dependant on the area of the pond as it varies during the year)
- Water in Tailings Stream (3,579 m^3/day)
- Mine dewatering (1,600 m^3/day)
- Seepage Reclaim (determined with analysis)

TSF Outputs:

- Water retained in tailings voids (1,455 m^3/day)
- Evaporation from pond (dependant on the area of the pond as it varies during the year)
- Water reclaim to the plant site for processing (3,360 m^3/day)
- Water transfer to treatment (determined with analysis)
- Embankment Seepage (determined with analysis)

A water/solids balance schematic showing the current water inputs and outputs for the TSF is provided as Figure 5.6.   The results of the water/solids balance will identify the transfer rates from the TSF to water treatment. The following is a discussion of the water input and output constraints that have been applied to the water/solids balance to identify the required pond levels and also the required water transfer rates.

Methodology

The monthly water/solids balance will be completed by applying various precipitation conditions over the planned 12 years of operations. The water/solids balance will be completed as a spreadsheet analysis and applied the design constraints, as listed above, with the @RISK simulation. The analysis will be used to ensure that operational pond levels are maintained to provide the water cover over the tailings beach and do not infringe above the prescribed maximum operational pond level established for each embankment stage.

Runoff into the pond will be from the contributing drainage basin areas and estimates of the runoff coefficients for each. Snowmelt parameters will be included within the model to account for the effects of snowpack and spring melt. Accumulated snow up to the months of March, April and May can be assigned to melt at a rate of 10 percent in March, 20 percent in April and 70 percent in May, meaning that 100 percent of the accumulated snow has melted by the end of May. A percentage of monthly snowfall will also be converting to runoff during the winter months. Consideration for the freezing conditions at the site during the winter months will also be included with the model by applying pond ice thickness. Pond levels in the TSF may need to be maintained to provide some unfrozen water to ensure that the pond does not become completely frozen to depth and to ensure that makeup water to the mill is provided on a yearly basis. Allowing the pond to freeze through its depth can result in “growing ice” as additional water is discharged onto the frozen surface which can also cause damage to intakes and reclaim pumps.

5.5.3 STORMWATER MANAGEMENT

The Maximum Operating Pond Level and allowances for containment of the EDS will be used for water pond management for each embankment stage during the project. The stormwater modelling for design of the emergency overflow spillway for each embankment Stage will involve assessing the IDF event for the facility based on the HPC. The HPC is the classification system established by the CDA as a selection criteria used to determine the overall hazard potential based on the effects of a dam failure. Each dam is generally classified in accordance with the severity of the hazard resulting from the failure of the dam or its associated structures and the perceived risk of occurrence. This hazard potential classification forms the basis for the design requirements and ongoing surveillance activities. Classification of each dam is carried out based on consideration of the potential consequences of failure, which includes Population at Risk, Potential Loss of Life, Environmental and Cultural Values and Infrastructure and Economics. The criteria that is used to determine the HPC for dams in accordance with the CDA Guidelines and MNR Best Management Practices is provided on Tables 5.1 and 5.2, inclusively. The required IDF based on the HPC is provided on Tables 5.3 and 5.4 for the CDA Guidelines and MNR Best Management Practices, inclusively. These criteria will be used to identify the HPC and corresponding IDF for the TSF as the project is advanced.

The prescribed IDF will be routed thought the facility and will be used to design the emergency overflow spillway. The spillway design will be completed with HydroCAD®, which is a computer program that utilizes accepted methods of hydrologic analysis to estimate the runoff flows resulting from a particular storm routed through a watershed(s) with specified characteristics.

The IDF event will be assessed by distributing the precipitation over time using the SCS (Soil Conservation Service) Type II distribution. Typically this method of analysis determines the time of concentration (tc) for each sub catchment based on the soil cover, average land slope and hydraulic length for each area. The time of concentration is the time required for runoff to arrive at the outlet of the sub-catchment from its most remote point. The soil cover is categorized using CN numbers based on SCS runoff curve numbers ranging from 1 to 99. The analysis will set the starting pond elevation at the invert of the spillway to model the potential worst case condition assuming that all potential allowances for water storage have been used. Due to the anticipated pond area corresponding to the starting elevation (spillway inverts) at the start of the model, a large portion of the catchment will be modelled as pond (open water) with a CN of 99. Additional inputs into the models included pond storage characteristics and spillway geometry.

To determine the required spillway configuration for the selected embankment crest elevations, HydroCAD® uses the IDF, catchment and storage information to develop a discharge rate and water level over time for a given spillway configuration. The spillway configuration is required to meet two principle design objectives, which include passing the peak flow within the designated freeboard allowance (minimum freeboard) and ultimately discharging the total IDF volume and returning the pond to normal levels within a reasonable period of time. The designated minimum freeboard allowance above the peak flood level is included to account for wave run-up. Freeboards for the facility will be determined utilizing the Lakes and Rivers Improvement Act and the CDA Guidelines.

5.6 EMBANKMENT STABILITY AND SEEPAGE

Stability and seepage assessments of the TSF embankments will be completed for each embankment stage of the project. The assessments will be used to determine the required dam cross section, consisting of upstream and downstream slopes, required zone thicknesses and crest width, to maintain the required Factor of Safety (FoS) against instability during operation and closure conditions. Stability assessment will utilize results from site investigations for foundation conditions and also fill material parameters from laboratory index testing. Design criteria for the embankment stability will utilize the CDA Guidelines to ensure the embankments are stable under various conditions and loadings. The minimum design criteria as prescribed by the CDA Guidelines are provided below:

Loading Conditions	Minimum Factor of Safety	Slope
End of Construction (before reservoir filling)	1.3	Downstream and Upstream
Long-term (steady state seepage, normal reservoir level)	1.5	Downstream and Upstream
Full or partial rapid drawdown	1.2 to 1.3	Upstream
Pseudo-static	1.0	Downstream and Upstream
Post –Earthquake	1.2 to 1.3	Downstream and Upstream

Stability assessment will be completed using the program SLOPE/W©, which is a limited equilibrium computer software program developed by Geo-Slope International Ltd. Bishops Simplified Method of Slices will be used to analyze potential failure surfaces through the embankment slopes and underlying foundations. The circular failure mode and the composite (block) failure modes for assessing potential sliding of the overburden on the underlying bedrock, were assessed as part of the stability modeling. Analysis will include static as well as pseudo-static conditions. The required seismic input is based on the HPC of the dam and the design criteria according to the CDA Guidelines and the MNR Best Management Practices is provided on Tables 5.5 and 5.6, inclusively.

A seepage assessment will be completed to estimate potential seepage flows from the perimeter embankments. The seepage that does leave the facility will be collected in the downstream seepage collection ditch and pumped back into the facility. The modelling will be completed using the computer program SEEP/W®. Seepage models will be developed from site investigation information as well as laboratory index testing of fill materials. The results of the water/solids balance modeling will be used to identify pond elevations as input parameters. Seepage assessment results will be utilized in the design of the seepage return system as well as to identify the location of the downstream seepage collection ditch.

5.7 TAILINGS MANAGEMENT

The Stage 1 TSF embankment will be stabilised at the pre-production stage and will be raised over the operational life of the facility to provide containment of tailings solid, operational and stormwater management. Spigotting from the embankment crest will be utilized to fill in the low areas of the basin and will allow the tailings to build a beach against the upstream embankment face that will provide stability to the upstream slope and aid in containment. Monitoring of the tailings placed in Year 1 can also be used to better identify the in situ tailings beach slopes and in-situ densities that can then be used to update the deposition model for the remainder of the life of the facility. Deposition into the TSF is anticipated to consist of sub-aqueous conditions resulting from the ponded water utilized to provide the cover over the tailings solids to prevent acid generation. Deposition will be from the embankment crest by opening a series of spigots and allow the tailings to flow into the basin area. The deposition location(s) will be moved progressively along the deposition line on the embankment crest on a daily basis or as required. This is generally carried out by closing one (1) spigot and opening (1) spigot at the other end of the series. This is repeated on a daily or on an as required basis in order to maximise the tailings densities and to ensure a uniform tailings elevation across the storage.

The tailings deposition system will consist of an HDPE delivery pipeline and an HDPE deposition pipeline for routing tailings to the TSF. The deliver pipeline will be aligned from the plant to the crest of the TSF embankment. The tailings deposition line will be aligned along the upstream crest of the embankment. The delivery and deposition pipelines will be connected to a flow control assembly located on the crest of the embankment that should be placed within a heated control building to prevent freezing. The flow control assembly will consist of a concrete pad to support a pipe header and a series of control valves to direct the tailings flow around the perimeter embankment.

The design of the tailings deposition system line will utilize the maximum anticipated tailings flow rate over the life of the facility. The design of the tailings deposition pipelines will consider the design criteria for the tailings consisting of solids content, specific gravity and anticipated flow rates. The deposition pipeline will also be equipped with a series of single point off takes spaced at approximately 25 m to 50 m centres along the pipeline. The spigot off takes will be comprised of tees, flexible hose and Spigot clamps.

The tailing delivery pipeline will be routed on the surface between the plant and TSF embankment. A sand berm is to be placed (on top of the pipe) at internals to act as a thrust support along the pipe route. Pipe routing under roadway access shall be installed in a corrugated galvanized culvert to allow minimal roadway disturbance, ease of inspection and maintenance requirements. Applicable slurry isolation valves shall be provided at each end of the pipes to allow for minimal downtime in the event of pipe switchover and drains at low point locations with containment as required along the pipe route.

The deposition pipeline can be relocated to the top of each embankment stage for each raise. Due to the potential erosion of the tailings flow and the potential sanding of the pipeline that can reduce the pipelines integrity, the pipeline should be monitored and routinely inspected for signs of deterioration. Monitoring can consist of installation of pressure gauges along the alignment to monitor changes in pressure resulting from a decrease in cross section. Deteriorated sections can be replaced in the field by cutting the pipeline, removing the deteriorated section and replacing it with a new section butt fused in the field.

All pumps and pipelines will need to be supplied as acid resistant due to the potentially acidic nature of the materials being handled. Pipelines should also be insulated and heat traced to ensure that the lines do not become frozen during winter operations.

5.8 MONITORING

Monitoring of the TSF will be required during the construction phase as well as during operations. Full time construction monitoring is recommended to ensure that the facilities are constructed according to the design intent as presented on the drawings and in accordance with the technical specifications. The monitoring program would include a quality assurance and quality control program, consisting of filed inspections and geotechnical laboratory testing, to ensure construction fill materials meet the specifications for the required zones.

Monitoring of the TSF embankments is also required during the operations. The monitoring will include survey pins to check for potential embankment movements, piezometers in the embankment to check for pore water pressures and monitoring wells downstream of the embankment to monitor groundwater quality. Any problems identified should result in an increase in monitoring frequency and the designer should be notified immediately to assess the situation. Regular inspections will help identify any areas of concern that may require maintenance or more detailed evaluation. The following general inspection program should be followed:

- Daily visual inspection of all embankments and berms, pipelines, pumps, culverts, spillways etc. to look for obvious problems such as pipeline damage, blockage, embankment seepage, slope instabilities, etc. During high precipitation period or spring freshet, more frequent inspections will be warranted.
- On a monthly basis, a more detailed inspection of all facilities should be conducted to look for any less obvious signs of potential problems
- During and following any extreme events, including snowmelt and precipitation, a more detailed inspection should be conducted to assess if any damages due to erosion, etc. require attention
- The facility should be inspected by a qualified Geotechnical Engineer on annual basis to verify that the embankments are performing as designed and that the operations are being continued as intended. The inspections would likely be carried out during or shortly after the spring melt under snow free conditions.

Seepage monitoring is also recommended during the operations. Groundwater monitoring wells are recommended downstream of the TSF to monitor/ identify if the facilities are not performing as required. This will help to ensure that the local environment is protected from seepage in the event that the containment systems are not performing and there is seepage occurring though the foundation and under/into the seepage collection ditches. Each monitoring installation should consist of one shallow hole, extending through into the overburden soils and the near surface horizon and one deep hole terminating at the underlying foundations. Each borehole will be cased and screened over an interval set in the field during installation, and sealed back to surface with low permeability grout. It is recommended that the boreholes be constructed before commissioning the tailings storage facility to accumulate baseline data specific to the storage location.

Porewater pressures should be monitored at various key locations within the TSF embankment to ensure that stability is not compromised. The monitoring will consist of standpipe piezometers installed at critical areas in the embankment. The base of the piezometer will be contained within the embankment to ensure that the phreatic surface within the embankment is measured. The standpipe piezometers would be installed at Stage 1 and raised with embankment staging. Survey pins will be installed along the embankment crest and downstream face to monitor any movement and the resulting effects on the embankment. Periodic survey checks of the embankment crests would be carried out to verify that no localized settlement has occurred resulting in the loss of freeboard.

Tailings performance monitoring will be used in the initial years of operation to identify the tailings behaviour related to beach slopes and its in situ density. The information collected during the initial years of operation can be applied to improve the calibration of the waster/solids balance and also as design parameters for subsequent stages of design. Monitoring of the following variables on a continuous basis is recommended thought out the life of the facility:

- Solids tonnage to the TSF.
- Water volume to the TSF from process or other streams.
- Rainfall and evaporation at the facility.
- Water transfer to the plant and treatment.

Monitoring of tailings moisture contents and densities, and surveying of the tailings beach and supernatant pond elevations should be conducted each year. Monitoring of pond levels and water transfer (volume & rates) from the TSF will be required to identify issues with increasing pond levels resulting from issues with the water transfer systems. The following monitoring is recommended:

- Daily recording of the pond water levels
- All pumps transferring water in or out of the TSF should be equipped with flow meters to allow pumping volumes to be estimated and compared to the water balance predictions
- Site specific meteorological data should be gathered and used in conjunction with the flows and levels to refine the hydrology modelling and improve future prediction
- Confirmation of ice thicknesses by drilling and measuring.

- Monthly monitoring of water levels in standpipes installed in the embankments and underlying foundations.

6 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations have been generated for the Goliath Project TSF based on the completion of the Alternatives Assessment.

6.1 CONCLUSIONS

- An Alternatives Assessment was completed to enable the selection of the Tailings Storage Facility location and deposition technology. Seven (7) locations and four (4) deposition technologies were assessed with a total of 22 potential alternatives. The assessment followed the Environment Canada's Guidelines for the Assessment of Alternatives for Mine Waste Disposal (Environment Canada 2013). Several input Indicators were assessed for the Environmental, Technical, Economic and Socio-Economic Accounts.
- A pre-screening assessment was used in accordance with the guidelines to identify options that were advanced thought the Alternatives Assessment process.
- The results of the Alternatives Assessment showed that Location 1 with conventional tailings deposition and future co-disposal of tailings into the underground mine workings (Option 1D) had the highest alternative merit score.
- The results of the sensitivity analysis were consistent with the Alternatives Assessment with Option 1D returning the highest alternative merit score.
- Option 1D is recommended as the preferred alternative for tailings management at the Goliath project site.
- Design parameters and assumptions developed to complete the Alternatives Assessment will form the basis for the design of the Tailings Storage Facility as the project is advanced to subsequent levels of design. Parameters and assumptions will be confirmed/refined/optimized with the subsequent levels of design as site specific information is obtained and design of other areas (mine design, waste rock stockpiles, plant site runoff and collection, etc.) are completed.

6.2 RECOMMENDATIONS

- A detailed Site Investigation (SI) program is recommended for completion as part future designs of the Tailings Storage Facility. The site investigation will be completed along the proposed alignments of the embankments. The detailed site investigation will provide in situ parameters, overburden details and depth to bedrock. This information will then be used to develop detailed foundation parameters for use in detailed stability and seepage modeling and also required foundation treatments. The SI should include sampling of potential borrow sources for construction fill materials.
- The site investigation will also be used to confirm the required basin containment and embankment containment measures that are based on the natural ground conditions and presence of low-permeable material in the basin area.
- Testing of the tailings is recommended to identify the materials in situ density and potential beach slopes for use in the detailed design. This can be completed by laboratory testing or with a small scale pilot project to determine tailings in situ density as well as potential tailings beach slopes.
- Detailed tailings deposition modeling should be completed as part of subsequent levels of design using updated parameters from available tailings test work.
- A site water management plan should be developed to identify water flows and volumes that will be reporting to the Tailings Storage Facility. The site water management plan will be used to complete a detailed water/solids balance analysis for the Tailings Storage Facility to identify yearly surplus water that requires direction to treatment.
- Confirmation of the acid potential of the mine waste materials should be determined prior to proceeding with the design.
- Complete mine design to confirm available volumes of NAG waste rock that can be used for construction fill materials for staged raising of the tailings storage facility. The mine design should also confirm available volume for co-disposal of tailings into the underground mine workings and also the type of tailings backfill to determine the type plant required to generate the backfill.
- The mine dewatering rate that reports to the Tailings Storage Facility can be refined to identify yearly flows for use in the water/solids balance analysis and identify yearly surplus water volumes.
- The HPC of the dam will be confirmed with the subsequent level of design once final embankment heights have been established based on detailed water/solids balance analysis and confirmation of the volume of tailings that can be directed to the underground mine workings. This will identify the IDF and stability seismic return period design requirements.

- Completion of detailed stability assessments for each proposed embankment stage utilizing geotechnical parameters collected from site investigations and required seismic return period.
- Completion of detailed seepage assessments to support the need to design seepage collection and pump-back systems.
- Design for closure will be required as the project is advanced.

7 OPPORTUNITIES

The following opportunities have been developed for the Tailings Storage Facility that are based on available information for the site.

- The style of embankment raising for the Tailings Storage Facility can be reviewed and optimized with subsequent levels of design. The style of embankment raising will be based on fill material availability, foundation conditions and stability assessments and local topography. Optimizing the embankment raising can reduce the fill material requirements and project costs over the life of the facility.

- Opportunities to utilize the mined out open pit should be considered for storage of tailings solids as the project is advanced. Utilizing the open pit will reduce the volume of tailings that require storage within the on-land Tailings Storage Facility, which will reduce the required embankment height (improve aesthetics and improve stability) and also reduce costs associated with dam construction.

8 REFERENCES

- "Guidelines for the Assessment of Alternatives for Mine Waste Disposal", by Environment Canada Mining and Processing Division DATE 2013
- "Project Description – Goliath Gold Project, Treasury Metals Incorporated", by Treasury Metals, November 26, 2012.
- "Feasibility Metallurgical Testing Goliath Gold Project", by ALS Metallurgy, Ref. No.: KM3406, September 4, 2012.
- "Goliath Gold Project Baseline Study November 2010 to November 2011" by Klohn Crippen Berger, Ref. No.: M09706A01.732, September 21, 2012.
- "Goliath Gold Project Environmental Baseline Studies Soil Baseline", in Draft, by Klohn Crippen Berger, Ref. No.: M09706A01.730, February 16, 2012.
- May 2013 Borehole Logs from TBTE.
- Metal Mining Effluent Regulations, Published by the Minister of Justice, SOR/2002-222, Current to January 14, 2014
- Memo: "Geochemical Evaluation of the Goliath Gold Project", in Draft by EcoMetrix, Ref. No.: Ref:
- 12:1938, June 20, 2013
- 20010 National Building Code Seismic Hazard Calculation
- Canadian Dam Association – Dam Safety Guidelines 2007
- Ontario Ministry of Natural Resources – Classification and Inflow Design Flood Criteria, Technical Bulletin, August 2011.
- Ontario Ministry of Natural Resources – Seismic Hazard Criteria, Assessment and Considerations, Technical Bulletin, August 2011
- Hogg, W. D. and Carr, D. A., 1985. Rainfall Frequency Atlas for Canada. Environment Canada.
- Lakes & Rivers Improvement Act Technical Guidelines – Criteria and Standards for Approval, Ministry of Natural Resources, June 2004.
- Environment Canada - Rawson Lake station (ID: 6036904, 49.65^{o}N, 93.72^{o}W)

9 SIGNATURE

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*This review report has been prepared for the exclusive use of Treasury Metals Incorporated and its representatives for this specific application described within this report. Any use that a third party makes of this report, or any reliance or decisions based on this report are sole responsibility of those parties.

TABLES

TABLE 2.1

TREASURY METALS INCORPORATED
GOLIATH PROJECT

TAILINGS STORAGE FACILITY ALTERNATIVES ASSESSMENT

PROBABILISTIC SEISMIC RISK PARAMETERS

P:\Mining\Treasury Metals\141-12598-00 - Alternatives Assessment\Report\Report 1, Rev. 0\Tables\[Table 2.1 - Seismic.xlsx]Table 2.1

	Probability of Exceedance per Year			
	0.01	**0.0021**	**0.001**	**0.000404**
Return Period in Years	100	476	1,000	2,475
Peak Horizontal Ground Acceleration (PGA)	0.003	0.011	0.019	0.036
Spectral Acceleration, Sa(0.2)	0.011	0.035	0.055	0.095
Spectral Acceleration, Sa(0.5)	0.007	0.022	0.034	0.057
Spectral Acceleration, Sa(1.0)	0.003	0.01	0.016	0.026
Spectral Acceleration, Sa(2.0)	0.001	0.003	0.005	0.008

Notes:

1. Source: National Building Code of Canada Interpolated Seismic Hazard Values.
2. Data calculated for location at Latitude 49.77^{o}N and Longitude 92.59^{o}W.
3. Values are in units of g.
4. Values are for "Firm Ground" as per the NBCC 2010 Soil Class C - average shear wave velocity 360-750 m/s.
5. Sa(T) is spectral acceleration where T is the period in seconds.
6. Median (5th percentile) values are given in unites of g.

TABLE 4.1

TREASURY METALS INC.
GOLIATH PROJECT

TAILINGS STORAGE FACILITY ALTERNATIVES ASSESSMENT

STEP 1 - IDENTIFICATION OF CANDIDATE ALTERNATIVES

Project Aspect	Candidate Locations	General Location
Tailings Management Facility Location	Location 1	Northeast of the proposed plant site
	Location 2	Northeast of Location 1
	Location 3	Far east of the plant site
	Location 4	South of Location 1, east side of Tree Nursery Road
	Location 5	Between Location 4 and Location 3
	Location 6	South of proposed mine site and south of existing Normans Road
	Location 7	South of Location 4, potential dry option

Project Aspect	Candidate Tailings Technology
Tailings Disposal Technology	Conventional Slurry Tailings
	Thickened Tailings
	Filtered/Dry Stack Tailings
	Conventional Slurry Tailings with Future Co-Disposal Portion of Tailings into mine workings

Number of Candidate Alternatives	Alternative Identification	Description
1	1A	Location 1- Conventional Slurry Tailings
2	1B	Location 1 - Thickened Tailings
3	1C	Location 1 - Filtered/Dry Stack Tailings
4	1D	Location 1 - Conventional with Future Co-Disposal
5	2A	Location 2- Conventional Slurry Tailings
6	2B	Location 2- Thickened Tailings
7	2C	Location 2 - Filtered/Dry Stack Tailings
8	3A	Location 3 - Conventional Slurry Tailings
9	3B	Location 3 - Thickened Tailings
10	3C	Location 3- Filtered/Dry Stack Tailings
11	4A	Location 4 - Conventional Slurry Tailings
12	4B	Location 4 - Thickened Tailings
13	4C	Location 4 - Filtered/Dry Stack Tailings
14	5A	Location 5- Conventional Slurry Tailings
15	5B	Location 5 - Thickened Tailings
16	5C	Location 5 - Filtered/Dry Stack Tailings
17	6A	Location 6 - Conventional Slurry Tailings
18	6B	Location 6 - Thickened Tailings
19	6C	Location 6 - Filtered/Dry Stack Tailings
20	7A	Location 7 - Conventional Slurry Tailings
21	7B	Location 7 - Thickened Tailings
22	7C	Location 7 - Filtered/Dry Stack Tailings

Notes:

1. Alternatives selected for pre-screening.

TABLE 4.2

TREASURY METALS INC.
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 2 -PRE-SCREENING ASSESSMENT OF CANDIDATE ALTERNATIVES

			Candidate Alternative Idnetifier[1]																					
Criteria #	**Pre-Screening Criteria**	**Rationale**	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**2C**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**6C**	**7A**	**7B**	**7C**
1	Would the TIA sterilize a potential Resource?	If a TIA that is located over an area where there are proven indicators of mineralization, or a reasonable indication of possible mineralization based on regional trends, may be excluded from further consideration.	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
2	Is any part of the Tailings Disposal Unproven Technology at the proposed throughput?	If a specific depositional method relies on unproven technology at the project site, then it could justifiability be argued that the alternative should be excluded from further consideration.	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
3	Is any part of the Tailings Disposal Unproven Technology at the given climate?	If a specific depositional technology could be adversely affected by the local climate conditions, then it could justifiability be argued that the alternative should be excluded from further consideration.	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
4	Does the life-of-mine tailings production exceed the available storage of the alternative?	If the selected alternative does not have the required capacity to hold the produced tailings, it should be eliminated.	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
5	Does the disposal site exceed a practical distance from the mill?	If an alternatives location is too far from the production facilities, it may become economically unviable and should be eliminated.	No	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No
6	Is the location topography favourable for the tailings deposition technology	Steep topography can be unfavourable for some types of tailings deposition (such as paste) and should be eliminated as an alternative.	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No
7	Does the increased cost of an alternative exceed a reasonable threshold for the viability of the project?	The feasibility of any mining project is sensitive to cost. Higher costs may be warranted to eliminate significant adverse effects; however, there is no reason to investigate alternatives requiring significant additional costs unless there is reasonable assumption of environmental gains, and as such, it should be eliminated.	No	No	No	No	No	No	Yes	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No	No	No
8	Does the Alternative present an Unacceptable Environmental Liability?	Treasury Metals Inc., follows the PDAC Framework for Responsible Mining. Treasury Metals policy states that they are committed to responsible stewardship of the environment. Their key focus is on meeting the company's goals of minimizing environmental impact, efficient use of the resources consumed and conserving natural resources for future generations. If an alternative is perceived to present an unacceptable environmental liability it should be eliminated.	No	No	No	No	No	No	No	No	No	Yes	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No
9	Does the Alternative exceed the risk threshold for failure of engineering containment?	If the tailings management facility exceeds the risk threshold for failure (CDA guidelines), then the Alternative should be eliminated.	No	No	No	No	No	No	No	No	No	No	No	No	No	N o	No	No	No	No	No	No	No	No
10	Does the footprint of the Alternative exceed the land position currently held by Treasury Metals Incorporated?	If the tailing management facility extends beyond the current land boundaries established by Treasury Metals Incorporated, then the Alternative should be eliminated.	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
11	Does the footprint of the Alternative occur above a geohazard, or a structural geological feature?	If the tailings management facility occurs above a geohazard or a structural geological feature that adversely affects the stability of said facility, than the Alternative should be eliminated.	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Should the Alternative be Excluded from Further Consideration			**No**	**No**	**No**	**No**	**No**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**	**No**	**Yes**	**Yes**	**Yes**

Alternative Identification	**Description**
1A	Location 1- Conventional Slurry Tailings
1B	Location 1 - Thickened Tailings
1C	Location 1 - Filtered/Dry Stack Tailings
1D	Location 1 - Conventional with Future Co-Disposal
2A	Location 2- Conventional Slurry Tailings
2B	Location 2- Thickened Tailings
2C	Location 2 - Filtered/Dry Stack Tailings
3A	Location 3 - Conventional Slurry Tailings
3B	Location 3 - Thickened Tailings
3C	Location 3- Filtered/Dry Stack Tailings
4A	Location 4 - Conventional Slurry Tailings
4B	Location 4 - Thickened Tailings
4C	Location 4 - Filtered/Dry Stack Tailings
5A	Location 5- Conventional Slurry Tailings
5B	Location 5 - Thickened Tailings
5C	Location 5 - Filtered/Dry Stack Tailings
6A	Location 6 - Conventional Slurry Tailings
6B	Location 6 - Thickened Tailings
6C	Location 6 - Filtered/Dry Stack Tailings
7A	Location 7 - Conventional Slurry Tailings
7B	Location 7 - Thickened Tailings
7C	Location 7 - Filtered/Dry Stack Tailings

Notes:

1. Options that do not pass pre-screening are not advanced though the Alternatives Assessment.

TABLE 4.3

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 3 - ALTERNATIVE CHARACTERIZATION

Environmental Account					Alternatives Location and Deposition Technology Identifier							
Sub-Account	**Description**	**Rationale**	**Indicator Parameter**	**Unit**	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**6A**	**6C**
Land Use	Distance from the Mine	Distance to monitoring, pipeline distance and/or haul distance (for filtered/dry stack tailings only) results in more construction and higher consumables (fuel) and emissions (noise, exhaust, dust)	Direct Distance from Plant Site to Structure	m	Shortest distance to the plant site at ~400 m	Shortest distance to the plant site at ~400 m	Shortest distance to the plant site at ~400 m	Shortest distance to the plant site at ~400 m	Longest distance to the plant site at ~2,200 m	Longest distance to the plant site at ~2,200 m	Medium distance to plant site at ~1,400 m	Medium distance to plant site at ~1,400 m
	Pipeline/Access Road Requirements	Additional requirements for pipeline or access road requirements beyond that existing that will be required for Option	Length of Additional Infrastructure Required	m	Minimal access road required as existing roads can be primarily used for access and pipeline alignments.	Minimal access road required as existing roads can be primarily used for access and pipeline alignments.	Existing road infrastructure can be used to haul tailings waste. Increased road maintenance requirements.	Minimal access road required as existing roads can be primarily used for access and pipeline alignments. Future planned road infrastructure can be used alignments to pump tailings to the mine workings.	Required development of access roads and pipeline alignments that will disturb existing land and vegetation. Will also require crossing several existing streams.	Required development of access roads and pipeline alignments that will disturb existing land and vegetation. Will also require crossing several existing streams.	More access roads and pipeline alignments required to be constructed than Location 1. Existing Tree Nursery Road can be used for part of the alignment.	Can use Tree Nursery Road for hauling, however will generate increased truck traffic on road used for mine access. Increased in dust generation around the mine area.
	Storage Facility and Associated Infrastructure Footprint	A larger footprint resulting in a greater disturbance to vegetation and species	Estimate of Storage Facility(s) Area	ha	Footprint Area ~ 88 ha	Footprint Area ~ 88 ha	Footprint Area 100 ha that includes tailings storage and water collection pond.	Footprint Area ~ 88 ha	Footprint Area ~ 246 ha	Footprint Area ~ 246 ha	Footprint Area ~ 54 ha	Footprint Area ~60 ha that includes tailings storage and water collection pond.
Water Impacts	Number of Main Watersheds Affected	Various locations may impact one or more watersheds	Number of Main Watersheds directly impacted	No	1	1	1	1	1	1	1	1
	Potential Impact to surface water availability	Various locations may have an impact to surface water availability	Qualitative Estimate of Potential Surface Water Impact	Rank	Closest proximity to Thunder Lake, medium proximity to Wabigoon Lake.	Closest proximity to Thunder Lake, medium proximity to Wabigoon Lake.	Closest proximity to Thunder Lake, medium proximity to Wabigoon Lake.	Closest proximity to Thunder Lake, medium proximity to Wabigoon Lake.	Farthest from Wabigoon Lake and Thunder Lake	Farthest from Wabigoon Lake and Thunder Lake	Closest proximity to Wabigoon Lake	Closest proximity to Wabigoon Lake
	Potential Impacts to Water Quality (ARD, Metal Leaching, etc)	Locations as well as construction materials may have impacts on water quality	Likelihood of Mining Impacts and mitigative measures required	Rank	Anticipated to be contained by natural clay basin and clay lined dam with internal drain system with secondary downstream seepage collection and pump back system.	Anticipated to be contained by natural clay basin and clay lined dam with internal drain system with secondary downstream seepage collection and pump back system.	Tailings waste stockpiled on surface. Runoff collected by perimeter collection ditches and routed to separate facility for containment and reclaim.	Anticipated to be contained by natural clay basin and clay lined dam with internal drain system with secondary downstream seepage collection and pump back system.	Anticipated to be contained by engineered liner in basin and upstream slopes of embankment with internal drain system and secondary downstream seepage collection and pump back system.	Anticipated to be contained by engineered liner in basin and upstream slopes of embankment with internal drain system and secondary downstream seepage collection and pump back system.	Anticipated to be contained by natural clay basin and clay lined dam with internal drain system with secondary downstream seepage collection and pump back system.	Tailings waste stockpiled on surface. Runoff collected by perimeter collection ditches and routed to separate facility for containment and reclaim.
Aquatic Habitat	Permanent Streams Impacted	Locations may impact one or more permanent streams	No. of Streams Directly Impacted	No	1 - Blackwater Creek may be permanently affected.	1 - Blackwater Creek may be permanently affected.	1 - Blackwater Creek may be permanently affected.	1 - Blackwater Creek may be permanently affected.	2 - Hughes Creek and Blackwater Creek may be permanently affected.	2 - Hughes Creek and Blackwater Creek may be permanently affected.	1 - Blackwater Creek may be permanently affected.	1 - Blackwater Creek may be permanently affected.
	Indirect impacts (downstream flow reductions)	Locations may have indirect impacts to downstream flows	No of Streams Potentially Indirectly Impacted	No	3 - Blackwater Creek, Hoffstroms Bay Creek may be permanently affect due to hydrological changes associated with dam and infrastructure development. Spring freshet level may be directly changed and total discharge volume for each creek may be adversely affected (Blackwater due to loss of tributary, and Hoffstroms Bay due to topographical change due to construction and flow variation).	3 - Blackwater Creek, Hoffstroms Bay Creek may be permanently affect due to hydrological changes associated with dam and infrastructure development. Spring freshet level may be directly changed and total discharge volume for each creek may be adversely affected (Blackwater due to loss of tributary, and Hoffstroms Bay due to topographical change due to construction and flow variation).	3 - Blackwater Creek, Hoffstroms Bay Creek may be permanently affect due to hydrological changes associated with dam and infrastructure development. Spring freshet level may be directly changed and total discharge volume for each creek may be adversely affected (Blackwater due to loss of tributary, and Hoffstroms Bay due to topographical change due to construction and flow variation).	3 - Blackwater Creek, Hoffstroms Bay Creek may be permanently affect due to hydrological changes associated with dam and infrastructure development. Spring freshet level may be directly changed and total discharge volume for each creek may be adversely affected (Blackwater due to loss of tributary, and Hoffstroms Bay due to topographical change due to construction and flow variation).	6 - Hughes Creek and Blackwater Creek may be permanently affected due to hydrological changes associated with damn and infrastructure development. Spring freshet levels may be directly changed and total discharge volume may be adversely affected (Blackwater Creek as the headwaters are in the TSF location and Hughes Creek due to tributary loss).	6 - Hughes Creek and Blackwater Creek may be permanently affected due to hydrological changes associated with damn and infrastructure development. Spring freshet levels may be directly changed and total discharge volume may be adversely affected (Blackwater Creek as the headwaters are in the TSF location and Hughes Creek due to tributary loss).	3 - Blackwater Creek may be permanently affected due to hydrological changes associated with dam and infrastructure development. Spring freshet level may be directly changed and total discharge volume for Blackwater Creek may be adversely affected (Blackwater due to loss of tributary).	3 - Blackwater Creek may be permanently affected due to hydrological changes associated with dam and infrastructure development. Spring freshet level may be directly changed and total discharge volume for Blackwater Creek may be adversely affected (Blackwater due to loss of tributary).
	Direct impact to open water	Various locations may impact open water	No of Water Bodies Directly Impacted	No	1 - Only impact associated with open water created by way of beaver dams on Blackwater Creek. Hydrological change to Blackwater Creek may cause flow concerns and abandonment of open water areas by local beaver population.	1 - Only impact associated with open water created by way of beaver dams on Blackwater Creek. Hydrological change to Blackwater Creek may cause flow concerns and abandonment of open water areas by local beaver population.	1 - Only impact associated with open water created by way of beaver dams on Blackwater Creek. Hydrological change to Blackwater Creek may cause flow concerns and abandonment of open water areas by local beaver population.	1 - Only impact associated with open water created by way of beaver dams on Blackwater Creek. Hydrological change to Blackwater Creek may cause flow concerns and abandonment of open water areas by local beaver population.	2 - Impact associated with open water created by beaver damns on Blackwater Creek and beaver damns within the Hughes Creek marshland, and Anderson road culvert dam. Loss of flow may lower water levels and in turn affect the local population at either of these locations.	2 - Impact associated with open water created by beaver damns on Blackwater Creek and beaver damns within the Hughes Creek marshland, and Anderson road culvert dam. Loss of flow may lower water levels and in turn affect the local population at either of these locations.	1 - Only impact associated with open water created by way of beaver dams on Blackwater Creek. Hydrological change to Blackwater Creek may cause flow concerns and abandonment of open water areas by local beaver population.	1 - Only impact associated with open water created by way of beaver dams on Blackwater Creek. Hydrological change to Blackwater Creek may cause flow concerns and abandonment of open water areas by local beaver population.
	Number of fish bearing lakes impacted	Various locations may impact fish bearing lakes	No of Fish Bearing Lakes Directly Affected	No	1 - Probable impact associated with Wabigoon Lake. Closest proximity to Thunder Lake, medium proximity to Wabigoon Lake.	1 - Probable impact associated with Wabigoon Lake. Closest proximity to Thunder Lake, medium proximity to Wabigoon Lake.	1 - Probable impact associated with Wabigoon Lake. Closest proximity to Thunder Lake, medium proximity to Wabigoon Lake.	1 - Probable impact associated with Wabigoon Lake. Closest proximity to Thunder Lake, medium proximity to Wabigoon Lake.	1 - Discharge would flow by way of Hughes or Blackwater Creek to Wabigoon Lake. Farthest from Wabigoon Lake and Thunder Lake	1 - Discharge would flow by way of Hughes or Blackwater Creek to Wabigoon Lake. Farthest from Wabigoon Lake and Thunder Lake	1 - Probable impact associated with Wabigoon Lake. Close proximity to Wabigoon Lake	1 - Probable impact associated with Wabigoon Lake. Close proximity to Wabigoon Lake
Terrestrial Habitat	Area of feeding or shelter loss due to TSF or associated structures.	Various locations may impact habitat of animals (moose, deer, bear etc)	No of Terrestrial Areas Directly Impacted	No.	1 - Impact area would be associated with footprint area associated with construction of TSF and associated infrastructure.	1 - Impact area would be associated with footprint area associated with construction of TSF and associated infrastructure.	1 - Impact area would be associated with footprint area associated with construction of TSF and associated infrastructure.	1 - Impact area would be associated with footprint area associated with construction of TSF and associated infrastructure.	1 - Impact area would be associated with footprint area associated with construction of TSF and associated infrastructure.	1 - Impact area would be associated with footprint area associated with construction of TSF and associated infrastructure.	1 - Impact area would be associated with footprint area associated with construction of TSF and associated infrastructure.	1 - Impact area would be associated with footprint area associated with construction of TSF and associated infrastructure.
	Existing vegetation, ecosystems will be lost	Various locations may impact wetlands, rare ecosystems, grasslands, forests and associated species.	Loss of Flora and Fauna	ha	FRI indicates that there are 6 varieties of forest type within the area (Ecosites include: Pine / Spruce / Feathermoss: Fresh Silty Soil, Spruce / Pine / Feathermoss: Fresh, Fine, Loamy-Clayey Soil, Hardwood-Fir-Spruce Mixedwood: Fresh, Fine, Loamy-Clayey Soil, Intermediate Swamp: Black Spruce (Tamarack), Organic Soil, Rich Swamp: Black Ash (Hardwoods), Organic Mineral Soil, Thicket Swamp: Mineral Soil). Birds and small mammals will be affected by development.	FRI indicates that there are 6 varieties of forest type within the area (Ecosites include: Pine / Spruce / Feathermoss: Fresh Silty Soil, Spruce / Pine / Feathermoss: Fresh, Fine, Loamy-Clayey Soil, Hardwood-Fir-Spruce Mixedwood: Fresh, Fine, Loamy-Clayey Soil, Intermediate Swamp: Black Spruce (Tamarack), Organic Soil, Rich Swamp: Black Ash (Hardwoods), Organic Mineral Soil, Thicket Swamp: Mineral Soil). Birds and small mammals will be affected by development.	FRI indicates that there are 6 varieties of forest type within the area (Ecosites include: Pine / Spruce / Feathermoss: Fresh Silty Soil, Spruce / Pine / Feathermoss: Fresh, Fine, Loamy-Clayey Soil, Hardwood-Fir-Spruce Mixedwood: Fresh, Fine, Loamy-Clayey Soil, Intermediate Swamp: Black Spruce (Tamarack), Organic Soil, Rich Swamp: Black Ash (Hardwoods), Organic Mineral Soil, Thicket Swamp: Mineral Soil). Birds and small mammals will be affected by development.	FRI indicates that there are 6 varieties of forest type within the area (Ecosites include: Pine / Spruce / Feathermoss: Fresh Silty Soil, Spruce / Pine / Feathermoss: Fresh, Fine, Loamy-Clayey Soil, Hardwood-Fir-Spruce Mixedwood: Fresh, Fine, Loamy-Clayey Soil, Intermediate Swamp: Black Spruce (Tamarack), Organic Soil, Rich Swamp: Black Ash (Hardwoods), Organic Mineral Soil, Thicket Swamp: Mineral Soil). Birds and small mammals will be affected by development.	FRI indicates that there are different varieties of forest type within the area (Ecosites include: (Poor Swamp: Black Spruce, Organic Soil, Intermediate Swamp: Black Spruce (Tamarack), Organic Soil, Treed Bog: Black Spruce, Organic Soil, Treed Fen: Tamarack-Black Spruce / Sphagnum, Organic Soil, Spruce - Pine / Feathermoss: Fresh, Sandy-Coarse Loamy Soil). Birds and small mammals will be affected by development.	FRI indicates that there are different varieties of forest type within the area (Ecosites include: (Poor Swamp: Black Spruce, Organic Soil, Intermediate Swamp: Black Spruce (Tamarack), Organic Soil, Treed Bog: Black Spruce, Organic Soil, Treed Fen: Tamarack-Black Spruce / Sphagnum, Organic Soil, Spruce - Pine / Feathermoss: Fresh, Sandy-Coarse Loamy Soil). Birds and small mammals will be affected by development.	FRI indicates that there are 7 varieties of forest type within the area (Ecosites include: Thicket Swamp: Mineral Soil, Shore Fen: Organic Soil, Fir - Spruce Mixedwood: Fresh, Coarse, Loamy Soil, Rock Barren, Hardwood-Fir-Spruce Mixedwood: Fresh, Fine, Loamy-Clayey Soil, Fir - Spruce Mixedwood: Moist, Silty-Clayey Soil). Birds and small mammals will be affected by development.	FRI indicates that there are 7 varieties of forest type within the area (Ecosites include: Thicket Swamp: Mineral Soil, Shore Fen: Organic Soil, Fir - Spruce Mixedwood: Fresh, Coarse, Loamy Soil, Rock Barren, Hardwood-Fir-Spruce Mixedwood: Fresh, Fine, Loamy-Clayey Soil, Fir - Spruce Mixedwood: Moist, Silty-Clayey Soil). Birds and small mammals will be affected by development.
Air Quality	Potential for Dust Emission (contributed by trucks)	Longer haul distances will increase potential dust contribution.	Length of Access Roads	km	No hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	No hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	Shortest haul distance related to tailings placement. Daily traffic required for tailings placement. Also traffic related to operations, maintenance and surveillance.	No hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	No hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	No hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	No hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	Longest haul distance related to tailings placement. Daily traffic required for tailings placement. Also traffic related to operations, maintenance and surveillance.
	Potential for Dust Emission (Contributed by tailings)	Potential for Deposited Tailings to produce Dust	Type of tailings technology used and potential dust generation	Rank	Lowest potential for dusting based on water storage within facility maintaining tailings beach in wet conditions.	Increased potential from conventional tailings based on potential less water being stored in facility.	Highest potential for dusting.	Lowest potential for dusting based on water storage within facility maintaining tailings beach in wet conditions.	Lowest potential for dusting based on water storage within facility maintaining tailings beach in wet conditions.	Increased potential from conventional tailings based on potential less water being stored in facility.	Lowest potential for dusting based on water storage within facility maintaining tailings beach in wet conditions.	Highest potential for dusting.
	Potential for Greenhouse Gas Emission (number of truck hours)	Increased truck traffic will increase potential for Greenhouse Gas Emissions.	Qualitative Rank of Potential Greenhouse Gas Emissions	Rank	Lowest potential, no hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	Lowest potential, no hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	Highest potential based on truck hauling used for tailings deposition.	Lowest potential, no hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	Lowest potential, no hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	Lowest potential, no hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	Lowest potential, no hauling of tailings required for tailings disposal. Traffic related to operations, maintenance and surveillance.	Highest potential based on truck hauling used for tailings deposition.
	Noise	Increased truck traffic will increase noise pollution	Qualitative rank - estimate of noise generation from truck traffic based on tailings disposal technology	Rank	Low noise generation	Low noise generation	High noise generation from truck traffic	Low noise generation	Low noise generation	Low noise generation	Low noise generation	High noise generation from truck traffic

Technical Account												
Sub-Account	**Description**	**Rationale**	**Indicator Parameter**	**Unit**	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**6A**	**6C**
Design	Foundation Conditions	Conditions of the foundation may be undesirable and may require additional stability measures	Qualitative Rank of Foundation Conditions	Rank	Natural ground in the area generally consisting of clay materials. Potential containment in basin area.	Natural ground in the area generally consisting of clay materials. Potential containment in basin area.	Natural ground in the area generally consisting of clay materials. Potential containment in basin area.	Natural ground in the area generally consisting of clay materials. Potential containment in basin area.	Natural ground in the area generally consisting of sands and gravels. Not suitable for basin containment.	Natural ground in the area generally consisting of sands and gravels. Not suitable for basin containment.	Potentially consisting of clay to bedrock knobs.	Potentially consisting of clay to bedrock knobs.
	Distance from Plant	Longer distance results in more access roads (or haul roads for dry stack) and pipeline construction, more pumping energy and potential booster stations (for conventional slurry or paste)	Distance From Plant Site to Far End of Facility for pipeline or haul road.	m	Closest proximity to plant site.	Closest proximity to plant site.	Closest proximity to plant site.	Closest proximity to plant site.	farthest proximity to plant site	farthest proximity to plant site	Medium proximity to plant site	Medium proximity to plant site.
	Topographic Complexity	More complex topography may constrain approaches to type of seepage ditch construction (based on expected flow velocity)	Qualitative Rank of Topographic Complexity	Rank	Local topography can be used to reduce embankment heights.	Favourable topography for paste tailings. Local topography can be used to minimize dam embankments.	Local topography favourable for tailings placement.	Local topography can be used to reduce embankment heights. Directing tailings underground in future years operations will also reduce required embankment heights. Minimal topographic change from the plant site.	local topography can be used to establish embankment layouts. Topography can be used for seepage collection.	Local topography can be used to establish embankment layouts. Largest topographic difference to the plant site at ~50 m elevation difference.	Undulating topography present, can be used to establish perimeter embankments. Potential bedrock can hinder establishing perimeter ditches.	Undulating topography will require operational planning for tailings placement.
	Topography	Elevation difference between processing plant and tailings storage facility affects pumping requirements	Elevation Difference From Plant Site at final Embankment Arrangement. For tailings pumping.	m	Medium topographic change from the plant site	Medium topographic change from the plant site	No tailings pumping	Medium topographic change from the plant site	Largest topographic difference to the plant site	Largest topographic difference to the plant site	Location is at equal or lower elevation difference from the plant site. Some topographic undulation between plant site and location.	No tailings pumping
	Dam Complexity	More complex dam design will result in more difficult construction requirements and associated monitoring conditions	Qualitative Rank of Dam Complexity	Rank	Zoned earthfill with low permeable clay layer or liner material. Foundation favourable for foundation key-in. Dam can be raised during operations.	Zoned earthfill with low permeable clay layer or liner material. Foundation favourable for foundation key-in. Dam can be raised during operations. Lower embankment heights resulting from higher in situ density conditions.	Containment dam for water collection and reclaim, separate facility from dry stack pile.	Zoned earthfill with low permeable clay layer or liner material. Foundation favourable for foundation key-in. Dam can be raised during operations. Anticipated lower dam heights with portion of tailings waste directed to the mine workings for storage.	Zoned earthfill with low permeable clay layer or liner material. Foundation anticipated to consist of sand or gravel that will require basin lining. Dam can be raised during operations.	Zoned earthfill with low permeable clay layer or liner material. Foundation anticipated to consist of sand or gravel that will require basin lining. Dam can be raised during operations. Lower embankment heights resulting from higher in situ density conditions.	Zoned earthfill with low permeable clay layer or liner material. Foundation may consist of rock that will be more complex for embankment key-in or liner anchorage. Foundation consisting of rock will provide good embankment stability. Dam can be raised during operations.	Containment dam for water collection and reclaim, separate facility from dry stack pile.
	Dam Hazard Classification	Based on classification systems, various designs can be assessed a hazard classification	CDA Dam Classification Estimate	Classification	HPC will be dependant on Environmental considerations and proximity to the plant site.	HPC will be dependant on Environmental considerations and proximity to the plant site.	HPC based on WCP	HPC will be dependant on Environmental considerations and proximity to the plant site.	HPC will be dependant on Environmental considerations.	HPC will be dependant on Environmental considerations.	Anticipated to require a higher HPC due to proximity to Hwy 17 and Wabigoon Lake.	HPC based on WCP
	Construction Material Availability	Areas closer to confirmed borrow pit sources and amount of material required to construct dams	Qualitative Rank of Construction Material Availability	Rank	Close to local clay borrow source and mine waste rock that will be provided from the open pit mining area. Adjacent to established roads for materials hauled from external sources.	Close to local clay borrow source and mine waste rock that will be provided from the open pit mining area. Adjacent to established roads for materials hauled from external sources.	Close to local clay borrow source and mine waste rock that will be provided from the open pit mining area. Adjacent to established roads for materials hauled from external sources.	Close to local clay borrow source and mine waste rock that will be provided from the open pit mining area. Adjacent to established roads for materials hauled from external sources.	Farther distance that Location 1 and 6 for local borrow sources, mine waste rock and external supplied materials. Will also require establishing construction roads for access.	Farther distance that Location 1 and 6 for local borrow sources, mine waste rock and external supplied materials. Will also require establishing construction roads for access.	Closest proximity for local borrow material, mine waste rock and also external supplied materials than Location 1 and 2.	Closest proximity for local borrow material, mine waste rock and also external supplied materials than Location 1 and 2.
	Slope Stability	Taller slopes required to achieve the required volume while minimizing footprint increases risk of instability	Preliminary Estimate of Total Embankment Height	m	24	22	18 (estimate of final height of tailings pile)	22	30	29	34	27 (estimate of final height of tailings pile)
	Slope Stability	Steeper slopes required to achieve the required volume while minimizing footprint increases risk of instability	Estimate of Slope Angle during operations	H:V	1.5H:1V	1.5H:1V	2.1H:1V	1.5H:1V	1.5H:1V	1.5H:1V	1.5H:1V	2.1H:1V
	Number of Watersheds	Larger footprints may impact more than one watershed and require additional drainage measures for settling ponds or water collection ditching.	No. of Primary Watersheds	No.	See Environmental Account Above.							

