StrataGold Corporation

EAGLE GOLD PROJECT

DESIGN REPORT FOR THE WASTE ROCK STORAGE AREAS

2019-01

JANUARY 2019

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1 INTRODUCTION

The Eagle Gold project includes two Waste Rock Storage Areas (WRSAs); one located in the Eagle Pup drainage and the other in the Platinum Gulch drainage. This report summarizes the geotechnical assessments and provides the designs for both the Eagle Pup and Platinum Gulch WRSAs.

Initial geotechnical engineering studies related to the current locations of the WRSAs were described in Knight Piesold's (1996) *Report on Feasibility Design of the Mine Waste Rock Storage Area*, Sitka's (1996) *Field Investigation Data Report, Dublin Gulch Project*, and Scott Wilson RPA's (2010) *Pre-feasibility Study on the Eagle Gold Project, Yukon Territory, Canada*.

Engineering design work performed on the WRSAs at that time was completed to an extent considered to be feasibility level (Knight Piesold, 1996); however, changes in property ownership, mineral resource updates, optimized mine plans, and changes to resource/reserve reporting requirements resulted in the preparation of the 2012 *Eagle Gold Feasibility Study* (Tetra Tech 2012).

This work was supported by several geotechnical site investigations conducted by BGC Engineering Inc. (BGC) in 2009, 2010, 2011, and 2012 (BGC 2010; 2011a, b; and 2012b, c) in support of pre-feasibility and feasibility studies. The previous site investigations were comprehensive and included numerous geotechnical drill holes, test pits, and subsequent laboratory testing programs. Based on a detailed review of previous investigations, it was determined that additional information was necessary to confirm the characteristics and extent of permafrost (including frozen materials with excess ice) within the WRSA and to complete the final issued for construction design of the WRSAs. As part of finalizing the mine plan and while also considering Water Use License QZ041-14 condition #40;

> *The Licensee shall characterize the foundation soils at all interim and final toes of waste rock benches proposed for the site. The characterization shall be sufficient to identify the presence of Ice-Rich Soil and the ability of foundation soils (when thawed) to resist liquefaction under the design seismic loading*

the following additional work was conducted:

- Detailed permafrost distribution mapping (including the identification of ice poor and ice-rich areas) of the Eagle Gold project area, including specifically the Eagle Pup and Platinum Gulch WRSA footprints (Tetra Tech/NELPCO 2017, Appendix 1)
- A spring geotechnical investigation designed specifically to augment the previous investigations by characterizing permafrost conditions in foundation areas critical to physical stability of the facilities (Tetra Tech/NELPCO 2018a, Appendix 2).

2 PROJECT SITE CHARACTERIZATION

2.1 CLIMATE

The project area is located within the Mayo Lake-Ross River Eco-region with the St. Elias mountain range to the west being the most dominant physical feature in the region affecting the climate (Stantec, 2010). The St. Elias range tends to block moist maritime air masses resulting in reduced air temperatures and precipitation. As a result, the project area is characterized as having a sub-Arctic “continental” type climate with moderate total annual precipitation and extreme temperature variations (Stantec, 2010).

Air temperatures at the Project site are consistent with those throughout the Yukon interior. Mean annual air temperature at site is -3.0°C at the Camp station (782 masl) (since 2009) and -3.8°C at the Potato Hills station (1420 masl) (since 2007). At the Camp station, monthly average temperature ranges from -20.4°C in December to 13.2°C in July, and -15.2°C to 10.8°C at the Potato Hills station, for the same months. The minimum (maximum) recorded 15-minute temperatures were -46.4°C (31.6°C) and -37.6°C (31.7°C) at the Camp and Potato Hills stations, respectively (Lorax 2018).

Average annual precipitation over the property ranges from 375 mm at the Camp Station to 582 mm at the Potato Hills Station, with July typically being the wettest month and representing 14% to 16% of the mean annual precipitation (Lorax 2017). Approximately half of the precipitation falls as snow, with a greater rain proportion lower in elevation - 57% at Camp Station (782 masl) compared to 47% rainfall at the Potato Hills Station (1420 masl) (Lorax 2017).

2.2 PHYSIOGRAPHY

The Project is situated within the Stewart Plateau which is a physiographic subdivision of the Yukon Plateau of the Yukon Plateau North Ecoregion. This area is characterized by broad, rolling hills of moderate relief, ranging in elevation from 700 masl to up to 1,700 masl. The upland areas generally coincide with resistant rock types such as local felsic intrusions. Major drainages in the area include Haggart Creek and Lynx Creek which eventually drain into the McQuesten River. In its lower reaches Haggart Creek is an extension of Lynx Creek and occupies a very large, broad, U-shaped glacial valley. In its upper reaches Haggart Creek is a much narrower U-shaped glacial valley indicating that it has been less extensively glaciated.

The majority of the Project site lies within the Dublin Gulch watershed which is a small tributary to Haggart Creek. Elevations in the vicinity of the Project range from approximately 730 masl near the confluence of 15 Pup and Haggart Creek, to about 1,525 masl at the summit of the Potato Hills, which forms the eastern boundary of the Dublin Gulch watershed.

The majority of the Project area was un-glaciated during the last glacial period (Bostock 1965), and has not been glaciated for more than 200,000 years. Much of the Project area displays physiographic characteristics of the unglaciated areas of the region, with narrow, V-shaped valleys and rounded upland surfaces. The valleys are deep and narrow to the head of streams, where they rise steeply and end abruptly (i.e., Cascallen, Bawn Boy), while in others (i.e., Stewart, Eagle Pup) evidence of glacial–ice action is still visible despite the extensive time since glaciations, Within these gulches the post-glacial terrain has been modified by gravity, water, and freeze-thaw mechanics, as evidenced by headscarps of ancient and inactive landslides, and observed rock and debris slides. While most of the mass wasting is pre-historic, there are a few areas of ongoing rock fall that continue to modify the terrain, particularly in the Stewart, Bawn Boy, and Olive Gulches. These active areas of rock fall exist generally in the eastern portion of the Dublin Gulch watershed.

Tributaries to Dublin Gulch include the Eagle Pup and Platinum Gulch drainages, which are proposed for placement of the WRSA's. The Eagle Pup drainage is a relatively broad drainage, while the Platinum Gulch drainage is more V-shaped. Both have very steep headwaters that become less steep in the mid valley areas.

2.3 PERMAFROST

Based on permafrost distribution maps (Brown, 1978, Heginbottom et al 1995), the Project area lies within a zone of discontinuous permafrost. On the regional scale permafrost distribution is typically controlled by mean annual temperature and precipitation, whereas on a local scale it is secondarily controlled by vegetation, surface sediments, soil moisture, slope aspect, and snow depth. Within the project area permafrost is typically found on north- and east-facing slopes, highlands, and poorly drained valley bottoms. Coarse-grained, free draining soils are typically ice-free, whereas fine-grained deposits are more likely to contain ice. When encountered the permafrost at the site is generally relatively warm with an average temperature close to 0°C. Ground temperatures have been measured with thermistors installed on site in 1995-1996, and 2009-2018. The measured ground temperatures showed the frozen ground to be relatively warm when observed, typically between 0°C and -1°C.

2.4 HYDROLOGY

The Project area is primarily located within the Dublin Gulch catchment, a small tributary to Haggart Creek, which flows into the South McQuesten River about 23 km from the project site. Other small drainages in the project footprint include Ann Gulch, Stewart Gulch, Eagle Pup, Suttles Gulch, and Platinum Gulch all of which are direct tributaries to either Dublin Gulch or Haggart Creek.

The hydrology of the region is characterized by a dominant snowmelt driven freshet signature, which typically occurs between early May and early June. The recession limb of the freshet tapers to a lower summer low-flow regime reflective of primarily groundwater, which is punctuated by periodic rainfall driven runoff events, typically one to four days in duration. Base flows are lowest in the winter and flow sub-ice in Haggart Creek and Dublin Gulch; in the smaller creeks, such as Platinum Gulch and Eagle Pup, groundwater is depleted and there is no flow under the ice (Lorax 2017).