TABLE 4.3

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 3 - ALTERNATIVE CHARACTERIZATION

Operations	Distance between storage facility and Mill Site	Longer access road requirements, longer transport distance for tailings materials required increased surveillance and potential for spills outside of containment areas.	Distance from Plant Site to Far End of Facility	m	2,200	2,200	2,200	2,200	5,200	5,200	2,400	2,400
	Operational Risks and Other Uncertainties	Various depositional technologies and locations may have additional operational risks	Qualitative Rank of operations assessment based on tailings and water management .	Rank	Tailings solids and water management contained within perimeter embankments. Water reclaim from the facility.	Tailings and water storage within single containment facility, potential requirements for further containment for water management. Capacity dependant on achieving consistent beach slopes and in situ densities in summer and winter conditions.	Tailings solids not contained within perimeter embankments. Potential dusting issue in summer. Potential to trap ice lenses in lifts. Will require snow removal during winter operations. Requires collection and containment of surface water runoff.	Tailings solids and water management contained within perimeter embankments. Water reclaim from the facility. Portion of tailings requires thickening and direction to the underground that reduces volume of tailings operations within the facility.	Tailings solids and water management contained within perimeter embankments. Water reclaim from the facility.	Tailings and water storage within single containment facility, potential requirements for further containment for water management. Capacity dependant on achieving consistent beach slopes and in situ densities in summer and winter conditions.	Tailings solids and water management contained within perimeter embankments. Water reclaim from the facility.	Tailings solids not contained within perimeter embankments. Potential dusting issue in summer. Potential to trap ice lenses in lifts. Will require snow removal during winter operations. Requires collection and containment of surface water runoff.
	Water Treatment Requirements	The depositional technologies have various water treatment requirements	Estimate of Water Treatment Volume	m^3	Highest anticipated volume of water released to supernatant pond. Facility required to provide storage of surplus water for direction to treatment.	Medium volume of water released to supernatant pond. May require inclusion of secondary water management facility during the operations.	Tailings dewatered at the plant site prior to being stored at the facility. Water treatment from runoff collection from stored tailings and other water collection at the site.	Highest volume of water released to supernatant pond. Facility required to provide storage of surplus water for direction to treatment.	Highest volume of water released to supernatant pond. Facility required to provide storage of surplus water for direction to treatment.	Medium volume of water released to supernatant pond. May require inclusion of secondary water management facility	Highest volume of water released to supernatant pond. Facility required to provide storage of surplus water for direction to treatment.	Tailings dewatered at the plant site prior to being stored at the facility. Water treatment from runoff collection from stored tailings and other water collection at the site.
Closure	Remediation Requirements	Complexity of Remediation requirements for Closure	Quantitative Rank of Remediation Requirements	Rank	Highest complexity, requiring facility closure (stabilize slopes) and surface water management design.	Medium to High complexity, requiring closure of facility.	Lowest complexity, requiring closure and capping of facility and providing stable final surfaces.	Highest complexity, requiring facility closure and water management design.	Highest complexity, requiring facility closure and water management design.	Medium to High complexity, requiring closure of facility.	Highest complexity, requiring facility closure and water management design.	Lowest complexity, requiring closure and capping of facility and providing stable final surfaces.
	Post Closure Water Treatment Requirements	Post Closure water treatment requirements may be more involved for various options.	Quantities Rank of Potential Post Closure Water Treatment Requirements	Rank	Potential short-term water treatment until facility is closed.	Potential short-term water treatment until facility is closed.	Potential long-term water treatment requirements - to be determined with monitoring of seepage and runoff after closure activities are completed.	Potential short-term water treatment until facility is closed.	Potential short-term water treatment until facility is closed.	Potential short-term water treatment until facility is closed.	Potential short-term water treatment until facility is closed.	Potential long-term water treatment requirements - to be determined with monitoring of seepage and runoff after closure activities are completed.
	Post Closure Landform Stability	Various landform designs may be more stable than others	Qualitative Rank - Estimate of Post Closure Landform Stability	Rank	Closure requires long-term stability of embankments, potential grading of slopes, medium embankment height	Closure requires long-term stability of embankments, potential grading of slopes, medium embankment height	Closure requires long-term stability of tailings pile slopes, may require regrading at closure for placement of cover material, lower final height.	Closure requires long-term stability of embankments, potential grading of slopes, medium embankment height	Closure requires long-term stability of embankments, potential grading of slopes, higher final embankment height	Closure requires long-term stability of embankments, potential grading of slopes, higher final embankment height	Closure requires long-term stability of embankments, potential grading of slopes, higher final embankment height	Closure requires long-term stability of tailings pile slopes, may require regrading at closure for placement of cover material, lower to medium final height.
	Post Closure Chemical Stability	Various closure plans may allow for more chemical stability	Qualitative Rank - Estimate of Post Closure Chemical Stability	Rank	Closure anticipated to consist of capping final tailings surface with low permeable liner or clay material and inclusion of a shedding cover with revegetation to prevent water infiltration into deposited tailings.	Closure anticipated to consist of capping final tailings surface with low permeable liner or clay material and inclusion of a shedding cover with revegetation to prevent water infiltration into deposited tailings.	Closure anticipated to consist of capping final tailings surface with low permeable clay material and revegetation.	Closure anticipated to consist of capping final tailings surface with low permeable liner or clay material and inclusion of a shedding cover with revegetation to prevent water infiltration into deposited tailings.	Closure anticipated to consist of capping final tailings surface with low permeable liner or clay material and inclusion of a shedding cover with revegetation to prevent water infiltration into deposited tailings.	Closure anticipated to consist of capping final tailings surface with low permeable liner or clay material and inclusion of a shedding cover with revegetation to prevent water infiltration into deposited tailings.	Closure anticipated to consist of capping final tailings surface with low permeable liner or clay material and inclusion of a shedding cover with revegetation to prevent water infiltration into deposited tailings.	Closure anticipated to consist of capping final tailings surface with low permeable clay material and revegetation.
Capacity	Tailings Storage Expansion Capacity	Some geographical locations and designs may allow for additional expansion requirements more easily than others	Qualitative Rank of Potential Expansion	Rank	Area is favourable to expansion for additional tailings storage through embankment raising.	Area is favourable to expansion for additional tailings storage through embankment raising.	Area is favourable to expansion for additional tailings storage with increases to footprint area or increased pile heights.	Area is favourable to expansion for additional tailings storage through embankment raising.	Area is favourable to expansion for additional tailings storage through embankment raising.	Area is favourable to expansion for additional tailings storage through embankment raising.	Area is less favourable to expansion due to local topography and adjacent property boundaries.	Area is less favourable to expansion due to local topography and adjacent property boundaries.
	Storage Efficiency	Designs may be more efficient than others at storing tailings	Storage Capacity Volume per Construction Material Volume	m^3/m^3	5	5.3	>7	5.2	4.6	4.1	2.4	>7
Water Management	Sensitivity to Climate Variability	Some locations and other influences can produce options that are more sensitive to climate variability	Qualitative Rank of climate sensitivity	Rank	moderate sensitivity to climate variability, requires reclaim from pond during winter with ice buildup in pond.	moderate to high sensitivity, requires reclaim from pond during winter with ice buildup in pond.	low to moderate sensitivity, requires reclaim from pond during winter with ice buildup in pond.	moderate sensitivity to climate variability, requires reclaim from pond during winter with ice buildup in pond.	moderate sensitivity to climate variability, requires reclaim from pond during winter with ice buildup in pond.	moderate to high sensitivity, requires reclaim from pond during winter with ice buildup in pond.	moderate sensitivity to climate variability, requires reclaim from pond during winter with ice buildup in pond.	low to moderate sensitivity, requires reclaim from pond during winter with ice buildup in pond.
	Surface Water Control Measures	Various options may require more complex surface water control measures	Qualitative Rank of Surface Water Control	Rank	Low complexity, consisting of containment within facility and reclaim from the facility. To be completed with surface water operational plan.	Moderate complexity. Bleed water anticipated, management within Cell 2 during initial phase of operations. Additional water management facility required in second phase of operations and required to store water from mine dewatering.	Moderate to High complexity. Surface water management required consisting of runoff from tailings pile and surrounding catchment runoff management. Separate facility required to store water from mine dewatering.	Low complexity, consisting of containment within facility and reclaim from the facility. To be completed with surface water operational plan. Less process water with portion of the tailings being directed to the underground.	Low complexity, consisting of containment within facility and reclaim from the facility. To be completed with surface water operational plan.	Moderate complexity. Bleed water anticipated, water management will include separate facility to manage surface water and mine dewatering.	Low complexity, consisting of containment within facility and reclaim from the facility. To be completed with surface water operational plan.	Moderate to High complexity. Surface water management required consisting of runoff from tailings pile and surrounding catchment runoff management. Separate facility required to store water from mine dewatering.
	Seepage Control Measures	Ability to restrict the migration of mine water	Qualitative Rank of Seepage Control	Rank	Seepage control with low permeable clay or liner materials. Collection of seepage with downstream ditching and pump back system.	Seepage control with low permeable clay or liner materials. Collection of seepage with downstream ditching and pump back system.	Seepage control with foundation liners (natural or product) and perimeter containment ditching.	Seepage control with low permeable clay or liner materials. Collection of seepage with downstream ditching and pump back system.	Seepage control with low permeable clay or liner materials. Collection of seepage with downstream ditching and pump back system.	Seepage control with low permeable clay or liner materials. Collection of seepage with downstream ditching and pump back system.	Seepage control with low permeable clay or liner materials. Collection of seepage with downstream ditching and pump back system.	Seepage control with foundation liners (natural or product) and perimeter containment ditching.

Economic Account

Sub-Account	Description	Rationale	Indicator Parameter	Unit	1A	1B	1C	1D	2A	2B	6A	6C
Life of Mine Costs	Capital	Larger Capital Costs will result in a decreased project return.	Factored Cost Ranking	Rank	34.5	28.8	9.9	29.1	119.3	113.4	54.1	6.3
	Operational	Larger Operational costs will result in a decreased project return	Factored Cost Ranking	Rank	2.9	10.9	31.3	10.9	3.7	11.7	3.1	31.3
	Fish Habitat Compensation	Increased fish habitat impacts increases compensation costs (including bonding, capital and monitoring)	Factored Cost Ranking	Rank	Not Assessed - Each Alternative Assigned a Neutral Rating							
	Closure and Reclamation Costs	More complex dam design will result in more difficult construction requirements and associated monitoring conditions	Factored Cost Ranking	Rank	18.4	18.4	10.8	18.4	51.5	51.5	11.5	7.4

Socio-Economic Account

Sub-Account	Description	Rationale	Indicator Parameter	Unit	1A	1B	1C	1D	2A	2B	6A	6C
Archaeology	Archaeological Potential	Tailings Storage Facility that impacts archaeological resources will potentially require additional investigation, permitting and may attract adverse public concern	Area of direct impact and archaeological potential	ha/potential	No archeological potential.	No archeological potential.	No archeological potential.	No archeological potential.	No archeological potential.	No archeological potential.	No archeological potential.	No archeological potential.
Health and Safety	Risk to Human Health	Tailings facilities that can generate tailings dust or potential discharge of untreated water can cause adverse affects to human health.	Qualitative Rank of Human Health Risk	Rank	Medium to High risk based on water management	Medium to High risk based on water management	High risk based on potential surface dusting	Medium to High risk based on water management	Medium risk based on lower embankments and water management.	Medium risk based on lower embankments and water management.	High Risk based on high dams and water management	High risk based on potential surface dusting
	Risk to Public Safety	Facilities with significant embankment heights can be less stable. Facilities without perimeter containment can be higher risk. Facilities dependant on water management can be higher risk if unwanted water is released from the facility.	Qualitative Rank of Public Safety Risk	Rank	Medium risk based on dam heights and water management	Medium risk based on dam heights and water management	Low to Medium risk based on reduced water management and tailings storage arrangement	Medium risk based on dam heights and water management	Low risk based on location and water management	Low risk based on location and water management	Medium risk based on dam heights and water management	Low to Medium risk based on reduced water management and tailings storage arrangement
	Risk to Worker Safety	Facilities that are upstream of other operating facilities or require increased manpower for operations can be higher risk to worker safety.	Qualitative Rank of Worker Safety Risk	Rank	Medium to High risk based on location and required operations.	Medium to High risk based on location and required operations.	High risk based on required daily operations.	Medium to High risk based on location and required operations.	Medium risk based on location and required operations.	Medium risk based on location and required operations.	High risk based on location and operations	High risk based on location and operations
Socio-Economic Indicators	Economic Benefits to Regional Communities	Facilities requiring start-up and future construction activities as well as on-going operations can beneficial to the regional community.	Qualitative Rank of Economic Benefits to Community	Rank	Medium Impact with initial construction costs, on-going construction costs, low operation costs.	Medium Impact with initial construction costs, on-going construction costs, low operation costs.	Low - Medium based on low initial construction costs and higher operational costs.	Medium Impact with initial construction costs, on-going construction costs, low operation costs.	Medium - High Impact with initial construction costs, on-going construction costs, low operation costs.	Medium - High Impact with initial construction costs, on-going construction costs, low operation costs.	Medium Impact with initial construction costs, on-going construction costs, low operation costs.	Low - Medium based on low initial construction costs and higher operational costs.
	Regional Job Creation and Diversity	Potential job creation for start-up construction, potential future construction or on-going operations.	Qualitative Rank of Job Creation - Employment Numbers	Rank	Medium indirect employment with initial construction costs, future construction costs and with low impact as TSF becomes operational to closure.	Medium indirect employment with initial construction costs, future construction costs and with low impact as TSF becomes operational to closure.	Low - Medium - Low initial costs to construct with higher employment as operational staff is greater in nature then traditional tailings facility.	Medium indirect employment with initial construction costs, future construction costs and with low impact as TSF becomes operational to closure.	Medium - High indirect employment with initial construction costs, future construction costs and with low impact as TSF becomes operational to closure.	Medium - High indirect employment with initial construction costs, future construction costs and with low impact as TSF becomes operational to closure.	Medium - High indirect employment with initial construction costs, with low impact as TSF becomes operational to closure.	Low - Medium - Low initial costs to construct with higher employment as operational staff is greater in nature then traditional tailings facility.
	Indirect Employment	Direct relation of Regional Job Creation.	Qualitative Rank of Potential Indirect Employment	Rank	Low to Medium indirect employment with initial construction costs, with low impact as TSF becomes operational to closure.	Low to Medium indirect employment with initial construction costs, with low impact as TSF becomes operational to closure.	Low - initial costs to construct with medium indirect employment as operational staff is greater in nature then traditional tailings facility.	Low to Medium indirect employment with initial construction costs, with low impact as TSF becomes operational to closure.	Low to Medium indirect employment with initial construction costs, with low impact as TSF becomes operational to closure.	Low to Medium indirect employment with initial construction costs, with low impact as TSF becomes operational to closure.	Low to Medium indirect employment with initial construction costs, with low impact as TSF becomes operational to closure.	Low - initial costs to construct with medium indirect employment as operational staff is greater in nature then traditional tailings facility.
First Nation Impacts	Aboriginal Rights	Potential impacts to identified areas of Aboriginal Rights	Qualitative Rank of Local Aboriginal Rights	Rank	Medium	Medium	Medium	Medium	Low	Low	Low	Low
	Extent of Traditional Land Use	Potential impacts to Traditional Land Use by Person	Qualitative Rank of Traditional Land Use	Rank	Medium	Medium	Medium	Medium	Low	Low	Low	Low
	Extent of Traditional Land Use	Potential impacts to Traditional Land Use by Activity	Qualitative Rank of Traditional Land Use	Rank	3 - Traditional uses of the area include that of berry picking, hunting, trapping, and mushroom picking.	3 - Traditional uses of the area include that of berry picking, hunting, trapping, and mushroom picking.	3 - Traditional uses of the area include that of berry picking, hunting, trapping, and mushroom picking.	3 - Traditional uses of the area include that of berry picking, hunting, trapping, and mushroom picking.	2 - Traditional uses of the area due to access issues are assumed to be hunting and trapping needs.	2 - Traditional uses of the area due to access issues are assumed to be hunting and trapping needs.	1 - Due to access concerns and the presence of private and Company own land this area has been only used for hunting.	1 - Due to access concerns and the presence of private and Company own land this area has been only used for hunting.
Recreational and Commercial Land Use	Visual Impact	Potential impact of facility above potential sight lines	Extent of structure above topography and sight lines	m	Low - Medium - TSF and Embankment system is in close proximity to the road network and the open pit. However due to tree height and associated topography dam will be visible in a limited fashion.	Low - Medium - TSF and Embankment system is in close proximity to the road network and the open pit. However due to tree height and associated topography dam will be visible in a limited fashion.	Low - Due to tree height and associated topography, dam and infrastructure will be visible in a limited fashion.	Low - Medium - TSF and Embankment system is in close proximity to the road network and the open pit. However due to tree height and associated topography dam will be visible in a limited fashion.	Low - TSF area is located at the furthest location from local community and road network.	Low - TSF area is located at the furthest location from local community and road network.	Low - Medium - TSF and Embankment system is in close proximity to the road network and the open pit. In initial stages of development dam may be visible from Thunder Lake as WRSA may not provide a visual buffer.	Low - Due to tree height and associated topography, dam and infrastructure will be visible in a limited fashion.
	Impact to Navigable Waters	Facility impact to established waterways used for travel	Area of Direct Impact	ha	0 - No impact to navigable waters throughout course of project.	0 - No impact to navigable waters throughout course of project.	0 - No impact to navigable waters throughout course of project.	0 - No impact to navigable waters throughout course of project.	0 - No impact to navigable waters throughout course of project.	0 - No impact to navigable waters throughout course of project.	0 - No impact to navigable waters throughout course of project.	0 - No impact to navigable waters throughout course of project.
	Extent of Recreational Land Use	Facility negatively impacting Recreational Land Use.	Qualitative Rank of Recreational Use	Rank	Low - Medium, concern for recreational activity as traditional use for area include berry picking, hunting, trapping, and mushroom picking. However area is under private property therefore activities have been limited .	Low - Medium, concern for recreational activity as traditional use for area include berry picking, hunting, trapping, and mushroom picking. However area is under private property therefore activities have been limited .	Low - Medium, concern for recreational activity as traditional use for area include berry picking, hunting, trapping, and mushroom picking. However area is under private property therefore activities have been limited .	Low - Medium, concern for recreational activity as traditional use for area include berry picking, hunting, trapping, and mushroom picking. However area is under private property therefore activities have been limited .	Low, limited recreational activities due to access issues. Limited to hunting and trapping.	Low, limited recreational activities due to access issues. Limited to hunting and trapping.	Low, limited recreational activities due to access and private	Low, limited recreational activities due to access and private
	Extent of Commercial Land Use	Facility negatively impacting Commercial Land Use.	Qualitative Rank of Commercial Use	Rank	0 - No impact to commercial land use.	0 - No impact to commercial land use.	0 - No impact to commercial land use.	0 - No impact to commercial land use.	0 - No impact to commercial land use.	0 - No impact to commercial land use.	0 - No impact to commercial land use.	0 - No impact to commercial land use.

Alternative Identification	Description
1A	Location 1- Conventional Slurry Tailings
1B	Location 1 - Thickened Tailings
1C	Location 1 - Filtered/Dry Stack Tailings
1D	Location 1 - Conventional with Future Co-Disposal
2A	Location 2- Conventional Slurry Tailings
2B	Location 2- Thickened Tailings
6A	Location 6 - Conventional Slurry Tailings
6C	Location 6 - Filtered/Dry Stack Tailings

Notes:

1. Indicators that can not be quantified have been assigned a rank to enable comparison for assessment.

TABLE 4.4

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 4 - MULTIPLE ACCOUNTS LEDGER FOR CANDIDATE ALTERNATIVES

Environmental Account				Indicator Quantity							
Sub-Account	**Description**	**Indicator**	**Indicator Parameter**	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**6A**	**6C**
Land Use	Distance from the Mine	Direct Distance from Plant Site to Structure	m	400	400	400	400	2,200	2,200	1,400	1,400
	Pipeline/Access Road Requirements	Length of Additional Infrastructure Required	m	700	700	700	700	2,400	2,400	1,500	1,500
	Storage Facility and Associated Infrastructure Footprint	Estimate of Storage Facility(s) Area	ha	88	88	100	88	246	246	54	61
Water Impacts	Number of Main Watersheds directly impacted	Number of Watersheds directly impacted	No	1	1	1	1	1	1	1	1
	Impact to surface water availability	Qualitative Estimate of Potential Surface Water	Rank	Medium - High	Medium - High	Medium - High	Medium - High	High	High	Medium	Medium
	Potential Impacts to Water Quality (ARD, Metal Leaching, etc)	Likelihood of Mining Impacts and mitigative measures required	Rank	Low - Medium	Medium	High	Low - Medium	Low - Medium	Medium	Low - Medium	High
Aquatic Habitat	Permanent Streams Impacted	No. of Streams Directly Impacted	No	1	1	1	1	2	2	1	1
	Indirect impacts (downstream flow reductions)	No of Streams Potentially Indirectly Impacted	No	3	3	3	3	6	6	3	3
	Direct impact to open water	No of Water Bodies Directly Impacted	No	1	1	1	1	1	1	1	1
	Fish Bearing Lakes	No of Fish Bearing Lakes Directly Affected	No	1	1	1	1	1	1	1	1
Terrestrial Habitat	Area of feeding or shelter loss due to TSF or associated structures.	No of Terrestrial Areas Directly Impacted	No	1	1	1	1	1	1	1	1
	Existing vegetation, ecosystems will be lose	Potential Loss to flura and Fana with construction and operations	ha	88	88	100	88	246	246	54	61
Air Quality	Potential for Dust Emission (contributed by trucks)	Length of Access Roads	km	0	0	700	0	0	0	0	1,500
	Potential for Dust Emission (Contributed by tailings)	Type of tailings technology used and potential dust generation	Rank	Low	Low to Medium	Medium to High	Low	Low	Low to Medium	Low	Medium to High
	Potential for Greenhouse Gas Emission (number of truck hours)	Qualitative Rank of Potential Greenhouse Gas Emissions	Rank	Low	Low	High	Low	Low	Low	Low	High
	Noise	Qualitative rank - estimate of noise generation from truck traffic based on tailings disposal technology	dB	Low	Low	High	Low	Low	Low	Low	High

Technical Account				Indicator Quantity							
Sub-Account	**Description**	**Indicator**	**Indicator Parameter**	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**6A**	**6C**
Design	Foundation Conditions	Qualitative Rank of Foundation Conditions	Rank	Anticipated to consist of clay over bedrock to sands and gravels.	Anticipated to consist of clay over bedrock to sands and gravels.	Anticipated to consist of clay over bedrock to sands and gravels.	Anticipated to consist of clay over bedrock to sands and gravels.	Anticipated to consist of sands and gravels	Anticipated to consist of sands and gravels	Anticipated to consist of clay to bedrock knob to swamp and organic material.	Anticipated to consist of clay to bedrock knob to swamp and organic material.
	Distance From Plant Site	Distance From Plant Site to Far End of Facility for pipeline or haul road.	m	2,200	2,200	2,200	2,200	5,200	5,200	2,400	2,400
	Topographic Complexity	Qualitative Rank of Topographic Complexity	Rank	Topography provides good use of undulating elevations for embankment construction and future raising. Suitable for tailings and water management	Topography provides good use of undulating elevations for embankment construction and future raising. Suitable for tailings and water management	Topography is suitable for storage of tailings solids. Area can also be used for water management.	Topography provides good use of undulating elevations for embankment construction and future raising. Suitable for tailings and water management	Topography provides good use of undulating elevations for embankment construction and future raising. Suitable for tailings and water management	Topography provides good use of undulating elevations for embankment construction and future raising. Suitable for tailings and water management	Topography could provide some challenges to embankment construction and raising due to potential bedrock outcropping. Some potential challenges to tailings management in initial years of operations.	Potential challenges to construction and tailings management due to undulating topography. Potential challenges to collection of surface water runoff.
	Topography	Elevation Difference From Plant Site at final Embankment Arrangement. For tailings pumping.	m	27	25	No Pumping	25	35	34	24	No Pumping
	Dam Complexity	Qualitative Rank of Dam Complexity	Rank	Zoned Earthfill with foundation key-in	Zoned Earthfill with foundation key-in	Berm and Ditch Containment	Zoned Earthfill with foundation key-in	Zoned Earthfill, foundation key-in with liner product	Zoned Earthfill, foundation key-in with liner product	Zoned earthfill, potential bedrock key-in.	Zoned earthfill, potential bedrock key-in.
	Dam Hazard Classification	CDA Dam Classification, MNR Dam Classification	CDA Dam Classification Estimate	High	High	High	High	High	High	Very High	Very High
	Construction Material Availability	Qualitative Rank of Construction Material Availability	Qualitative Rank of Construction Material Availability	Medium distance to potential clay borrow source at Open Pit Mine and material hauled in from off-site.	Medium distance to potential clay borrow source at Open Pit Mine and material hauled in from off-site.	Medium distance to potential clay borrow source at Open Pit Mine and material hauled in from off-site.	Medium distance to potential clay borrow source at Open Pit Mine and material hauled in from off-site.	Farthest distance from potential clay source at Open Pit Mine and material hauled in from off-site.	Farthest distance from potential clay source at Open Pit Mine and material hauled in from off-site.	Closest distance to potential clay borrow source at Open Pit Mine and material hauled in from off-site.	Closest distance to potential clay borrow source at Open Pit Mine and material hauled in from off-site.
	Slope Stability	Preliminary Estimate of Total Embankment Height	m	24	22	18	22	30	29	34	27
	Slope Stability	Estimate of Slope Angle during operations	H:V	1.5H:1V	1.5H:1V	2.1H:1V	1.5H:1V	1.5H:1V	1.5H:1V	1.5H:1V	2.1H:1V
	Number of Watersheds	No. of Primary Watersheds	No	1	1	1	1	1	1	1	1
Operations	Operation Distance	Distance From Plant Site to Far End of Facility	m	2,200	2,200	2,200	2,200	5,200	5,200	2,400	2,400
	Operational Risks and Other Uncertainties	Qualitative Rank of operations assessment based on tailings and water management .	Rank	Requires tailings deposition planning and operational management with consideration of seasonal influences for water management. Water management requires several reclaim lines and monitoring.	Requires tailings deposition planning and operational management. Potential seasonal influence on tailings deposition. Water management may require two facilities and several reclaim lines and monitoring.	Requires truck placement of tailings. Seasonal influences will require snow clearing of tailings area and potential ice lensing in placed tailings. Water management in separate facility with reclaim line.	Requires tailings deposition planning and operational management with consideration of seasonal influences for water management. Water management requires several reclaim lines and monitoring.	Requires tailings deposition planning and operational management with consideration of seasonal influences for water management. Water management requires several reclaim lines and monitoring.	Requires tailings deposition planning and operational management. Potential seasonal influence on tailings deposition. Water management may potential require two facilities and several reclaim lines and monitoring.	Requires tailings deposition planning and operational management with consideration of seasonal influences for water management. Water management requires several reclaim lines and monitoring.	Requires truck placement of tailings. Seasonal influences will require snow clearing of tailings area and potential ice lensing in placed tailings. Water management in separate facility with reclaim line.
	Water Treatment Requirements	Estimate of Water Treatment Volume	m^3/yr	340,000	250,000	720000	340,000	702,000	620,000	260,000	690,000
Closure	Remediation Requirements	Quantitative Rank of Remediation Requirements	Rank	Closure of embankment slopes and containment area.	Closure of embankment slopes and containment area. Potential reclamation of water collection pond if used.	Closure of slopes and final surfaces. Potential for progressive reclamation. Reclamation of water management facility.	Closure of embankment slopes and containment area.	Closure of embankment slopes and containment area.	Closure of embankment slopes and containment area. Potential reclamation of water management facility, if used.	Closure of embankment slopes and containment area.	Closure of slopes and final surfaces. Potential for progressive reclamation. Reclamation of water management facility.
	Post Closure Water Treatment Requirements	Quantities Rank of Potential Post Closure Water Treatment Requirements	Rank	Potential short-term water treatment requirements until closure activities completed.	Potential short-term water treatment requirements until closure activities completed.	Potential short to long-term water treatment requirements after closure.	Potential short-term water treatment requirements until closure activities completed.	Potential short-term water treatment requirements until closure activities completed.	Potential short-term water treatment requirements until closure activities completed.	Potential short-term water treatment requirements until closure activities completed.	Potential short to long-term water treatment requirements after closure.
	Post Closure Landform Stability	Qualitative Rank - Estimate of Post Closure Landform Stability	Rank	Medium to High - Single dam structure stabilized at closure	Medium - Potential two dam structures stabilized at closure	Low to Medium - Stockpile of tailings covered at closure, slopes regraded, includes closure of dam structure for water management.	Medium to High - Single dam structure stabilized at closure, lower dam heights than 1A	Medium to High - Single dam structure stabilized at closure	Medium - Potential two dam structures stabilized at closure	Medium to High - Single dam structure stabilized at closure	Low to Medium - Stockpile of tailings covered at closure, slopes regraded, includes closure of dam structure for water management.
	Post Closure Chemical Stability	Qualitative Rank - Estimate of Post Closure Chemical Stability	Rank	Medium to High - Facility uses low-permeable embankment and basin, capped with engineered liner and shedding cover.	Medium to High - Facility uses low-permeable embankment and basin, capped with engineered liner and shedding cover.	Low to Medium - Facility uses foundation seepage collection and final surface covered with shedding cover.	Medium to High - Facility uses low-permeable embankment and basin, capped with engineered liner and shedding cover.	High - Facility uses engineered liner for embankments and basin, capped with engineered liner and shedding cover.	High - Facility uses engineered liner for embankments and basin, capped with engineered liner and shedding cover.	Medium to High - Facility uses low-permeable embankment and basin, capped with engineered liner and shedding cover.	Low to Medium - Facility uses foundation seepage collection and final surface covered with shedding cover.

TABLE 4.4

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 4 - MULTIPLE ACCOUNTS LEDGER FOR CANDIDATE ALTERNATIVES

Capacity	Tailings Storage Expansion Capacity	Qualitative Rank of Potential Expansion	Rank	High - Area and Topography favourable for tailings expansion	High - Area and Topography favourable for tailings expansion	High - Area and Topography favourable for tailings expansion	High - Area and Topography favourable for tailings expansion	High - Area and Topography favourable for tailings expansion	High - Area and Topography favourable for tailings expansion	Low - Area unfavorable to expansion due to adjacent land, topography and adjacent infrastructure.	Low - Area unfavorable to expansion due to adjacent land, topography and adjacent infrastructure.
	Storage Efficiency	Storage Capacity Volume per Construction Material Volume	m^3/m^3	5.0	5.3	>7	5.2	4.6	4.1	2.4	>7
Water Management	Sensitivity to Climate Variability	Qualitative Rank of climate sensitivity	Rank	Medium	moderate to high sensitivity	moderate to high sensitivity	lowest sensitivity to climate variability	lowest sensitivity to climate variability	moderate to high sensitivity	lowest sensitivity to climate variability	moderate to high sensitivity
	Surface Water Control Measures	Qualitative Rank of Surface Water Control	Rank	Medium - Fully contained within a single impoundment with water transfer to plant site for reclaim and treatment.	Low to Medium - Collection in single facility, potential requirement for secondary facility with water transfer to plant site for reclaim and treatment.	Medium to High - Surface runoff collected in single facility, water management within single faculty with transfer to plant site for reclaim and treatment.	Medium - Fully contained within a single impoundment with water transfer to plant site for reclaim and treatment.	Medium - Fully contained within a single impoundment with water transfer to plant site for reclaim and treatment.	Low to Medium - Collection in single facility, Potential use of secondary facility with water transfer to plant site for reclaim and treatment.	Medium - Fully contained within a single impoundment with water transfer to plant site for reclaim and treatment.	Medium to High - Surface runoff collected in single facility, water management within single faculty with transfer to plant site for reclaim and treatment.
	Seepage Control Measures	Qualitative Rank of Seepage Control	Rank	High - Seepage collection by perimeter ditch and berm with pump back system.	Medium to High - Seepage collection by perimeter ditch and berm with pump back system from two potential containment areas.	Low to Medium - Seepage collection from foundation, collection by ditch and berm with transfer to secondary containment facility. Secondary containment facility to have berm and ditch with pump back system.	High - Seepage collection by perimeter ditch and berm with pump back system.	High - Seepage collection by perimeter ditch and berm with pump back system.	Medium to High - Seepage collection by perimeter ditch and berm with pump back system from two potential containment areas.	High - Seepage collection by perimeter ditch and berm with pump back system.	Low to Medium - Seepage collection from foundation, collection by ditch and berm with transfer to secondary containment facility. Secondary containment facility to have berm and ditch with pump back system.

Economic Account				Indicator Quantity							
Sub-Account	**Description**	**Indicator**	**Indicator Parameter**	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**6A**	**6C**
Life of Mine Costs	Capital	Factored Cost Ranking	Rank	5.5	4.6	1.6	4.6	18.9	18	8.6	1.0
	Operational	Factored Cost Ranking	Rank	1.0	3.8	10.8	3.8	1.3	3.9	1.1	10.8
	Fish Habitat Compensation	Factored Cost Ranking	Rank	Not Assessed - Each Alternative Assigned a Neutral Rating							
	Closure and Reclamation Costs	Factored Cost Ranking	Rank	2.5	2.5	1.5	2.5	7.0	7.0	1.6	1.0

Socio-Economic Account				Indicator Quantity							
Sub-Account	**Description**	**Indicator**	**Indicator Parameter**	**1A**	**1B**	**1C**	**1D**	**2A**	**2B**	**6A**	**6C**
Archaeology	Archaeological Potential	Area of direct impact and archaeological potential	ha/potential	0, Low	0, Low	0, Low	0, Low	0, Low	0, Low	0, Low	0, Low
Health and Safety	Risk to Human Health	Qualitative Rank of Human Health Risk	Rank	Medium - High	Medium - High	High	Medium - High	Medium	Medium	High	High
	Risk to Public Safety	Qualitative Rank of Public Safety Risk	Rank	Medium	Medium	Low - Medium	Medium	Low	Low	Medium	Low to Medium
	Risk to Worker Safety	Qualitative Rank of Worker Safety Risk	Rank	Medium - High	Medium - High	High	Medium - High	High	High	High	High
Socio-Economic Indicators	Economic Benefits to Regional Communities	Qualitative Rank of Economic Benefits to Community	Rank	Medium	Medium	Low	Medium	Medium - High	Medium - High	Low - Medium	Low
	Regional Job Creation and Diversity	Qualitative Rank of Job Creation - Employment Numbers	Rank	Medium	Medium	Low	Medium	Medium - High	Medium - High	Medium	Low
	Indirect Employment	Qualitative Rank of Potential Indirect Employment	Rank	Low - Medium	Low - Medium	Low	Low-Medium	Low - Medium	Low - Medium	Low - Medium	Low
First Nation Impacts	Aboriginal Rights	Qualitative Rank of Local Aboriginal Rights	Rank	Medium	Medium	Medium	Medium	Low	Low	Low	Low
	Extent of Traditional Land Use (# of individual users)	Qualitative Rank of Traditional Land Use	Rank	Medium	Medium	Medium	Medium	Low	Low	Low	Low
	Extent of Traditional Land Use (# of Activities)	Qualitative Rank of Traditional Land Use	Rank	3	3	3	3	2	2	1	1
Recreational and Commercial Land Use	Visual Impact	Extent of structure above topography and sight lines	m	24	22	18	22	30	29	34	27
	Impact to Navigable Waters	Area of Direct Impact	ha	0	0	0	0	0	0	0	0
	Extent of Recreational Land Use	Qualitative Rank of Recreational Use	Rank	88, Medium	100, Medium	Medium	88, Medium	246, Low	Low	54, Low	47, Low
	Extent of Commercial Land Use	Qualitative Rank of Commercial Use	Rank	0	0	0	0	0	0	0	0

Alternative Identification	Description
1A	Location 1- Conventional Slurry Tailings
1B	Location 1 - Thickened Tailings
1C	Location 1 - Filtered/Dry Stack Tailings
1D	Location 1 - Conventional with Future Co-Disposal
2A	Location 2- Conventional Slurry Tailings
2B	Location 2- Thickened Tailings
6A	Location 6 - Conventional Slurry Tailings
6C	Location 6 - Filtered/Dry Stack Tailings

Notes:
1. Inputs for Indicators based on available information and work completed to date.