2.5 GEOLOGIC SETTING

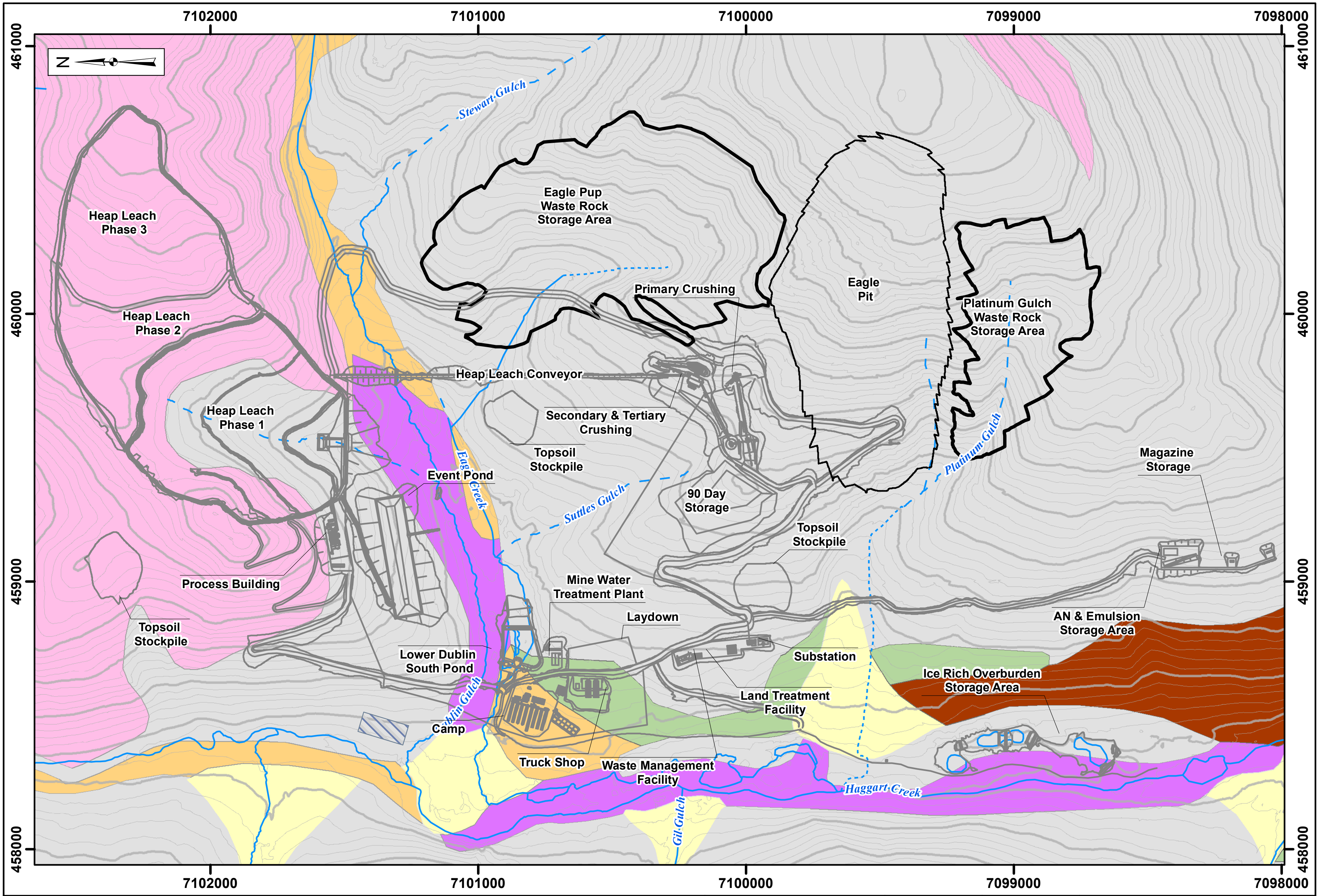
2.5.1 Surficial Geology

The surficial geology of the project area has been mapped by Bond (1998) and is illustrated in Figure 2.5-1. Pleistocene and Holocene colluvial deposits are abundant in the project area and generally consist of diamicton, gravel, shattered bedrock, and lenses of sand and silt derived from chemical and physical weathering of bedrock and surficial materials. Transport of surface material occurs as creep, sheetwash, and mass wasting and is common on all slopes in the area.

Glacial till is infrequently observed in the project area (Bond, 1998). Where till does occur, it is generally either a silty or sandy clay matrix with clasts up to cobble size, although boulders and larger glacial erratics do occur in large concentrations in the area (mostly in the valley bottoms), indicating more extensive glacial extent than can be discerned from the distribution of glacial till. The valley bottoms are dominated by alluvium and placer mining tailings. The north facing uplands are covered by an apron or blanket of colluvium over bedrock, as compared with the southern facing uplands, where bedrock is nearer to surface and covered by a veneer of colluvium. The Haggart Creek valley to the west of the project site is filled with a mix of alluvial deposits and placer tailings. A till blanket has been mapped along the east side of Haggart Creek, south of its confluence with Dublin Gulch.

2.5.2 Bedrock Geology

The project area is underlain by Proterozoic to Lower Cambrian metasediments of the Hyland Group which have been intruded by Cretaceous age stocks, dykes, and sills (JDS 2016). The metasediments are comprised of intercalated quartzites, phyllites, and minor limestones. The quartzites are variably gritty, micaceous, and massive and the phyllites are comprised of muscovite-sericite and chlorite (JDS 2016). The metasediments have been deformed by a regional Cretaceous thrusting event that resulted in the formation of moderate to strong foliation. Subsequent folding has resulted in the foliation generally dipping moderately northwest to southwest throughout the project area. Following the regional deformation the country rocks were intruded by Cretaceous age stocks, dykes, and sills ranging in composition from quartz monzonite to quartz diorite (JDS 2016). The Dublin Gulch granodiorite stock is the largest of these intrusions throughout the project site and trends approximately 070° coincident with the axis of the Dublin Gulch anticline (JDS 2016).



Legend:

Waste Rock Storage Area Footprint

Open Pit Footprint

Contour (50m)

Contour (10m)

Perennial

Ephemeral

Intermittent

Bond 1998 Surficial Geology

- Alluvial Fan
- Other Alluvial Deposits
- Colluvium Apron or Blanket
- Glaciofluvial Terrace
- Placer Tailings
- Bedrock with Colluvium Veneer
- Till Blanket

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0 125 250 500

Metres

Projection:

NAD 83 UTM Zone 8N

Drawn By:

JK

Date:

2019/01/22

Figure:

2.5-1

EAGLE GOLD PROJECT YUKON TERRITORY

Site Surficial Geology

3 SITE GEOTECHNICAL INVESTIGATIONS IN SUPPORT OF DESIGN

3.1 1995 - 1996 KNIGHT PIESOLD

Previous geotechnical site investigations were carried out at the Eagle Gold property in 1995 and 1996 by Knight Piesold and Sitka Corp. The investigations included evaluation of the surficial materials and bedrock conditions at four potential heap leach pad locations, two potential waste rock storage areas, the open pit and at potential sources for borrow material.

3.1.1 Test Pits

As part of the geotechnical investigations, 63 test pits were excavated in 1995 and another 233 were excavated in 1996. Of these, 51 were located within the footprint of the Eagle Pup waste rock storage area (EP WRSA) and 11 were within the Platinum Gulch waste rock storage area (PG WRSA) footprint.

3.1.2 Boreholes

Eleven diamond drill holes were completed in 1995 to determine the near-surface conditions of potential heap leach facility locations. Then in 1996 there were five diamond drill holes completed as part of an open pit slope stability program and another 33 shallow diamond drill holes completed to further characterize near-surface conditions across the site. Of the total diamond drill holes drilled over the two year period, eight were located within the footprint of the EP WRSA and five were located within the PG WRSA footprint.

In addition to the diamond drill holes, there were also 19 auger holes drilled on the property in 1996. The holes were drilled in anticipation of locating a potential borrow source material and were not within the footprints of either WRSA.

3.1.3 Piezometers

Three of the six monitoring wells installed in the EP WRSA footprint in 1996 were completed as piezometers with depths of up to 30.2 meters.

3.1.4 Thermistors

A total of 10 thermistors were installed during the geotechnical investigations between 1995 and 1996. Two of the thermistors were installed within the PG WRSA and three were installed within the EP WRSA.

3.1.5 Monitoring Wells

In 1996 six monitoring wells were installed within the EP WRSA footprint and three were installed within the PG WRSA footprint. The EP monitoring wells ranged from 3.4 meters deep to 38.1 meters deep and targeted the overburden, metasediments and granodiorite. All three of the PG monitoring wells were 9.2 meters deep and set in overburden and talus.

3.1.6 Laboratory Testing

During Knight Piesold's 1995 geotechnical investigation 36 soil samples were collected from excavated test pits. The test pits were located in potential Heap Leach areas and were not within the footprint of either WRSA.

These samples were tested in a laboratory for Natural Moisture Content, Atterberg Limits, Particle Size Distribution and Specific Gravity. Furthermore, of the total samples, nine were selected for additional Modified Proctor Compaction tests and Permeability tests (Falling Head Permeability Method).

During the 1996 investigation Sitka collected 108 samples from test pits and drillholes, some of which were located within the EP WRSA but none were within the footprint of the PG WRSA. Of these total samples; 38 samples had Atterberg Limits defined, 93 underwent particle size analysis, 8 samples were subject to direct shear testing, 10 were tested for moisture-density relationship, 4 samples underwent one-dimensional consolidation testing, 7 had permeability tests conducted and one was analyzed for organic content.