TABLE 4.5

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 5 - VALUE-BASED DECISION PROCESS
QUANTITATIVE SCORING FOR CANDIDATE ALTERNATIVES INDICATORS

Environmental Account						
Indicator	**Descriptor**					
	1 (Worst)	**2**	**3**	**4**	**5**	**6 (Best)**
Direct Distance from Plant Site to Structure	>2,000	2,000 - 1,600	1,600 - 1,200	1,200 - 900	900 - 500	>500
Length of Additional Infrastructure Required	>2,000	2,000 - 1,600	1,600 - 1,200	1,200 - 900	900 - 500	>500
Estimate of Storage Facility(s) Area	>100	100 - 90	90 - 80	80 - 70	70 - 60	>60
Number of Main Watersheds directly impacted	6	5	4	3	2	1
Qualitative Estimate of Potential Surface Water Impact	High	High to Medium	Medium	Medium to Low	Low	>Low
Likelihood of Mining Impacts and mitigative measures required	High Potential	High to Medium Potential	Medium Potential	Medium to Low Potential	Low Potential	>Low Potential
No. of Streams Directly Impacted	>4	4	3	2	1	>1
No of Streams Potentially Indirectly Impacted	>4	4	3	2	1	>1
No of Water Bodies Directly Impacted	5	4	3	2	1	>1
No of Fish Bearing Lakes Directly Affected	5	4	3	2	1	>1
No of Terrestrial Areas Directly Impacted	5	4	3	2	1	>1
Potential Loss to flura and Fana with construction and operations	Permanent loss of flora and fauna of footprint area >100 ha	Permanent loss of flora and fauna of footprint area of 90 to 100 ha.	Permanent loss of flora and fauna of footprint area of 80 to 90 ha.	Permanent loss of flora and fauna of footprint area of 50 to 80 ha.	Short-term loss of flora/fauna during construction.	No Impact
Length of Access Roads	>2,000	2,000 - 1,600	1,600 - 1,200	1,200 - 900	900 - 500	>500
Type of tailings technology used and potential dust generation	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative Rank of Potential Greenhouse Gas Emissions	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative rank - estimate of noise generation from truck traffic based on tailings disposal technology	High	High to Medium	Medium	Medium to Low	Low	>Low

Technical Account						
Indicator	**Descriptor**					
	1 (Worst)	**2**	**3**	**4**	**5**	**6 (Best)**
Qualitative Rank of Foundation Conditions	Conditions providing poor foundation strength and poor containment, consisting primarily of swamp or organic materials.	Conditions providing poor foundation strength and poor containment, having areas of potential swamp or organic materials.	Conditions providing fair foundation strength and fair containment, having areas of potential swamp or organic material.	Conditions providing good foundation strength and poor containment, minimal areas of swamp or organic material.	Conditions providing fair foundation strength and poor containment, minimal areas of swamp or organic material	Conditions providing good foundation conditions and low permeable material for containment, no presence of swamp or organic material.
Distance From Plant Site to Far End of Facility for pipeline or haul road.	>5000	5,000 to 4,000	4,000 - 3,000	3,000 - 2,000	2,000 - 1,000	<1000
Qualitative Rank of Topographic Complexity	Topography provides difficulties to dam construction, embankment raising, tailings and water management.	Topography provides difficulties to dam construction, embankment raising, and tailings management but is suitable for water management.	Topography provides difficulties to dam construction, embankment raising, but is suitable for tailings and water management.	Topography is suitable for dam construction and embankment raising but is not suitable for tailings and water management.	Topography is suitable for dam construction, embankment raising and tailings management but is not suitable for water management.	Topography is suitable for dam construction and embankment raising, tailings and water management.
Elevation Difference From Plant Site at Final Embankment Elevation, for tailings pumping.	60 - 50	50 - 40	40 - 30	30 - 20	20 - 10	<10
Qualitative Rank of Tailings Dam Complexity	Embankment Constructed on sloping ground, difficult foundation key-in, significant internal drain system with engineering products required for containment.	Embankment Constructed on sloping ground, favourable foundation key-in, significant internal drain system and engineering products required for containment.	Embankment Constructed mostly perpendicular to sloping ground, favourable foundation key-in, significant internal drain system and engineering products required for containment.	Embankment Constructed primarily perpendicular to ground, favourable foundation key-in, moderate internal drain system and engineering products required for containment.	Embankments constructed primarily perpendicular to sloping ground, favourable foundation key-in conditions, moderate internal drain system and low permeable fill material.	Low height berm and ditch system for surface runoff containment.
CDA Dam Classification Estimate	Extreme	Very High	High	Significant	Low	No Rating
Qualitative Rank of Construction Material Availability	Farthest Distance from Sources, Dependant on Mine Waste	Farthest distance, not dependant on mine waste	Medium Distance, Dependant on Mine Waste	Medium Distance, not dependant on mine waste	Close to Source, dependant on mine waste	Close to Sources, not dependant on Mine Waste
Preliminary Estimate of Total Embankment Height	>50	50-40	40-30	30-20	20-10	<10
Estimate of Slope Angle during operations	1.0H:1V	1.5H:1V	2.0H:1V	2.5H1V	3.0H:1V	3.5H:1V
No. of Primary Watersheds	6	5	4	3	2	1
Distance From Plant Site to Far End of Facility	3,000 - 2,500	2,500 - 2,000	2,000 - 1,500	1,500 - 1,000	1,000 - 500	<500
Qualitative Rank of operations assessment based on tailings and water management .	Potential difficulty with tailings and water management.	Potential difficulty with tailings management, moderate difficulty with water management.	Moderate Difficulty with tailings and water management.	Favourable water management, moderate difficulty with tailings management.	Favourable tailings management, moderate difficulty with water management.	Favourable tailings and water management.
Estimate of Water Treatment Volume per Year	>900,000	900,000 - 700,000	700,000 - 500,000	500,000 - 300,000	300,000 - 100,000	<100,000
Quantitative Rank of Remediation Requirements	Reclamation of more than one facility with potential long term water management requirements.	Reclamation of more than one facility with water management requirements.	Reclamation of more than one facility with no water management requirements	Reclamation of single facility with potential water management requirements.	Reclamation of single facility with no potential water management.	Reclamation of single facility with no potential water management and potential progressive reclamation.
Quantities Rank of Potential Post Closure Water Treatment Requirements	Water treatment in perpetuity	Long-Term Water treatment to Perpetuity	Long-Term Water Treatment.	Long-Term to Short-Term Water Treatment	Short-Term Water Treatment.	No water treatment requirements
Qualitative Rank - Estimate of Post Closure Landform Stability	Low	Low to Medium	Medium	Medium to High	High	>High
Qualitative Rank - Estimate of Post Closure Chemical Stability	Low	Low to Medium	Medium	Medium to High	High	>High
Qualitative Rank of Potential Expansion	Low	Low to Medium	Medium	Medium to High	High	>High

TABLE 4.5

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 5 - VALUE-BASED DECISION PROCESS
QUANTITATIVE SCORING FOR CANDIDATE ALTERNATIVES INDICATORS

Storage Capacity Volume per Construction Material Volume	<3	3-4	4-5	5-6	6-7	<7
Qualitative Rank of climate sensitivity	<High	High	High to Medium	Medium	Medium to Low	Low
Qualitative Rank of Surface Water Control	Low	Low to Medium	Medium	Medium to High	High	>High
Qualitative Rank of Seepage Control	Low	Low to Medium	Medium	Medium to High	High	>High

Economic Account						
Indicator	**Descriptor**					
	1 (Worst)	**2**	**3**	**4**	**5**	**6 (Best)**
Capitol Costs, $M, Life of Mine (differentiating)	>9	9-7	7-6	6-5	5-2	<2
Operational Cost Estimate, $M, Life of Mine	>6	6-5	5-4	4-3	3-2	<2
Potential Fish Habitat Compensation, $M, Life of Mine	5	4	3	2	1	0
Closure Cost Estimate, $M, Life of Mine (differentiating)	>6	6-5	5-3	4-3	3-1	1

Socio-Economic Account						
Indicator	**Descriptor**					
	1 (Worst)	**2**	**3**	**4**	**5**	**6 (Best)**
Area of direct impact and archaeological potential	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative Rank of Human Health Risk	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative Rank of Public Safety Risk	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative Rank of Worker Safety Risk	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative Rank of Economic Benefits to Community	Low	Low to Medium	Medium	Medium to High	High	>High
Qualitative Rank of Job Creation - Employment Numbers	Low	Low to Medium	Medium	Medium to High	High	>High
Qualitative Rank of Potential Indirect Employment	Low	Low to Medium	Medium	Medium to High	High	>High
Qualitative Rank of Local Aboriginal Rights	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative Rank of Traditional Land Use	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative Rank of Traditional Land Use	5	4	3	2	1	<1
Extent of structure above topography and sight lines	>30	30-25	25-20	20-15	15-10	<10
Area of Direct Impact	>50	50-40	40-30	30-20	20-10	<10
Qualitative Rank of Recreational Use	High	High to Medium	Medium	Medium to Low	Low	>Low
Qualitative Rank of Commercial Use	High	High to Medium	Medium	Medium to Low	Low	>Low

Notes:
1. Scoring based on inputs for assessment Indicators.

TABLE 4.6

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 5 - VALUE-BASED DECISION PROCESS
QUANTITATIVE WEIGHTING FOR CANDIDATE ALTERNATIVES INDICATORS

Environmental Account

Sub-Account	Indicator	Indicator Weight	Alternatives Location and Deposition Technology Identifier															
			1A		1B		1C		1D		2A		2B		6A		6C	
			Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score
		W	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)
Land Use	Direct Distance from Plant Site to Structure	6	6	36	6	36	6	36	6	36	1	6	1	6	3	18	3	18
	Length of Additional Infrastructure Required	6	5	30	5	30	5	30	5	30	1	6	1	6	3	18	3	18
	Estimate of Storage Facility(s) Area	6	3	18	3	18	2	12	3	18	1	6	1	6	6	36	5	30
Water Impacts	Number of Main Watersheds directly impacted	6	1	6	1	6	1	6	1	6	1	6	1	6	1	6	1	6
	Qualitative Estimate of Potential Surface Water Impact	6	2	12	2	12	2	12	2	12	1	6	1	6	3	18	3	18
	Likelihood of Mining Impacts and mitigative measures required	6	4	24	3	18	1	6	4	24	4	24	3	18	4	24	1	6
Aquatic Habitat	No. of Streams Directly Impacted	6	5	30	5	30	5	30	5	30	4	24	4	24	5	30	5	30
	No of Streams Potentially Indirectly Impacted	6	3	18	3	18	3	18	3	18	1	6	1	6	3	18	3	18
	No of Water Bodies Directly Impacted	6	5	30	5	30	5	30	5	30	5	30	5	30	5	30	5	30
	No of Fish Bearing Lakes Directly Affected	6	5	30	5	30	5	30	5	30	5	30	5	30	5	30	5	30
Terrestrial Habitat	No of Terrestrial Areas Directly Impacted	6	5	30	5	30	5	30	5	30	5	30	5	30	5	30	5	30
	Potential Loss to flura and Fana with construction and operations	6	3	18	3	18	2	12	3	18	1	6	1	6	4	24	4	24
Air Quality	Length of Access Roads	6	6	36	6	36	5	30	6	36	6	36	6	36	6	36	3	18
	Type of tailings technology used and potential dust generation	6	5	30	4	24	2	12	5	30	5	30	4	24	5	30	2	12
	Qualitative Rank of Potential Greenhouse Gas Emissions	6	5	30	5	30	1	6	5	30	5	30	5	30	5	30	1	6
	Qualitative rank - estimate of noise generation from truck traffic based on tailings disposal technology	6	5	30	5	30	1	6	5	30	5	30	5	30	5	30	1	6

Technical Account

Sub-Account	Indicator	Indicator Weight	Alternatives Location and Deposition Technology Identifier															
			1A		1B		1C		1D		2A		2B		6A		6C	
			Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score
		W	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)
Design	Qualitative Rank of Foundation Conditions	3	5	15	5	15	5	15	5	15	4	12	4	12	3	9	3	9
	Distance From Plant Site to Far End of Facility for pipeline or haul road.	3	4	12	4	12	4	12	4	12	1	3	1	3	4	12	4	12
	Qualitative Rank of Topographic Complexity	3	6	18	6	18	6	18	6	18	6	18	6	18	2	6	1	3
	Elevation Difference From Plant Site at final embankment height, for tailings pumping	3	4	12	4	12	6	18	4	12	3	9	3	9	4	12	6	18
	Qualitative Rank of Dam Complexity	3	5	15	5	15	6	18	5	15	3	9	4	12	2	6	6	18
	CDA Dam Classification Estimate	3	3	9	3	9	3	9	3	9	3	9	3	9	2	6	2	6
	Qualitative Rank of Construction Material Availability	3	5	15	5	15	6	18	5	15	1	3	1	3	3	9	4	12
	Preliminary Estimate of Total Embankment Height	3	4	12	4	12	5	15	4	12	3	9	4	12	3	9	3	9
	Estimate of Slope Angle during operations	3	2	6	2	6	3	9	2	6	2	6	2	6	2	6	3	9
	No. of Primary Watersheds	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3
Operations	Distance From Plant Site to Far End of Facility	3	2	6	2	6	2	6	2	6	1	3	1	3	2	6	2	6
	Qualitative Rank of operations assessment based on tailings and water management .	3	5	15	4	12	3	9	5	15	5	15	4	12	3	9	4	12
	Estimate of Water Treatment Volume	3	4	12	5	15	2	6	4	12	2	6	3	9	5	15	3	9
Closure	Quantitative Rank of Remediation Requirements	3	4	12	4	12	3	9	4	12	4	12	3	9	4	12	3	9
	Quantities Rank of Potential Post Closure Water Treatment Requirements	3	5	15	5	15	4	12	5	15	5	15	5	15	5	15	4	12
	Qualitative Rank - Estimate of Post Closure Landform Stability	3	4	12	3	9	2	6	4	12	4	12	3	9	4	12	2	6
	Qualitative Rank - Estimate of Post Closure Chemical Stability	3	4	12	4	12	2	6	4	12	5	15	5	15	4	12	2	6
Capacity	Qualitative Rank of Potential Expansion	3	5	15	5	15	5	15	5	15	5	15	5	15	1	3	1	3
	Storage Capacity Volume per Construction Material Volume	3	3	9	4	12	6	18	4	12	3	9	3	9	1	3	6	18
Water Management	Qualitative Rank of climate sensitivity	3	4	12	3	9	5	15	4	12	4	12	3	9	4	12	5	15
	Qualitative Rank of Surface Water Control	3	3	9	2	6	4	12	3	9	3	9	2	6	3	9	4	12
	Qualitative Rank of Seepage Control	3	5	15	4	12	2	6	5	15	5	15	4	12	5	15	2	6

Economic Account

Sub-Account	Indicator	Indicator Weight	Alternatives Location and Deposition Technology Identifier															
			1A		1B		1C		1D		2A		2B		6A		6C	
			Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score	Indicator Value	Indicator Merit Score
		W	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)
Life of Mine Costs	Factored Cost Ranking	1.5	4	6	5	7.5	6	9	5	7.5	1	1.5	1	1.5	2	3	6	9
	Factored Cost Ranking	1.5	6	9	5	7.5	1	1.5	5	7.5	6	9	4	6	6	9	1	1.5
	Factored Cost Ranking	1.5	3	4.5	3	4.5	3	4.5	3	4.5	3	4.5	3	4.5	3	4.5	3	4.5
	Factored Cost Ranking	1.5	5	7.5	5	7.5	5	7.5	5	7.5	1	1.5	1	1.5	5	7.5	6	9

TABLE 4.6

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 5 - VALUE-BASED DECISION PROCESS
QUANTITATIVE WEIGHTING FOR CANDIDATE ALTERNATIVES INDICATORS

Socio-Economic Account																		
Sub-Account	**Indicator**	**Indicator Weight**	**Alternatives Location and Deposition Technology Identifier**															
			1A		**1B**		**1C**		**1D**		**2A**		**2B**		**6A**		**6C**	
			Indicator Value	**Indicator Merit Score**	**Indicator Value**	**Indicator Merit Score**	**Indicator Value**	**Indicator Merit Score**	**Indicator Value**	**Indicator Merit Score**	**Indicator Value**	**Indicator Merit Score**	**Indicator Value**	**Indicator Merit Score**	**Indicator Value**	**Indicator Merit Score**	**Indicator Value**	**Indicator Merit Score**
		W	**S**	**(SxW)**	**S**	**(SxW)**	**S**	**(SxW)**	**S**	**(SxW)**	**S**	**(SxW)**	**S**	**(SxW)**	**S**	**(SxW)**	**S**	**(SxW)**
Archaeology	Area of direct impact and archaeological potential	3	5	15	5	15	5	15	5	15	5	15	5	15	5	15	5	15
Health and Safety	Qualitative Rank of Human Health Risk	3	2	6	2	6	1	3	2	6	3	9	3	9	1	3	1	3
	Qualitative Rank of Public Safety Risk	3	3	9	3	9	4	12	3	9	5	15	5	15	3	9	4	12
	Qualitative Rank of Worker Safety Risk	3	2	6	2	6	1	3	2	6	3	9	3	9	1	3	3	9
Socio-Economic Indicators	Qualitative Rank of Economic Benefits to Community	3	3	9	3	9	1	3	3	9	4	12	4	12	2	6	1	3
	Qualitative Rank of Job Creation - Employment Numbers	3	3	9	3	9	1	3	3	9	4	12	4	12	3	9	1	3
	Qualitative Rank of Potential Indirect Employment	3	2	6	2	6	1	3	2	6	2	6	2	6	2	6	1	3
First Nation Impacts	Qualitative Rank of Local Aboriginal Rights	3	3	9	3	9	3	9	3	9	5	15	5	15	5	15	5	15
	Qualitative Rank of Traditional Land Use	3	3	9	3	9	3	9	3	9	5	15	5	15	5	15	5	15
	Qualitative Rank of Traditional Land Use	3	3	9	3	9	3	9	3	9	4	12	4	12	5	15	5	15
Recreational and Commercial Land Use	Extent of structure above topography and sight lines	3	3	9	3	9	4	12	3	9	2	6	2	6	1	3	2	6
	Area of Direct Impact	3	6	18	6	18	6	18	6	18	6	18	6	18	6	18	6	18
	Qualitative Rank of Recreational Use	3	3	9	3	9	3	9	3	9	5	15	5	15	5	15	5	15
	Qualitative Rank of Commercial Use	3	6	18	6	18	6	18	6	18	6	18	6	18	6	18	6	18
Sub-Account Merit Score				**837**		**816**		**709.5**		**840**		**718.5**		**694.5**		**783**		**687**
Sub-Account Merit Rating				**3.99**		**3.89**		**3.38**		**4.00**		**3.42**		**3.31**		**3.73**		**3.27**

Alternative Identification	**Description**
1A	Location 1- Conventional Slurry Tailings
1B	Location 1 - Thickened Tailings
1C	Location 1 - Filtered/Dry Stack Tailings
1D	Location 1 - Conventional with Future Co-Disposal
2A	Location 2- Conventional Slurry Tailings
2B	Location 2- Thickened Tailings
6A	Location 6 - Conventional Slurry Tailings
6C	Location 6 - Filtered/Dry Stack Tailings

WSP

TABLE 4.7

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 5 - VALUE-BASED DECISION PROCESS
QUANTITATIVE WEIGHTING AND ANALYSIS FOR CANDIDATE ALTERNATIVES SUB-ACCOUNTS

Environmental Account

Sub-Account	Sub-Account Weight	Alternatives Location and Deposition Technology Identifier															
		1A		1B		1C		1D		2A		2B		6A		6C	
		Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score
	W	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)
Land Use	6	4.7	28.0	4.7	28.0	4.3	26.0	4.7	28.0	1.0	6.0	1.0	6.0	4.0	24.0	3.7	22.0
Water Impacts	6	2.3	14.0	2.0	12.0	1.3	8.0	2.3	14.0	2.0	12.0	1.7	10.0	2.7	16.0	1.7	10.0
Aquatic Habitat	6	4.5	27.0	4.5	27.0	4.5	27.0	4.5	27.0	3.8	22.5	3.8	22.5	4.5	27.0	4.5	27.0
Terrestrial Habitat	6	4.0	24.0	4.0	24.0	3.5	21.0	4.0	24.0	3.0	18.0	3.0	18.0	4.5	27.0	4.5	27.0
Air Quality	6	5.3	31.5	5.0	30.0	2.3	13.5	5.3	31.5	5.3	31.5	5.0	30.0	5.3	31.5	1.8	10.5

Technical Account

Sub-Account	Sub-Account Weight	Alternatives Location and Deposition Technology Identifier															
		1A		1B		1C		1D		2A		2B		6A		6C	
		Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score
	W	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)
Design	3	3.9	11.7	3.9	11.7	4.5	13.5	3.9	11.7	2.7	8.1	2.9	8.7	2.6	7.8	3.3	9.9
Operations	3	3.7	11.0	3.7	11.0	2.3	7.0	3.7	11.0	2.7	8.0	2.7	8.0	3.3	10.0	3.0	9.0
Closure	3	4.3	12.8	4.0	12.0	2.8	8.3	4.3	12.8	4.5	13.5	4.0	12.0	4.3	12.8	2.8	8.3
Capacity	3	4.0	12.0	4.5	13.5	5.5	16.5	4.5	13.5	4.0	12.0	4.0	12.0	1.0	3.0	3.5	10.5
Water Management	3	4.0	12.0	3.0	9.0	3.7	11.0	4.0	12.0	4.0	12.0	3.0	9.0	4.0	12.0	3.7	11.0

Economic Account

Sub-Account	Sub-Account Weight	Alternatives Location and Deposition Technology Identifier															
		1A		1B		1C		1D		2A		2B		6A		6C	
		Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score
	W	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)
Life of Mine Costs	1.5	4.5	6.8	4.5	6.8	3.8	5.6	4.5	6.8	2.8	4.1	2.3	3.4	4.0	6.0	4.0	6.0

Socio-Economic Account

Sub-Account	Sub-Account Weight	Alternatives Location and Deposition Technology Identifier															
		1A		1B		1C		1D		2A		2B		6A		6C	
		Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score	Sub-Account Merit Rating	Sub-Account Merit Score
	W	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)
Archaeology	3	5.0	15.0	5.0	15.0	5.0	15.0	5.0	15.0	5.0	15.0	5.0	15.0	5.0	15.0	5.0	15.0
Health and Safety	3	2.3	7.0	2.3	7.0	2.0	6.0	2.3	7.0	3.7	11.0	3.7	11.0	1.7	5.0	2.7	8.0
Socio-Economic Indicators	3	2.7	8.0	2.7	8.0	1.0	3.0	2.7	8.0	3.3	10.0	3.3	10.0	2.3	7.0	1.0	3.0
First Nation Impacts	3	3.0	9.0	3.0	9.0	3.0	9.0	3.0	9.0	4.7	14.0	4.7	14.0	5.0	15.0	5.0	15.0
Recreational and Commercial Land Use	3	4.5	13.5	4.5	13.5	4.8	14.3	4.5	13.5	4.8	14.3	4.8	14.3	4.5	13.5	4.8	14.3
Account Merit Score			**243.2**		**237.5**		**204.6**		**244.7**		**212.0**		**203.8**		**232.6**		**206.4**
Account Merit Rating			**4.0**		**3.9**		**3.3**		**4.0**		**3.4**		**3.3**		**3.8**		**3.4**

Alternative Identification	Description
1A	Location 1- Conventional Slurry Tailings
1B	Location 1 - Thickened Tailings
1C	Location 1 - Filtered/Dry Stack Tailings
1D	Location 1 - Conventional with Future Co-Disposal
2A	Location 2- Conventional Slurry Tailings
2B	Location 2- Thickened Tailings
6A	Location 6 - Conventional Slurry Tailings
6C	Location 6 - Filtered/Dry Stack Tailings

TABLE 4.8

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 5 - VALUE-BASED DECISION PROCESS
QUANTITATIVE WEIGHTING AND ANALYSIS FOR CANDIDATE ALTERNATIVES ACCOUNTS

Account	Account Weight	Alternatives Location and Deposition Technology Identifier															
		1A		1B		1C		1D		2A		2B		6A		6C	
		Account Merit Rating	Account Merit Score	Account Merit Rating	Account Merit Score	Account Merit Rating	Account Merit Score	Account Merit Rating	Account Merit Score	Account Merit Rating	Account Merit Score	Account Merit Rating	Account Merit Score	Account Merit Rating	Account Merit Score	Account Merit Rating	Account Merit Score
	W	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)	S	(SxW)
Environment	6	4.2	24.9	4.0	24.2	3.2	19.1	4.2	24.9	3.0	18.0	2.9	17.3	4.2	25.1	3.2	19.3
Technical	3	4.0	11.9	3.8	11.4	3.8	11.3	4.1	12.2	3.6	10.7	3.3	9.9	3.0	9.1	3.2	9.7
Project Economics	1.5	4.5	6.8	4.5	6.8	3.8	5.6	4.5	6.8	2.8	4.1	2.3	3.4	4.0	6.0	4.0	6.0
Socio-Economic	3	3.5	10.5	3.5	10.5	3.2	9.5	3.5	10.5	4.3	12.9	4.3	12.9	3.7	11.1	3.7	11.1
Alternative Merit Score			**54.0**		**52.9**		**45.4**		**54.3**		**45.7**		**43.5**		**51.3**		**46.1**
Alternative Merit Rating			**4.00**		**3.92**		**3.36**		**4.03**		**3.38**		**3.22**		**3.80**		**3.41**

Alternative Identification	Description
1A	Location 1- Conventional Slurry Tailings
1B	Location 1 - Thickened Tailings
1C	Location 1 - Filtered/Dry Stack Tailings
1D	Location 1 - Conventional with Future Co-Disposal
2A	Location 2- Conventional Slurry Tailings
2B	Location 2- Thickened Tailings
6A	Location 6 - Conventional Slurry Tailings
6C	Location 6 - Filtered/Dry Stack Tailings

TABLE 4.9

TREASURY METALS
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

STEP 6 - SENSITIVITY ANALYSIS

Analysis ID	Scenario Description	Alternative Merit Rating							
		1A	1B	1C	1D	2A	2B	6A	6C
Base Case	Results of Alternatives Assessment	4.00	3.92	3.36	4.03	3.38	3.22	3.80	3.41
No. 1	Change All Environmental Weights to 9	4.03	3.94	3.33	4.05	3.31	3.16	3.87	3.38
No. 2	Change All Technical Weights to 6	4.00	3.90	3.43	4.03	3.42	3.24	3.66	3.38
No. 3	Change All Weights to 1	4.03	3.96	3.46	4.05	3.40	3.18	3.73	3.54
No. 4	Change all Socio-Economic Weights to 1.5	4.07	3.97	3.39	4.09	3.27	3.09	3.81	3.38

Alternative Identification	Description
1A	Location 1- Conventional Slurry Tailings
1B	Location 1 - Thickened Tailings
1C	Location 1 - Filtered/Dry Stack Tailings
1D	Location 1 - Conventional with Future Co-Disposal
2A	Location 2- Conventional Slurry Tailings
2B	Location 2- Thickened Tailings
6A	Location 6 - Conventional Slurry Tailings
6C	Location 6 - Filtered/Dry Stack Tailings

TABLE 5.1

TREASURY METALS INCORPORATED
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

CANADIAN DAM ASSOCIATION - DAM SAFETY GUIDELINES 2007
DAM CLASSIFICATION

Dam Class	Population at Risk [note 1]	Incremental Losses		
		Loss of Life [note 2]	**Environmental and Cultural Values**	**Infrastructure and Economics**
Low	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary Only	Unspecified	No Significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or Fewer	Significant loss or deterioration of *important* fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very High	Permanent	100 or Fewer	Significant loss or deterioration of *critical* fish or wildlife habitat Restoration or compensation in kind possible but not impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More Than 100	Major loss of *critical* fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

Notes:

Note 1. Definition for population at risk:

None - There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseen misadventure.

Temporary - People are only temporary temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing thorough on transportation routes, participating in recreational activities).

Permanent - The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is caused out).

Note 2. Implications for loss of life:

Unspecified - The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirements, for example, might not be higher if the temporary population is not likely to be present during the flood season.

TABLE 5.2

TREASURY METALS INCORPORATED
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

MINISTRY OF NATURAL RESOURCES
CLASSIFICATION AND INFLOW DESIGN FLOOD CRITERIA - TECHNICAL BULLETIN
HAZARD POTENTIAL CLASSIFICATION

Hazard Potential	**Hazard Categories - Incremental Losses[1]**			
	Life Safety[2]	**Property Losses[3]**	**Environmental Losses**	**Cultural - Built Heritage Losses**
Low	No potential loss of life	Minimal damage to property with estimates losses not to exceed $300,000.	Minimal loss of fish and/or wildlife habitat with high capability of natural restoration resulting in a very low likelihood of negatively affecting the status of the population.	Reversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act.
Moderate	No potential loss of life	Moderate damage with estimated losses not to exceed $3 million, to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or structures not for human habitation, infrastructure and services including local roads and railway lines. The inundation zone is typically undeveloped or predominantly rural or agricultural, or it is managed so that the land usage is for transient activities such as with day-use facilities. Minimal damage to residential, commercial, and industrial areas, or land identified as designated growth areas as shown in official plans.	Moderate loss or deterioration of fish and/or wildlife habitat with moderate capability of natural restoration resulting in a low likelihood of negatively affecting the status of the population.	Irreversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act. Reversible damage to provincially designated cultural heritage site under the Ontario Heritage Act or nationally recognized heritage sites.
High	Potential Loss of life of 1 - 10 persons	Appreciable damage with estimated losses not to exceed #30 million, to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or residential, commercial, industrial areas, infrastructure and services, or land identified as designated growth areas as shown in official plans. Infrastructure and services includes regional roads, railway lines, or municipal water and wastewater treatment facilities and publicly-owned utilities	Appreciable loss of fish and/or wildlife habitat or significant deterioration of critical fish and/or wildlife habitat with reasonable likelihood of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered, or reversible damage to the habitat of that species.	Irreversible damage to provincially designated cultural heritage site under the Ontario Heritage Act or damage to nationally recognized heritage sites.
Very High	Potential loss of life of 11 or more persons	Extensive damage, estimated losses in excess of $30 million, to buildings, agricultural, forestry, mineral aggregate and mining, and petroleum resources operations, infrastructure and services. Typically includes destruction of, or extensive damage to, large residential, institutional, concentrated commercial and industrial areas and major infrastructure and services, or land identified as designated growth areas as shown in official plans. infrastructure and services includes highways, railway lines or municipal water and wastewater treatment facilities and publicly-owned utilities.	Extensive loss of fish and/or wildlife habitat with very little or no feasibility of being able to apply natural or assisted recovery activities to promote species recovery to viable popu8lation levels. Loss of a viable portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered or irreversible damage to the habitat of that species.	

Notes:

1. Incremental losses are those losses resulting from dam failure above those which would occur under the same conditions (flood, earthquake or other event) with the dam in place but without failure of the dam.

2. Life safety. Refer to Technical Guide – River and Streams Systems: Flooding Hazard Limits, Ontario Ministry of Natural Resources, 2002, for definition of 2 x 2 rule. The 2 x 2 rule defines that people would be at risk if the product of the velocity and the depth exceeded 0.37 square metres per second or if velocity exceeds 1.7 metres per second or if depth of water exceeds 0.8 metres. For dam failures under flood conditions the potential for loss of life is assessed based on permanent dwellings (including habitable buildings and trailer parks) only. For dam failures under normal (sunny day) conditions the potential for loss of life is assessed based on both permanent dwellings (including habitable dwellings, trailer parks and seasonal campgrounds) and transient persons.

3. Property losses refer to all direct losses to third parties; they do not include losses to the owner, such as loss of the dam, or revenue. The dollar losses, where identified, are indexed to Statistics Canada values Year 2000.

4. An HPC must be developed under both flood and normal (sunny day) conditions.

5. Evaluation of the hazard potential is based on both present land use and on anticipated development as outlined in the pertinent official planning documents (e.g. Official Plan). In the absence of an approved Official Plan the HPC should be based on expected development within the foreseeable future. Under the Provincial Policy Statement, 'designated growth areas' means lands within settlement areas designated in an official plan for growth over the long-term planning horizon (specifies normal time horizon of up to 20 years), but which have not yet been fully developed. Designated growth areas include lands which are designated and available for residential growth in accordance with the policy, as well as lands required for employment and other uses (Italicized terms as defined in the PPS, 2005).

6. Where several dams are situated along the same watercourse, consideration must be given to the cascade effect of failures when classifying the structures, such that if failure of an upstream dam could contribute to failure of a downstream dam, then the HPC of the upstream dam must be the same as or greater than that of the downstream structure.

7. The HPC is determined by the highest potential consequences, whether life safety, property losses, environmental losses, or cultural-built heritage losses.

TABLE 5.3

TREASURY METALS INCORPORATED
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

CANADIAN DAM ASSOCIATION - DAM SAFETY GUIDELINES 2007
INFLOW DESIGN FLOOD (IDF) AND CONSEQUENCE CLASSES

Consequence Class	IDF
Low	1/100-year
Significant	Between 1/100 and 1/1,000 year (Note 1)
High	1/3 between 1/1,000-year and PMP (Note 2)
Very High	2/3 between 1/1,000-year and PMF (Note 2)
Extreme	PMF

Notes:

Note 1. Selected based on incremental flood analysis, exposure and consequence of failure

Note 2. Extrapolation of flood statistics beyond 1/1,000 year flood (10-3 AEP) is generally discouraged. The PMF has no associated AEP. The flood defined as "1/3 between 1/1,000-year and PMF" or "2/3 between 1/1,000-year and PMF" has no defined AEP.

TABLE 5.4

TREASURY METALS INCORPORATED
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

MINISTRY OF NATURAL RESOURCES
CLASSIFICATION AND INFLOW DESIGN FLOOD CRITERIA - TECHNICAL BULLETIN
RANGE OF MINIMUM INFLOW DESIGN FLOODS[2]

Hazard Potential Classification	**Range of Minimum Inflow Design Floods[1]**			
	Life Safety[3]		**Property and Environment**	**Cultural - Built Heritage**
Low	25 Year Flood to 100 Year Flood			
Moderate	100 Year Flood to 1,000 year flood or Regulatory Flood whichever is greater			
High	1 - 10	1/3 between the 1,000 year flood and PMF	1,000 Year Flood or Regulatory Flood whichever is greater to 1/3 between the 1,000 year flood and PMF	1,000 Year Flood or Regulatory Flood whichever is greater
Very High	11 - 100	2/3 between the 1,000 year Flood and PMF	1/3 between the 1,000 Year Flood and PMF to PMF	
	Greater than 100	PMF		

Notes:

1. The selection of the IDF within the range of flows provided should be commensurate with the hazard potential losses within the HPC Table. The degree of study required to define the hazard potential losses of dam failure will vary with the extent of existing and potential downstream development and the type of dam (size and shape of breach and breach time formation).

2. As an alternative to using the table the IDF can also be determined by an incremental analysis. Incremental analysis is a series of scenarios for various increasing flows, both with and without dam failure that is used to determine where there is no longer any significant additional threat to loss of life, property, environment and cultural – built heritage to select the appropriate IDF.

3. Where there is a potential for loss of life the IDF may be reduced provided that a minimum of 12 hours advanced warning time is available from the time of dam failure until the arrival of the inundation wave, provided that property, environment, or cultural – built heritage losses do not prescribe a higher IDF.

TABLE 5.5

TREASURY METALS INCORPORATED
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

CANADIAN DAM ASSOCIATION - DAM SAFETY GUIDELINES 2007
SUGGESTED DESIGN EARTHQUAKE LEVELS

Dam Class	AEP EDGM [note 1]
Low	1/500
Significant	1/1,000
High	1/2,500
Very High	1/5,000 [note 2]
Extreme	1/10,000 [note 2]

Notes:

Acronyms: AEP, annual exceedance probability; EDGM, earthquake design ground motion

Note 1. AEP levels for EDGM are to be used for mean rather than median estimates for the hazard.

Note 2. The EDGM value must be justified to demonstrate conformation to societal norms of acceptable risk. Justification can be provided with the help of failure modes analysis focused on the particular modes that can contribute to failure initiated by a seismic event. If justification cannot be provided the EDGM should be 1/10,000.

TABLE 5.6

TREASURY METALS INCORPORATED
GOLIATH PROJECT

TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

MINISTRY OF NATURAL RESOURCES
SEISMIC HAZARD CRITERIA, ASSESSMENT AND CONSIDERATIONS - TECHNICAL BULLETIN
DESIGN EARTHQUAKE CRITERIA

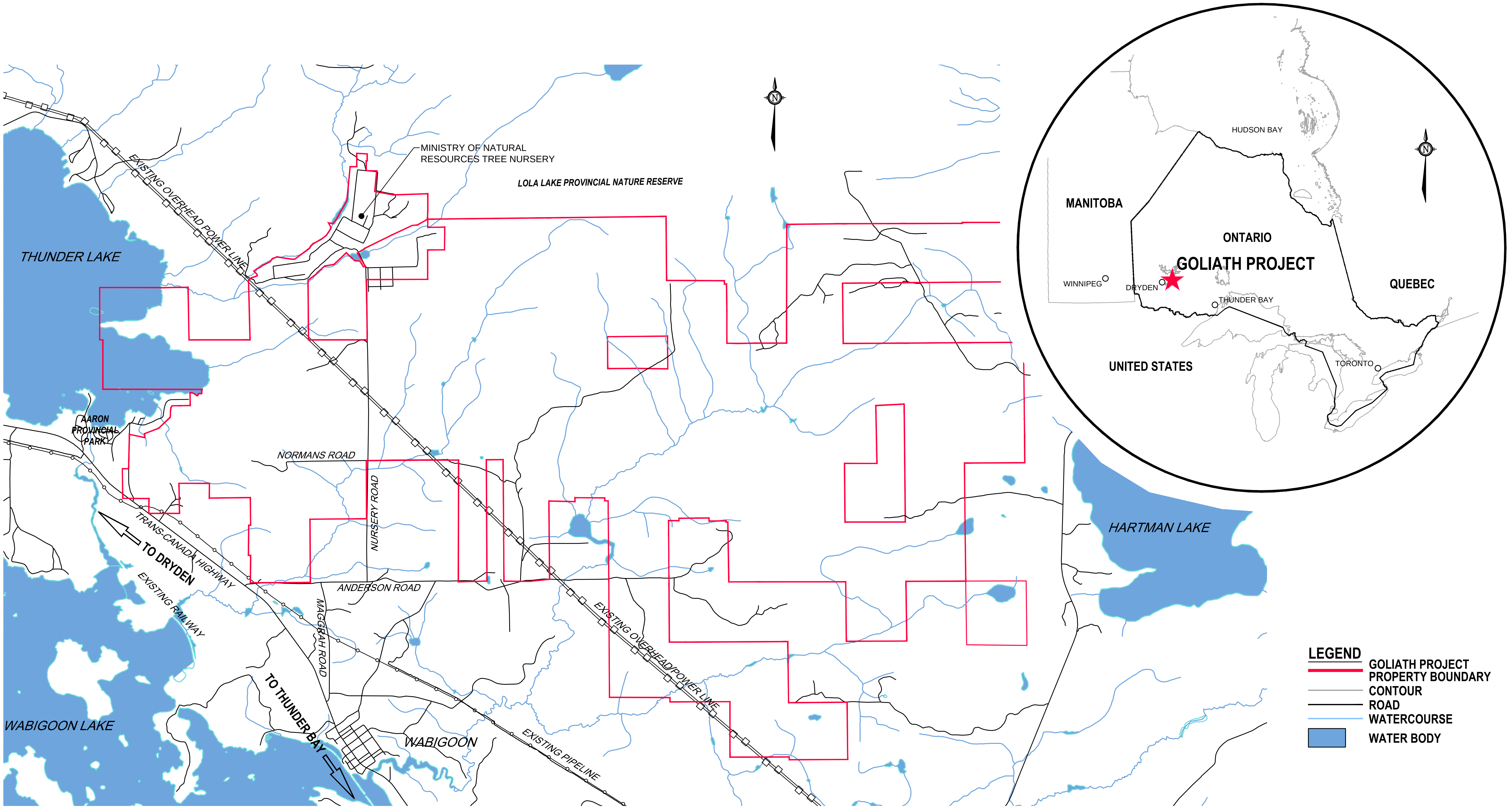
Hazard Potential Classification	**Earthquake Design Ground Motion (annual exceedance probability)**			
	Life Safety[3]		**Property and Environment**	**Cultural - Built Heritage**
Low	500 year			
Moderate	500 to 1,000 year			
High	10 or fewer	2,500 year	1,000 to 2,500 year	1,000 year
Very High	11 - 100	5,000 year	2,500 to 10,000 year	
	More than 100	10,000 year		

Notes:

1. The AEP levels are to be used for the "mean" rather than the "median" estimates. The mean is the expected value given the epistemic uncertainties and, for typical seismic hazard computations in Canada, the mean hazard value typically lies between the 65th and 75th percentiles of the hazard distribution. The median is at the 50th percentile.

2. Generally, a seismic hazard evaluation will not be required for Low or Moderate HPC dams unless specifically requested by the Minister with supporting rationale.

FIGURES



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0 500 1000 1500 2000 2500 metres

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PROJECT:
TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:
PROJECT SITE LOCATION PLAN
AND KEY PLAN

PROJECT NO: 141–12598–00

SCALE: 1:50000

DRAWN BY: G. HOOGWERF

CHECKED BY: B. PLUMRIDGE

ISSUE/REVISION: FINAL 0

ISSUE DATE: JULY 21, 2014

FIGURE NO: FIGURE 1.1

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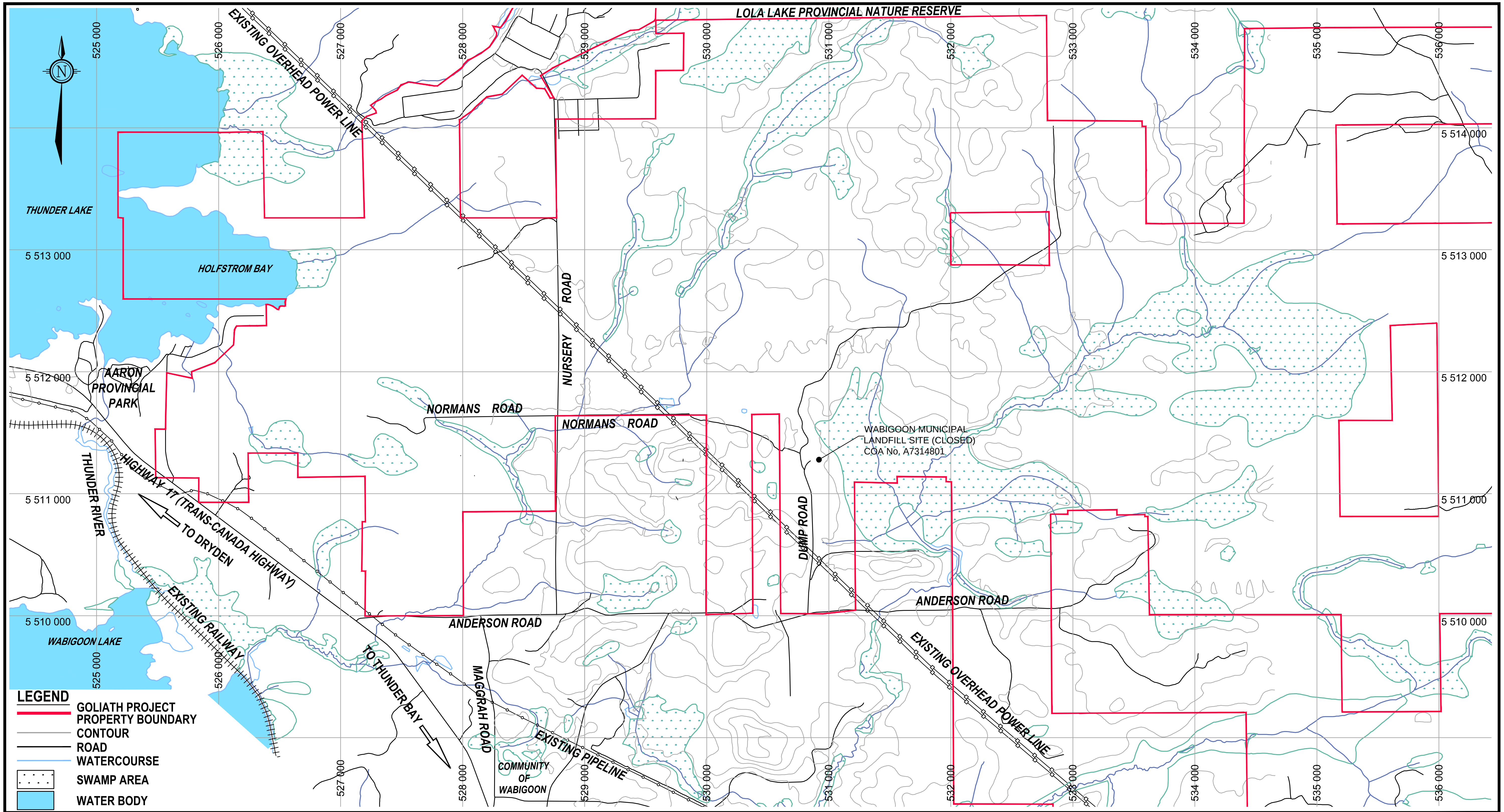

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0 500 1000 metres

NOTES:

- COORDINATES SHOWN REFER TO NAD83 UTM ZONE 15.
- CONTOURS SHOWN ARE 10m INTERVAL FROM ONTARIO BASE MAPPING.