3.2 2009 - 2012 BGC

Geotechnical site investigations were carried out in the Project area by BGC in 2009, 2010, 2011 and 2012. During the four field programs data was collected throughout the site to evaluate and characterize the near-surface materials and shallow bedrock conditions. The investigations were conducted in support of a Feasibility Study and addressed site conditions at proposed heap leach pads, WRSA's, crushers, conveyors, plant site buildings and other miscellaneous mine infrastructure sites. Deeper bedrock conditions were also evaluated by BGC during the 2009, 2010 and 2011 in Eagle open pit area to serve as the basis for the BGC (2012b) pit slope stability assessment.

3.2.1 Test Pits

There were 254 test pits excavated between 2009 and 2012, of these 31 were located within the footprint of the EP WRSA and seven were within the footprint of the PG WRSA. The programs were conducted to investigate the type and distribution of surficial materials and to investigate near-surface foundation conditions. Potential borrow source areas within the project site were also investigated as part of the programs.

3.2.2 Boreholes

There were 58 diamond drill holes and 35 auger drill holes drilled as part of the geotechnical investigations between 2009 and 2012. Ten of the diamond drillholes were drilled within the footprint of the EP WRSA and four were within the footprint of the PG WRSA. None of the auger holes were within the footprints of the WRSA's.

The auger boreholes ranged from 2.7 meters deep to 31.1 meters deep and generally continued until either the limits of the drill rig were met or until drilling refusal. The purpose of the auger drill holes was wide-ranging and included logging and sampling of near-surface unconsolidated material, Standard Penetration Test (SPT) testing and installation of monitoring wells, piezometers, thermistors and casing for geophysical surveying.

The 58 diamond drill holes drilled ranged in depth from 15.1 meters deep to 50.7 meters deep. The purpose of the diamond drill holes included rock logging and sampling, point load testing and installation of monitoring wells, piezometers, thermistors and casing for geophysical surveying. The diamond drill holes provided data and information at depths not capable with auger drilling, but typically did not provide the recovery of near-surface materials that the auger drilling provided.

3.2.3 Piezometers

During 2011 and 2012 a total of 30 PVC standpipe piezometers were installed in both auger and diamond drill holes. The purpose of these standpipe piezometers was to enable observations of groundwater elevations and also to support estimates of the hydraulic conductivity of formation materials through slug testing. Two of the standpipe piezometers were located within the PG WRSA footprint, none were located within the EP WRSA footprint.

In 2011 two vibrating wire piezometers were installed; one in an auger hole at the proposed Eagle Pup WRSA and the other in an inclined diamond drill hole at the proposed plant site.

Data from the various piezometers and monitoring wells was subsequently used for numerical hydrogeological modeling carried out by BGC and most recently summarized in BGC (2014).

3.2.4 Thermistors

A total of 13 thermistor strings were installed between 2009 and 2012, of these two were installed within the EP WRSA footprint and none were installed within the PG WRSA footprint. The purpose of the thermistors was to obtain ground temperature profiles and information on potential permafrost conditions. Ten of the thermistors were 10 meter long, single point thermistors and three were 25 meter, multi-point thermistors. In most cases the thermistors were installed in areas of suspected permafrost conditions but at least one was installed in an area not expected to have frozen ground as a check of field temperature observations.

3.2.5 Monitoring Wells

A total of 14 monitoring wells were installed during the 2009 field program and another two during the 2010 field program. Of the 14 originally installed two each were within the EP and PG WRSA footprints. The installations were completed in cooperation with Stantec, who was completing a separate hydrogeological investigation at the time.

3.2.6 Laboratory Testing

Significant laboratory testing took place between 2009 and 2012 as part of the BGC geotechnical investigations. The types of laboratory work completed included soils testing, rock strength testing and borrow source testing. The soils testing programs included the following analyses: Grain Size (Sieve and Hydrometer), Moisture Content, Atterberg Limits, Specific Gravity, Soluble Sulphate, Modified Proctor and Permeability analyses. Rock strength testing included uniaxial compressive strength, Brazilian tensile strength, point load strength and direct shear testing. The borrow source material lab testing was tailored to aid in the characterization of the materials, according to the requirements of each potential borrow source.

Two labs were engaged: Golder Associates from Burnaby, BC, which conducted some of the soil index testing and all of the rock strength testing, and GeoNorth, from Prince George, BC, which conducted some of the soil index testing, compaction testing, permeability testing, and aggregate testing.

3.3 2018 TETRA TECH

The spring 2018 geotechnical investigation (Tetra Tech/NELPCO 2018a) was designed specifically to augment the previous investigations by characterizing permafrost conditions in foundation areas at interim and final toes, and critical to physical stability of the WRSA and stockpile facilities. The investigation consisted of coring and testing of frozen and unfrozen overburden soils to identify the presence of ice-rich material, and to characterize thawed foundation soils to resist liquefaction under the design seismic load.

3.3.1 Boreholes

Thirteen boreholes were drilled using a sonic drill rig. A sonic drill was selected for the program due to its ability to recover overburden and other unconsolidated materials. Sonic drilling was not particularly effective in coring bedrock but the primary focus of the program was soil and permafrost sampling above bedrock.

Six of the boreholes were drilled within the EP WRSA footprint and four were drilled within the Platinum Gulch WRSA footprint. The six EP WRSA boreholes had an average depth to bedrock of 4.7 m and an average completion depth of 15.4 m. The four PG WRSA boreholes had an average depth to bedrock of 9.5 m and an average completion depth of 15.6 m.

Overburden soil recovery ranged from 90% to 100%, but in some cases, core was thermally and/or mechanically disturbed from the drilling process. Holes were typically only drilled far enough into bedrock to confirm that competent bedrock had been reached. The 13 boreholes ranged in depth from 5.5 m to 21.3 m bgs.

Frozen and unfrozen overburden soil and bedrock core examination and logging was conducted immediately following core recovery to ensure that there was minimal thermal disturbance to the frozen core samples. This allowed accurate identification, logging, and sampling of frozen and unfrozen overburden core.

3.3.2 Thermistors

A total of six multi-bead ground temperature (thermistor) cables (GTCs) and seven single-bead thermistor strings were installed in the completed boreholes. GTCs were installed at 15 m to 20 m depths in GT18-01, GT18-05, GT18-07, GT18-08, GT18-09, and GT18-15. Single-bead thermistor strings were installed at 8 m to 9 m depths in GT18-02, GT18-04, GT18-06, GT18-10, GT18-11, GT18-16 and GT18-17. Within the EP WRSA footprint there were three GTCs installed and three single-bread thermistors installed. Within the PG WRSA footprint there were two GTCs installed and two single-bead thermistors installed.

3.3.3 Laboratory Testing

Eight samples were tested for excess ice content at the onsite laboratory located in the camp facility. These samples were selected because they showed potential for the presence of excess ice. Five of the eight samples selected were also tested on-site for moisture content and one sample was tested on site for salinity analysis.

The remainder of the samples were shipped to Whitehorse and Edmonton for testing and storage at Tetra Tech’s geotechnical laboratories. The off-site testing included natural moisture and excess ice contents, grain size analysis, bulk densities, and direct shear tests. Moisture content testing was completed on 32 samples, hydrometer (particle size) analyses were completed on 12 samples, bulk density analysis was performed on four samples, wash sieve analysis was completed on 13 samples and direct shear was completed on four samples.

4 WASTE ROCK FOUNDATIONS

The PG WRSA will be located to the south of the proposed Eagle pit, within the Platinum Gulch watershed and the EP WRSA will be located to the north and northeast of the proposed Eagle pit, within the Eagle Pup watershed.

4.1 OVERBURDEN

4.1.1 Organics

A thin organic cover is widespread across the project site overlying the other overburden units. The cover primarily consists of vegetative root mat, moss, silt and sand, and other organic matter in varying proportions. The organic layer in the area of the EP WRSA consists mainly of dark brown to black fibrous peat up to 0.3 m thick. The organic layer in the area of the PG WRSA consists of dark red to brown to black fibrous peat up to 0.3 m thick.

4.1.2 Colluvium Soils

A layer of transported soils beneath the organics and above bedrock exists across most of the site. The soils formed by slope wash are referred to as colluvium. Across the Eagle site, colluvium depth is typically shallowest along ridge tops and upper valleys and deepest towards lower elevations and valley bottoms.

The depth of the colluvium soils within the WRSA footprint typically ranges from 1 to 10 m in depth and consist of poorly to well-graded silt, sand and gravel mixtures with cobbles disseminated throughout. Colluvium soils within the WRSA footprints are typically permafrost free or ice-poor permafrost with ice-rich soils[1] occurring locally in drainage bottoms. The ice-rich soils are typically shallow, within approximately 3 m from the ground surface.