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PROJECT:
TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:
EXISTING SITE CONDITIONS

PROJECT NO: 141–12598–00
SCALE: 1:30000
DRAWN BY: G. HOOGWERF
CHECKED BY: B. PLUMRIDGE
ISSUE/REVISION: FINAL 0
ISSUE DATE: JULY 21, 2014
FIGURE NO: FIGURE 2.1

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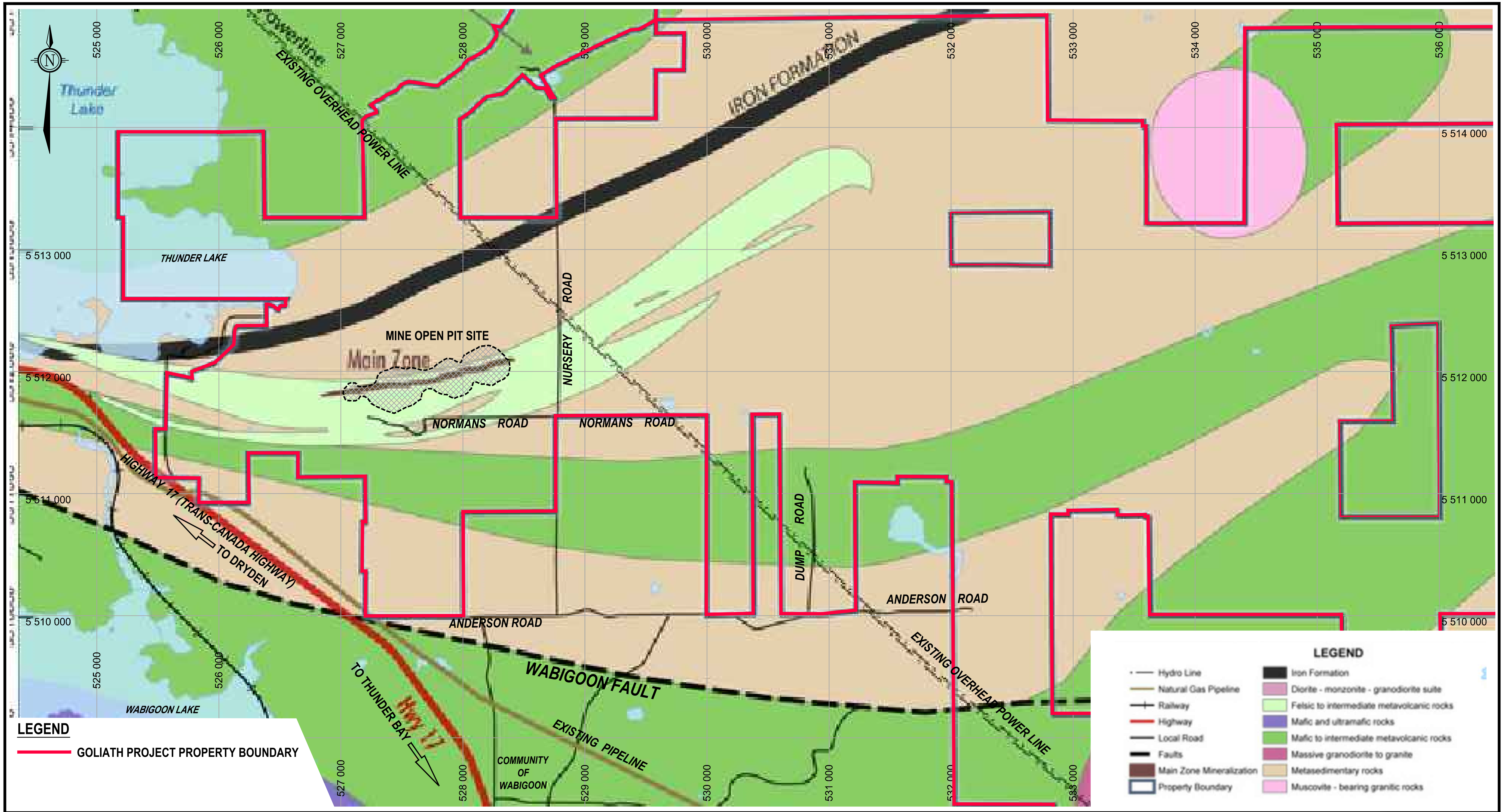

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0 500 1000 metres

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PROJECT:
TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:
REGIONAL STRUCTURAL GEOLOGY
AND LITHOLOGIC UNITS

PROJECT NO: 141–12598–00
SCALE: 1:30000
DRAWN BY: G. HOOGWERF
CHECKED BY: B. PLUMRIDGE
ISSUE/REVISION: FINAL 0
ISSUE DATE: JULY 21, 2014
FIGURE NO: FIGURE 2.2

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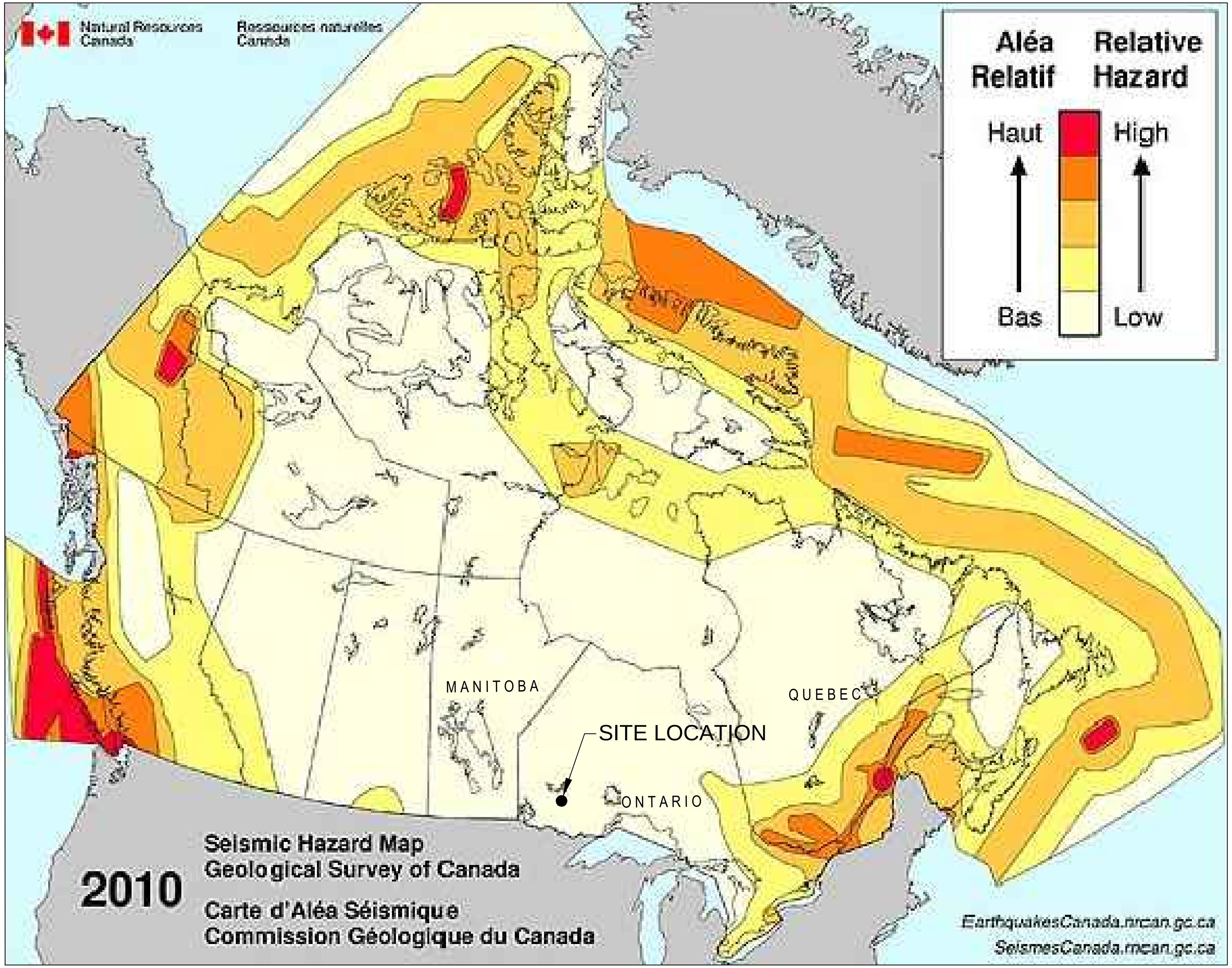

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PROJECT:
TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:
SEISMIC HAZARD MAP OF CANADA

PROJECT NO: 141-12598-00
SCALE: NOT TO SCALE
DRAWN BY: G. HOOGWERF
CHECKED BY: B. PLUMRIDGE
ISSUE/REVISION: FINAL 0
ISSUE DATE: JULY 21, 2014
FIGURE NO: FIGURE 2.3

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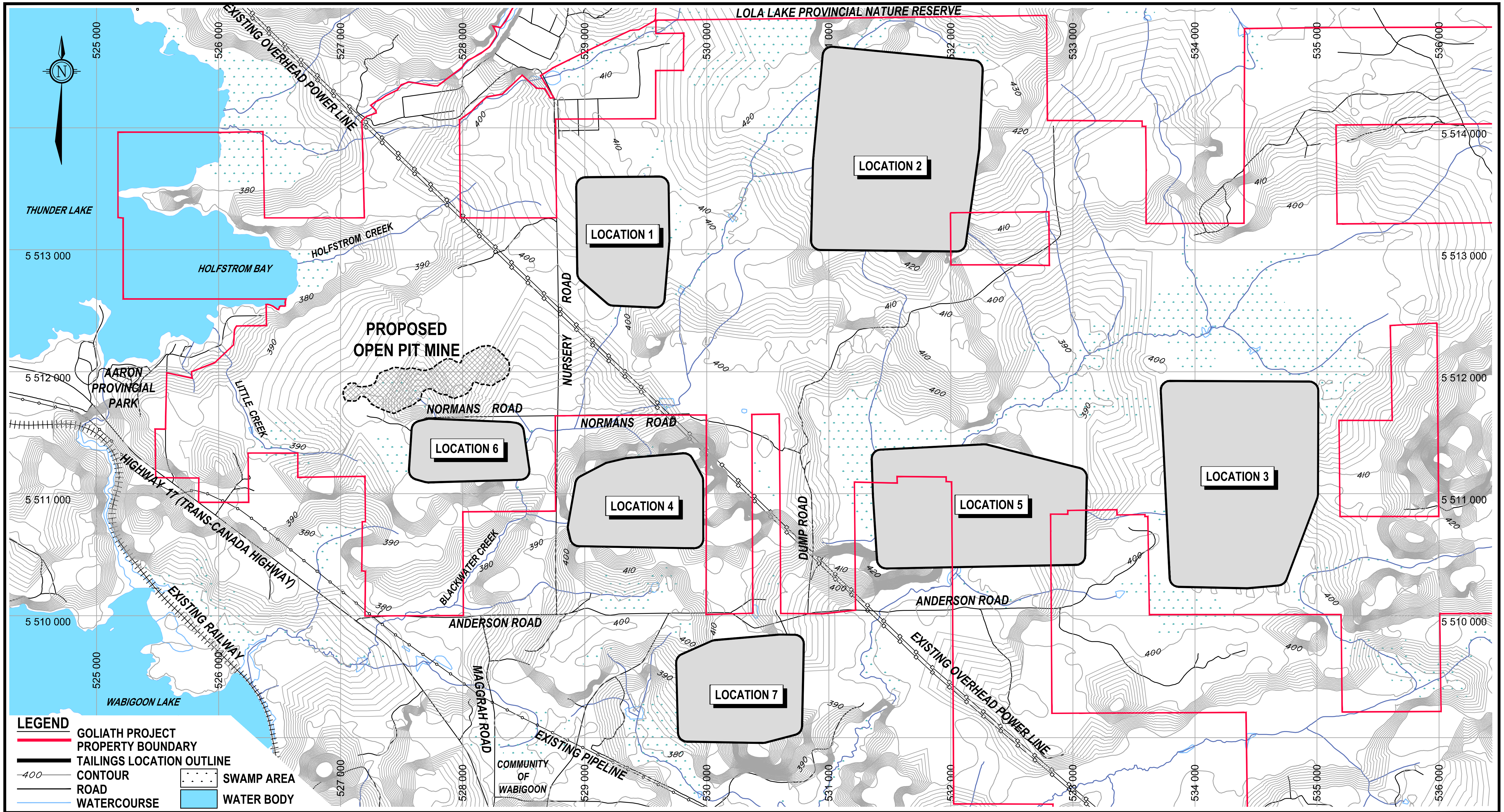

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NOTES:

- COORDINATES SHOWN REFER TO NAD83 UTM ZONE 15.
- CONTOURS SHOWN ARE 1m INTERPOLATED FROM ONTARIO BASE MAPPING 10m CONTOUR INTERVAL.
- TAILINGS FACILITY LOCATION OUTLINES UTILIZED FOR COMPLETION OF THE ALTERNATIVES ASSESSMENT.

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PROJECT:

TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:

TAILINGS STORAGE FACILITY
CANDIDATE LOCATIONS

PROJECT NO:	141-12598-00
SCALE:	1:30000
DRAWN BY:	G. HOOGWERF
CHECKED BY:	B. PLUMRIDGE
ISSUE/REVISION:	FINAL 0
ISSUE DATE:	JULY 21, 2014
FIGURE NO:	FIGURE 4.1

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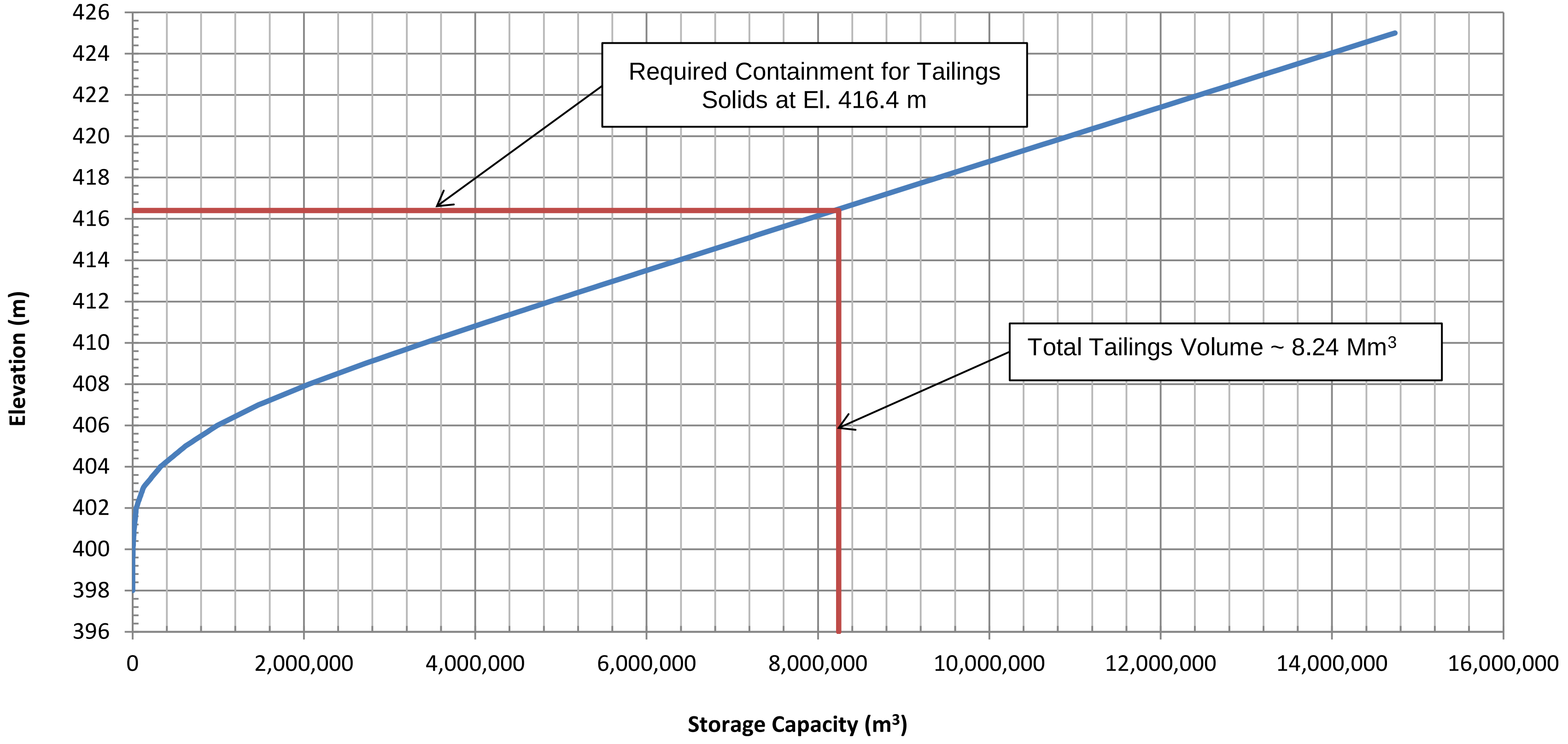


Notes:

1. Capacity is based on preliminary alignment and flat tailings beach.
2. Tailings storage based on conventional tailings with co-disposal of tailings solids into underground mine working after Year 5 of the operations.
3. Based on Option 1D of Alternatives Assessment.

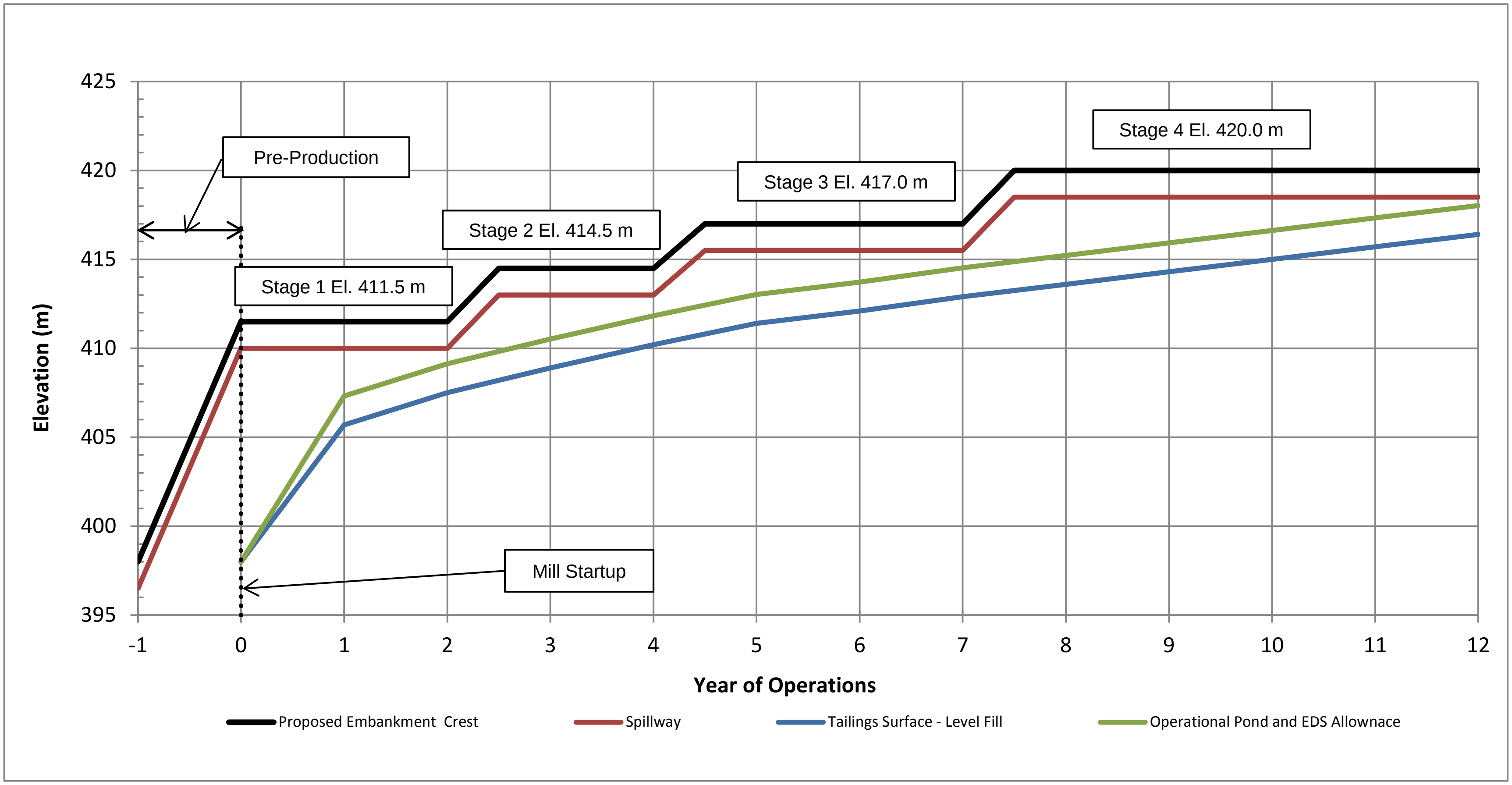
Prepared By:	BRP	Checked By:	HBW	Approved By:	HBW

TREASURY METALS INC.

GOLIATH PROJECT

LOCATION 1
STAGE-STORAGE CURVE

FIGURE 5.1	Project No.: 141-12598-00	Ref. No.: 0



Notes:

1. Proposed emabnkment staging is preliminary and is based on infomration avaialble.

2. Tailings surface is based on level fill.

3. Allowance for Operational Pond and Environmental Design Storm (EDS) for operatioinal and stormwater management and to maintian water cover over tailings.

Prepared By:	BRP	Checked By:	HBW	Approved By:	HBW

TREASURY METALS INC.

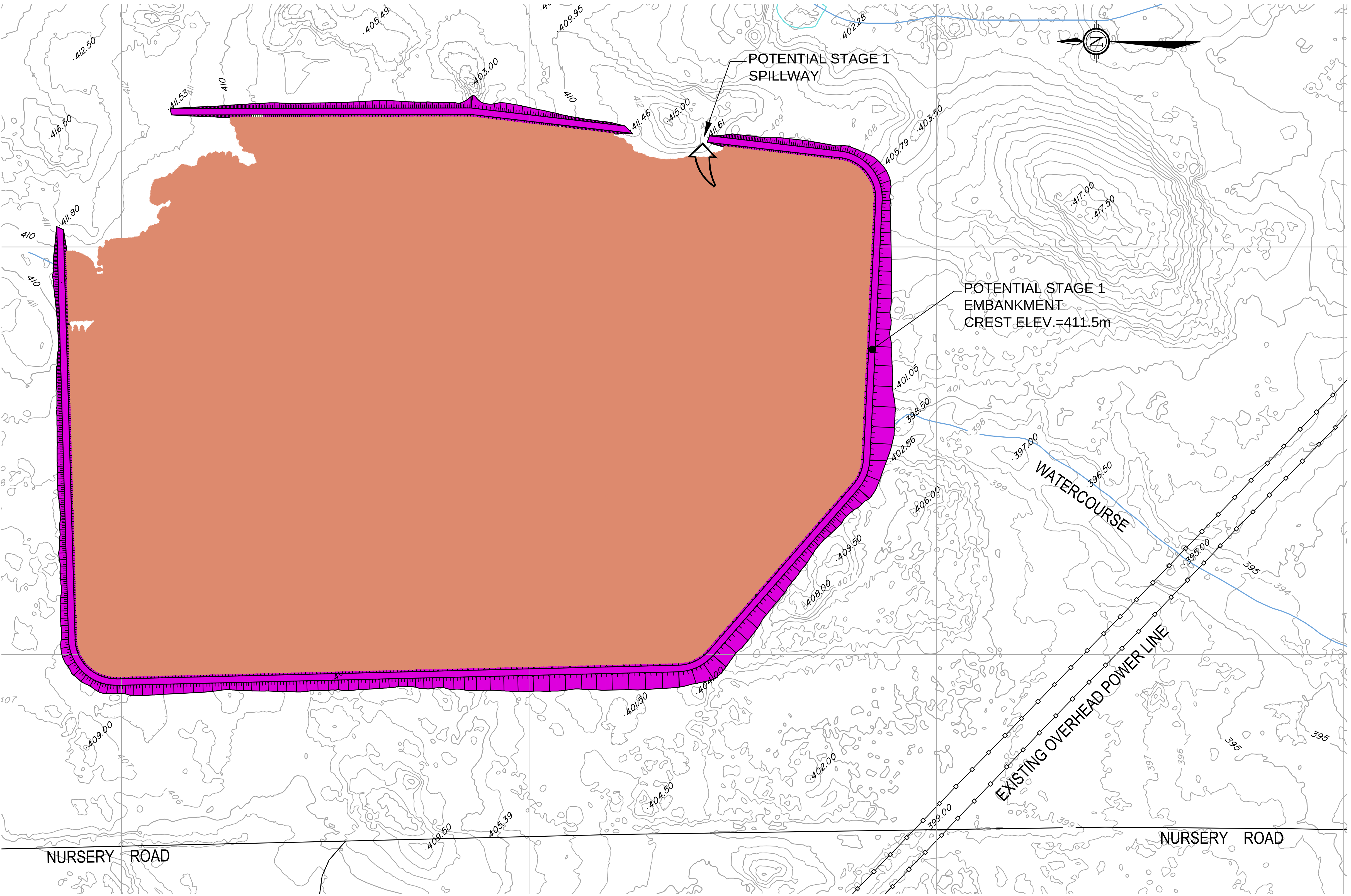
GOLIATH PROJECT
ALTERNATIVES ASSESSMENT

LOCATION 1
EMBANKMENT STAGING

FIGURE 5.2

Project No.: 141-12598-00

Ref. No.: 0



LEGEND

───	CONTOUR
───	ROAD
───	WATERCOURSE
─○─○─	POWER LINE
⇦	PROPOSED SPILLWAY
🟫	PROPOSED TAILINGS FILL AREA
🟪	PROPOSED EMBANKMENT

NOTES:

1. DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. PRELIMINARY STAGE 1 EMBANKMENT FOR ALTERNATIVE 1D (LOCATION 1 WITH FUTURE CO-DISPOSAL OF TAILINGS).
3. INFORMATION PRESENTED IS PRELIMINARY ONLY AND NOT INTENDED FOR CONSTRUCTION.

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0 50 100 150 200 250 metres

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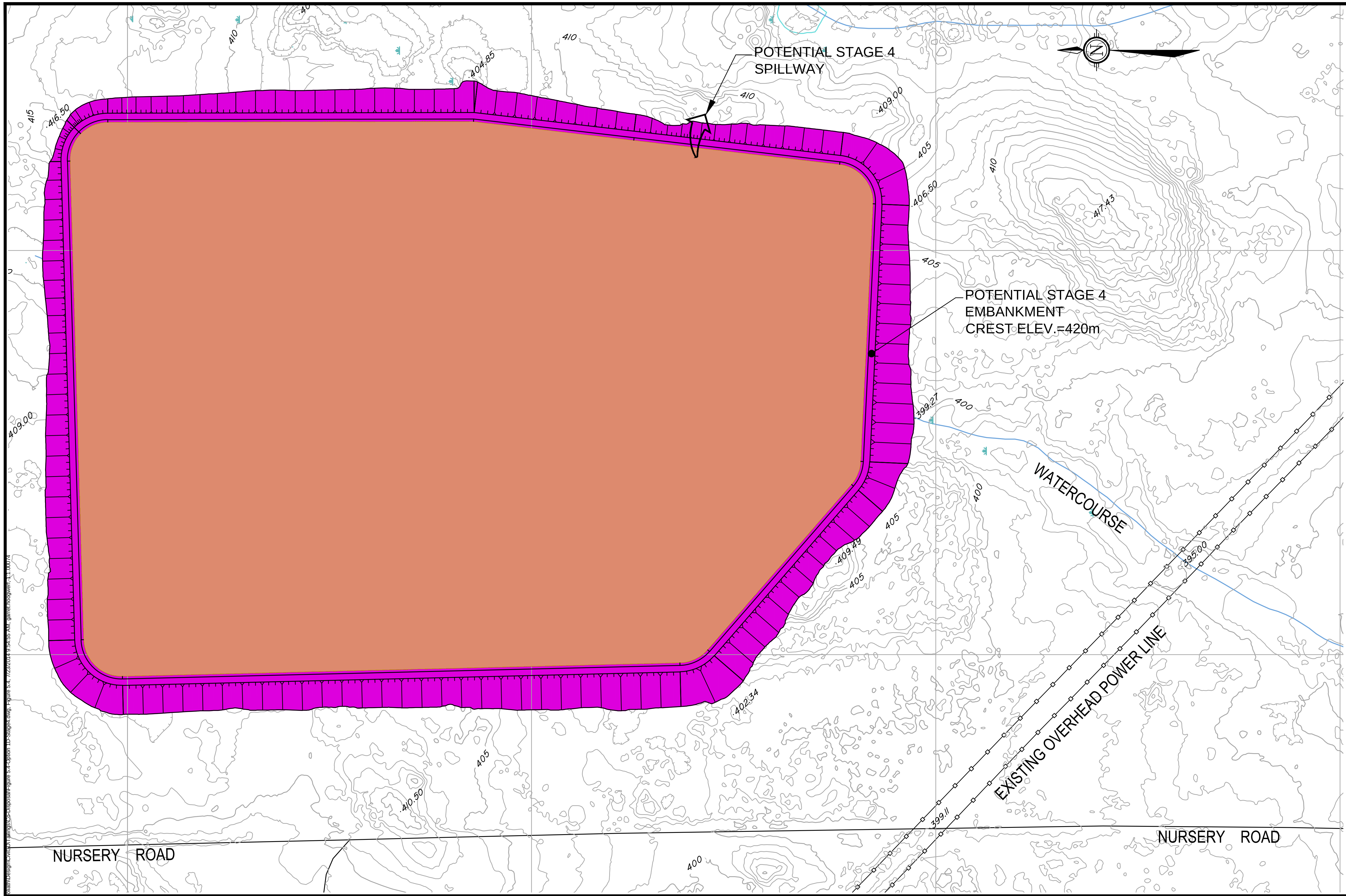
PROJECT:
TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:
LOCATION 1,
STAGE 1 PLAN

PROJECT NO: 141-12598-00
SCALE: 1:5000
DRAWN BY: G. HOOGWERF
CHECKED BY: B. PLUMRIDGE
ISSUE/REVISION: FINAL 0
ISSUE DATE: JULY 21, 2014
FIGURE NO: FIGURE 5.3

S:\01-ACTIVE PROJECTS\2014\141-12598-00 Treasury Metals-Goliath\Design\Civil3D\Tailings\Co-Disposal\Figure 5.3-Option1D-Stage1.dwg, Figure 5.3, 7/23/2014 9:51:58 AM, garret.hoogwerf, 1:1.03432



LEGEND

CONTOUR
ROAD
WATERCOURSE
POWER LINE
PROPOSED SPILLWAY
🟧 PROPOSED TAILINGS FILL AREA
🟪 PROPOSED EMBANKMENT

NOTES:

1. DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. PRELIMINARY STAGE 4 EMBANKMENT FOR ALTERNATIVE 1D (LOCATION 1 WITH FUTURE CO-DISPOSAL OF TAILINGS).
3. INFORMATION PRESENTED IS PRELIMINARY ONLY AND NOT INTENDED FOR CONSTRUCTION.

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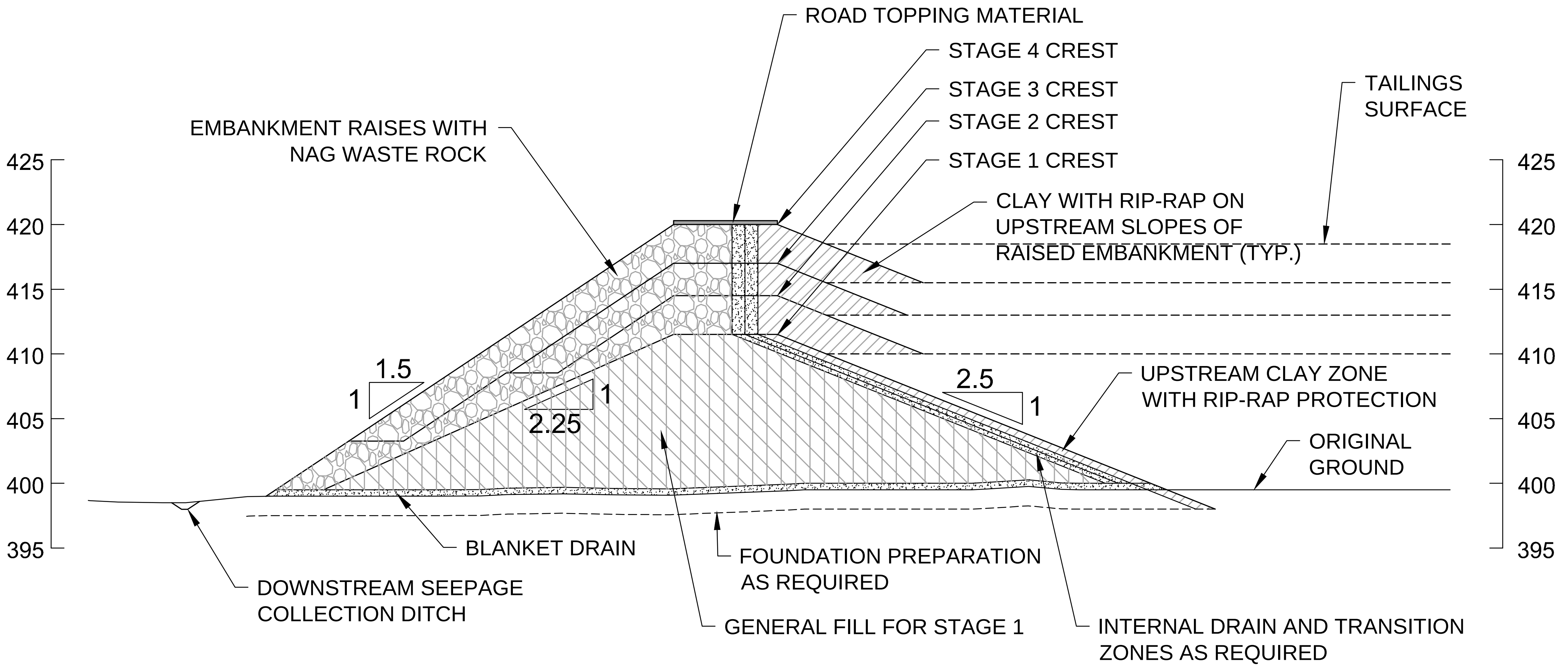
PROJECT:
TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:
LOCATION 1,
STAGE 4 PLAN

PROJECT NO: 141–12598–00
SCALE: 1:5000
DRAWN BY: G. HOOGWERF
CHECKED BY: B. PLUMRIDGE

ISSUE/REVISION: FINAL 0
ISSUE DATE: JULY 21, 2014
FIGURE NO: FIGURE 5.4

S:\01-ACTIVE PROJECTS\2014\141-12598-00 Treasury Metals-Goliath\Design\Civil3D\Tailings\Co-Disposal\Figure 5.4-Option 1D-Stage4.dwg, Figure 5.4, 7/23/2014 9:54:55 AM, garret.hoogwerf, 1:1.00074



NOTES:

1. DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
2. CONCEPT SHOWN IS PRELIMINARY AND NOT INTENDED FOR CONSTRUCTION. THIS CONCEPT ASSUMES CENTRELINE STYLE FOR EMBANKMENT RAISE.
3. EMBANKMENT STAGING AND STYLE OF RAISE TO BE CONFIRMED / OPTIMIZED WITH SUBSEQUENT LEVELS OF DESIGN.
4. CONCEPT SHOWN IS FOR LOCATION 1 ONLY.
5. FOUNDATION PREPARATION TO BE DETERMINED WITH SITE INVESTIGATION.
6. EMBANKMENT DIMENSIONS AND SLOPES TO BE CONFIRMED WITH DETAILED STABILITY. ASSESSMENT.

LEGEND

▧ GENERAL FILL
▦ NAG WASTE ROCK
▨ LOW PERMEABLE MATERIAL (CLAY)
░ DRAIN AND TRANSITION

WSP

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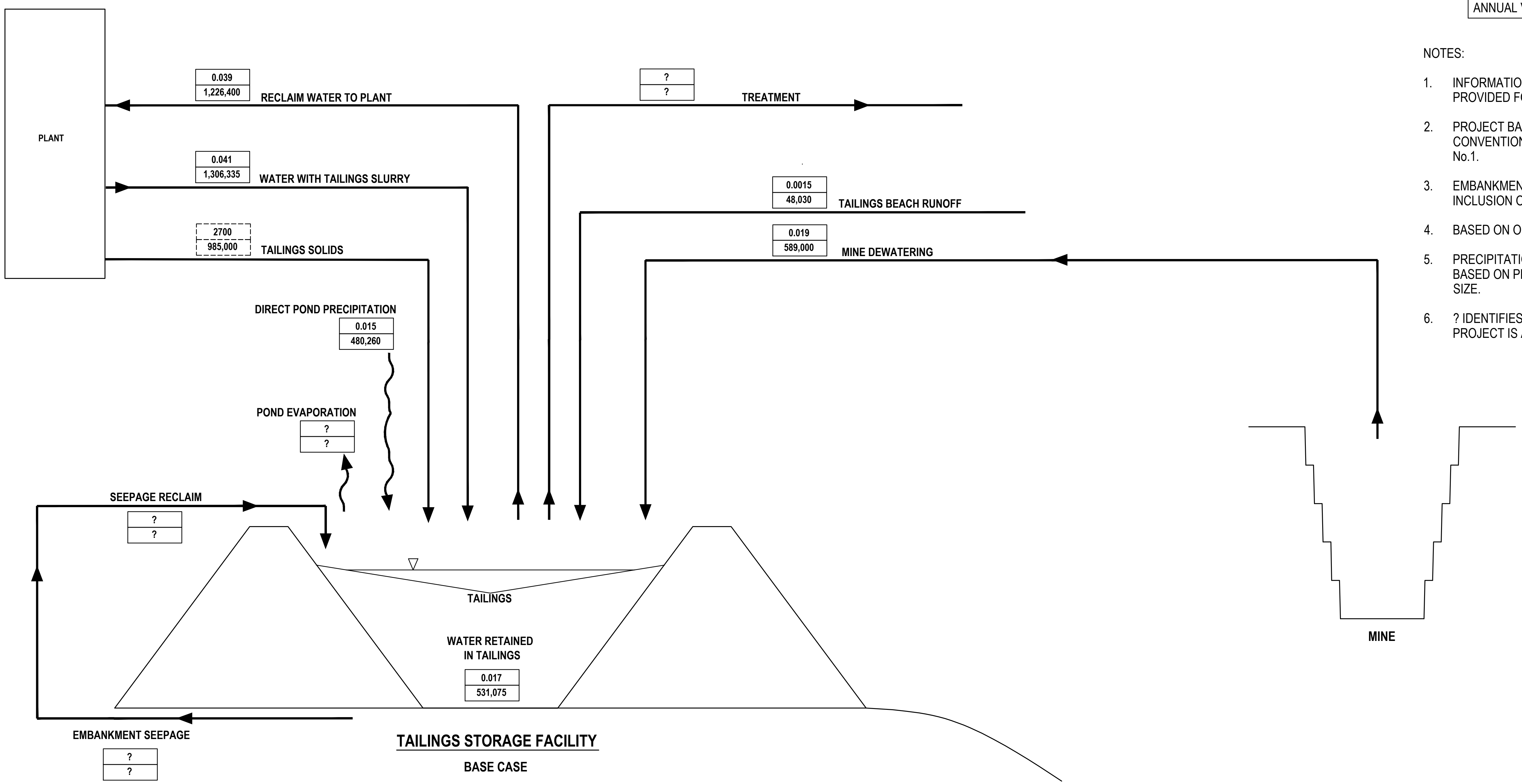
PROJECT:
TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:
LOCATION 1
POTENTIAL CROSS SECTION

PROJECT NO: 141-12598-00
SCALE: AS SHOWN
DRAWN BY: G. HOOGWERF
CHECKED BY: B. PLUMRIDGE

ISSUE/REVISION: FINAL 0
ISSUE DATE: JULY 21, 2014
FIGURE NO: FIGURE 5.5

S:\01-ACTIVE PROJECTS\2014\141-12598-00 Treasury Metals-Goliath\Design\Civil3D\Tailings\Co-Disposal\Figure 5.5-Dam Section.dwg, Figure 5.5, 7/23/2014 9:49:58 AM, garret.hoogwerf, 1:1.03432



TAILINGS STORAGE FACILITY

BASE CASE

LEGEND

FLOW RATE m³/s	DTPD
ANNUAL VOLUME m³	DTPA

NOTES:

1. INFORMATION SHOWN IS PRELIMINARY AND IS PROVIDED FOR DISCUSSION AND CONFIRMATION.
2. PROJECT BASE CASE SHOWN CONSISTING OF CONVENTIONAL TAILINGS DEPOSTION TO LOCATION No.1.
3. EMBANKMENT SEEPAGE WILL BE DEPENDENT ON INCLUSION OF A LINER CONTAINMENT SYSTEM.
4. BASED ON OPERATION 365 DAYS PER YEAR.
5. PRECIPITATION INTO TAILINGS STORAGE FACILITY IS BASED ON PRELIMINARY ESTIMATES OF LAYOUT AND SIZE.
6. ? IDENTIFIES VALUES TO BE DETERMINED AS THE PROJECT IS ADVANCED.

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PROJECT:
TREASURY METALS - GOLIATH PROJECT
TAILINGS STORAGE FACILITY
ALTERNATIVES ASSESSMENT

TITLE:
WATER/SOLIDS BALANCE SCHEMATIC

PROJECT NO: 141-12598-00
SCALE: NOT TO SCALE
DRAWN BY: G. HOOGWERF
CHECKED BY: B. PLUMRIDGE
ISSUE/REVISION: FINAL 0
ISSUE DATE: JULY 21, 2014
FIGURE NO: FIGURE 5.6

APPENDIX

WSP

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MEMO

TO:	TREASURY METALS	**DATE:**	**July 21, 2014**
FROM:	**WSP**		Job No.: 141-12598-00
SUBJECT:	GOLIATH PROJECT – 2014 SITE INVESTIGATION - FACTUAL SOILS SUMMARY		

1. Introduction

The Treasury Metals, Goliath Property, is located near the City of Dryden in Ontario. Exploration drilling is currently on-going at the site to support the future development of a gold mine. The mine, when in operations, will consist of open-pit followed by underground mining developments with on-site processing and mine waste storage. A small scale site investigation was completed in March/April of 2013 for the purpose of supporting the future planned pre-feasibility design for the plant site and on-land tailings storage facility. The site investigation was used to investigate the sub-surface soil conditions in two (2) potential Tailings Storage Facility (TSF) areas, consisting of Location 1 and Location 6, being considered as part of the projects Alternative Assessment study as well as in potential locations for the processing plant site.

The site investigation work was completed between March 25 and April 2, 2014. TBT Engineering Ltd. (TBTE) completed the investigations with site supervision completed by Treasury Metals site representatives. The geotechnical investigation consisted of advancing geotechnical boreholes along with performing in situ testing to facilitate the collection of data and soil samples for identification and laboratory testing, and also to determine the in situ densities, level of compaction and relative in place strength of the materials present. TBTE also completed field sample identification and also prepared Borehole Logs for the project. The Borehole Logs are currently in Draft and can be updated to reflect the results of the laboratory program and the project is advanced to the design phase. The following sections provide the factual soils information collected from the site investigation. The information presented below can be used to support design activities as the project is advanced.

2. Drilling

The site investigation program included advancement of twenty (20) boreholes at the property, consisting of seven (7) in TSF Location 1 Area, three (3) in the TSF Location 6 Area, five (5) at the Plant Site Option 1 and five (5) at the Plant Site Option 2. These have been identified as BH14-01 to BH14-21 and summary details are provided in the Table, below. A planned borehole, identified as BH14-16 was not completed as part of the site investigation program due the presence of snow that limited access to the proposed area. The locations of the Boreholes advanced during the site investigation program are shown on Figure A1, attached.

Advancement of the boreholes utilized a CME 55 drill (3.25" hollow stem auger), mounted on a Marooka track machine The depth of Borehole advancement ranged from a minimum of 1.05 m below ground surface in BH14-02 to 18.6 m in BH13-15. All Boreholes were advanced to depths of auger refusal, with the exception of BH-13 for which drilling was ceased if refusal was not achieved below 9.0 m. The site investigation included discreet interval sampling, standard penetration testing, and shear vane testing where soft, cohesive soils were encountered. Soil samples were collected in a 50 mm outside diameter split-spoon sampler, for identification and laboratory testing. A summary of the boreholes advanced as part of the site investigation program is provided as Table A1, attached.

Borehole	Date	Borehole Depth (m)	General Location
BH14-01	March 27, 2014	1.5	TSF Option 1
BH14-02	March 27, 2014	1.05	TSF Option 1
BH14-03	March 26, 2014	6.0	TSF Option 1
BH14-04	March 26, 2014	8.1	TSF Option 1
BH14-05	March 25, 2014	13.75	TSF Option 1
BH14-06	March 26, 2014	9.9	TSF Option 1
BH14-07A	March 27, 2014	12.3	TSF Option 1
BH14-08	April 2, 2014	9.0	TSF Option 6
BH14-09A	April 2, 2014	7.5	TSF Option 6
BH14-10A	April 3, 2014	1.35	TSF Option 6
BH14-11	March 30, 2014	11.1	Plant Site Option 1
BH14-12	March 30, 2014	9.6	Plant Site Option 1
BH14-13	March 31, 2014	9.6	Plant Site Option 1
BH14-14	March 31, 2014	9.15	Plant Site Option 1
BH14-15	March 29, 2014	18.6	Plant Site Option 1
BH14-16	Not drilled due to access restrictions		
BH14-17	March 28, 2014	2.7	Plant Site Option 2
BH14-18	March 28, 2014	2.7	Plant Site Option 2
BH14-19	March 28, 2014	3.75	Plant Site Option 2
BH14-20	March 28, 2014	10.5	Plant Site Option 2
BH14-21	March 28, 2014	5.1	Plant Site Option 2

3. Sampling

Split spoon samples from the Standard Penetration Tests (SPT's) were collected for potential laboratory testing from all Boreholes advanced during the site investigation program with the exception of BH14-02 and BH14-10A. Borehole BH14-02 was drilled to 1.05 m and was stopped due to auger and split spoon refusal. Borehole BH14-10A was drilled to 1.35 m entirely within non-native fill material and was suspended due to auger refusal.

All samples were stored in plastic bags to preserve the natural moisture content. A summary of the field samples collected during the site investigation program are provided on Table A2, attached. Soil samples were selected by an experienced geotechnical engineer for additional geotechnical index testing that was completed by the TBT Engineering Limited geotechnical laboratory in Thunder Bay, Ontario.

4. In Situ Testing

In situ testing was completed during the site investigation program that consisted of SPT's in all boreholes advanced during the site investigation program, with the exception of BH14-02, and BH14-10A. Split spoons were advanced with the CME550 drill for the purpose of sample collection and "N" counts were recorded. Vane Shear testing was also completed in a Clay layer in boreholes BH14-06 to BH14-09A, BH14-11 to BH14-17, BH14-19 and BH14-20. The SPT's were completed using a standard split spoon sampler, 50 mm in diameter and 600 mm in length, which was driven ahead of the augers or casing by the force exerted by a 63.5 kg hammer free falling through a distance of 750 mm. The use of the split spoon facilitated collection of the soil samples in addition to obtaining SPT "N" values, which are shown on the borehole logs, attached. The recorded SPT "N" values can be used to provide an indication of soil density and strength. The SPT "N" values are summarized on Table A3. The "N" value provides an indication of the soils in situ density, stiffness and strength that can be correlated to the resistance to penetration of the sampler. This method is recommended for sandy material but should be used with caution for cohesive soil material.