Based on the Tetra Tech/NELPCO (2018a) geotechnical investigation, permafrost mapping program (Tetra Tech/NELPCO 2017), and previous investigations by BGC (2010, 2011a, 2012a and 2012c) the highest potential for ice-rich materials within the WRSA footprints is along the Platinum Gulch drainage bottom as well as some of the drainage bottoms in the upper Eagle Pup valley. Additional information regarding ice-rich colluvium is contained in Section 5.4.1.3 Ice-Rich Colluvium.

4.2 BEDROCK

Two major rock types have been encountered below the overburden soils within and adjacent to the footprints of the WRSA's: metasediments and intrusives. The metasedimentary bedrock typically consists of phyllite, fine-grained schist, hornfels and bedded quartzite. The intrusive rock is typically fresh, altered and/or oxidized granodiorite. With the exception of a small portion of the upper EP WRSA valley, the WRSAs will be founded primarily on metasedimentary bedrock.

4.2.1 Weathered Bedrock

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[1] Ice-poor permafrost: perennially frozen ground – predominantly ice-poor with ground ice content generally less than 10% by volume of visible ice or not visible ground ice (Tetra Tech/NELPCO 2017)

Beneath the colluvium, a horizon of variably weathered bedrock typically exists before competent (or fresh) bedrock is reached. The depth and intensity of bedrock weathering is gradational and varies substantially across the site depending on parent rock type, elevation and other factors.

The metasedimentary rock nearest the ground surface is often completely weathered to silt with trace gravel or to sand and gravel with cobbles and some fines. The gravel and cobble clasts tend to be friable, platy and may exhibit a 'soapy' film due to weathering.

The near-surface, weathered intrusive rock was often observed to be either completely weathered to silty sand, or sandy silt, or highly weathered to a poorly graded sand. This typically grades somewhat imperceptibly to moderately weathered and then to fresh bedrock within 5 to 10 meters. Bedrock weathering and fracturing appears to be deeper within the open pit area due to a high number of structural intersections.

4.2.2 Fresh Bedrock

The transition from weathered bedrock to a more competent bedrock is highly variable across the site. Competent 'fresh' rock is generally not observed in test pits, and is usually not observed in shallow borehole depths. When reached, fresh bedrock is typically strong and significantly less fractured than the weathered bedrock above but is still considered a well jointed rock mass with individual blocks commonly formed between various discontinuities.

4.3 PERMAFROST

Frozen ground occurs throughout the footprints both the Eagle Pup and Platinum Gulch WRSAs, with more than half the data points (or observations) reporting frozen conditions (BGC 2012d). The frozen ground frequently contained excess ice. Detailed permafrost distribution mapping was carried by Tetra Tech/NELPCO (2017) to better understand the distribution of frozen ground with varying proportions of excess ice. The mapping was based on:

- the detailed geotechnical (i.e., borehole, test pit and thermistor) database collected in 2009, 2010, 2011 and 2012 by BGC and in 2018 by Tetra Tech/NELPCO,
- geobotanical indicators (stunted black spruce stands on shallow permafrost vs. deciduous (dominantly aspen) stands within predominantly permafrost-free terrain), slope aspect (north-facing vs. south-facing slopes), and extrapolated surface appearance (texture, colour, hue, etc.), and,
- field calibration comparing mapping units where permafrost conditions were identified including confirmations with the borehole database (including thermistors), and the field and laboratory test data.

Mapping units were subdivided using the following criteria: ice poor (ground ice content generally less than 10% by volume of visible ice or not visible ground ice) to ice-rich (ground ice content generally ranging between 10% and 50% by volume of visible ice) to very ice-rich (ground ice content locally exceeding 50% by volume of visible ice) to predominantly permafrost free (although may include small patches of ice-poor or ice-rich permafrost).

The results (Figure 2 in Appendix 2) indicate that the footprint of the EP WRSA is largely underlain by permafrost free terrain, with ice-poor permafrost along the valley walls. Small isolated zones of ice-rich permafrost occur predominantly in zones within the upper southern portion of the footprint. The footprint of the PG WRSA is largely underlain by ice-poor permafrost, with thin bands of ice-rich material or zones of permafrost free conditions.