A total of 56 in situ Field Vane Shear tests were performed as part of the site investigation activities. The Vane Shear Test is a measurement of the in situ undrained shear strength of cohesive materials. The vane is advanced into the soil layer ahead of the augers and then rotated and the torsional force required to cause shearing is used to calculate the undrained shear strength. The vane is then re-torqued to determine the remolded strength of the soil. The results of the in situ Field Vane Shear Tests are provided on Table A3, attached.

5. Laboratory Testing

Geotechnical laboratory index testing was performed on selected samples of the materials collected during the site investigation program for general characterization and determination of in situ parameters. Testing was completed by the TBT laboratory in Thunder Bay and was limited to natural moisture content determination, grain size analysis and Atterberg Limits. A summary of the laboratory testing results is provided in Table A4, attached. The laboratory analysis results as provided from TBTE are attached.

6. Geotechnical Summary

The following sections provide a geotechnical summary of the material encountered during the site investigation completed at the Goliath Property. The subsurface soil descriptions have been generalized into the geological units and are presented below.

- Fill
- Topsoil – Organics
- Sand
- Silt
- Clay

6.1. Fill

Fill material was encountered in BH14-10A and was described as being sand, some gravel and occasional cobbles. The Fill material extended from the surface of the borehole to a depth of 1.35 m at auger refusal. Two (2) auger samples were collected in the Fill material. No in situ testing or laboratory testing was completed on the fill material as part of the site investigation program.

6.2. Topsoil – Organics

A surface organic layer or topsoil was encountered in BH14-01 to BH14-09A, BH14-11 to BH14-15 and BH14-17 to BH14-21. The organic layer was generally described as being black to brown and was frozen in BH14-14 and BH14-15. Roots were noted in the layer in BH14-05 and BH14-20. Sand was noted within the layer in BH14-19. The organic layer was encountered at the surface and generally extended to a depth of 0.1 m below the original ground with a maximum depth of 1.5 m in BH14-14.

6.3. Sand

Sand layers were encountered during the site investigation at the site that consisted of upper and lower layers. The upper layer was encountered underlying the Topsoil-Organics layer in BH14-01 to BH14-07, BH14-09A, BH14-11 to BH14-13, BH14-15, BH14-17, BH14-18, BH14-20 and BH14-21. The lower layer was encountered underlying the Silt layer in BH13-04 and BH14-05 and underlying the Clay layer in BH14-09A, BH14-13 and BH14-17. The Sand layer was generally described as being silty to some and silt to trace silt, brown to black to grey. Rock fragments were noted at depth in BH14-05. Clay content was noted in the layer in BH14-09A. The upper sand layer was encountered below the organic layer at a depth of 0.1 m and extended to a maximum depth of 3.8 m in BH14-05. The lower sand layer was encountered at a minimum depth, underlying the clay layer, in BH14-17 and extended to a depth of 2.7 m below the original ground to auger refusal. The lower sand layer was encountered at a maximum depth below the original ground at 9.0 m, underlying the clay layer, and extended to auger refusal at a depth of 9.6 m.

A total of 14 (fourteen) moisture content tests were completed on selected samples of the Sand material and the results are provided in the laboratory results attached. The minimum moisture content was 15.8%, maximum was 26.1%, with an average of 20.5%. One (1) grain size test was completed on the Sand layer and the results are provided on Figure A2, attached.

A total of 30 in situ SPT's were completed in the sand layer during the site investigation program. The resultant SPT N values ranges from a minimum of 2 to a maximum of greater than 50 with an average of 15 indicating a very loose to very dense material consistency.

6.4. Silt

Silt layers were encountered at various depths below the original ground during the site investigation activities. The Silt layer was encountered underlying the Sand layer in BH14-03 to BH14-7A and BH14-11 and underlying the Clay layer in BH14-14, BH14-15, BH14-18, BH14-19 and BH14-21. The Silt Layer was underlain by Sand in BH14-04 and BH14-05 and was underlain by a Clay layer in BH14-06 to BH14-08, BH14-15 and BH14-21. The Silt layer ranged in depth, below the upper Sand layer from 0.6 m below the original ground in BH14-11 and extended to a maximum depth of 12 m in Bh14-15 below the original ground. The Silt layer encountered below the Clay layer extended from a minimum depth of 4.5 m below the original ground in BH14-21 to a maximum depth of 18.6 m (auger refusal) in BH14-15. The Silt layer extended to the maximum advancement or auger refusal in BH14-03 (6.0 m), BH14-06 (9.9 m), BH14-15 (18.6 m) and BH14-21 (5.1 m).

The Silt layer was generally described as consisting of Silt and Sand and Clay, trace sand to sandy to some sand, trace to some clay and is generally grey in color, layered with red clay and grey silt and grey clay seems.

A total of 20 moisture content tests were completed on selected samples of the Silt material and the results are attached in the Laboratory Results. The minimum moisture content was 13.5%, maximum was 30.3%, with an average of 22.5%. Six (6) grain size analysis tests were completed on the Silt in BH14-03 to BH14-06 inclusive and the results are provided on Figure A3, attached.

A total of 30 in situ SPT's were completed in the Silt layer during the site investigation program. The resultant SPT N values ranges from no reading (weight of hammer) to >50 with an average of 9 indicating a very loose to very dense material that is generally loose. One (1) in situ shear vane test was completed in the silt layer with a result of greater than 100 kPa.

6.5. Clay

Clay layers were encountered at various locations and depths during the site investigation program. Clay was encountered underlying the Topsoil-Organics layer in BH14-08, 14-09A, BH14-13, BH14-14 and BH14-19. The Clay layer was also encountered underlying the Silt layer in BH14-06, BH14-07A, BH14-11 and BH14-21 and underlying the Sand layer in BH14-12, BH14-15, BH14-17, BH14-18 and BH14-20. The Clay layer extended from a minimum depth of 0.1 m in BH14-08 and BH14-09A to a depth of 10.5 m in BH14-20. A layer of Clay was also encountered underlying the Silt layer in BH14-15 and extended from depths of 12 m to 15 m below the original ground level. The Clay layer extended to refusal or maximum advancement in BH14-02 (1.05 m), BH14-07A (12.3 m), BH14-08 (9.0 m), BH14-11 (11.1 m), BH14-12 (9.6 m), and BH14-20 (10.5 m).

The Clay layer was generally described as being clay and silt to silt and clay to silty, brown and grey to grey (dark to light) to reddish grey in color and was occasionally layered. Red clay and grey (dark to light) clay to silt layers were observed in BH14-06. Some gravel and rock fragments were observed at depth in layer in BH14-07A. Sand seems were observed in BH14-12. The Clay layer was described as consisting of clay, silt, sand and gravel at depth in BH14-11. Silt seems were observed in BH14-14 and BH14-15 at a depth of 3.0 m.

A total of 20 moisture content tests were completed on selected samples of the Clay material and the results are attached in the Laboratory Results. The minimum moisture content was 16.5%, maximum was 46.2%, with an average of 33.6%.

Two Atterberg Limits tests were completed on samples of the Clay. The results from BH14-06, Sample No. SS7 had a liquid limit of 25%, Plastic Limit of 19.1% and Plasticity Index of 6.0 indicating a USCS Classification of CL-ML. The Atterberg Limits test result from BH14-08, Sample No. SS3 had a liquid limit of 46%, Plastic Limit of 22% and Plasticity Index of 24 indicating a USCS Classification of CL. The results of the Atterberg Limits testing are provided as Figure A4, attached. Two (2) grain size analysis was completed on the Clay material and the results are provided on Figure A5, attached.

A total of 73 in situ SPT's were completed in the Clay layer during the site investigation program. The resultant SPT N values ranges from no reading (weight of hammer) to >50 with an average of 3. SPT values of >50 were most likely influenced by the underlying layer, that was close to refusal, and therefore have not been included as inputs for material strength indications. The maximum SPT value, not including the refusal value, was 17. The results of the field SPT's indicate a very soft to very stiff material range with an average of soft. A total of 56 in situ shear vane tests were completed to identify the undrained shear strength. The results indicated a minimum value of 20 kPa and maximum value of greater than 100 kPa with an average value of 73 kPa. A total of 46 re-shear tests were completed with a minimum value of 3 kPa, maximum value of 70 kPa and average value of 21 kPa.

7. Summary

The site investigation completed at the Goliath Project site near Dryden, Ontario consisted on 20 boreholes advanced in two (2) potential TSF areas and also in two (2) potential plant site locations. Soil thicknesses of up to 13.75 m were identified within BH14-05 in the proposed area of Location 1 tailings storage facility. A small scale laboratory testing program was completed on selected samples and were concentrated in the potential tailings storage facility areas. The Borehole Logs were generated by TBTE and are currently in Draft and will require updating to reflect the results of the laboratory testing program and will be completed once the design phase of the project has been initiated. The results of the site investigation program will be used to advance the planned design phases of the project and will form the basis for development of future site investigation programs that are anticipated to include test pitting of potential fill materials for construction activities.

Attachments:

- Table A1 – Summary of Borehole Details
- Table A2 – Summary of Field Samples
- Table A3 – Summary of In Situ Testing
- Table A4 – Borehole Samples Lab Testing Results
- Figure A1 – Site Investigation Locations
- Figure A2 – Grain Size Results – Sand
- Figure A3 – Grain Size Results – Silt
- Figure A4 – Plasticity Chart – Clay

- Figure A5 – Grain Size Results – Clay
- TBTE Borehole Logs (Draft)
- Laboratory Testing

TABLE A1

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF BOREHOLE DETAILS

Drillhole No.	Coordinates		Depth of Drillhole (m)	General Location
	Northing (m)	Easting (m)		
BH14-01	5512562	529491	1.50	Tailings Storage Facility Location 1, Southeast Corner
BH14-02	5512932	529632	1.05	Tailings Storage Facility Location 1, East Side
BH14-03	5513400	529660	6.00	Tailings Storage Facility Location 1, Northeast Corner
BH14-04	5513576	529264	8.10	Tailings Storage Facility Location 1, North Side
BH14-05	5513425	528949	13.75	Tailings Storage Facility Location 1, Northwest Corner
BH14-06	5512942	528957	9.90	Tailings Storage Facility Location 1, West Side
BH14-07A	5512321	529150	12.30	Tailings Storage Facility Location 1, Soutwest Corner
BH14-08	5511549	528132	9.00	Tailings Storage Facility Location 6, North side
BH14-09A	5511570	528374	9.00	Tailings Storage Facility Location 6, Northeast Side
BH14-10A	5511168	527763	1.35	Tailings Storage Facility Location 6, South side
BH14-11	5512098	529026	11.10	Plant Site 1 - East Side
BH14-12	5512093	528978	9.60	Plant Site 1 - North Side
BH14-13	5512121	528957	9.60	Plant Site 1 - Northwest Corner
BH14-14	5512062	528933	9.15	Plant Site 1 - West Side
BH14-15	5511938	528962	18.60	Plant Site 1 - South Side
BH14-17	5512879	528077	2.70	Plant Site 2 - West Side
BH14-18	5512748	528151	2.70	Plant Site 2 - South Side
BH14-19	5512845	528233	3.75	Plant Site 2 - Southeast Corner
BH14-20	5513035	528118	10.50	Plant Site 2 - Northwest Corner
BH14-21	5512927	528282	5.10	Plant Site 2 - Northeast Corner

TABLE A2

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF FIELD SAMPLES

Drillhole No.	Sample No.	Depth		Sample Type	Geological Unit
		From (m)	To (m)		
BH14-01	AS1	0.4	0.60	Auger	Sand
BH14-01	SS2	0.8	1.30	Split Spoon	Sand
BH14-02	AS1	0.4	0.60	Auger	Sand
BH14-02	AS2	0.6	1.00	Auger	Clay
BH14-03	AS1	0.4	0.80	Auger	Sand
BH14-03	SS2	0.80	1.25	Split Spoon	*Silt*[1]
BH14-03	SS3	1.50	2.10	Split Spoon	Silt
BH14-03	SS4	2.40	2.80	Split Spoon	Silt
BH14-03	SS5	3.00	3.40	Split Spoon	Silt
BH14-03	SS6	4.60	5.20	Split Spoon	Silt
BH14-04	AS1	0.40	0.80	Auger	Sand
BH14-04	SS2	0.80	1.20	Split Spoon	Sand
BH14-04	SS3	1.60	2.00	Split Spoon	Sand
BH14-04	SS4	2.60	3.00	Split Spoon	Sand
BH14-04	SS5	3.00	3.40	Split Spoon	Sand
BH14-04	SS6	4.60	5.00	Split Spoon	Silt
BH14-04	SS7	6.00	6.40	Split Spoon	Silt
BH14-04	SS8	7.70	8.10	Split Spoon	Sand
BH14-05	AS1	0.40	0.80	Auger	Sand
BH14-05	SS2	0.80	1.20	Split Spoon	Sand
BH14-05	SS3	1.60	2.00	Split Spoon	Sand
BH14-05	SS4	2.40	3.00	Split Spoon	Sand
BH14-05	SS5	3.00	3.40	Split Spoon	Sand
BH14-05	SS6	3.80	4.20	Split Spoon	Silt
BH14-05	SS7	4.50	4.90	Split Spoon	Silt
BH14-05	SS8	5.40	4.80	Split Spoon	Silt
BH14-05	SS9	6.00	6.40	Split Spoon	Silt
BH14-05	SS10	6.80	7.20	Split Spoon	Silt
BH14-05	SS11	7.60	8.00	Split Spoon	Silt
BH14-05	SS12	8.20	8.60	Split Spoon	Silt
BH14-05	SS13	9.00	9.40	Split Spoon	Silt
BH14-05	SS14	9.20	10.20	Split Spoon	Silt
BH14-05	SS15	10.50	10.90	Split Spoon	Sand

TABLE A2

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF FIELD SAMPLES

Drillhole No.	Sample No.	Depth		Sample Type	Geological Unit
		From (m)	To (m)		
BH14-05	SS16	11.30	11.70	Split Spoon	Sand
BH14-05	SS17	12.00	12.40	Split Spoon	Sand
BH14-05	SS18	12.80	13.20	Split Spoon	Sand
BH14-05	SS19	13.40	13.60	Split Spoon	Sand
BH14-06	AS1	0.40	0.80	Auger	Sand
BH14-06	SS2	0.80	1.20	Split Spoon	Sand
BH14-06	SS3	1.60	2.00	Split Spoon	Sand
BH14-06	SS4	2.20	2.60	Split Spoon	Sand
BH14-06	SS5	3.00	3.40	Split Spoon	Silt
BH14-06	SS6	4.50	4.90	Split Spoon	Clay
BH14-06	SS7	6.00	6.40	Split Spoon	Clay
BH14-06	SS8	7.50	7.90	Split Spoon	Silt
BH14-06	SS9	9.10	9.50	Split Spoon	Silt
BH14-07A	AS1	0.40	0.80	Auger	Sand
BH14-07A	SS2	0.80	1.20	Split Spoon	Sand
BH14-07A	SS3	1.60	2.00	Split Spoon	Sand
BH14-07A	SS4	2.40	2.80	Split Spoon	Sand
BH14-07A	SS5	3.00	3.40	Split Spoon	Silt
BH14-07A	SS6	4.50	4.90	Split Spoon	Clay
BH14-07A	SS7	6.00	6.40	Split Spoon	Clay
BH14-07A	SS8	7.60	8.00	Split Spoon	Clay
BH14-07A	SS9	9.00	9.40	Split Spoon	Clay
BH14-07A	S10A	10.70	11.00	Split Spoon	Clay
BH14-07A	S10B	11.00	11.20	Split Spoon	Clay
BH14-07A	SS11	12.00	12.30	Split Spoon	Clay

TABLE A2

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF FIELD SAMPLES

Drillhole No.	Sample No.	Depth		Sample Type	Geological Unit
		From (m)	To (m)		
BH14-08	AS1	0.40	0.80	Auger	Clay
BH14-08	SS2	0.80	1.20	Split Spoon	Clay
BH14-08	SS3	1.60	2.00	Split Spoon	Clay
BH14-08	SS4	2.40	2.80	Split Spoon	Clay
BH14-08	SS5	3.00	3.40	Split Spoon	Clay
BH14-08	SS6	4.50	4.90	Split Spoon	Clay
BH14-08	SS7	7.20	7.60	Split Spoon	Clay
BH14-08	SS8	7.70	8.10	Split Spoon	Clay
BH14-09	AS1	0.20	0.60	Auger	Clay
BH14-09	SS2	0.80	1.40	Split Spoon	Clay
BH14-09	SS3	1.60	2.00	Split Spoon	Clay
BH14-09	SS4	2.00	2.40	Split Spoon	Clay
BH14-09	SS5	4.50	4.90	Split Spoon	Clay
BH14-09	SS6	6.00	6.40	Split Spoon	Clay
BH14-09	SS7	7.50	7.90	Split Spoon	Sand
BH14-10A	AS1	0.20	0.60	Auger	Fill
BH14-10A	AS2	0.80	1.20	Auger	Fill
BH14-11	AS1	0.30	0.70	Auger	Sand
BH14-11	SS2	0.70	1.10	Split Spoon	Silt
BH14-11	SS3	1.50	2.00	Split Spoon	Clay
BH14-11	SS4	2.40	2.70	Split Spoon	Clay
BH14-11	SS5	3.00	3.40	Split Spoon	Clay
BH14-11	SS6	4.80	5.20	Split Spoon	Clay
BH14-11	SS7	6.00	6.40	Split Spoon	Clay
BH14-11	SS8	7.50	7.90	Split Spoon	Clay
BH14-11	SS9	9.00	9.40	Split Spoon	Clay
BH14-11	SS10	10.60	11.00	Split Spoon	Clay

TABLE A2

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF FIELD SAMPLES

Drillhole No.	Sample No.	Depth		Sample Type	Geological Unit
		From (m)	To (m)		
BH14-12	AS1	0.30	0.70	Auger	Sand
BH14-12	SS2	0.70	1.10	Split Spoon	Silt
BH14-12	SS3	1.50	2.00	Split Spoon	Clay
BH14-12	SS4	2.40	2.70	Split Spoon	Clay
BH14-12	SS5	3.00	3.40	Split Spoon	Clay
BH14-12	SS6	4.80	5.20	Split Spoon	Clay
BH14-12	SS7	6.00	6.40	Split Spoon	Clay
BH14-12	SS8	7.50	7.90	Split Spoon	Clay
BH14-12	SS9	9.00	9.40	Split Spoon	Clay
BH14-13	AS1	0.30	0.70	Auger	Clay
BH14-13	SS2	0.70	1.40	Split Spoon	Clay
BH14-13	SS3	1.60	2.00	Split Spoon	Clay
BH14-13	SS4	2.20	2.60	Split Spoon	Clay
BH14-13	SS5	3.00	3.40	Split Spoon	Clay
BH14-13	SS6	4.50	4.90	Split Spoon	Clay
BH14-13	SS7	6.00	6.40	Split Spoon	Clay
BH14-13	SS8	7.50	7.90	Split Spoon	Clay
BH14-13	SS9	9.00	9.40	Split Spoon	Sand
BH14-14	AS1	0.30	0.70	Auger	Organics
BH14-14	SS2	0.70	1.40	Split Spoon	Organics
BH14-14	SS3	1.60	2.00	Split Spoon	Clay
BH14-14	SS4	2.40	2.80	Split Spoon	Clay
BH14-14	SS5	3.00	3.40	Split Spoon	Clay
BH14-14	SS6	4.50	4.90	Split Spoon	Clay
BH14-14	SS7	6.00	6.40	Split Spoon	Clay
BH14-14	SS8	7.50	7.90	Split Spoon	Clay
BH14-14	SS9	9.00	9.20	Split Spoon	Silt

TABLE A2

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF FIELD SAMPLES

Drillhole No.	Sample No.	Depth		Sample Type	Geological Unit
		From (m)	To (m)		
BH14-15	AS1	0.30	0.70	Auger	Organics
BH14-15	SS2	0.70	1.30	Split Spoon	Sand
BH14-15	SS3	1.60	2.00	Split Spoon	Sand
BH14-15	SS4	2.20	2.60	Split Spoon	Clay
BH14-15	SS5	3.10	3.50	Split Spoon	Clay
BH14-15	SS6	4.60	5.00	Split Spoon	Clay
BH14-15	SS7	6.00	6.40	Split Spoon	Clay
BH14-15	SS8	7.60	8.00	Split Spoon	Clay
BH14-15	SS9	9.00	9.40	Split Spoon	Silt
BH14-15	SS10	10.50	10.90	Split Spoon	Silt
BH14-15	SS11	12.00	12.40	Split Spoon	Clay
BH14-15	SS12	13.60	14.00	Split Spoon	Clay
BH14-15	SS13	15.00	15.40	Split Spoon	Silt
BH14-15	SS14	16.50	16.90	Split Spoon	Silt
BH14-15	SS15	18.00	18.60	Split Spoon	Silt
BH14-17	AS1	0.30	0.70	Auger	Organics
BH14-17	SS2	0.70	1.30	Split Spoon	Sand
BH14-17	SS3	1.50	2.10	Split Spoon	Clay
BH14-17	SS4	2.30	2.70	Split Spoon	Sand
BH14-18	AS1	0.30	0.70	Auger	Sand
BH14-18	SS2	0.90	1.40	Split Spoon	Clay
BH14-18	SS3	1.60	2.00	Split Spoon	Clay
BH14-18	SS4	2.30	2.70	Split Spoon	Silt
BH14-19	AS1	0.40	0.80	Auger	Organics
BH14-19	SS2	0.80	1.40	Split Spoon	Clay
BH14-19	SS3	1.60	2.10	Split Spoon	Clay
BH14-19	SS4	2.30	2.90	Split Spoon	Clay
BH14-19	SS5	3.00	3.60	Split Spoon	Clay/Silt

TABLE A2

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF FIELD SAMPLES

Drillhole No.	Sample No.	Depth		Sample Type	Geological Unit
		From (m)	To (m)		
BH14-20	AS1	0.40	0.70	Auger	Organics
BH14-20	SS2	0.70	1.30	Split Spoon	Sand
BH14-20	SS3	1.50	1.90	Split Spoon	Clay
BH14-20	SS4	2.20	2.60	Split Spoon	Clay
BH14-20	SS5	3.00	3.50	Split Spoon	Clay
BH14-20	SS6	4.50	5.00	Split Spoon	Clay
BH14-20	SS7	6.00	6.50	Split Spoon	Clay
BH14-20	SS8	7.60	8.10	Split Spoon	Clay
BH14-20	SS9	9.00	9.40	Split Spoon	Clay
BH14-21	AS1	0.40	0.80	Auger	Sand
BH14-21	SS2	0.80	1.20	Split Spoon	Sand
BH14-21	SS4	1.50	2.10	Split Spoon	Silt
BH14-21	SS5	2.30	2.70	Split Spoon	Clay
BH14-21	SS6	3.00	3.40	Split Spoon	Clay
BH14-21	SS7	4.50	5.10	Split Spoon	Silt

Note:

1. Geological units presented above are based on field obervations provided on BH Logs by TBTE with changes based on lab testing results (identified in italics). BH Logs are in Draft and require updating to reflect lab testing restults.

TABLE A3

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF IN SITU TESTING

Drillhole No.	**Depth**		**Geological Unit**	**Standard Penetration Test (SPT)**	**Vane Shear Test**	
	From (m)	**To (m)**		**N Blows per Foot**	**Initial kPa**	**Reshear kPa**
BH14-01	0.80	1.30	Sand	7		
BH14-03	0.80	1.25	*Silt* [3]	13		
BH14-03	1.50	2.10	Silt	8		
BH14-03	2.40	2.80	Silt	7		
BH14-03	3.00	3.40	Silt	6		
BH14-03	4.60	5.20	Silt	5		
BH14-04	0.80	1.20	Sand	13		
BH14-04	1.60	2.00	Sand	16		
BH14-04	2.60	3.00	Sand	21		
BH14-04	3.00	3.40	Sand	12		
BH14-04	4.60	5.00	Silt	7		
BH14-04	6.00	6.40	Silt	6		
BH14-04	7.70	8.10	Sand	8		
BH14-05	0.80	1.20	Sand	14		
BH14-05	1.60	2.00	Sand	32		
BH14-05	2.40	3.00	Sand	23		
BH14-05	3.00	3.40	Sand	3		
BH14-05	3.80	4.20	Silt	10		
BH14-05	4.50	4.90	Silt	4		
BH14-05	5.40	4.80	Silt	6		
BH14-05	6.00	6.40	Silt	3		
BH14-05	6.80	7.20	Silt	4		
BH14-05	7.60	8.00	Silt	6		

TABLE A3

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF IN SITU TESTING

Drillhole No.	Depth		Geological Unit	Standard Penetration Test (SPT)	Vane Shear Test	
	From (m)	To (m)		N Blows per Foot	Initial kPa	Reshear kPa
BH14-05	8.20	8.60	Silt	7		
BH14-05	9.00	9.40	Silt	4		
BH14-05	9.20	10.20	Silt	4		
BH14-05	10.50	10.90	Sand	8		
BH14-05	11.30	11.70	Sand	12		
BH14-05	12.00	12.40	Sand	25		
BH14-05	12.80	13.20	Sand	12		
BH14-05	13.40	13.60	Sand	>50		
BH14-06	0.80	1.20	Sand	11		
BH14-06	1.60	2.00	Sand	10		
BH14-06	2.20	2.60	Sand	9		
BH14-06	3.00	3.40	Silt	2		
BH14-06	4.50	4.90	Clay	1		
BH14-06	6.00	6.40	Clay	3		
BH14-06	7.50	7.90	Silt	6	39	4
BH14-06	9.10	9.50	Silt	14		
BH14-07A	0.80	1.20	Sand	13		
BH14-07A	1.60	2.00	Sand	17		
BH14-07A	2.40	2.80	Sand	7		
BH14-07A	3.00	3.40	Silt	4		
BH14-07A	4.50	4.90	Clay	0	52	4
BH14-07A	6.00	6.40	Clay	0	24	9
BH14-07A	7.60	8.00	Clay	9	>100	37
BH14-07A	9.00	9.40	Clay	2	75	9

TABLE A3

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF IN SITU TESTING

Drillhole No.	Depth		Geological Unit	Standard Penetration Test (SPT)	Vane Shear Test	
	From (m)	To (m)		N Blows per Foot	Initial kPa	Reshear kPa
BH14-07A	10.70	11.00	Clay	17		
BH14-07A	12.00	12.30	Clay, silty	>50		
BH14-08	0.80	1.20	Clay	4	>100	
BH14-08	1.60	2.00	Clay	5	>100	
BH14-08	2.40	2.80	Clay	6	>100	
BH14-08	3.00	3.40	Clay	5		
BH14-08	4.50	4.90	Clay	4	>100	47
BH14-08	7.20	7.60	Clay	3	62	12
BH14-08	7.70	8.10	Clay	2	>100	
BH14-09A	0.80	1.40	Clay	6		
BH14-09A	1.60	2.00	Clay	6	>100	70
BH14-09A	2.00	2.40	Clay	7		
BH14-09A	4.50	4.90	Clay	5		
BH14-09A	6.00	6.40	Clay	1	>100	44
BH14-09A	7.50	7.90	Sand	6		
BH14-11	0.70	1.10	Silt	0		
BH14-11	1.50	2.00	Clay	0	22	3
BH14-11	2.40	2.70	Clay	0	25	4
BH14-11	3.00	3.40	Clay	0	25	4
BH14-11	4.80	5.20	Clay	1	22	4
BH14-11	6.00	6.40	Clay	0	87	20
BH14-11	7.50	7.90	Clay	2	60	11
BH14-11	9.00	9.40	Clay	3	>100	44
BH14-11	10.60	11.00	Clay	10		

TABLE A3

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF IN SITU TESTING

Drillhole No.	Depth		Geological Unit	Standard Penetration Test (SPT)	Vane Shear Test	
	From (m)	To (m)		N Blows per Foot	Initial kPa	Reshear kPa
BH14-12	0.70	1.10	Silt	3		
BH14-12	1.50	2.00	Clay	3		
BH14-12	2.40	2.70	Clay	5	>100	
BH14-12	3.00	3.40	Clay	4	>100	33
BH14-12	4.80	5.20	Clay	2	>100	58
BH14-12	6.00	6.40	Clay	0	70	14
BH14-12	7.50	7.90	Clay	1	58	23
BH14-12	9.00	9.40	Clay	10	>100	
BH14-13	0.70	1.40	Clay	1		
BH14-13	1.60	2.00	Clay	3	>100	7
BH14-13	2.20	2.60	Clay	2	>100	44
BH14-13	3.00	3.40	Clay	3	>100	28
BH14-13	4.50	4.90	Clay	3	>100	14
BH14-13	6.00	6.40	Clay	2	62	14
BH14-13	7.50	7.90	Clay	1	55	11
BH14-13	9.00	9.40	Sand	5	>100	20
BH14-14	0.30	0.70	Organics	2		
BH14-14	1.60	2.00	Clay	2	>100	65
BH14-14	2.40	2.80	Clay	3	>100	23
BH14-14	3.00	3.40	Clay	0	82	
BH14-14	4.50	4.90	Clay	1		
BH14-14	6.00	6.40	Clay	1	62	9
BH14-14	7.50	7.90	Clay	1	>100	70
BH14-14	9.00	9.20	Silt	>50		

TABLE A3

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF IN SITU TESTING

Drillhole No.	Depth		Geological Unit	Standard Penetration Test (SPT)	Vane Shear Test	
	From (m)	To (m)		N Blows per Foot	Initial kPa	Reshear kPa
BH14-15	0.70	1.30	Sand	2		
BH14-15	1.60	2.00	Sand	5		
BH14-15	2.20	2.60	Clay	0	40	5
BH14-15	3.10	3.50	Clay	0	50	7
BH14-15	4.60	5.00	Clay	0	42	5
BH14-15	6.00	6.40	Clay	0	60	15
BH14-15	7.60	8.00	Clay	1	35	8
BH14-15	9.00	9.40	Silt	12		
BH14-15	10.50	10.90	Silt	2		
BH14-15	12.00	12.40	Clay	1	82	14
BH14-15	13.60	14.00	Clay	1		
BH14-15	15.00	15.40	Silt	1	25	16
BH14-15	16.50	16.90	Silt	2	>100	
BH14-15	18.00	18.60	Silt	13		
BH14-17	0.70	1.30	Sand	9		
BH14-17	1.50	2.10	Clay	2		
BH14-17	2.30	2.70	Sand	>50	55	9
BH14-18	0.90	1.40	Clay	7		
BH14-18	1.60	2.00	Clay	8		
BH14-18	2.30	2.70	Silt	>50		
BH14-19	0.80	1.40	Clay	7		
BH14-19	1.60	2.10	Clay	13	>100	
BH14-19	2.30	2.90	Clay	3	>100	23
BH14-19	3.00	3.60	Clay/Silt	4	>100	35

TABLE A3

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

SUMMARY OF IN SITU TESTING

Drillhole No.	**Depth**		**Geological Unit**	**Standard Penetration Test (SPT)**	**Vane Shear Test**	
	From (m)	**To (m)**		**N Blows per Foot**	**Initial kPa**	**Reshear kPa**
BH14-20	0.70	1.30	Sand	7		
BH14-20	1.50	1.90	Clay	5	>100	
BH14-20	2.20	2.60	Clay	5	>100	28
BH14-20	3.00	3.50	Clay	3	70	9
BH14-20	4.50	5.00	Clay	2	45	12
BH14-20	6.00	6.50	Clay	3	55	12
BH14-20	7.60	8.10	Clay	2	50	22
BH14-20	9.00	9.40	Clay	0	22	5
BH14-21	0.80	1.20	Sand	19		
BH14-21	1.50	2.10	Silt	10		
BH14-21	2.30	2.70	Clay	4		
BH14-21	3.00	3.40	Clay	2		
BH14-21	4.50	5.10	Silt	5		

Notes:

1. Blanks indicate no testing completed.
2. Site Investigation completed by TBT Engineering.
3. Geological units presented above are based on field observations provided on BH Logs by TBTE with changes based on lab testing results (identified in italics). BH Logs are in Draft and require updating to reflect lab testing restults.

TABLE A4

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

BOREHOLE SAMPLES LAB TESTING RESULTS

Drillhole No.	Sample No.	Sample Type	Geological Unit	Natural Moisture Content (%)	Atterberg Limits			Grain Size Distribution				
					LL (%)	PL (%)	PI (%)	Cobbles >75mm	Gravel (19mm-No.4)	Sand (No. 4-#200)	Silt (<No. 200)	Clay (< No. 200)
BH14-01	AS1	Auger	Sand									
BH14-01	SS2	Split Spoon	Sand									
BH14-02	AS1	Auger	Sand									
BH14-02	AS2	Auger	Clay									
BH13-03	AS1	Auger	Sand	26.2								
BH14-03	SS2	Split Spoon	*Silt*[4]	20.2				0.00	0.0	13.2	78.8	8.0
BH14-03	SS3	Split Spoon	Silt	25.7								
BH14-03	SS4	Split Spoon	Silt	27.2								
BH14-03	SS5	Split Spoon	Silt	22.1								
BH14-03	SS6	Split Spoon	Silt	22.3				0.00	0.0	5.6	62.4	32.0
BH14-04	AS1	Auger	Sand									
BH14-04	SS2	Split Spoon	Sand	20.1								
BH14-04	SS3	Split Spoon	Sand	20.4								
BH14-04	SS4	Split Spoon	Sand	21.4								
BH14-04	SS5	Split Spoon	Sand	23.3								
BH14-04	SS6	Split Spoon	Silt	23.6				0.00	0.0	6.3	73.7	20.0
BH14-04	SS7	Split Spoon	Silt	25.2								
BH14-04	SS8	Split Spoon	Sand	20.9								
BH14-05	AS1	Auger	Sand									
BH14-05	SS2	Split Spoon	Sand	19.1								
BH14-05	SS3	Split Spoon	Sand									
BH14-05	SS4	Split Spoon	Sand	15.8								
BH14-05	SS5	Split Spoon	Sand									
BH14-05	SS6	Split Spoon	Silt	18.9								
BH14-05	SS7	Split Spoon	Silt	23.5				0.00	0.0	1.1	83.9	15.0
BH14-05	SS8	Split Spoon	Silt	19.6								
BH14-05	SS9	Split Spoon	Silt	27.0				0.00	0.0	0.3	64.7	35.0
BH14-05	SS10	Split Spoon	Silt	25.5								
BH14-05	SS11	Split Spoon	Silt									
BH14-05	SS12	Split Spoon	Silt	14.1								
BH14-05	SS13	Split Spoon	Silt									
BH14-05	SS14	Split Spoon	Silt	13.5								
BH14-05	SS15	Split Spoon	Sand									
BH14-05	SS16	Split Spoon	Sand									
BH14-05	SS17	Split Spoon	Sand									
BH14-05	SS18	Split Spoon	Sand									
BH14-05	SS19	Split Spoon	Sand									

TABLE A4

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

BOREHOLE SAMPLES LAB TESTING RESULTS

Drillhole No.	Sample No.	Sample Type	Geological Unit	Natural Moisture Content (%)	Atterberg Limits			Grain Size Distribution				
					LL (%)	PL (%)	PI (%)	Cobbles >75mm	Gravel (19mm-No.4)	Sand (No. 4-#200)	Silt (<No. 200)	Clay (< No. 200)
BH14-06	AS1	Auger	Sand									
BH14-06	SS2	Split Spoon	Sand	21.3								
BH14-06	SS3	Split Spoon	Sand	19.6								
BH14-06	SS4	Split Spoon	Sand	20.5								
BH14-06	SS5	Split Spoon	Silt	21.7				0.00	0.0	18.0	71.0	11.0
BH14-06	SS6	Split Spoon	Clay	32.3								
BH14-06	SS7	Split Spoon	Clay	27.1	25.0	19.1	6.0	0.00	0.0	1.0	54.0	45.0
BH14-06	SS8	Split Spoon	Silt	23.3								
BH14-06	SS9	Split Spoon	Silt	19.8								
BH14-07A	AS1	Auger	Sand									
BH14-07A	SS2	Split Spoon	Sand	15.8								
BH14-07A	SS3	Split Spoon	Sand	23.0				0.00	0.0	46.8	47.2	6.0
BH14-07A	SS4	Split Spoon	Sand	19.5								
BH14-07A	SS5	Split Spoon	Silt	25.7								
BH14-07A	SS6	Split Spoon	Clay	22.2								
BH14-07A	SS7	Split Spoon	Clay	46.2								
BH14-07A	SS8	Split Spoon	Clay	31.1								
BH14-07A	SS9	Split Spoon	Clay									
BH14-07A	SS10	Split Spoon	Clay									
BH14-07A	SS11	Split Spoon	Clay									
BH14-08	AS1	Auger	Clay	26.0								
BH14-08	SS2	Split Spoon	Clay	33.0				0.00	0.0	1.9	26.1	72.0
BH14-08	SS3	Split Spoon	Clay	35.7				0.00	0.0	1.9	26.1	72.0
BH14-08	SS4	Split Spoon	Clay	36.3	46.0	22.0	24.0					
BH14-08	SS5	Split Spoon	Clay	39.2								
BH14-08	SS6	Split Spoon	Clay	31.7								
BH14-08	SS7	Split Spoon	Clay	34.9								
BH14-08	SS8	Split Spoon	Clay									

TABLE A4

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

BOREHOLE SAMPLES LAB TESTING RESULTS

Drillhole No.	Sample No.	Sample Type	Geological Unit	Natural Moisture Content (%)	Atterberg Limits			Grain Size Distribution				
					LL (%)	PL (%)	PI (%)	Cobbles >75mm	Gravel (19mm-No.4)	Sand (No. 4-#200)	Silt (<No. 200)	Clay (< No. 200)
BH14-09A	AS1	Auger	Clay									
BH14-09A	SS2	Split Spoon	Clay									
BH14-09A	SS3	Split Spoon	Clay									
BH14-09A	SS4	Split Spoon	Clay									
BH14-09A	SS5	Split Spoon	Clay									
BH14-09A	SS6	Split Spoon	Clay									
BH14-09A	SS7	Split Spoon	Sand									
BH14-10A	AS1	Auger	Fill									
BH14-10A	AS2	Auger	Fill									
BH14-11	AS1	Auger	Sand									
BH14-11	SS2	Split Spoon	Silt									
BH14-11	SS3	Split Spoon	Clay									
BH14-11	SS4	Split Spoon	Clay									
BH14-11	SS5	Split Spoon	Clay									
BH14-11	SS6	Split Spoon	Clay									
BH14-11	SS7	Split Spoon	Clay									
BH14-11	SS8	Split Spoon	Clay									
BH14-11	SS9	Split Spoon	Clay									
BH14-11	SS10	Split Spoon	Clay									
BH14-12	AS1	Auger	Sand									
BH14-12	SS2	Split Spoon	Clay	39.1								
BH14-12	SS3	Split Spoon	Clay	45.7								
BH14-12	SS4	Split Spoon	Clay	41.8								
BH14-12	SS5	Split Spoon	Clay	32.0								
BH14-12	SS6	Split Spoon	Clay									
BH14-12	SS7	Split Spoon	Clay	31.3								
BH14-12	SS8	Split Spoon	Clay									
BH14-12	SS9	Split Spoon	Clay	16.1								

TABLE A4

TREASURY METALS
GOLIATH PROJECT

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

BOREHOLE SAMPLES LAB TESTING RESULTS

Drillhole No.	Sample No.	Sample Type	Geological Unit	Natural Moisture Content (%)	Atterberg Limits			Grain Size Distribution				
					LL (%)	PL (%)	PI (%)	Cobbles >75mm	Gravel (19mm-No.4)	Sand (No. 4-#200)	Silt (<No. 200)	Clay (< No. 200)
BH14-13	AS1	Auger	Clay									
BH14-13	SS2	Split Spoon	Clay									
BH14-13	SS3	Split Spoon	Clay									
BH14-13	SS4	Split Spoon	Clay									
BH14-13	SS5	Split Spoon	Clay									
BH14-13	SS6	Split Spoon	Clay									
BH14-13	SS7	Split Spoon	Clay									
BH14-13	SS8	Split Spoon	Clay									
BH14-13	SS9	Split Spoon	Sand									
BH14-14	AS1	Auger	Organics									
BH14-14	SS2	Split Spoon	Organics									
BH14-14	SS3	Split Spoon	Clay									
BH14-14	SS4	Split Spoon	Clay									
BH14-14	SS5	Split Spoon	Clay									
BH14-14	SS6	Split Spoon	Clay									
BH14-14	SS7	Split Spoon	Clay									
BH14-14	SS8	Split Spoon	Clay									
BH14-14	SS9	Split Spoon	Silt									
BH14-15	AS1	Auger	Organics									
BH14-15	SS2	Split Spoon	Sand									
BH14-15	SS3	Split Spoon	Sand									
BH14-15	SS4	Split Spoon	Clay									
BH14-15	SS5	Split Spoon	Clay									
BH14-15	SS6	Split Spoon	Clay									
BH14-15	SS7	Split Spoon	Clay									
BH14-15	SS8	Split Spoon	Clay									
BH14-15	SS9	Split Spoon	Silt									
BH14-15	SS10	Split Spoon	Silt									
BH14-15	SS11	Split Spoon	Clay									
BH14-15	SS12	Split Spoon	Clay									
BH14-15	SS13	Split Spoon	Silt									
BH14-15	SS14	Split Spoon	Silt									
BH14-15	SS15	Split Spoon	Silt									
BH14-17	AS1	Auger	Organics									
BH14-17	SS2	Split Spoon	Sand									
BH14-17	SS3	Split Spoon	Clay									
BH14-17	SS4	Split Spoon	Sand									
BH14-18	AS1	Auger	Sand									
BH14-18	SS2	Split Spoon	Clay									
BH14-18	SS3	Split Spoon	Clay									
BH14-18	SS4	Split Spoon	Silt									

TABLE A4

TREASURY METALS
GOLIATH PROJECT

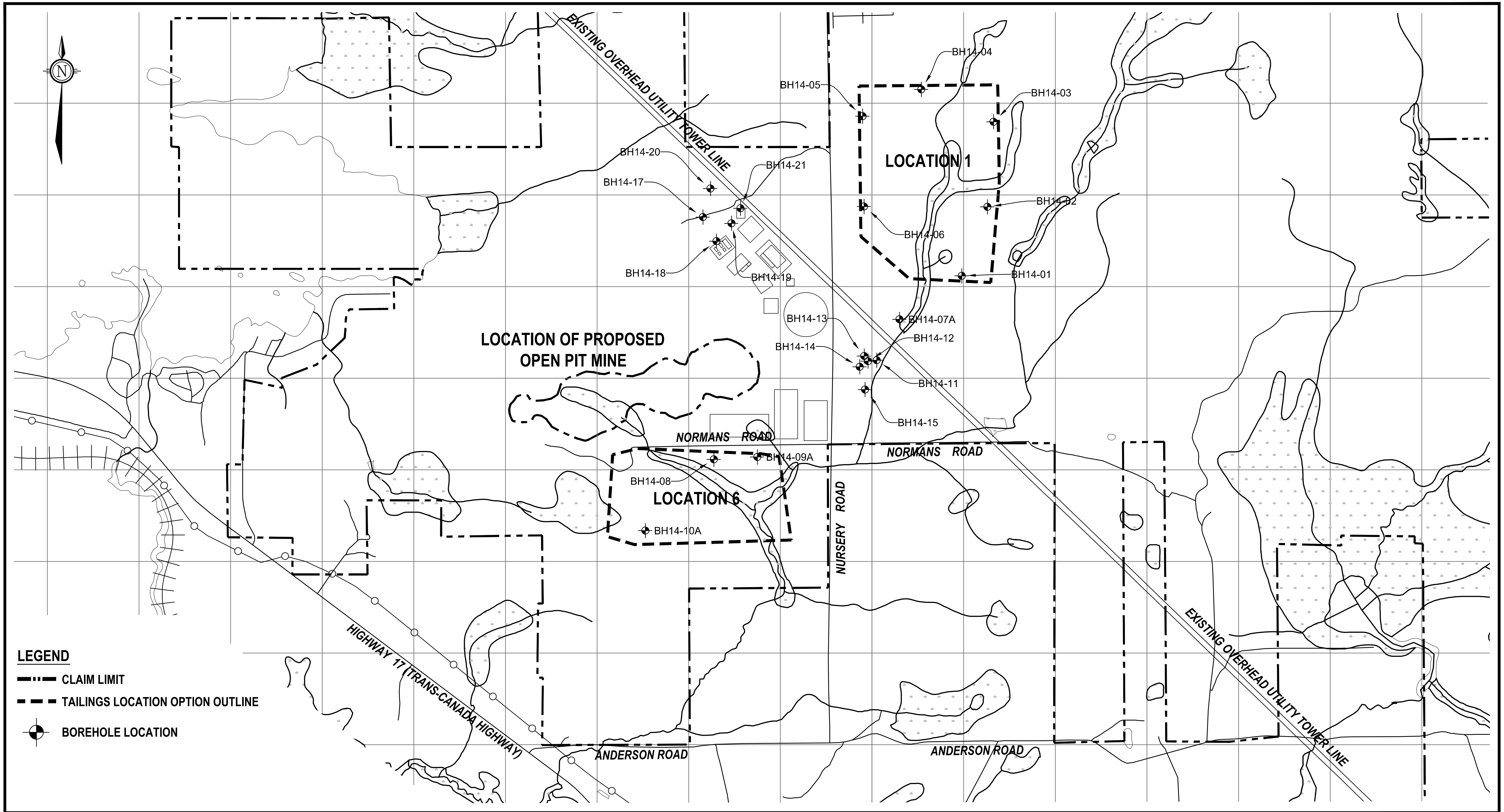
2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

BOREHOLE SAMPLES LAB TESTING RESULTS

Drillhole No.	Sample No.	Sample Type	Geological Unit	Natural Moisture Content (%)	Atterberg Limits			Grain Size Distribution				
					LL (%)	PL (%)	PI (%)	Cobbles >75mm	Gravel (19mm-No.4)	Sand (No. 4-#200)	Silt (<No. 200)	Clay (< No. 200)
BH14-19	AS1	Auger	Organics									
BH14-19	SS2	Split Spoon	Clay									
BH14-19	SS3	Split Spoon	Clay									
BH14-19	SS4	Split Spoon	Clay									
BH14-19	SS5	Split Spoon	Clay/Silt									
BH14-20	AS1	Auger	Organics									
BH14-20	SS2	Split Spoon	Sand									
BH14-20	SS3	Split Spoon	Clay									
BH14-20	SS4	Split Spoon	Clay									
BH14-20	SS5	Split Spoon	Clay									
BH14-20	SS6	Split Spoon	Clay									
BH14-20	SS7	Split Spoon	Clay									
BH14-20	SS8	Split Spoon	Clay									
BH14-20	SS9	Split Spoon	Clay									
BH14-21	AS1	Auger	Sand									
BH14-21	SS2/3	Split Spoon	Sand to Silt	21.9/20.8								
BH14-21	SS4	Split Spoon	Silt	30.3								
BH14-21	SS5	Split Spoon	Clay	32.8								
BH14-21	SS6	Split Spoon	Clay	36.5								
BH14-21	SS7	Split Spoon	Silt	20.6								

Notes:

1. Samples collected during 2014 Site Investigation.
2. Lab testing completed by TBT Engineering Limited Laboratory in Thunder Bay, ON.
3. Blanks indicate no testing completed.
4. Geological units presented above are based on field obervations provided on BH Logs by TBTE with changes based on lab testing results (identified in italics). BH Logs are in Draft and require updating to reflect lab testing restults.



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WSP

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THUNDER BAY (ONTARIO)
CANADA P7B 0A3
TEL.: 807 625-6700 | FAX: 807 625-4491
WWW.WSPGROUP.COM

0 500 1000 metres

PROJECT:

TREASURY METALS - GOLIATH PROJECT
TAILINGS ALTERNATIVES ASSESSMENT

TITLE:

2014 SITE INVESTIGATION
BOREHOLE LOCATIONS

PROJECT NO: 141-12598-00

SCALE: 1:20000

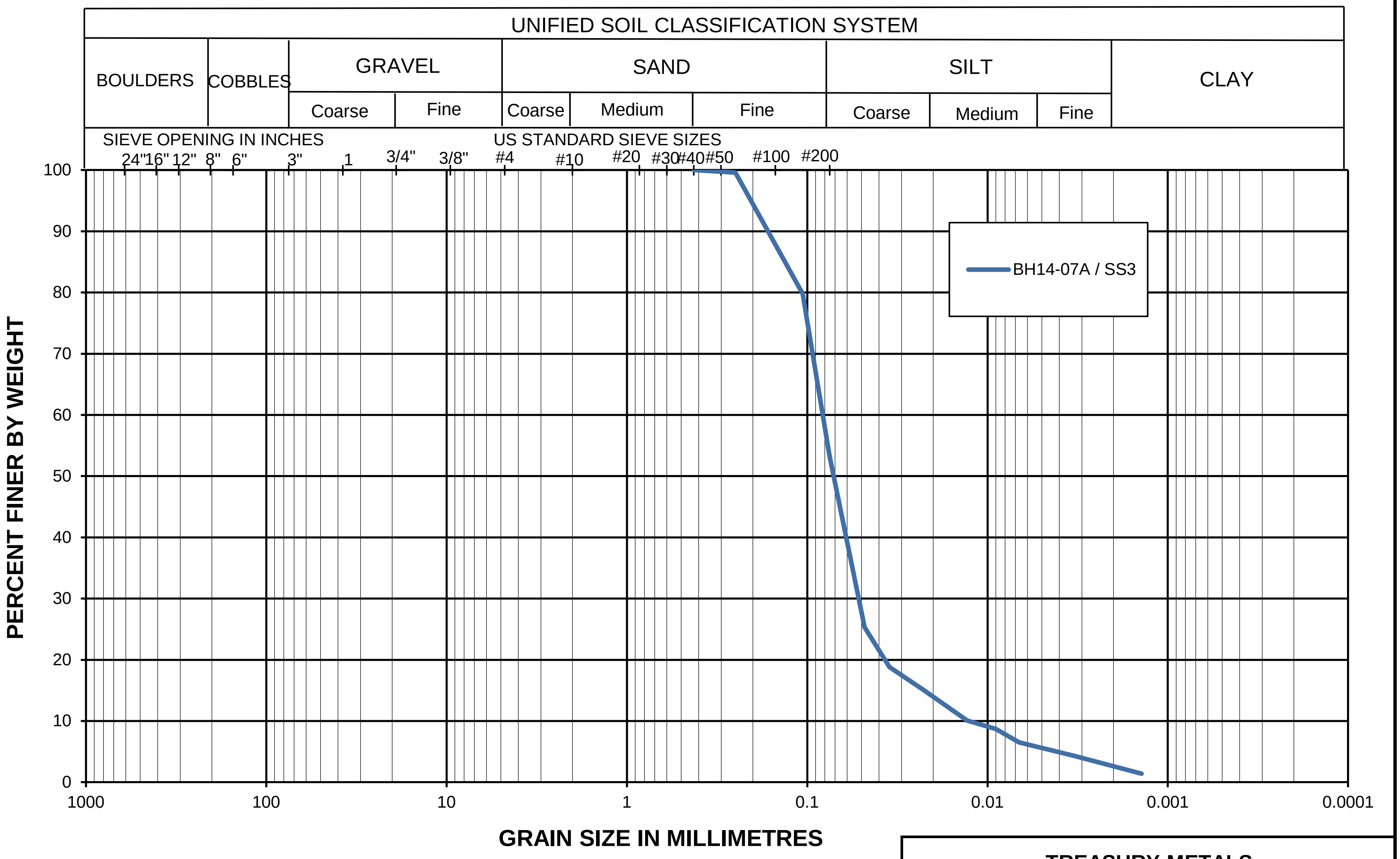
DRAWN BY: G. HOOGWERF

CHECKED BY: B. PLUMRIDGE

ISSUE/REVISION: FINAL 0

ISSUE DATE: JULY 21, 2014

FIGURE NO: FIGURE A1



Notes

1. Samples collected during 2014 site investigation program.
2. Lab testing completed by TBT Engineering in Thunder Bay, ON.

TREASURY METALS

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

GRAIN SIZE RESULTS
SAND

WSP

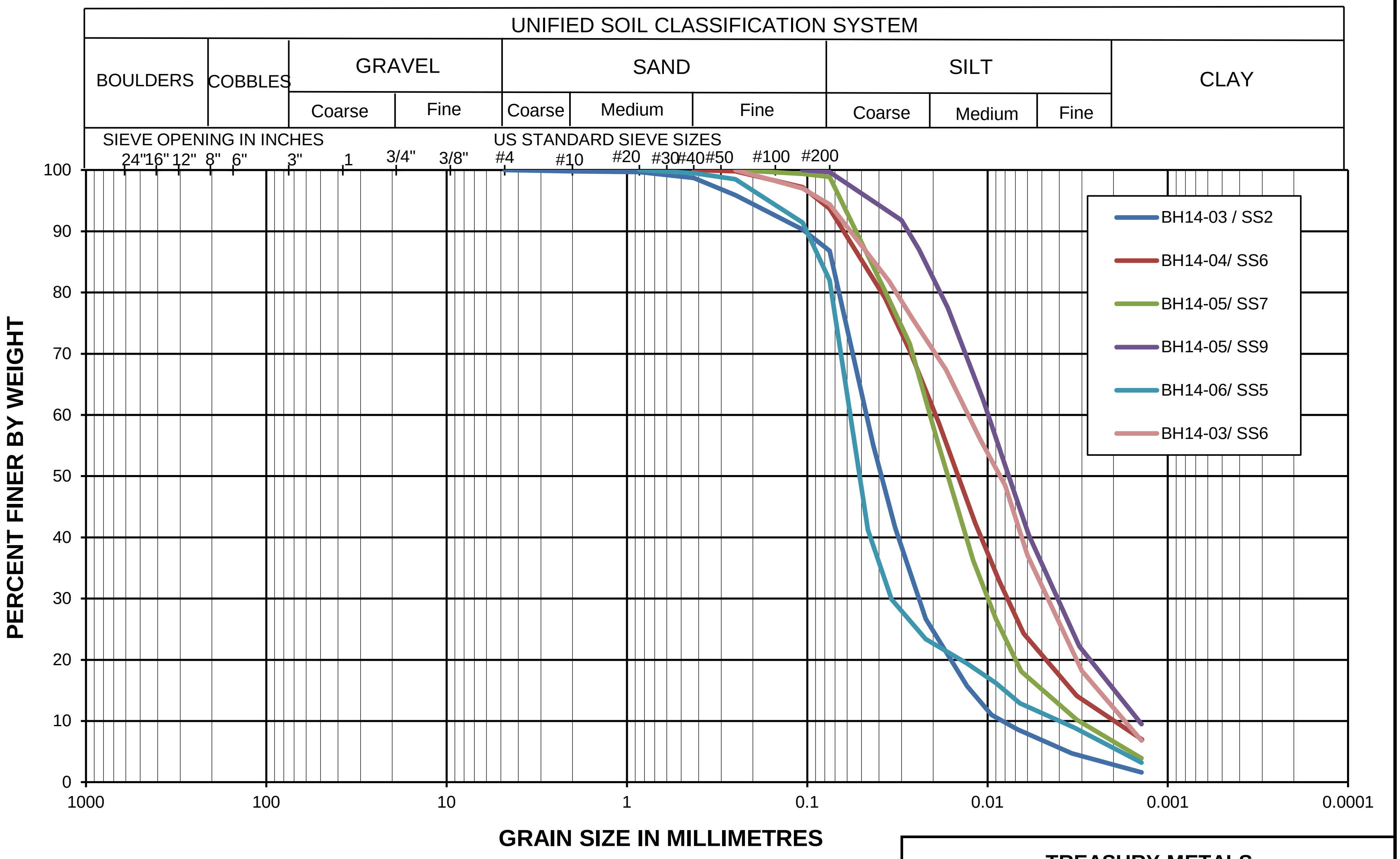
141-12598-00

REV.
0

FIGURE A2

P:\Mining\Treasury Metals\141-12598-00 - Alternatives Assessment\Data\Factual Soils Report\1_FINAL\[Figure A3 - Grain Size Results SILT.xls]Figure 3.2

Print date: 22-Jul-14



Notes

1. Samples collected during 2014 site investigation program.
2. Lab testing completed by TBT Engineering in Thunder Bay, ON.

TREASURY METALS

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

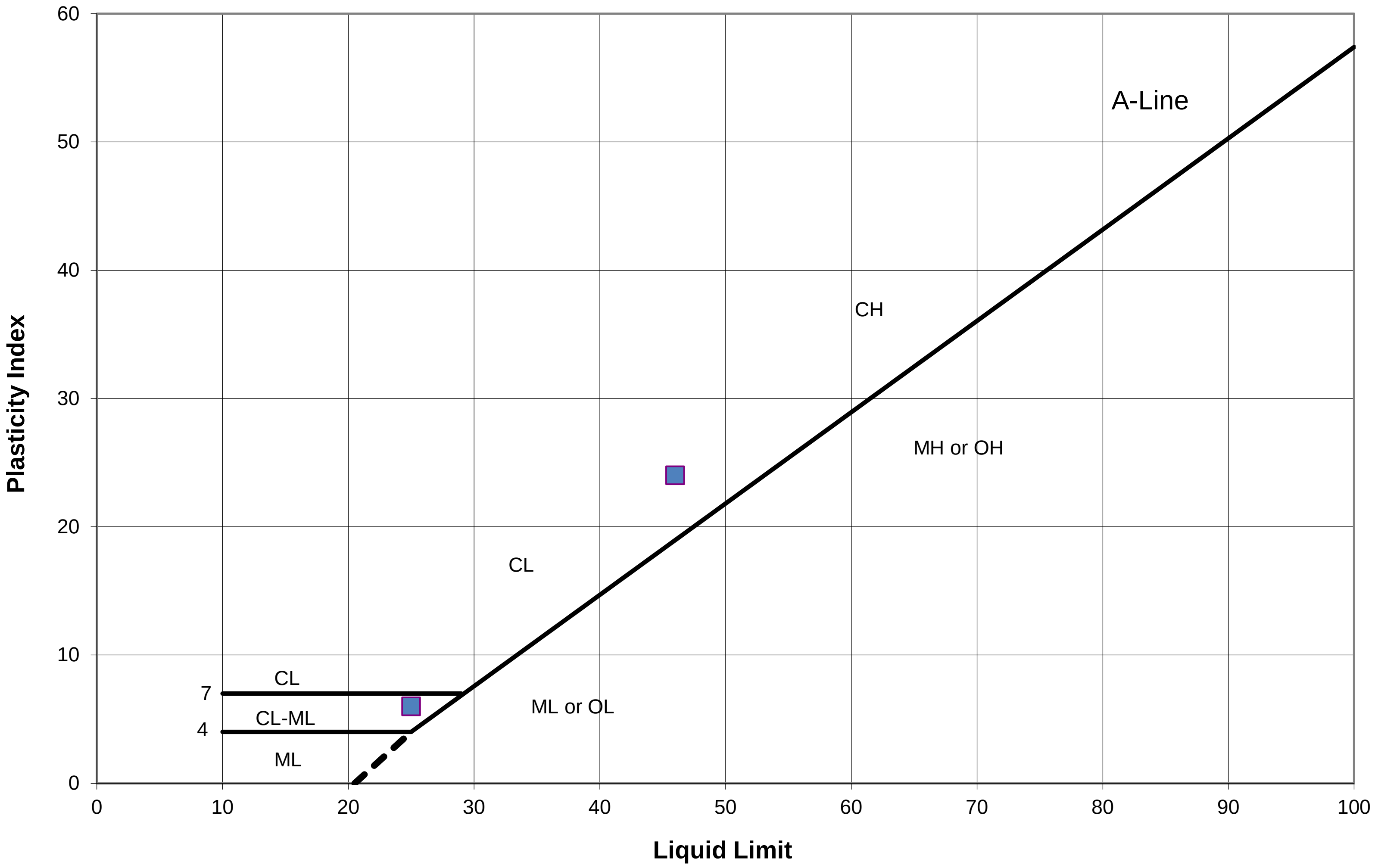
GRAIN SIZE RESULTS
SILT

WSP

141-12598-00

REV.
0

FIGURE A3



TREASURY METALS

2014 SITE INVESTIGATION

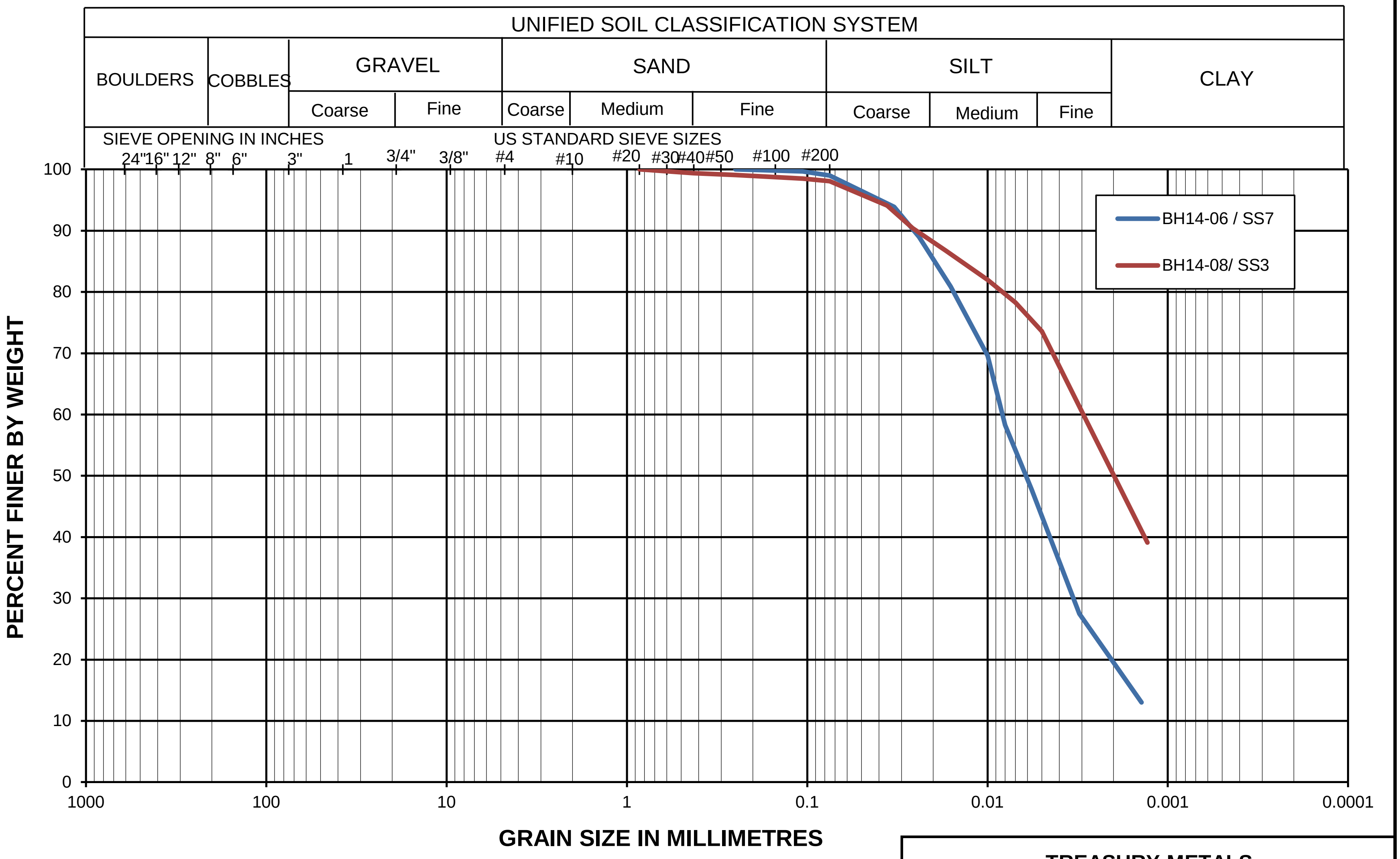
PLASTICITY CHART
CLAY

WSP

FIGURE A4

Project No. 141-12598-00

REV. 0



Notes

1. Samples collected during 2014 site investigation program.
2. Lab testing completed by TBT Engineering in Thunder Bay, ON.

TREASURY METALS

2014 SITE INVESTIGATION
FACTUAL SOILS SUMMARY

GRAIN SIZE RESULTS
CLAY

WSP

141-12598-00

REV.
0

FIGURE A5

LOG OF BOREHOLE 14-01

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5512562 E 529491**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 27**

CPT (kPa) 300 600 900 1200 1500 (kPa)
✕ FIELD SHEAR (kPa) ⊗ Lab Shear (kPa)
■ SPT (N) ◆ DCPT
0 20 40 60 80 100

PLASTIC LIMIT w_P ◆ NATURAL MOISTURE CONTENT w ● LIQUID LIMIT w_L ▲
WATER CONTENT (%) 20 40 60

SOIL PROFILE				SAMPLES							REMARKS
DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS	DEPTH SCALE	CPT / SPT (N)	WATER CONTENT (%)	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		ORGANICS, black									Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
		SAND, trace Silt, brown			AS1						
1		SAND, Silty, grey and brown			SS2	7		1	■		
		End of Borehole @ 1.5 m. Auger refusal.									

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 1

LOG OF BOREHOLE 14-02

TBT REF. No.:	**14-035**	SURFACE ELEV.:	**metres**
CLIENT:	**Treasury Metals Incorporated**	COORDINATES:	**UTM 15 N 5512932 E 529632**
PROJECT:	**Goliath Project**	EQUIPMENT:	**HS Auger**
LOCATION:	**Tree Nursery Road** **Dryden, Ontario**	DIAMETER:	**80mm ID**
		DATE:	**2014 March 27**

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	DEPTH SCALE	CPT (kPa) 300 600 900 1200 1500 (kPa) × FIELD SHEAR (kPa) ⊗ Lab Shear (kPa) ■ SPT (N) ◆ DCPT 0 20 40 60 80 100	PLASTIC LIMIT w_P ◆ NATURAL MOISTURE CONTENT w ● LIQUID LIMIT w_L ▲ WATER CONTENT (%) 20 40 60	REMARKS GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES					
		ORGANICS, black									Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
		SAND, trace Silt, brown			AS1						
		CLAY and SILT, grey			AS2						
1		End of Borehole @ 1.05 m. Auger and Split Spoon refusal.						1			
2								2			
3								3			
4								4			
5								5			
6								6			
7								7			
8								8			
9								9			
10								10			
11								11			
12								12			
13								13			
14								14			

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Web: www.tbte.ca

SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 2

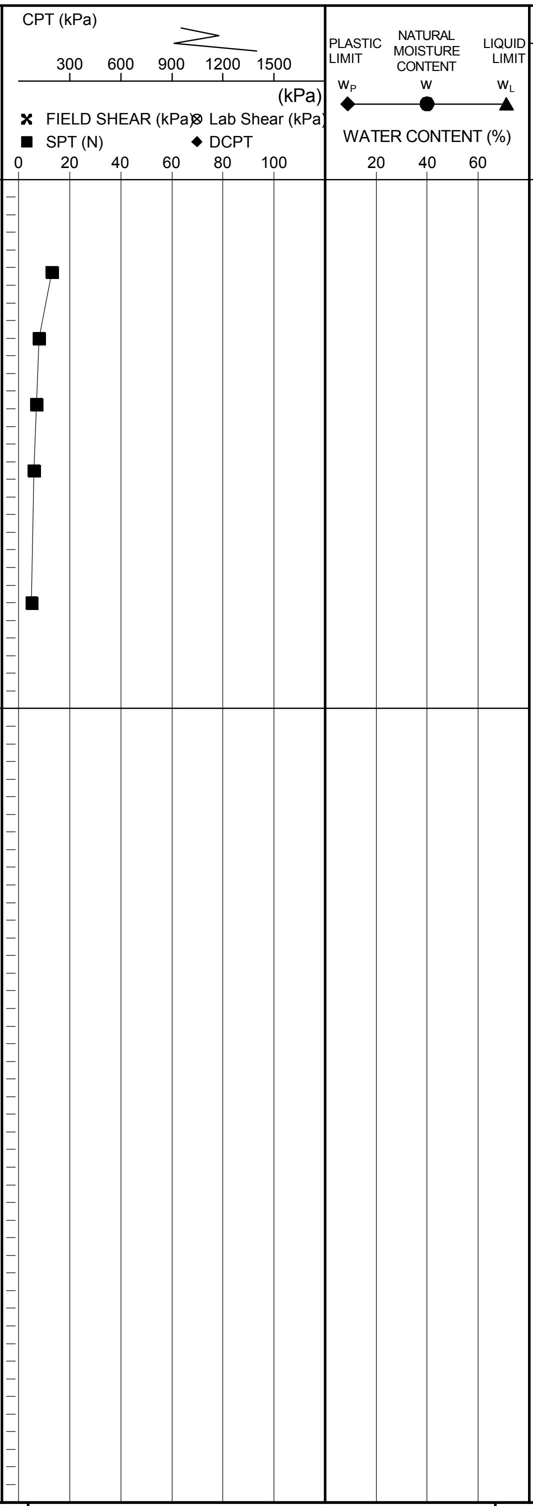
LOG OF BOREHOLE 14-03

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5513400 E 529660**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 26**

SOIL PROFILE		SAMPLES	
DEPTH	DESCRIPTION	TYPE	"N" VALUES
	ORGANICS, black		
1	SAND, some Silt, brown	AS1 SS2	 13
2	SILT and SAND, trace Clay, layered, grey	SS3 SS4	8 7
3–4	SILT, some Clay and Sand, grey	SS5	6
5	SILT and CLAY, grey	SS6	5
6	End of Borehole @ 6.0 m. Auger refusal.		

GROUND WATER CONDITIONS



REMARKS

GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing. Standpipe installed to 2.9 m.

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

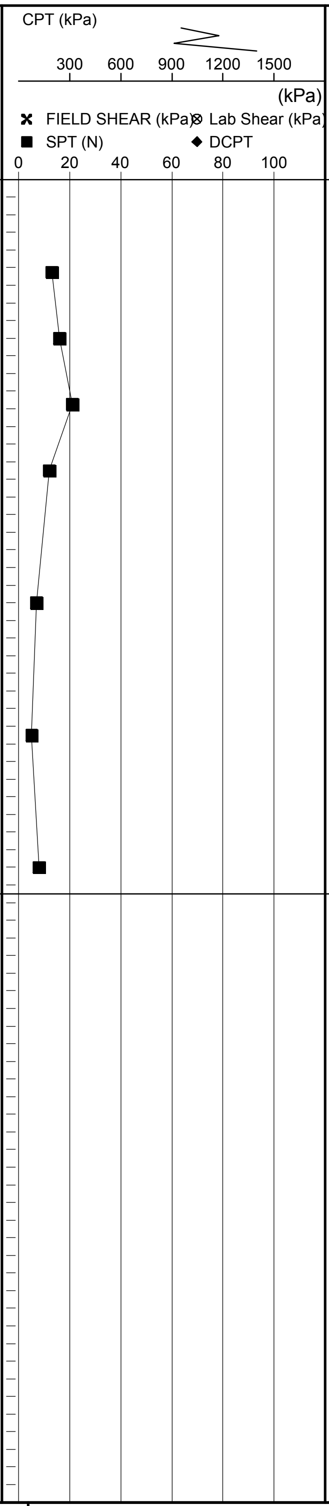
ENCLOSURE 3

LOG OF BOREHOLE 14-04

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5513576 E 529264**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 26**

SOIL PROFILE DESCRIPTION	SAMPLES TYPE	"N" VALUES
ORGANICS, black		
SAND, trace Silt, brown	AS1	
- - - - - - grey	SS2	13
	SS3	16
	SS4	21
	SS5	12
SILT, trace Clay, grey	SS6	7
SILT and SAND, trace Clay, grey	SS7	5
SAND, trace Silt, grey	SS8	8
End of Borehole @ 8.1 m. Auger refusal.		



PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%)
20 40 60

REMARKS
GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 4

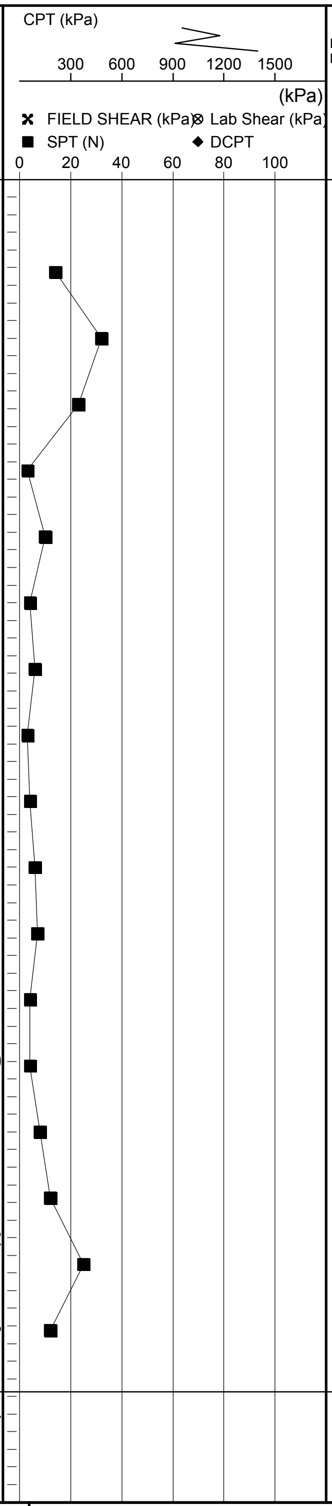
LOG OF BOREHOLE 14-05

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5513425 E 528949**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 25**

SOIL PROFILE | SAMPLES

DESCRIPTION	TYPE	"N" VALUES
ORGANCIS, roots, black		
SAND, some Silt, brown	AS1	
SAND, Silty, grey	SS2	14
	SS3	32
	SS4	23
	SS5	3
SILT, Sandy, grey	SS6	10
SILT, trace Sand, grey	SS7	4
	SS8	6
SILT and CLAY, grey	SS9	3
SILT, some Clay, grey	SS10	4
	SS11	6
	SS12	7
	SS13	4
	SS14	4
SAND, Silty, grey	SS15	8
SAND, trace Silt, grey	SS16	12
	SS17	25
	SS18	12
- rock fragments in split spoon	SS19	>50
End of Borehole @ 13.75 m. Split spoon refusal.		



PLASTIC LIMIT w_P ◆ | NATURAL MOISTURE CONTENT w ● | LIQUID LIMIT w_L ▲

WATER CONTENT (%) 20 40 60

REMARKS

GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

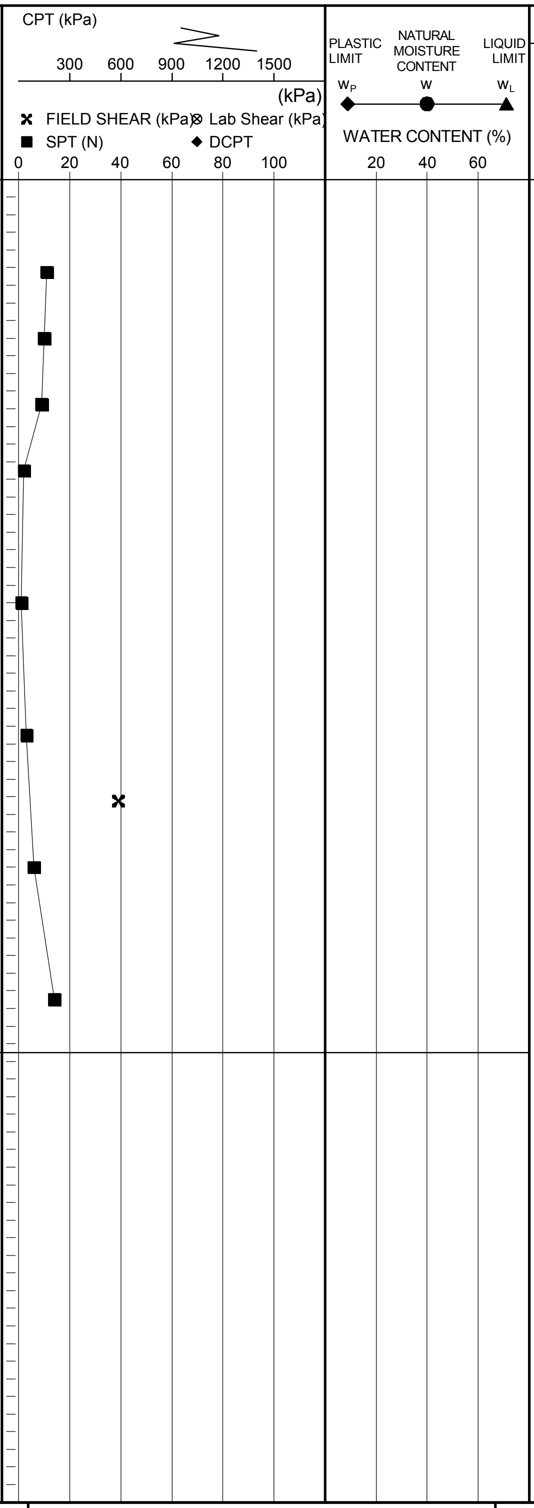
ENCLOSURE 5

LOG OF BOREHOLE 14-06

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5512942 E 528957**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 26**

SOIL PROFILE DESCRIPTION	SAMPLES TYPE	"N" VALUES	REMARKS
ORGANICS, black			Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
SAND, some Silt, black	AS1		
SAND, trace Silt, brown	SS2 SS3 SS4	11 10 9	
SILT and CLAY, trace sand, layered - red clay and grey silt layers	SS5	2	
CLAY and SILT, layered - dark grey clay and light grey silt layers	SS6	1	
CLAY, grey	SS7	3	Remold shear vane test = 4 KPa
SILT, some Clay and Sand, layered, grey	SS8 SS9	6 14	
End of Borehole @ 9.9 m. Auger refusal.			



GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

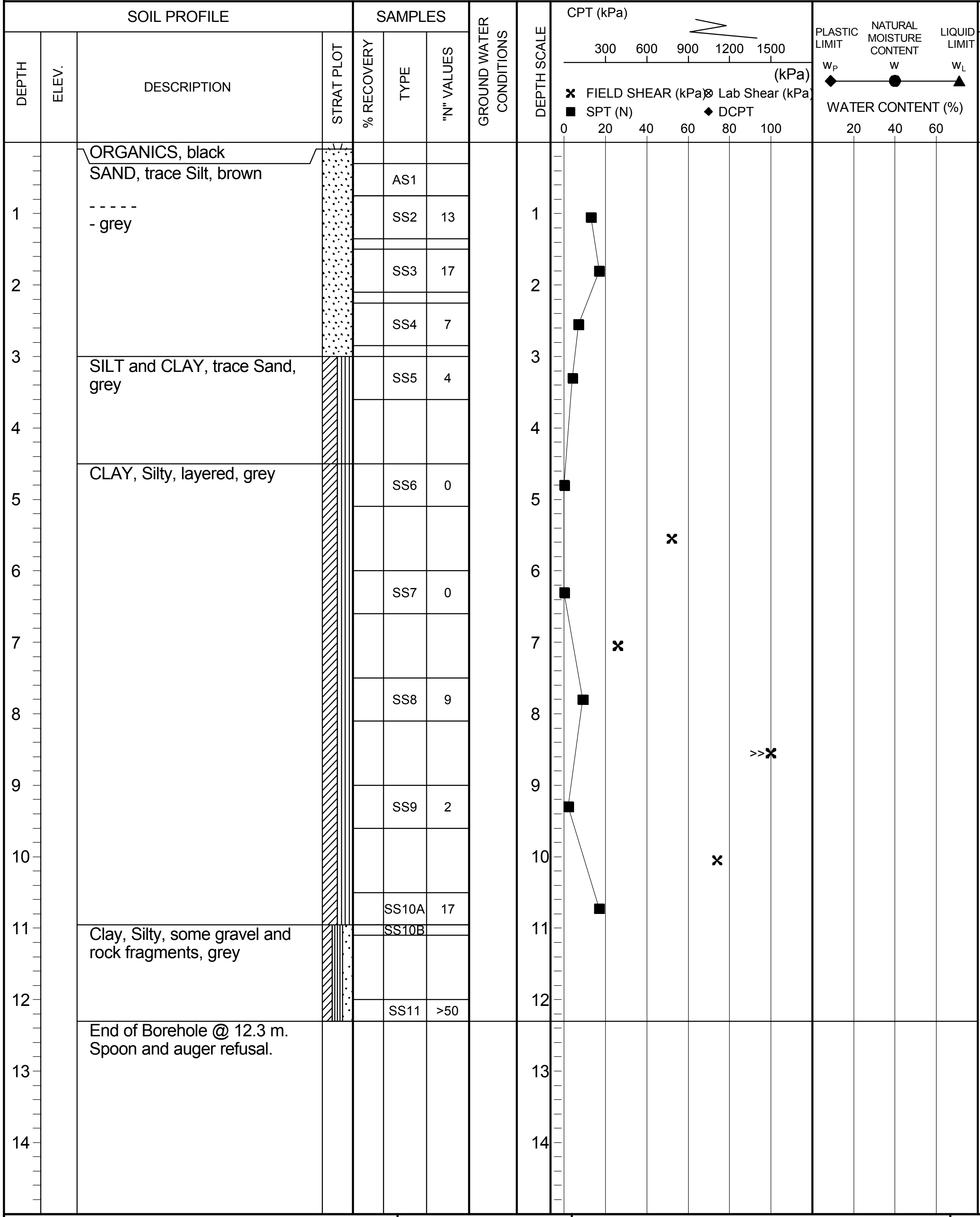
ENCLOSURE 6

LOG OF BOREHOLE 14-07A

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5512321 E 529150**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 27**

SOIL PROFILE		SAMPLES				REMARKS
DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ORGANICS, black						Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
SAND, trace Silt, brown			AS1			
- - - - - - grey			SS2	13		
			SS3	17		
			SS4	7		
SILT and CLAY, trace Sand, grey			SS5	4		
CLAY, Silty, layered, grey			SS6	0		
						Remold shear vane test = 4 KPa
			SS7	0		
						Remold shear vane test = 9 KPa
			SS8	9		
						Remold shear vane test = 37 KPa
			SS9	2		
						Remold shear vane test = 9 Kpa
			SS10A	17		
Clay, Silty, some gravel and rock fragments, grey			SS10B			Rock fragments in split spoon sample (SS10B)
			SS11	>50		
End of Borehole @ 12.3 m. Spoon and auger refusal.						



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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

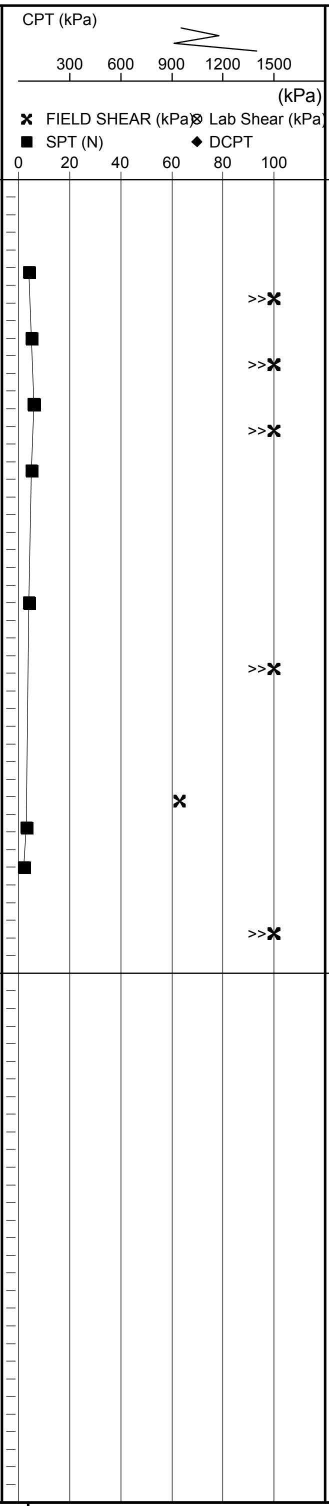
NOTES:

ENCLOSURE 7

LOG OF BOREHOLE 14-08

TBT REF. No.:	**14-035**	SURFACE ELEV.:	**metres**
CLIENT:	**Treasury Metals Incorporated**	COORDINATES:	**UTM 15 N 5511549 E 528132**
PROJECT:	**Goliath Project**	EQUIPMENT:	**HS Auger**
LOCATION:	**Tree Nursery Road** **Dryden, Ontario**	DIAMETER:	**80mm ID**
		DATE:	**2014 April 2**

DEPTH (m)	ELEV.	SOIL PROFILE DESCRIPTION	TYPE	"N" VALUES
0		ORGANICS, black		
		CLAY, brown and grey	AS1	
1			SS2	4
2			SS3	5
2.5			SS4	6
3			SS5	5
4.5		CLAY and SILT, layered, grey	SS6	4
6.0		Clay, grey		
7.5			SS7	3
8			SS8	2
9		End of Borehole @ 9.0 m. Auger refusal.		



PLASTIC LIMIT w_P ◆ — NATURAL MOISTURE CONTENT w ● — LIQUID LIMIT w_L ▲

WATER CONTENT (%) 20 40 60

REMARKS — GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.

Shear vanes attempted at 1.35 m, 2.1 m and 2.85 m, vane refused when pushing

Remold shear vane test = 47 KPa

Remold shear vane test = 12 KPa

No shear of vane during test.

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

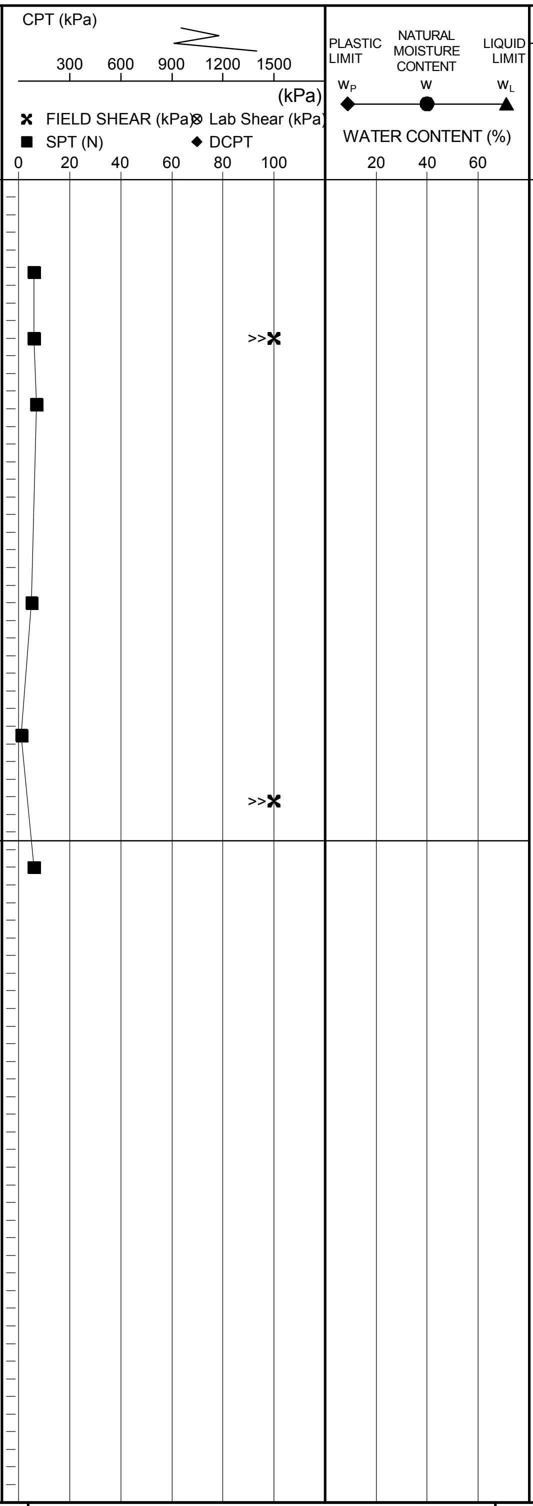
ENCLOSURE 8

LOG OF BOREHOLE 14-09A

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5511570 E 528374**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 April 2**

SOIL PROFILE – DESCRIPTION	SAMPLES – TYPE	"N" VALUES
ORGANICS, black CLAY, brown and grey	AS1	
	SS2	6
	SS3	6
	SS4	7
CLAY and SILT, red clay with grey silt seams		
CLAY and SILT, layered, grey	SS5	5
	SS6	1
SAND, SILT, and CLAY, grey	SS7	6
End of Borehole @ 7.5 m. Auger refusal.		



REMARKS

GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.

Remold shear vane test = 70 KPa

Remold shear vane test = 44 KPa

01A-2 STANDARD BH 14-035 TREASURY METALS DRYDEN.GPJ TBT.GDT 14/4/16

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 9

LOG OF BOREHOLE 14-10A

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5511168 E 527763**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 April 3**

SOIL PROFILE | SAMPLES

CPT (kPa) 300 600 900 1200 1500 (kPa)
× FIELD SHEAR (kPa) ⊗ Lab Shear (kPa)
■ SPT (N) ◆ DCPT
0 20 40 60 80 100

PLASTIC LIMIT w_P ◆ NATURAL MOISTURE CONTENT w ● LIQUID LIMIT w_L ▲
WATER CONTENT (%) 20 40 60

REMARKS
GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS	DEPTH SCALE	REMARKS
		FILL - SAND, some Gravel, occasional cobbles			AS1				Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing. Borehole location appears to be on an old access road.
1					AS2			1	
		End of Borehole @ 1.35 m. Auger refusal.							
2								2	
3								3	
4								4	
5								5	
6								6	
7								7	
8								8	
9								9	
10								10	
11								11	
12								12	
13								13	
14								14	

01A-2 STANDARD BH 14-035 TREASURY METALS DRYDEN.GPJ TBT.GDT 14/4/16

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 10

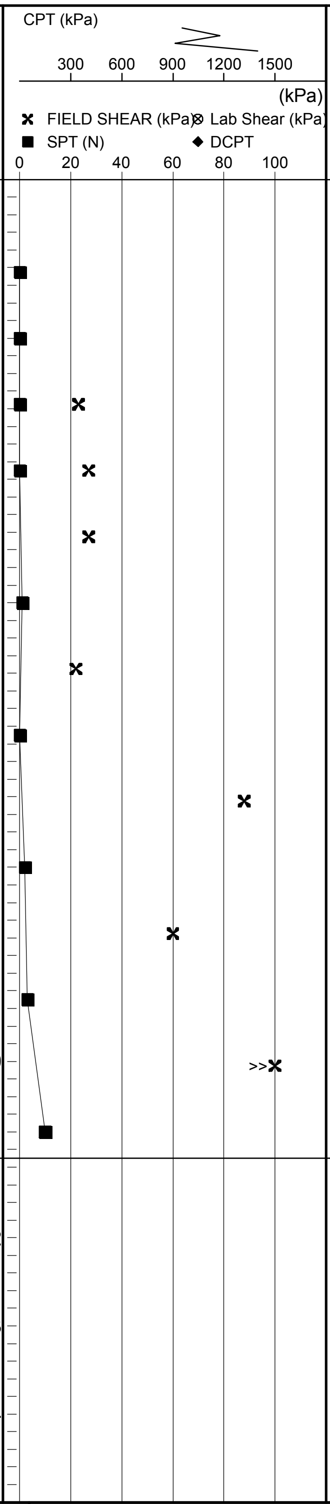
LOG OF BOREHOLE 14-11

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5512098 E 529026**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 30**

SOIL PROFILE: DESCRIPTION	SAMPLES: TYPE	SAMPLES: "N" VALUES
ORGANICS, black		
SAND, brown	AS1	
SILT, some Sand and Clay, grey	SS2	0
CLAY, grey	SS3	0
	SS4	0
	SS5	0
	SS6	1
CLAY, reddish grey	SS7	0
CLAY, some Silt layers, grey	SS8	2
	SS9	3
CLAY, SILT, SAND and GRAVEL	SS10	10
End of Borehole @ 11.1 m. Spoon refusal.		

GROUND WATER CONDITIONS: standpipe to 2.9 m



PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%)
20 40 60

REMARKS
GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Soil descriptions are based on field visual observation only.
Soil descriptions should be verified by laboratory testing.

Standpipe installed to 2.9 m.

Remold shear vane test = 3 KPa

Remold shear vane test = 4 KPa

Remold shear vane test = 4 KPa

Remold shear vane test = 4 KPa

Remold shear vane test = 20 KPa

Remold shear vane test = 11 KPa

Remold shear vane test = 44 KPa

01A-2 STANDARD BH 14-035 TREASURY METALS DRYDEN.GPJ TBT.GDT 14/4/16

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

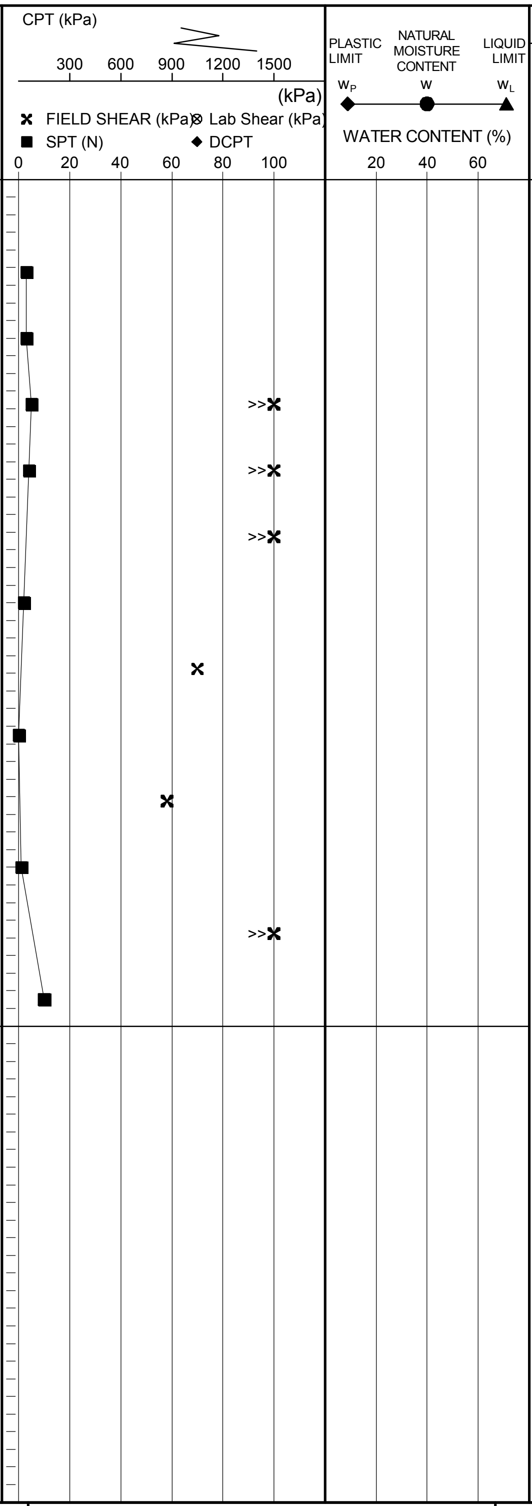
ENCLOSURE 11

LOG OF BOREHOLE 14-12

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5512093 E 528978**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 30**

DESCRIPTION	TYPE	"N" VALUES	REMARKS
ORGANICS, black			Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
SAND, brown	AS1		
CLAY, some Sand and Silt seams, brown and grey	SS2	3	
CLAY and SILT, layered, grey and brown	SS3	3	
	SS4	5	Soil did not shear on shear vane test.
	SS5	4	Remold shear vane test = 33 KPa
			Remold shear vane test = 58 KPa
CLAY and SILT, layered, grey	SS6	2	
			Remold shear vane test = 14 KPa
	SS7	0	
			Remold shear vane test = 23 KPa
	SS8	1	
			Vane refused
	SS9	10	
CLAY, SILT, SAND and GRAVEL, grey			
End of Borehole @ 9.6 m. Spoon refusal.			



GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

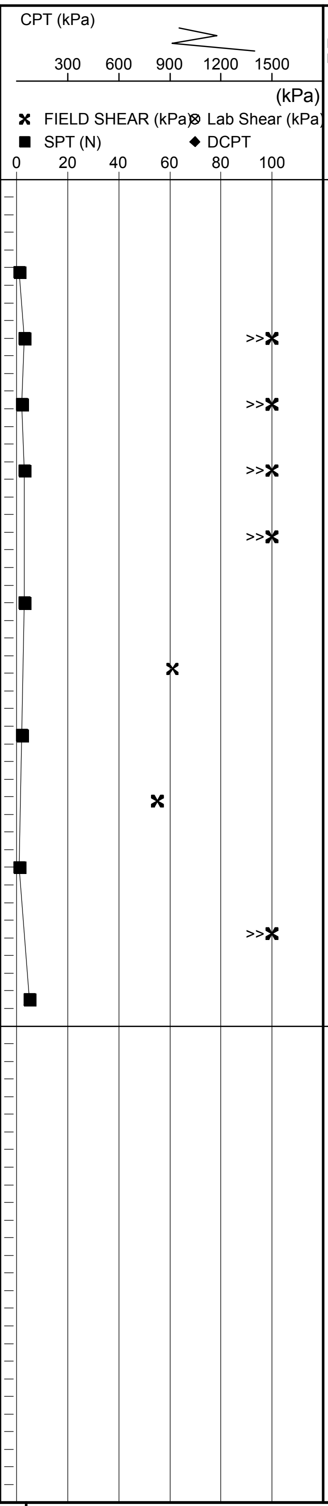
NOTES:

ENCLOSURE 12

LOG OF BOREHOLE 14-13

TBT REF. No.:	**14-035**	SURFACE ELEV.:	**metres**
CLIENT:	**Treasury Metals Incorporated**	COORDINATES:	**UTM 15 N 5512121 E 528957**
PROJECT:	**Goliath Project**	EQUIPMENT:	**HS Auger**
LOCATION:	**Tree Nursery Road Dryden, Ontario**	DIAMETER:	**80mm ID**
		DATE:	**2014 March 31**

SOIL PROFILE		SAMPLES		REMARKS
DEPTH	DESCRIPTION	TYPE	"N" VALUES	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0	ORGANICS, black			Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
	CLAY and SILT, layered, brown and grey	AS1		
1		SS2	1	
2		SS3	3	Remold shear vane test = 7 KPa
		SS4	2	Remold shear vane test = 44 KPa
3	CLAY, grey	SS5	3	Remold shear vane test = 28 KPa
4				
4.5	CLAY, reddish grey	SS6	3	
5				Remold shear vane test = 14 KPa
6	CLAY and SILT, layered, grey	SS7	2	
7				Remold shear vane test = 11 KPa
8		SS8	1	
9	SAND, trace Silt, grey	SS9	5	Remold shear vane test = 20 KPa
9.6	End of Borehole @ 9.6 m. Refusal not achieved.			Client instructed TBTE to cease drilling this borehole at 9.0m if refusal was not achieved.



PLASTIC LIMIT W_P ◆ — NATURAL MOISTURE CONTENT W ● — LIQUID LIMIT W_L ▲

WATER CONTENT (%) 20 40 60

GROUND WATER CONDITIONS

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

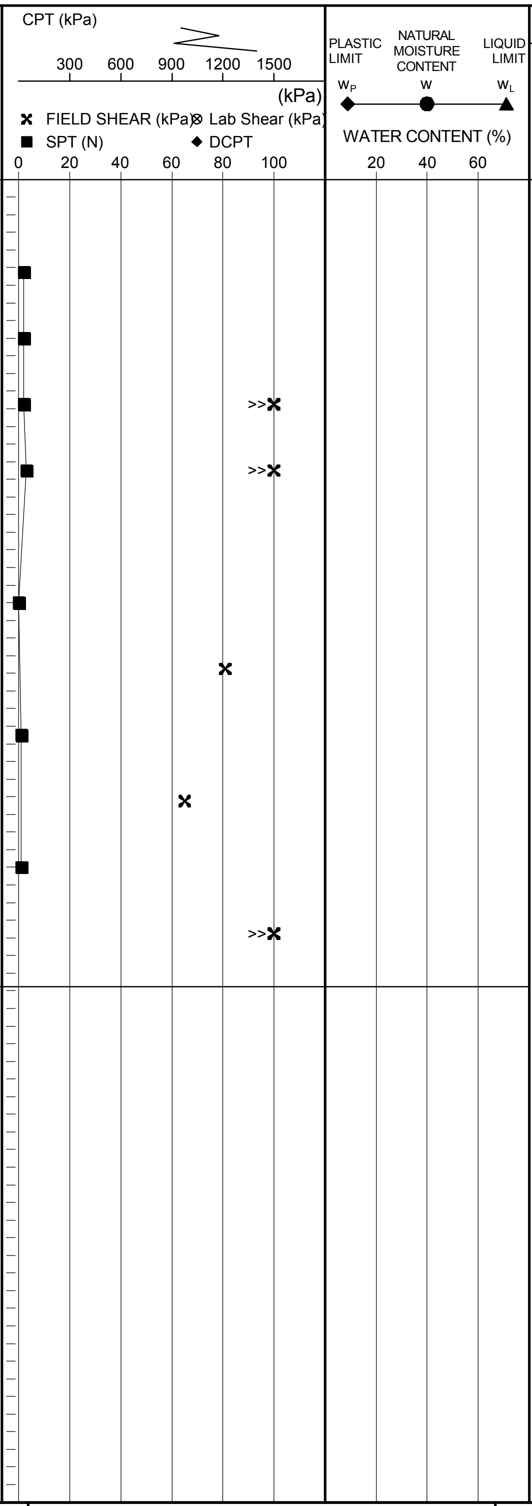
ENCLOSURE 13

LOG OF BOREHOLE 14-14

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5512062 E 528933**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 31**

DEPTH	DESCRIPTION	TYPE	"N" VALUES	REMARKS
	ORGANICS, black			Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
		AS1		
1	- - - - - - frozen	SS2	2	
	CLAY, grey			
2		SS3	2	
		SS4	2	Remold shear vane test = 65 KPa
3	CLAY, some Silt seams, grey	SS5	3	Remold shear vane test = 23 KPa
4				
	CLAY, reddish grey	SS6	0	
5				
6	CLAY, grey	SS7	1	
7				Remold shear vane test = 9 KPa
8		SS8	1	
				Remold shear vane test = 70 KPa
9	SILT and SAND, some Clay	SS9	>50	
	End of Borehole @ 9.15 m. Spoon refusal.			



GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 14

PAGE 1 OF 1

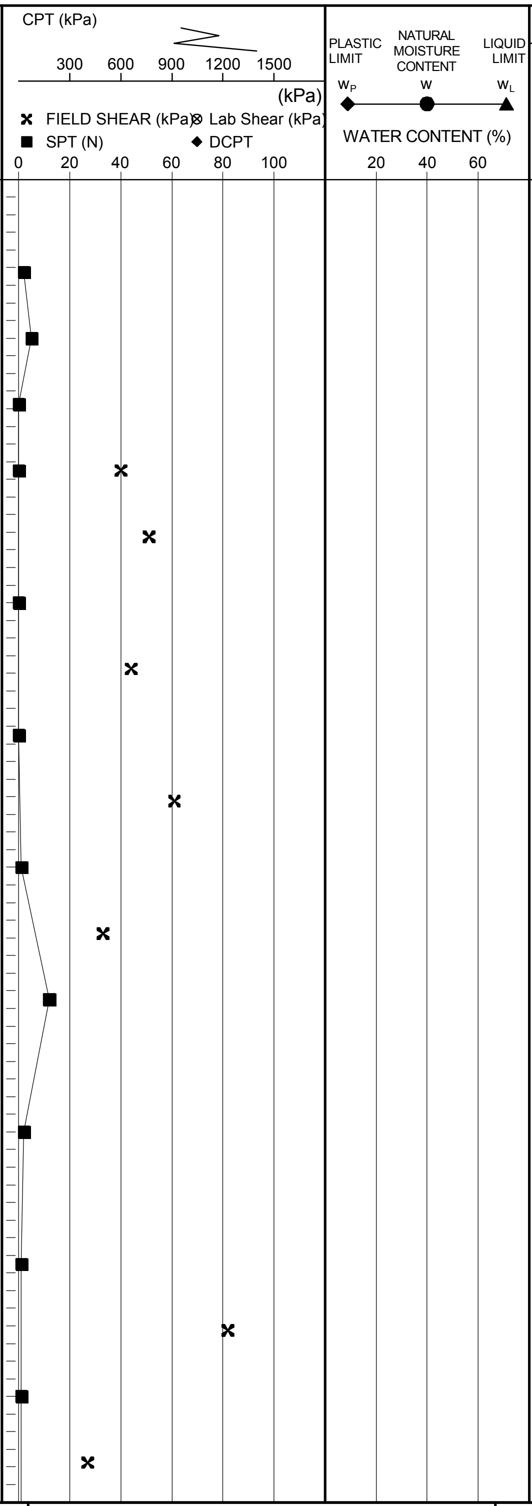
01A-2 STANDARD BH 14-035 TREASURY METALS DRYDEN.GPJ TBT.GDT 14/4/16

LOG OF BOREHOLE 14-15

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5511938 E 528962**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 29**

SOIL PROFILE DESCRIPTION	SAMPLES TYPE	"N" VALUES	REMARKS
ORGANICS, frozen, black	AS1		Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
SAND, some ORGANICS, trace Silt, grey	SS2	2	
	SS3	5	
CLAY, reddish grey, occasional Silt seams	SS4	0	
	SS5	0	Remold shear vane test = 5 KPa
			Remold shear vane test = 7 KPa
	SS6	0	
			Remold shear vane test = 5 KPa
	SS7	0	
			Remold shear vane test = 15 KPa
	SS8	1	
			Remold shear vane test = 8 KPa
SILT, grey	SS9	12	
SILT, some Clay seams, grey	SS10	2	
CLAY. grey	SS11	1	
			Remold shear vane test = 14 KPa
	SS12	1	
			Remold shear vane



GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

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Web: www.tbte.ca

SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

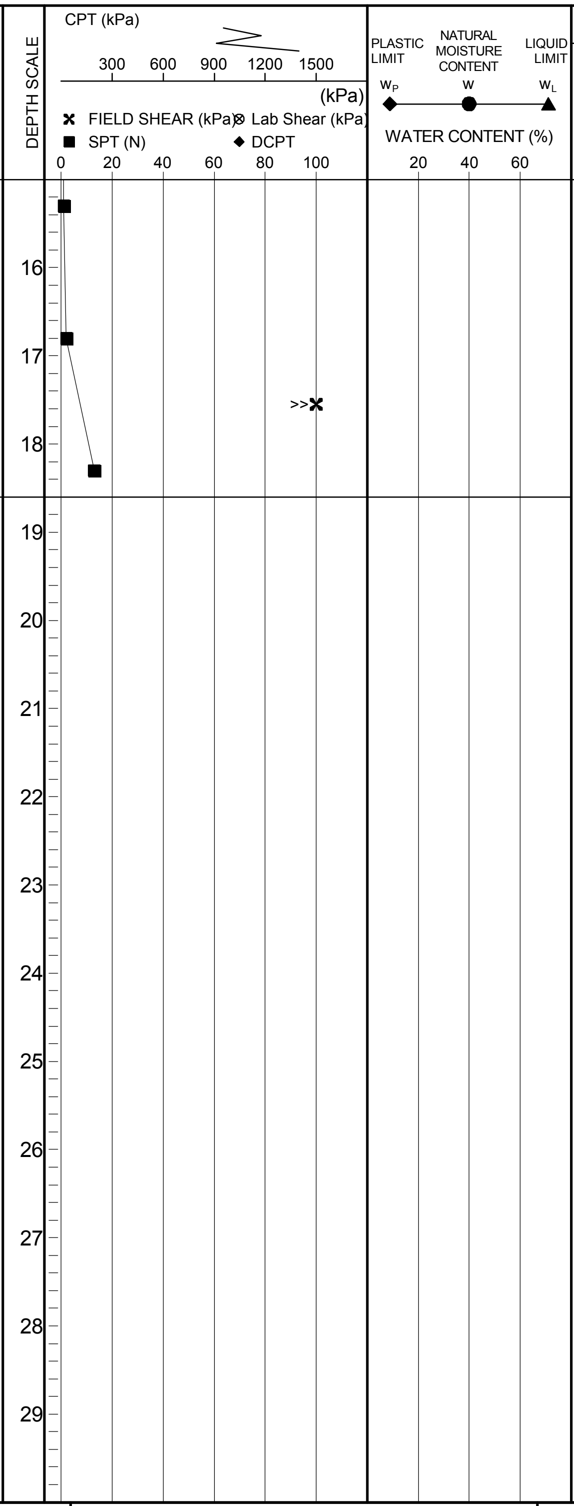
NOTES:

ENCLOSURE 15

LOG OF BOREHOLE 14-15

TBT REF. No.:	**14-035**	SURFACE ELEV.:	**metres**
CLIENT:	**Treasury Metals Incorporated**	COORDINATES:	**UTM 15 N 5511938 E 528962**
PROJECT:	**Goliath Project**	EQUIPMENT:	**HS Auger**
LOCATION:	**Tree Nursery Road** **Dryden, Ontario**	DIAMETER:	**80mm ID**
		DATE:	**2014 March 29**

SOIL PROFILE				SAMPLES					REMARKS
DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS		GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		SILT, grey			SS13	1			test = 16 KPa
		SILT and CLAY, layered, grey			SS14	2			
									No soil shear on vane test.
					SS15	13			
		End of Borehole @ 18.6 m. Spoon refusal.							



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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

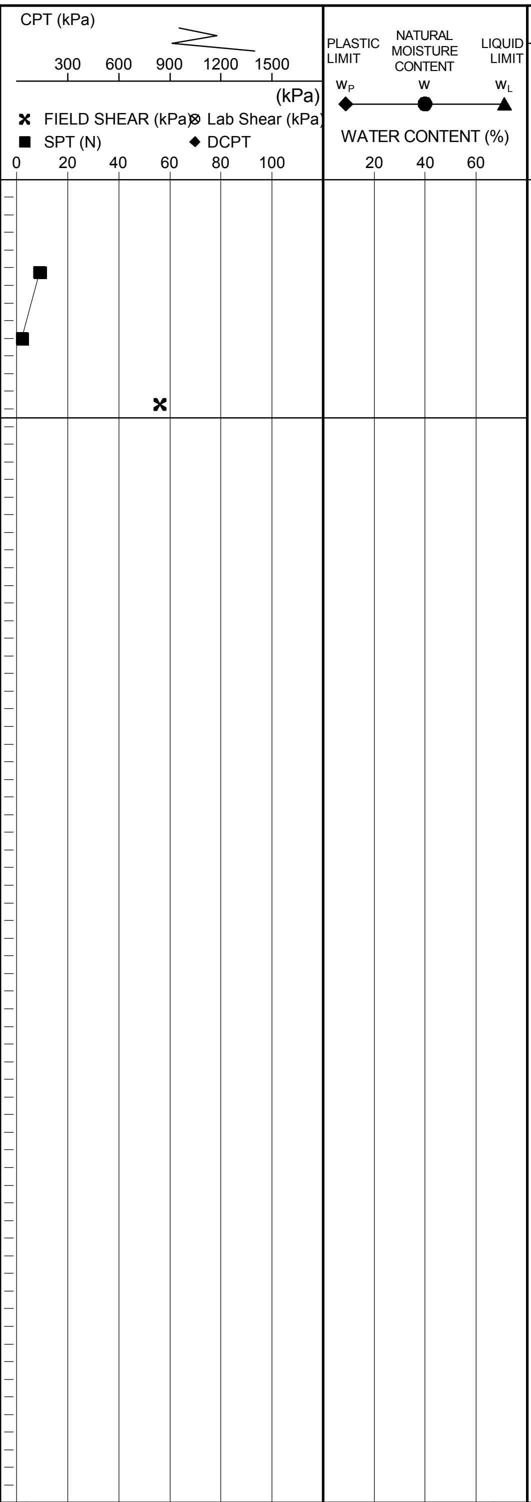
NOTES:

ENCLOSURE 16

LOG OF BOREHOLE 14-17

TBT REF. No.:	**14-035**	SURFACE ELEV.:	**metres**
CLIENT:	**Treasury Metals Incorporated**	COORDINATES:	**UTM 15 N 5512879 E 528077**
PROJECT:	**Goliath Project**	EQUIPMENT:	**HS Auger**
LOCATION:	**Tree Nursery Road** **Dryden, Ontario**	DIAMETER:	**80mm ID**
		DATE:	**2014 March 28**

DEPTH	ELEV.	DESCRIPTION (SOIL PROFILE)	% RECOVERY	TYPE (SAMPLES)	"N" VALUES	GROUND WATER CONDITIONS	REMARKS
		ORGANICS, black		AS1			Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
1		SAND, trace Silt, brown		SS2	9		
2		CLAY, some Silt, grey		SS3	2		
		SAND, some Clay, Silt and Gravel, grey		SS4	>50		Remold shear vane test = 9 KPa
3		End of Borehole @ 2.7 m. Auger refusal.					



GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

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Email: tbte@tbte.ca
Web: www.tbte.ca

SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

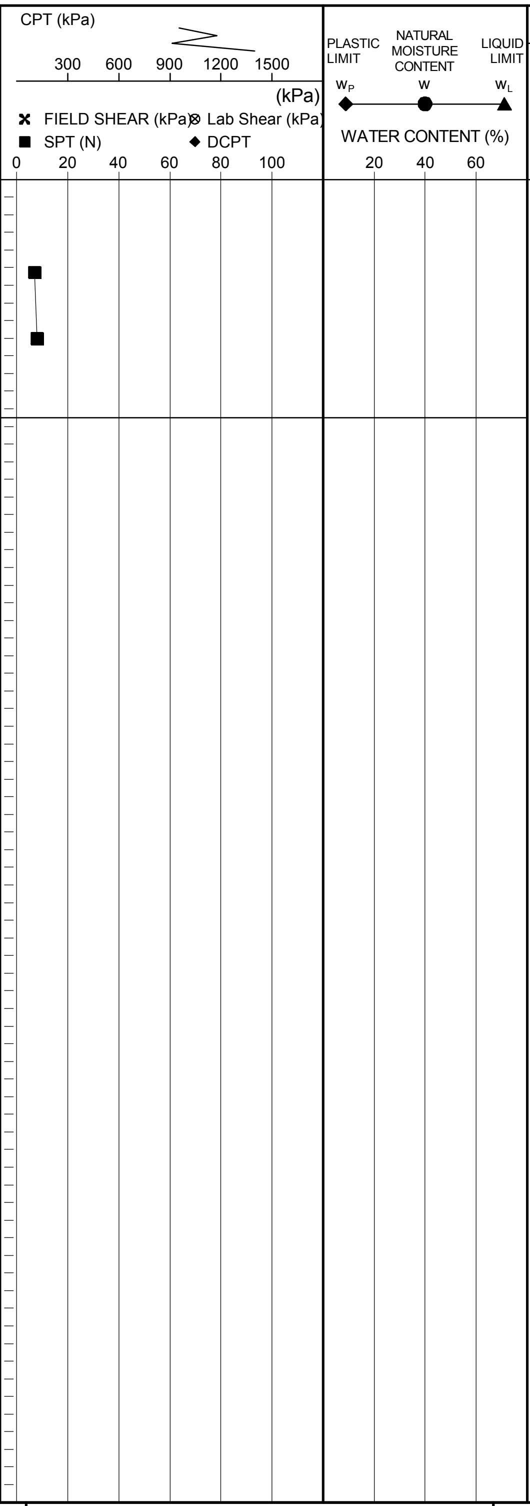
NOTES:

ENCLOSURE 17

LOG OF BOREHOLE 14-18

TBT REF. No.:	**14-035**	SURFACE ELEV.:	**metres**
CLIENT:	**Treasury Metals Incorporated**	COORDINATES:	**UTM 15 N 5512748 E 528151**
PROJECT:	**Goliath Project**	EQUIPMENT:	**HS Auger**
LOCATION:	**Tree Nursery Road** **Dryden, Ontario**	DIAMETER:	**80mm ID**
		DATE:	**2014 March 28**

SOIL PROFILE				SAMPLES					REMARKS
DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES	GROUND WATER CONDITIONS	DEPTH SCALE	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		ORGANICS, black							Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.
		SAND, trace Silt, brown			AS1				
1		CLAY and SILT, layered, grey			SS2	7		1	
2					SS3	8		2	
		SILT, trace Sand and Clay, grey			SS4	>50			
3		End of Borehole @ 2.7 m. Auger refusal.						3	
4								4	
5								5	
6								6	
7								7	
8								8	
9								9	
10								10	
11								11	
12								12	
13								13	
14								14	



01A-2 STANDARD BH 14-035 TREASURY METALS DRYDEN.GPJ TBT.GDT 14/4/16

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 18

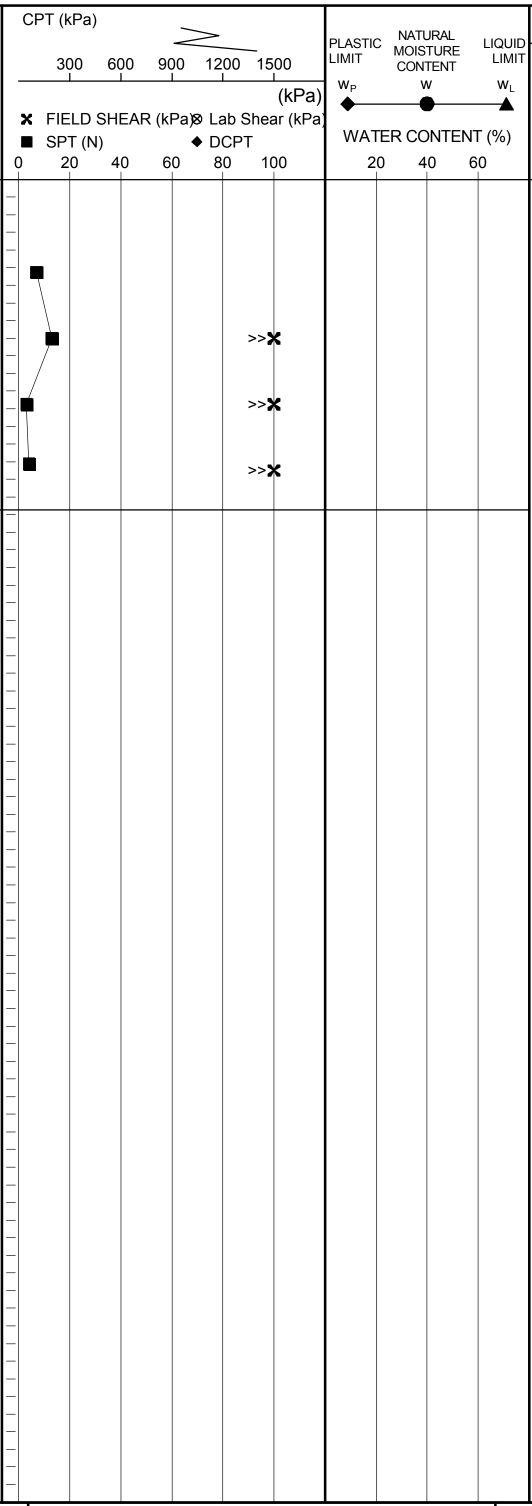
LOG OF BOREHOLE 14-19

TBT REF. No.:	**14-035**	SURFACE ELEV.:	**metres**
CLIENT:	**Treasury Metals Incorporated**	COORDINATES:	**UTM 15 N 5512845 E 528233**
PROJECT:	**Goliath Project**	EQUIPMENT:	**HS Auger**
LOCATION:	**Tree Nursery Road** **Dryden, Ontario**	DIAMETER:	**80mm ID**
		DATE:	**2014 March 28**

SOIL PROFILE				SAMPLES		
DEPTH	ELEV.	DESCRIPTION	STRAT PLOT	% RECOVERY	TYPE	"N" VALUES
		ORGANICS and SAND, brown			AS1	
1		CLAY and SILT, layered, grey			SS2	7
2					SS3	13
		CLAY. grey			SS4	3
3					SS5A	4
		SILT, some Sand and Clay			SS5B	
4		End of Borehole @ 3.75 m. Auger refusal.				
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

GROUND WATER CONDITIONS

DEPTH SCALE



REMARKS

GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.

No soil shear on vane test.

Remold shear vane test = 23 KPa

remold shear vane teast = 35 KPa

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 19

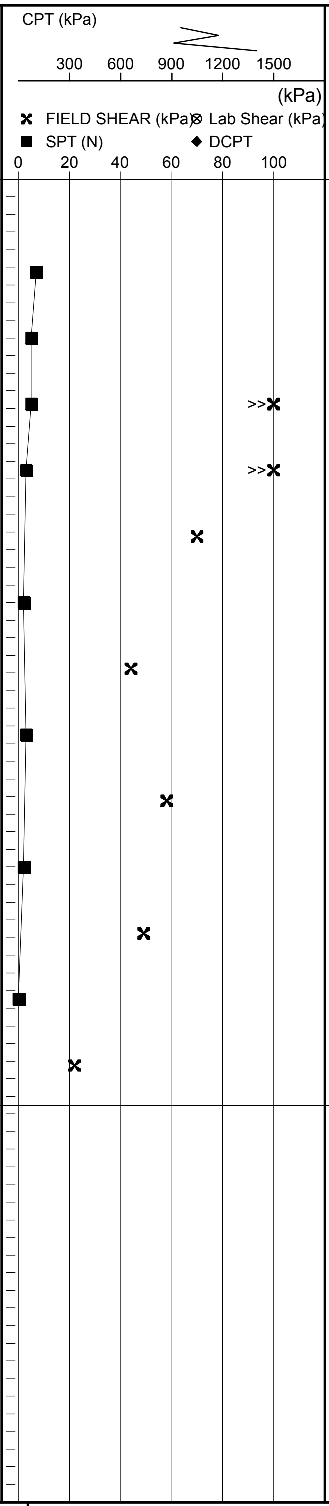
LOG OF BOREHOLE 14-20

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5513035 E 528118**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 28**

SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES TYPE	"N" VALUES
ORGANICS, roots, black	⺌	AS1	
SAND, trace SIlt, brown	⁘	SS2	7
CLAY and SILT, layered, grey and brown	▨	SS3	5
		SS4	5
		SS5	3
		SS6	2
		SS7	3
		SS8	2
		SS9	0
End of Borehole @ 10.5 m. Spoon and auger refusal.			

Column headings: DEPTH, ELEV., DESCRIPTION, STRAT PLOT, % RECOVERY, TYPE, "N" VALUES, GROUND WATER CONDITIONS, DEPTH SCALE; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L, WATER CONTENT (%) 20 40 60; GRAIN SIZE DISTRIBUTION (%) GR SA SI CL



REMARKS

Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.

No soil shear in vane test.

Remold shear vane test = 28 KPa

Remold shear vane test = 9 KPa

Remold shear vane test = 12 KPa

Remold shear vane test = 12 KPa

Remold shear vane test = 22 KPa

Remold shear vane test = 5 KPa

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 20

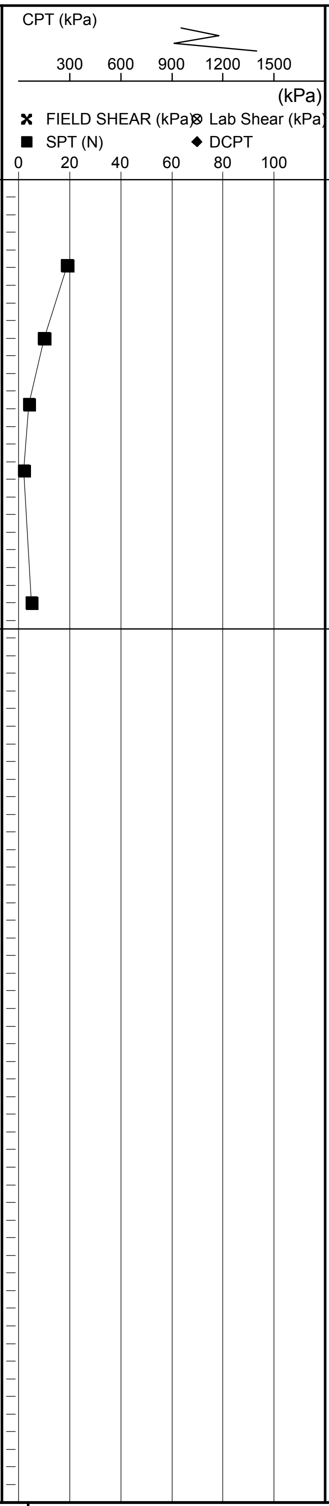
LOG OF BOREHOLE 14-21

TBT REF. No.: **14-035**
CLIENT: **Treasury Metals Incorporated**
PROJECT: **Goliath Project**
LOCATION: **Tree Nursery Road**
Dryden, Ontario

SURFACE ELEV.: **metres**
COORDINATES: **UTM 15 N 5512927 E 528282**
EQUIPMENT: **HS Auger**
DIAMETER: **80mm ID**
DATE: **2014 March 28**

SOIL PROFILE DESCRIPTION	SAMPLES TYPE	"N" VALUES
ORGANICS, black		
SAND, trace Silt, brown	AS1	
	SS2A	19
SAND, some Silt, grey	SS2B	
SILT, trace Clay and Sand	SS4	10
CLAY and SILT, layered, grey	SS5	4
	SS6	2
SILT, trace Sand, grey	SS7	5
End of Borehole @ 5.1 m. Auger refusal.		

Column headings: DEPTH, ELEV., DESCRIPTION, STRAT PLOT, % RECOVERY, TYPE, "N" VALUES, GROUND WATER CONDITIONS, DEPTH SCALE



PLASTIC LIMIT w_P ◆ — NATURAL MOISTURE CONTENT w ● — LIQUID LIMIT w_L ▲

WATER CONTENT (%)
20 40 60

REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Soil descriptions are based on field visual observation only. Soil descriptions should be verified by laboratory testing.

01A-2 STANDARD BH 14-035 TREASURY METALS DRYDEN.GPJ TBT.GDT 14/4/16

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SAMPLE TYPE LEGEND

AS	Auger Sample
SS	Split Spoon Sample
TW	70mm Thin Wall Tube
CC	Concrete Core
RC	Rock Core
PS	Ponar Sample
CB	Core Barrel
HS	Hiller Sample
AC	Asphalt Core

NOTES:

ENCLOSURE 21

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Natural Moisture Content Determination

Client: Treasury Metals
TBTE Project No.: 14-048
Client Project No.: Goliath Project
Tested By/Date: F. Valela / April 22, 2014
Project Description: Tailings Storage Facility
Reported By: Forch Valela
Report To: Mark Wheeler
Reviewed By: Forch Valela

Lab No.	BH / TP No.	Sample No.	Depth (m)	Moisture	Remarks
14-915	**BH 3**	AS 1	**0.5**	**26.7**	
14-916	**BH 3**	SS 2	**0.8**	**20.2**	
14-917	**BH 3**	SS 3	**1.5**	**25.7**	
14-918	**BH 3**	SS 4	**2.3**	**27.2**	
14-919	**BH 3**	SS 5	**3.0**	**22.1**	
14-920	**BH 3**	SS 6	**4.5**	**22.3**	
14-921	**BH 4**	SS 2	**0.8**	**20.1**	
14-922	**BH 4**	SS 3	**1.5**	**20.4**	
14-923	**BH 4**	SS 4	**2.3**	**21.4**	
14-924	**BH 4**	SS 5	**3.0**	**23.3**	
14-925	**BH 4**	SS 6	**4.5**	**23.6**	
14-926	**BH 4**	SS 7	**6.0**	**25.2**	
14-927	**BH 4**	SS 8	**7.5**	**20.9**	
14-928	**BH 5**	SS 2	**0.8**	**19.1**	
14-929	**BH 5**	SS 4	**2.3**	**15.8**	
14-930	**BH 5**	SS 6	**3.8**	**18.9**	
14-931	**BH 5**	SS 7	**4.5**	**23.5**	
14-932	**BH 5**	SS 8	**5.3**	**19.6**	
14-933	**BH 5**	SS 9	**6.0**	**27.0**	
14-934	**BH 5**	SS 10	**6.8**	**25.5**	
14-935	**BH 5**	SS 12	**8.3**	**14.1**	
14-936	**BH 5**	SS 14	**9.8**	**13.5**	
14-937	**BH 6**	SS 2	**0.8**	**21.3**	
14-938	**BH 6**	SS 3	**1.5**	**19.6**	
14-939	**BH 6**	SS 4	**2.3**	**20.5**	
14-940	**BH 6**	SS 5	**3.0**	**21.7**	
14-941	**BH 6**	SS 6	**4.5**	**32.3**	
14-942	**BH 6**	SS 7	**6.0**	**27.1**	
14-943	**BH 6**	SS 8	**7.5**	**23.3**	
14-944	**BH 6**	SS 9	**9.0**	**19.8**	
14-945	**BH 7A**	SS 2	**0.8**	**15.8**	
14-946	**BH 7A**	SS 3	**1.5**	**23.0**	
14-947	**BH 7A**	SS 4	**2.3**	**19.5**	
14-948	**BH 7A**	SS 5	**3.0**	**25.7**	
14-949	**BH 7A**	SS 6	**4.5**	**22.2**	
14-950	**BH 7A**	SS 7	**6.0**	**46.2**	
14-951	**BH 7A**	SS 8	**7.5**	**31.1**	

Natural Moisture Content Determination

Client:	Treasury Metals	TBTE Project No.:	14-048
Client Project No.:	Goliath Project	Tested By/Date:	F. Valela / April 22, 2014
Project Description:	Tailings Storage Facility	Reported By:	Forch Valela
Report To:	Mark Wheeler	Reviewed By:	Forch Valela FV

Lab No.	BH / TP No.	Sample No.	Depth (m)	Moisture	Remarks
14-952	**BH 8**	SS 2	**0.8**	**26.0**	
14-953	**BH 8**	SS 3	**1.5**	**33.0**	
14-954	**BH 8**	SS 4	**2.3**	**35.7**	
14-955	**BH 8**	SS 5	**3.0**	**36.3**	
14-956	**BH 8**	SS 6	**4.5**	**39.2**	
14-957	**BH 8**	SS 7	**6.0**	**31.7**	
14-958	**BH 8**	SS 8	**7.5**	**34.9**	
14-959	**BH 12**	SS 2	**0.8**	**39.1**	
14-960	**BH 12**	SS 3	**1.5**	**45.7**	
14-961	**BH 12**	SS 4	**2.3**	**41.8**	
14-962	**BH 12**	SS 5	**3.0**	**32.0**	
14-963	**BH 12**	SS 7	**6.0**	**31.3**	
14-964	**BH 12**	SS 9	**9.0**	**16.1**	
14-965	**BH 21**	SS 2A	**0.8**	**21.9**	
14-966	**BH 21**	SS 2B	**1.2**	**20.8**	
14-967	**BH 21**	SS 3	**1.5**	**30.3**	
14-968	**BH 21**	SS 4	**2.4**	**32.8**	
14-969	**BH 21**	SS 5	**3.0**	**36.5**	
14-970	**BH 21**	SS 6	**4.5**	**20.6**	

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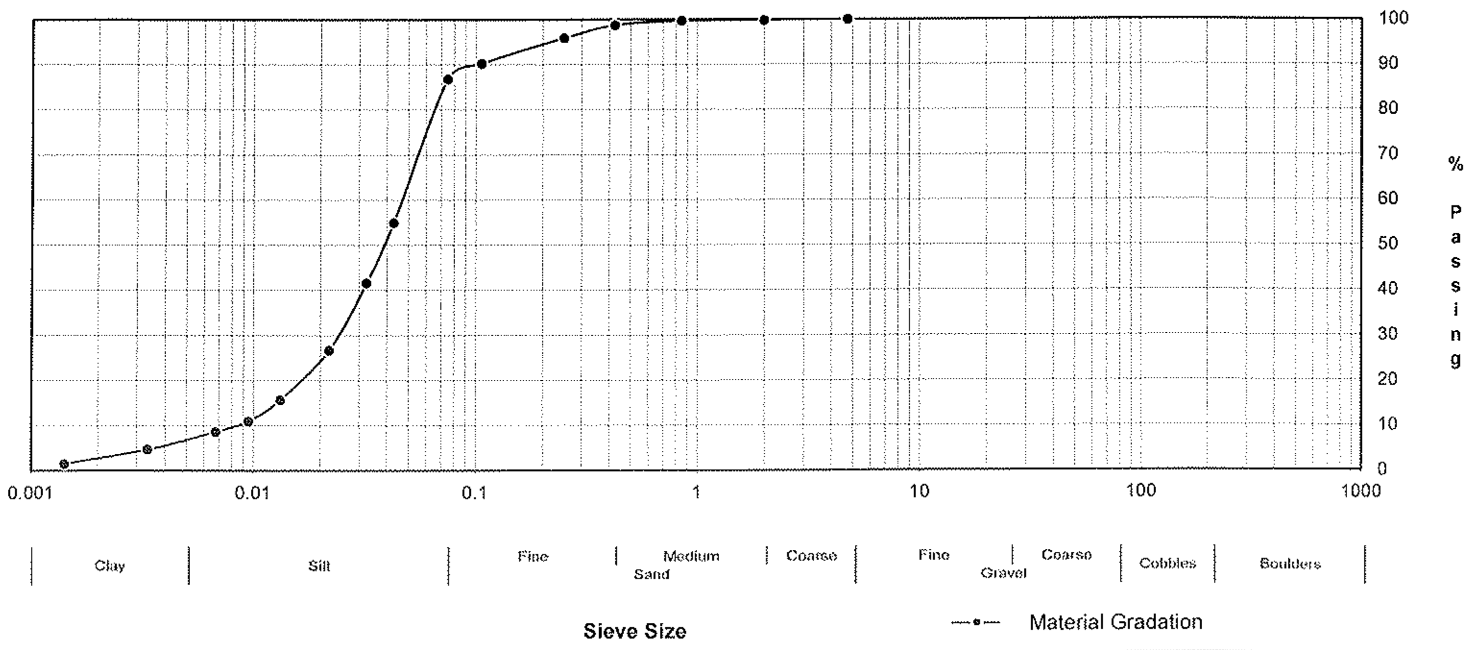
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-916
Location:	Tailings Storage Facility	Sample Location	BH 3 SS 2 0.75m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.042960	55.0
25.0		$0.032480	41.6
19.0		$0.021933	26.7
13.2		$0.013223	15.7
9.5		$0.009515	11.0
4.75	100.0	$0.006786	8.6
2.00	99.8	$0.003350	4.7
0.850	99.7	$0.001420	1.6
0.425	98.7		
0.250	95.9	5 µm	8.0
0.106	90.3	2 µm	2.0
0.075	86.8		

Grain Size Analysis



%Gravel		% Silt	78.8	% NMC	20.2	Frost Heave Susc.		Material Suitability	
% Sand	13.2	% Clay	8.0	PI		Erodibility (k)		Soil Classification	

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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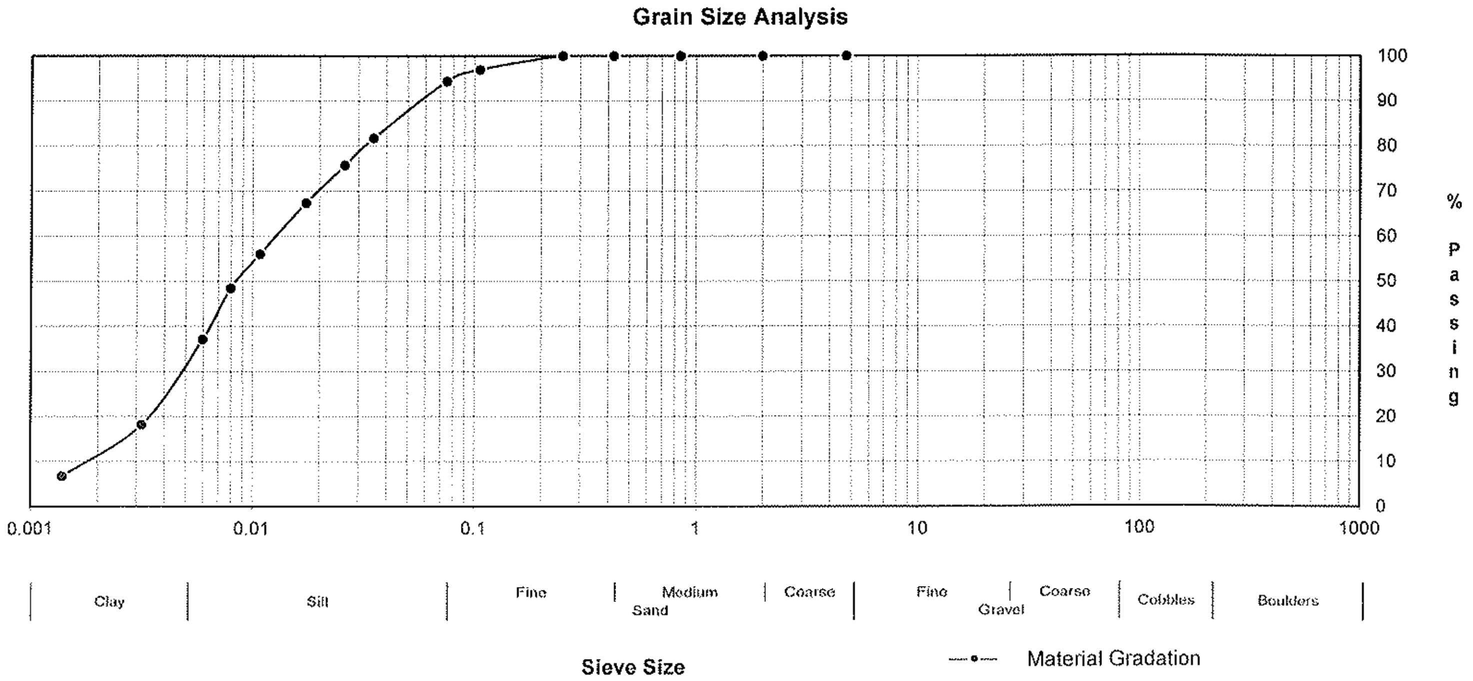
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-920
Location:	Tailings Storage Facility	Sample Location	BH 3 SS 6 4.5m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela AW

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.035058	81.8
25.0		$0.025999	75.7
19.0		$0.017440	67.4
13.2		$0.010805	56.1
9.5		$0.007968	48.5
4.75	100.0	$0.005965	37.1
2.00	100.0	$0.003174	18.2
0.850	100.0	$0.001390	6.8
0.425	100.0		
0.250	100.0	5 µm	32.0
0.106	97.0	2 µm	11.0
0.075	94.4		



%Gravel		% Silt	62.4	% NMC	22.3	Frost Heave Susc.		Material Suitability	
% Sand	5.6	% Clay	32.0	PI		Erodibility (k)		Soil Classification	

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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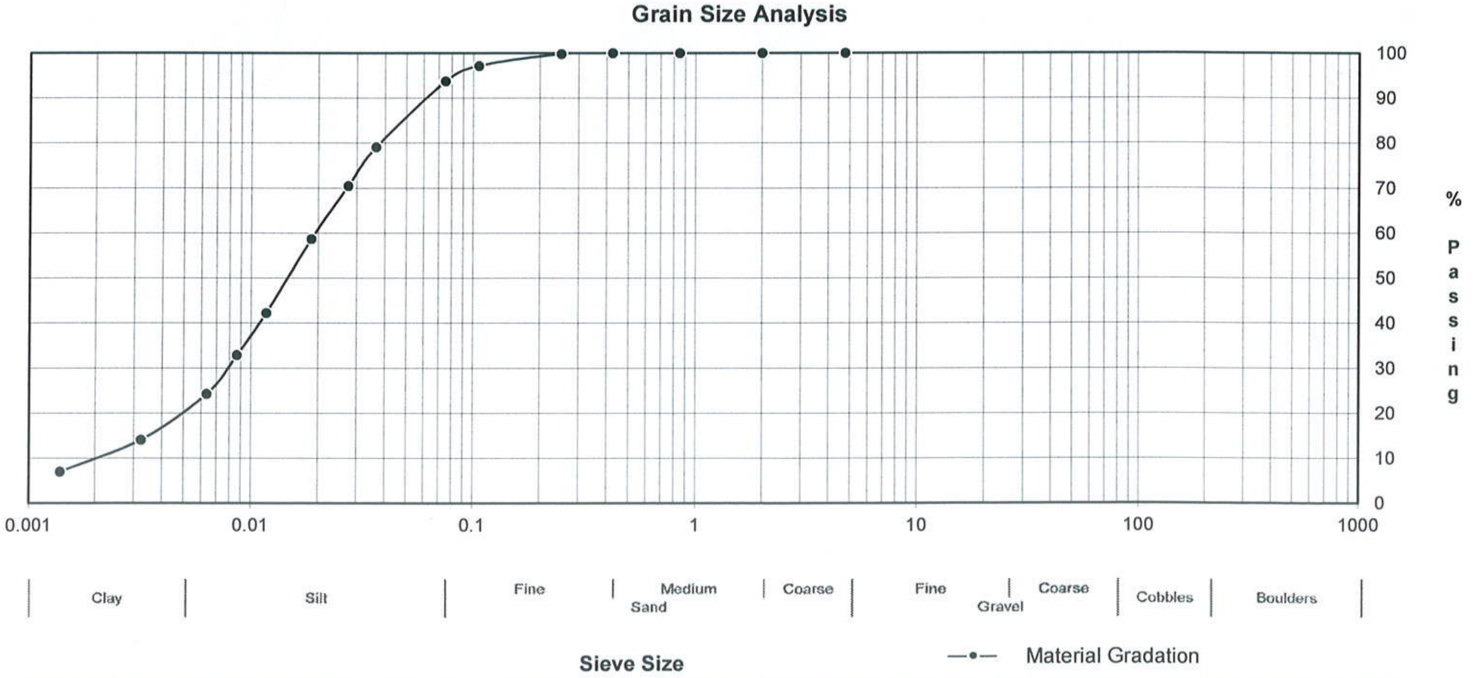
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-925
Location:	Tailings Storage Facility	Sample Location	BH 4 SS 6 4.5m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela AV

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.036512	79.1
25.0		$0.027405	70.5
19.0		$0.018614	58.7
13.2		$0.011704	42.3
9.5		$0.008639	32.9
4.75	100.0	$0.006335	24.3
2.00	100.0	$0.003230	14.1
0.850	100.0	$0.001389	7.0
0.425	100.0		
0.250	99.8	5 µm	20.0
0.106	97.2	2 µm	10.0
0.075	93.7		



%Gravel		% Silt	73.7	% NMC	23.6	Frost Heave Susc.		Material Suitability	
% Sand	6.3	% Clay	20.0	PI		Erodibility (k)		Soil Classification	

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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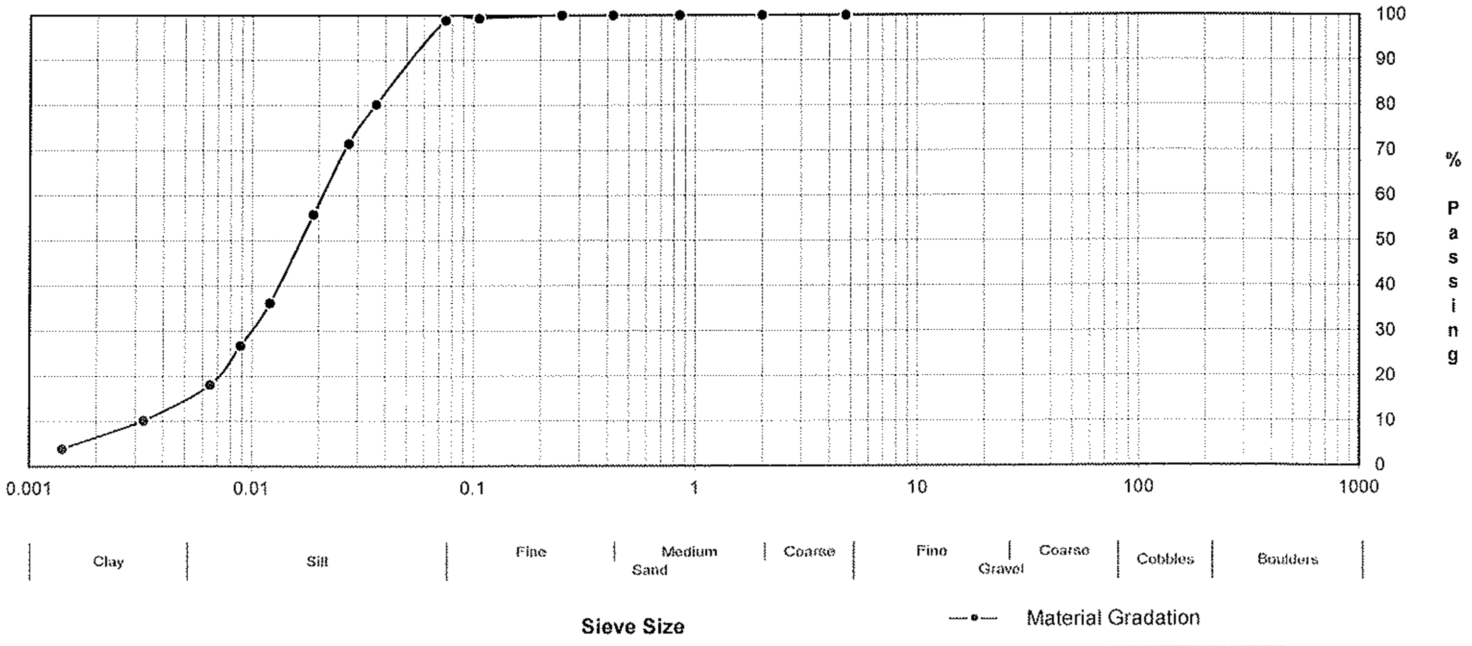
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-931
Location:	Tailings Storage Facility	Sample Location	BH 5 SS 7 4.5m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.036339	80.2
25.0		$0.027289	71.6
19.0		$0.018955	55.8
13.2		$0.012056	36.2
9.5		$0.008878	26.7
4.75	100.0	$0.006498	18.1
2.00	100.0	$0.003278	10.2
0.850	100.0	$0.001406	3.9
0.425	100.0		
0.250	100.0	5 µm	15.0
0.106	99.4	2 µm	7.0
0.075	98.9		

Grain Size Analysis



%Gravel		% Silt	83.9	% NMC	23.5	Frost Heave Susc.		Material Suitability	
% Sand	1.1	% Clay	15.0	PI		Erodibility (k)		Soil Classification	

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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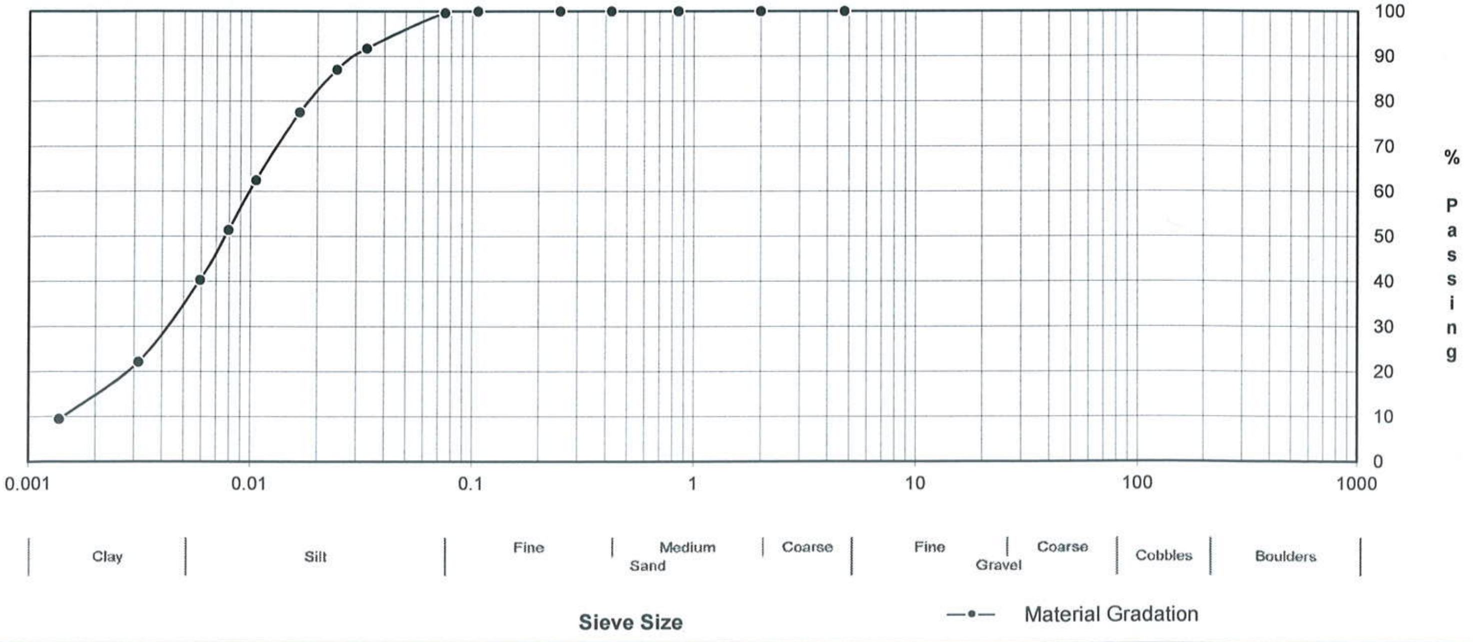
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-933
Location:	Tailings Storage Facility	Sample Location	BH 5 SS 9 6.0m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela FV

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.033220	91.8
25.0		$0.024451	87.0
19.0		$0.016613	77.5
13.2		$0.010557	62.5
9.5		$0.007930	51.4
4.75	100.0	$0.005918	40.4
2.00	100.0	$0.003134	22.2
0.850	100.0	$0.001378	9.5
0.425	100.0		
0.250	100.0	5 µm	35.0
0.106	100.0	2 µm	14.0
0.075	99.7		

Grain Size Analysis



%Gravel		% Silt	64.7	% NMC	27.0	Frost Heave Susc.		Material Suitability	
% Sand	0.3	% Clay	35.0	PI		Erodibility (k)		Soil Classification	

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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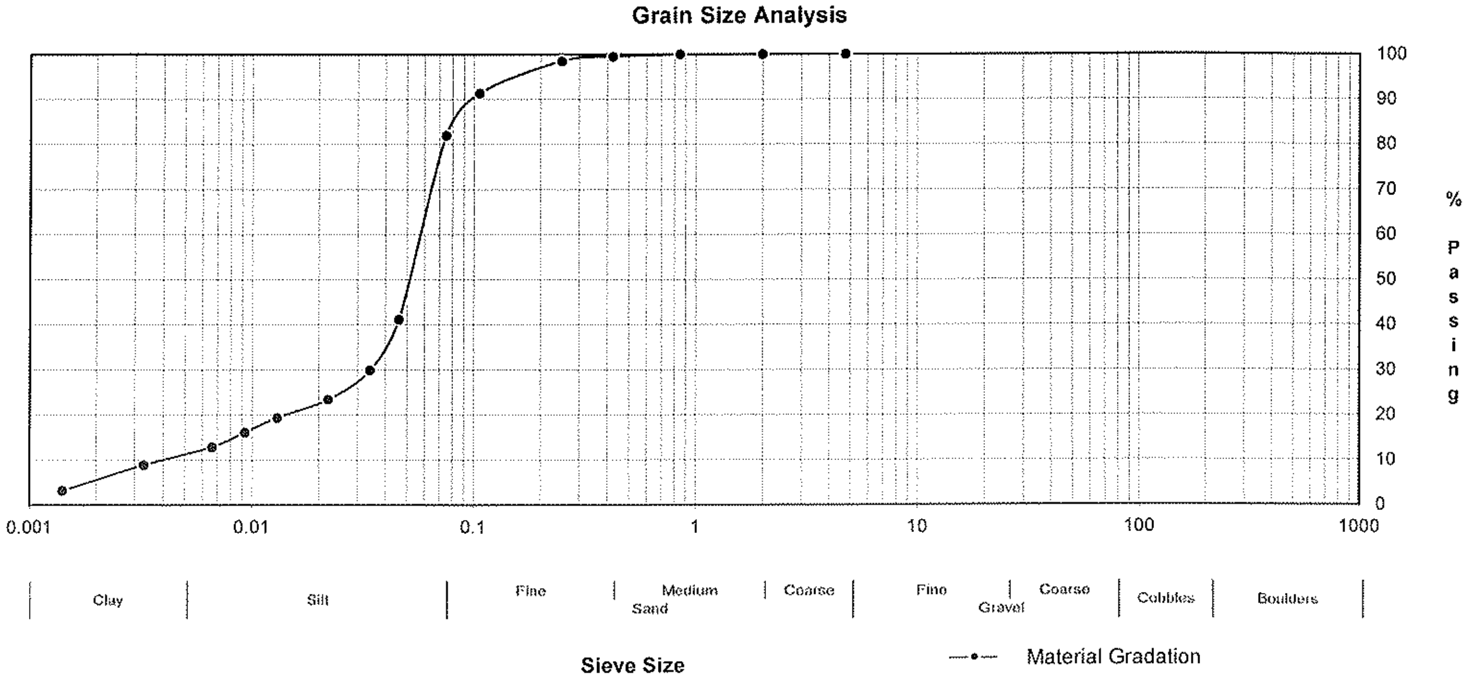
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-940
Location:	Tailings Storage Facility	Sample Location	BH 6 SS 5 3.0m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.045956	41.2
25.0		$0.034110	29.9
19.0		$0.022135	23.4
13.2		$0.012978	19.4
9.5		$0.009288	16.2
4.75	100.0	$0.006645	12.9
2.00	100.0	$0.003302	8.9
0.850	100.0	$0.001412	3.2
0.425	99.5		
0.250	98.5	5 µm	11.0
0.106	91.4	2 µm	6.0
0.075	82.0		



%Gravel		% Silt	71.0	% NMC	21.7	Frost Heave Susc.		Material Suitability	
% Sand	18.0	% Clay	11.0	PI		Erodibility (k)		Soil Classification	

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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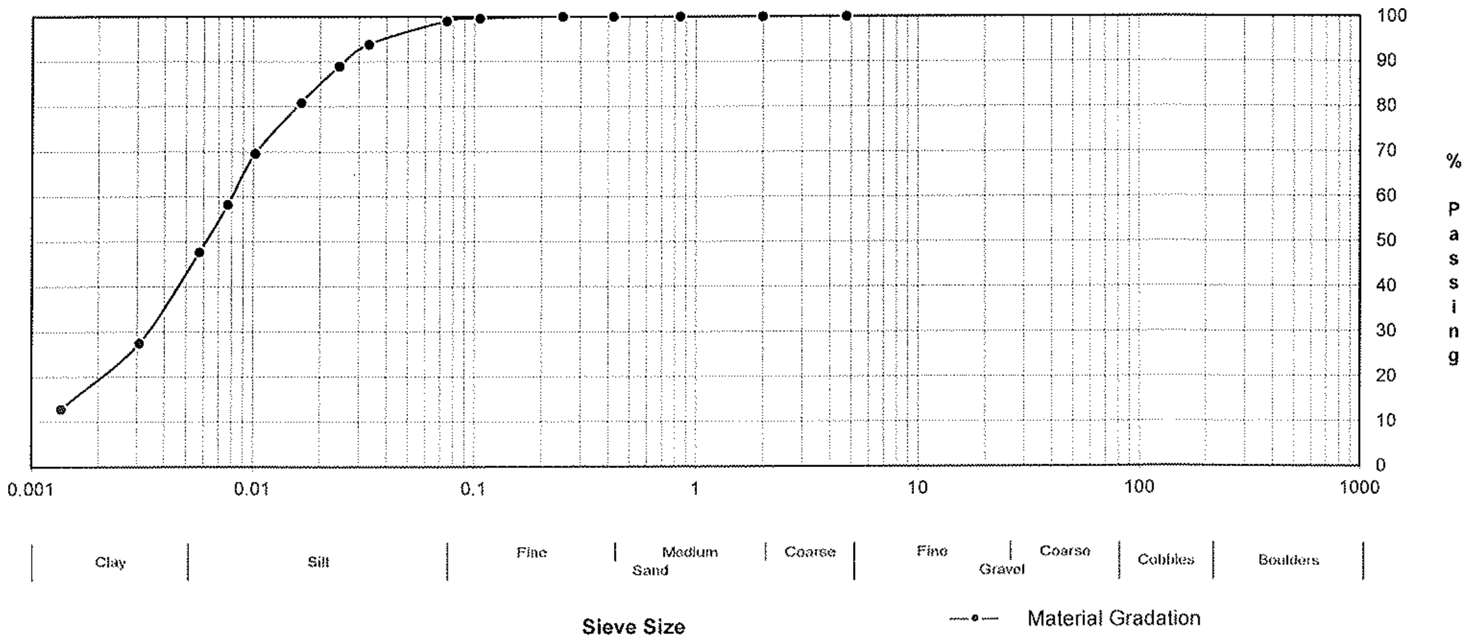
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-942
Location:	Tailings Storage Facility	Sample Location	BH 6 SS 7 6.0m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.033209	93.9
25.0		$0.024443	89.0
19.0		$0.016423	80.9
13.2		$0.010209	69.6
9.5		$0.007699	58.3
4.75	100.0	$0.005742	47.8
2.00	100.0	$0.003074	27.5
0.850	100.0	$0.001362	13.0
0.425	100.0		
0.250	100.0	5 µm	45.0
0.106	99.7	2 µm	20.0
0.075	99.0		

Grain Size Analysis



%Gravel		% Silt	54.0	% NMC	27.1	Frost Heave Susc.		Material Suitability	
% Sand	1.0	% Clay	45.0	PI	6.0	Erodibility (k)		Soil Classification	CL-ML

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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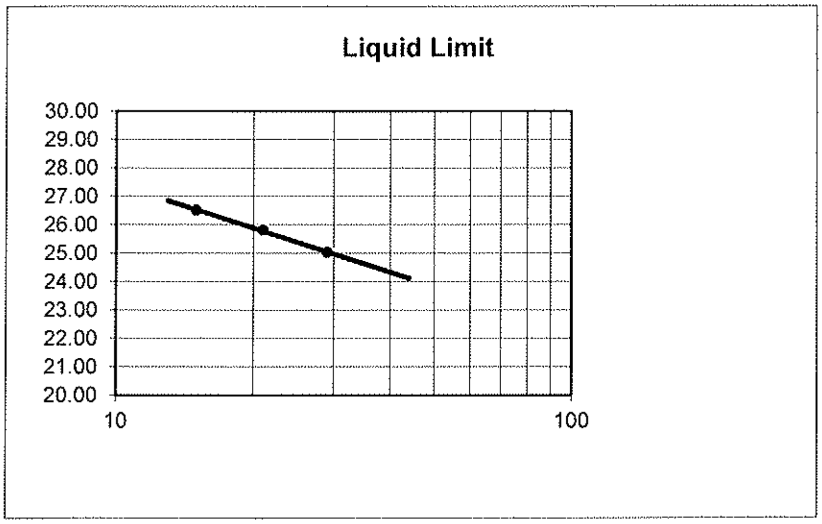
Atterberg Limits

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-942
Location:	Tailings Storage Facility	Sample Location:	BH 6 SS 7 6.0m
Reported To:	Mark Wheeler	Tested By/Date:	G.Homac / April 21, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela

Liquid Limit Determination

Dish No.:	21	P	4		Liquid Limit 25 Blows
Wet Soil + Dish:	37.36	37.306	38.551		
Dry Soil + Dish:	34.216	33.893	35.18		
Moisture:	3.144	3.413	3.371		
Dish:	22.358	20.675	21.716		
Dry Soil:	11.858	13.218	13.464		
% Moisture:	26.51	25.82	25.04		
No. of Blows:	15	21	29		
Liquid Limits:	25	25	25		25



Liquid Limit, %:	25
Plastic Limit, %:	19
Plasticity Index:	6

Plastic Limit Determination

Dish No.:	1	2			Natural Moisture TT
Wet Soil + Dish:	27.631	27.108			965
Dry Soil + Dish:	26.392	25.886			800.1
Moisture:	1.239	1.222			164.9
Dish:	19.895	19.484			191.8
Dry Soil:	6.497	6.402			608.3
% Moisture:	19.07	19.09			27.1
Average:		19			

Test Method : ASTM: D4318, D2216

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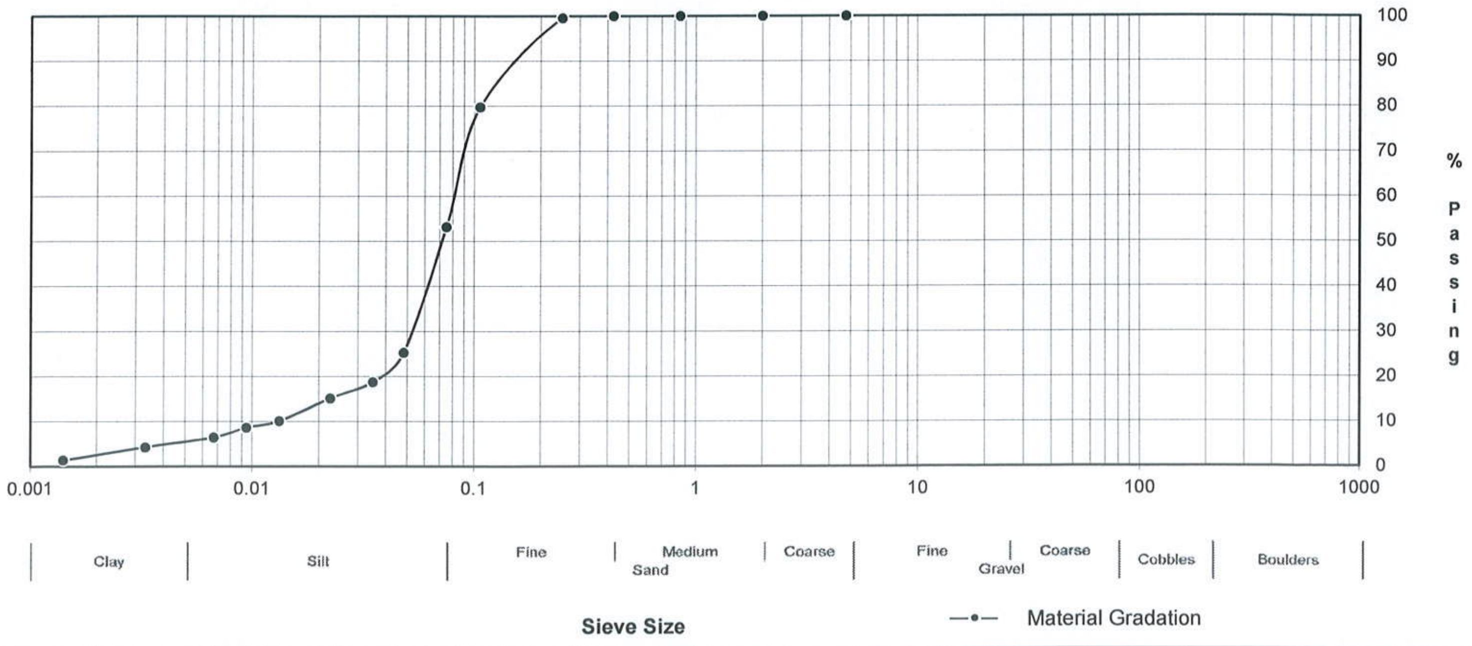
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-946
Location:	Tailings Storage Facility	Sample Location	BH 7A SS 3 1.5m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.048185	25.3
25.0		$0.035059	18.8
19.0		$0.022513	15.2
13.2		$0.013267	10.1
9.5		$0.009435	8.7
4.75	100.0	$0.006728	6.5
2.00	100.0	$0.003324	4.3
0.850	100.0	$0.001417	1.4
0.425	100.0		
0.250	99.6	5 µm	6.0
0.106	79.8	2 µm	2.5
0.075	53.2		

Grain Size Analysis



%Gravel		% Silt	47.2	% NMC	23.0	Frost Heave Susc.		Material Suitability	
% Sand	46.8	% Clay	6.0	PI		Erodibility (k)		Soil Classification	

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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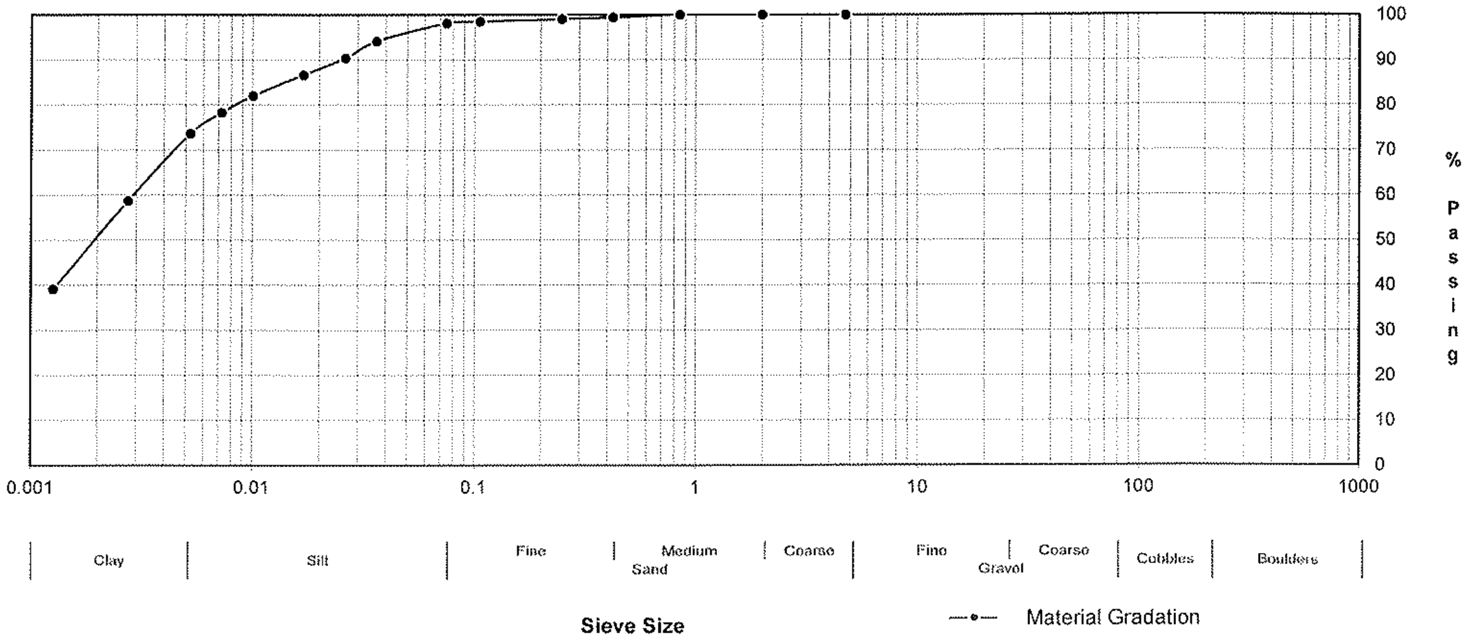
Grain Size Analysis of Soil By Hydrometer

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-953
Location:	Tailings Storage Facility	Sample Location	BH 8 SS 3 1.5m
Reported To:	Mark Wheeler	Tested By/Date:	F.Valela / G.Homac / April 22, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela

Sieve Analysis		Hydrometer Analysis	
Sieve (mm)	% Passing	Diameter (mm)	% Finer
100			
50.0			
37.5		$0.036325	94.1
25.0		$0.026269	90.4
19.0		$0.016975	86.7
13.2		$0.010055	82.0
9.5		$0.007251	78.3
4.75	100.0	$0.005249	73.6
2.00	100.0	$0.002754	58.7
0.850	100.0	$0.001255	39.1
0.425	99.4		
0.250	99.1	5 µm	72.0
0.106	98.5	2 µm	51.0
0.075	98.1		

Grain Size Analysis



%Gravel		% Silt	26.1	% NMC	33.0	Frost Heave Susc.		Material Suitability	
% Sand	1.9	% Clay	72.0	PI		Erodibility (k)		Soil Classification	

Remarks: Test Method LS 701, 702, ASTM D2216, D4318

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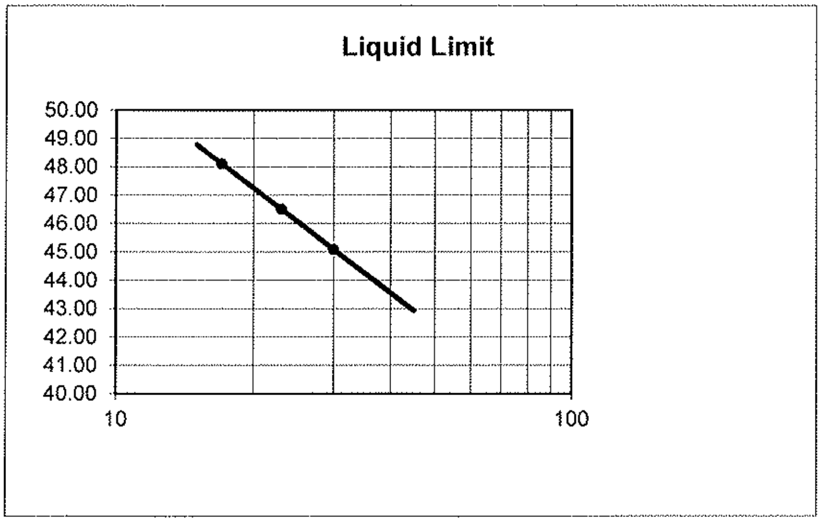
Atterberg Limits

Client:	Treasury Metals	TBTE Project No.:	14-048
Project:	Goilath Project	Lab No.:	14-954
Location:	Tailings Storage Facility	Sample Location:	BH 8 SS 4 2.25m
Reported To:	Mark Wheeler	Tested By/Date:	G.Homac / April 21, 2014
Sampled By/Date:	Craig Johnson	Reviewed By:	Forch Valela

Liquid Limit Determination

Dish No.:	37	T	15		Liquid Limit 25 Blows
Wet Soil + Dish:	37.927	35.616	35.762		
Dry Soil + Dish:	33.103	31.145	31.449		
Moisture:	4.824	4.471	4.313		
Dish:	22.406	21.531	22.486		
Dry Soil:	10.697	9.614	8.963		
% Moisture:	45.10	46.51	48.12		
No. of Blows:	30	23	17		
Liquid Limits:	46	46	46		46



Liquid Limit, %:	46
Plastic Limit, %:	22
Plasticity Index:	24

Plastic Limit Determination

					Natural Moisture
Dish No.:	4	5			T
Wet Soil + Dish:	27.331	26.161			613.8
Dry Soil + Dish:	26.073	24.904			501.3
Moisture:	1.258	1.257			112.5
Dish:	20.239	19.093			186.6
Dry Soil:	5.834	5.811			314.7
% Moisture:	21.56	21.63			35.7
Average:	22				

Test Method : ASTM: D4318, D2216

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MEMO

TO: MARK WHEELER (TREASURY METALS)
DATE: **September 15, 2014**
141-12598-00.01
FROM: **BEN PLUMRIDGE (WSP)**
SUBJECT: GOLIATH PROJECT – TAILINGS MANAGEMENT, SUMMARY SECTIONS, REV. 1

Mark,

As per your request, we have revised the summary sections for the proposed Goliath Project, Tailings Storage Facility (TSF) located in Dryden, Ontario. The summary sections were previously provided on July 9, 2014 and the revision addresses updated information for the NAG rock availability. Please review and let us know if there are revisions or additions that are required. ▲R1

Regards,

Ben Plumridge, P. Eng.
Senior Engineer – Mining

Pre-Production Phase

The Pre-Production Phase of the project for the Tailings Storage Facility (TSF) will be completed prior to commissioning the plant site and the start of processing of ore from the mining facilities. The preliminary plan for tailings management at the Goliath site will consist of establishing a starter dam to provide storage for tailings waste during the initial years of operation. This will be followed by subsequent raising of the impoundment embankments (dams) to accommodate future storage of tailings during the operations.

The Pre-Production Phase of the project will consist of construction activities to establish the starter dam for storage of tailings storage, operational and stormwater management. Contractors will mobilize plant and equipment required for the construction activities. There are existing access roads to the site that will be utilized during the mobilization and construction activities. Temporary construction roads or accesses will be established as required during the construction activities. Access roads that are no longer required once the construction activities are completed will be removed and the areas rehabilitated while other access roads, that are needed to provide access to the TSF, will be left in-place during the mining operations. The contractor will establish a laydown area for plant and equipment during the construction activities. The established laydown areas can be left in-place for subsequent construction programs for the dam raises during the operations followed by rehabilitation after the closure activities have been completed.

The proposed area for the TSF is currently undeveloped and therefore will require site preparation activities prior to embankment construction. The TSF site area will be cleared of all trees and shrubs from the site and embankment dam footprint areas. Merchantable timber can sold to local forestry operations while other non-merchantable materials can be chipped and spread at the site.

The footprint areas of the basin and embankment will be stripped and grubbed to remove all organic material and to expose the in situ foundation materials. The material from the stripping and grubbing activities will be stockpiled at the site for future closure and reclamation activities. The exposed footprint areas for the starter dam (embankment) will be inspected once exposed and areas consisting of soft, saturated or unsuitable material will be excavated and replaced with competent fill materials. The final foundation footprint areas will be proof rolled in preparation for fill placement for the embankments.

The embankment starter dam will be constructed of zoned earthfill consisting of an upstream low-permeable clay material with graded filter and transition zones while the downstream shell zone will be constructed using local borrow material. The clay zone will be keyed into the basin foundation materials to provide a seepage cut-off and thus decrease potential risk of seepage from the facility. The clay material is anticipated to be provided from borrow sources on the Goliath site (i.e. overburden stripping from the open pit mine area) and the graded filter and transition zones will be provided from gravel pits in the Dryden area. The downstream shell zone will be provided from local borrow sources or alternatively from gravel pits in the Dryden area if local fill materials are not suitable or if there is insufficient fill volumes available. Non-woven geotextile may be used between the drain and transition zones, as required, to provide sufficient support and permeability between the fill materials. The final surface of the embankment will be finished with road topping material to provide protection from traffic and also to provide protection of the clay zone. The upstream slope will be protected from wave and ice damage with layer of riprap while the downstream slope can be vegetated to prevent surface erosion damage.

The basin area of the TSF is anticipated to consist of clay materials. Areas where in situ clay is not found to be present or other higher permeable in situ materials are encountered will require treatment to minimize potential seepage from the basin area. Engineered low-permeability liner products can be placed in these areas and tied into the in situ clays or alternatively clay from borrow sources at the site can be used to provide the low permeable lining.

The starter dam will include an emergency overflow spillway to prevent water from overtopping the embankments in the event that significant storms are encountered. The alignment along the downstream toe will have collection ditches to collect seepage in the event that seepage flows occur through the dam. The collection ditches will be routed to a collection point that will have a sump and pump system that will return the seepage water to the TSF impoundment area. The starter dam will also have monitoring wells installed in the crest and downstream of the dam to monitor the phreatic surface within the dam and to collect samples for water quality monitoring.

Operations Phase

The TSF starter dam will be completed by the end of the Pre-Production Phase and will be used for tailings solids storage as well as storage of operational and stormwater as part of site water management during the operations phase. Tailings solids will be routed to the TSF from the plant site via a high density polyethylene (HDPE) pipeline. A HDPE tailings delivery pipeline will be used to deliver the tailings to the TSF and a tailings distribution pipeline will be used to deposit tailings solids into the facility. The tailings distribution pipeline will be aligned on the embankment crest and will be equipped with spigot off-takes. A low height berm will be established on the crest and behind the pipeline to prevent tailings solids from being discharged to the environment in the event of a spill or line break. Deposition of tailings solids from the crest will be by spigotting. A series of spigots will be open to allow for uniform deposition into the facility. The deposition area will subsequently be moved around the full perimeter of the TSF by systematically closing one (1) spigot and opening another spigot at the far end of the spigot series. This type of deposition will provide for deposition of tailings solids in controlled lifts to provide optimize potential in situ density and maximum utilization of the storage available.

Water management for the TSF will address need for both operational and stormwater management. The tailings solids have been classified as potentially acid generating and therefore a water cover has been planned to cover the tailings during the operating period. Maintaining a cover of water over the tailings solids beach will restrict contact with the atmosphere and reduce the potential for the tailings to generate acid. Other operational water management requirements at the TSF will consist ensuring that there is sufficient reclaim water available to be directed to the ore processing facility as well as removal of excess or surplus water to the final effluent point. Reclaim water will be returned to processing plant by pumping from either a floating barge or stationary system via an HDPE pipeline to the processing plant.

Raising of the TSF perimeter embankments will also need to occur during the operational phase of the project and will require a construction program that will be similar to the Pre-Production Phase. The number of construction programs that will be required to raise the dams during the Operational Phase of the project will be dependent on the anticipated life of mine as well as the ore processing rate during the operations. Raising of the TSF perimeter embankments will utilize an embankment method that is stable (i.e. downstream, center-line, modified center-line) and that will provide the required storage capacity for tailings solids, along with operational and stormwater volumes. The road topping material on the dam will be removed to expose the existing clay zone in order for the new raise material to tie-in to the fill material (clay) for the embankment raise. The low permeable upstream clay zone and internal drains and transition zones will be extended to the required heights for each embankment raise. Preliminary assumption have been assigned for the downstream shell zone for the embankment raises during the operation phase that consisted of utilizing mine waste rock provided from the mining operations. This assumption is dependent on the availability of the mine waste rock consist of ▲R1
non-acid generating (NAG) material the ability to sort and remove the potential acid generating (PAG) mine waste rock at the source. The Alternative Assessment for the location of the TSF was completed utilizing the assumption that NAG mine waste rock would be available in the operations phase of the project. Other construction fill materials will be considered if insufficient NAG rock for use in construction is identified as the project is advanced and additional information becomes available. Other fill materials will consist of local borrow materials at the Goliath site as well as fill materials supplied from local gravel pits in the Dryden area. The design of the dam, consisting of footprint layout, downstream slope and filter grading, will reflect the type of material available and used in the dams downstream shell zone to ensure that the dam has acceptable stability factors of safety. Erosion protection measures for the downstream slopes will be designed based on the material type that is utilized for the downstream shell zone of the dam structure.

Each raise of the TSF embankment will require decommissioning of the existing emergency overflow spillway and subsequent construction of a new spillway. Existing monitoring wells would also require extending and the downstream seepage collection ditches would require re-establishing to accommodate the new embankment toe alignment with each embankment raise.

Monitoring of the dam structure and the water management will be completed during the Operational Phase of the project. Monitoring of the dam will consist of daily inspections and recording of findings by TM staff. This will consist of a visual inspection of the dam, water levels and tailings placement operations consisting tailings deposition rate and location. Treasury Metals staff will complete more detailed inspections on a monthly basis that will consist of a visual inspection and preparation of condition rating of the dam and its components. A photo record will also be completed as part of the monthly inspections. A Dam Safety Inspection will be completed on an annual basis by a qualified engineer and a full Dam Safety Review will also be completed at the required interval as defined by the Hazard Potential Classification in accordance with the Canadian Dam Safety Guidelines and the Ministry of Natural Resources Best Management Practices. Monitoring activities at the dam will also include recoding water levels in the monitoring wells as well as collection of water samples for laboratory analysis.

Tailings deposition and water management will continue until mining activities are completed. After the mining activities are completed, the TSF will enter the Closure and Reclamation Phase of the project.

Closure and Reclamation Phase

The closure phase of the project for the TSF will be initiated once the mining activities and ore processing have been completed. Closure and reclamation of the TSF will consist of capping the final tailings beach surface and reclamation of the facility. Standing water that is present at the end of the operations will be removed and the final tailings beach surface regraded, as required to ensure it is totally free draining. Grading of the final tailings beach surface will be completed in conjunction with placement of a pioneer or base/stabilization layer over the tailings surface for access. A low permeable layer of clay will then be placed over the pioneer layer. The clay layer can be tied into the embankment upstream clay zone to provide complete encapsulation of the tailings surface. A granular shedding layer will be placed over the clay layer to allow runoff the shed from the surface. A layer of topsoil, stockpiled from the site preparation activities, will then be placed over the granular and the final surface will be vegetated. The downstream slopes of the embankments will also be regraded and covered with topsoil and revegetated.

The water reclaim pump, reclaim pipeline and tailings delivery and distribution pipelines will be decommissioned and removed from the site. The emergency overflow spillway will be decommissioned. The monitoring wells present in the crest of the dam can remain in-place as well as the monitoring wells located on the downstream area of the dam for use during the closure monitoring phase. Access roads that are no longer required will be scarified and revegetated.

Monitoring of the closed facility will be completed and will consist of annual Dam Safety Inspections of the closed facility as well as Dam Safety Reviews at the required timeline interval, as discussed above for the Operations Phase.