4.4 GROUNDWATER AND PHREATIC CONDITION

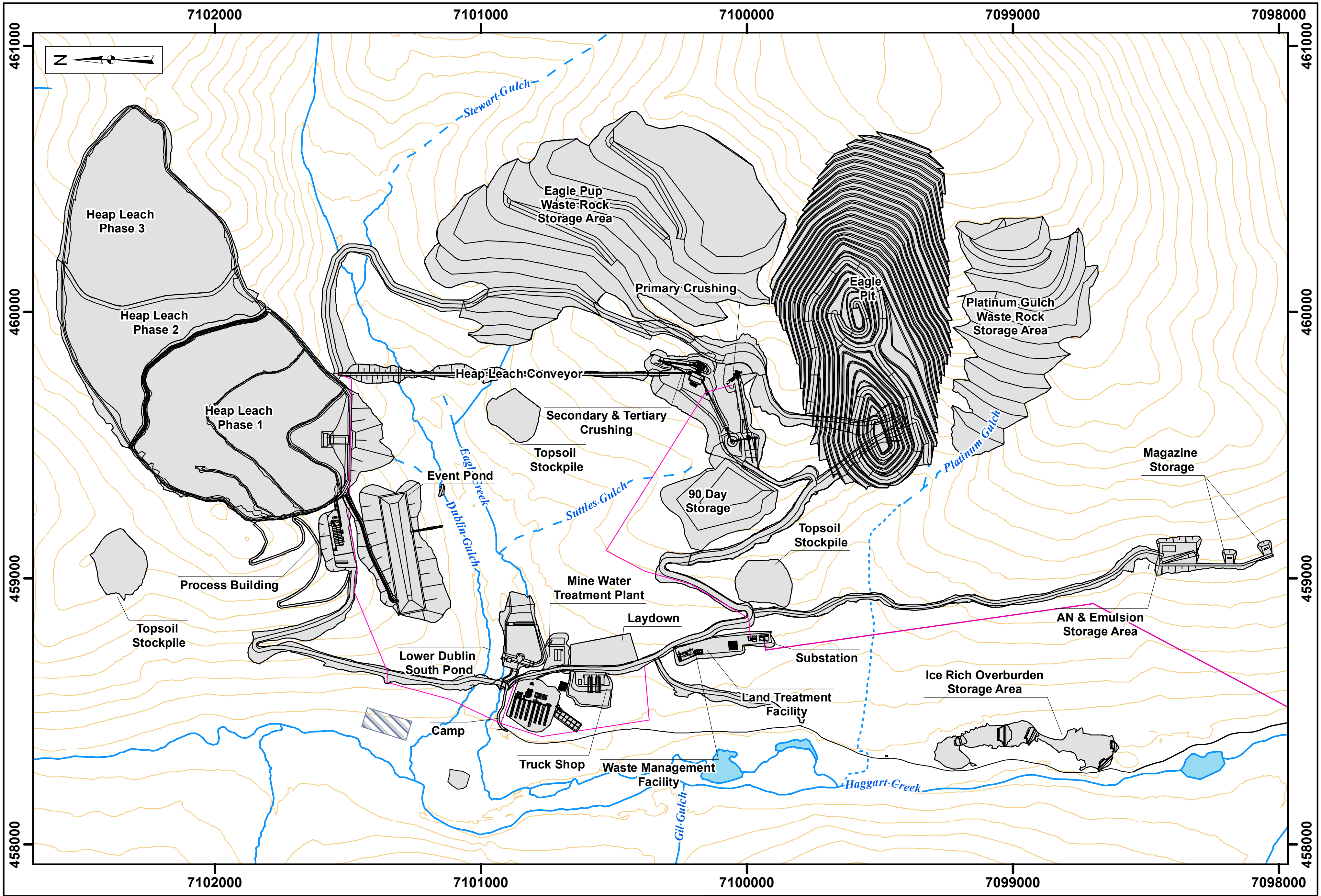
Generally groundwater has been observed deeper (>10 m below ground surface (bgs)) at higher elevations and shallow (<3 m bgs) in lower elevations and in valley bottoms of both the Eagle Pup and Platinum drainages. Springs and seeps have been observed in a few locations where valley bottoms have narrowed. These are typically associated with the re-emergence of a stream from channel deposits (i.e., a gaining reach), as is the case with one seep in Eagle Pup. In this case, thin alluvium overlies shallow bedrock which likely forces the water to the surface and causes the emergence. Lower Eagle Pup is a perennial stream with very minor flow still detectable sub-ice in the winter. Platinum Gulch is an intermittent to ephemeral drainage, with very little groundwater input. This suggests the groundwater table may be somewhat deeper below the surface in Platinum Gulch than in Eagle Pup.

Based on monitoring well data and other borehole data, the interpreted piezometric surfaces in both valleys appear to generally mimic the surface topography. Groundwater level data collected since 2009 exhibit common seasonal trends in all monitored locations, characterized by relatively high water levels corresponding to spring freshet and fall precipitation events, and relatively low water levels related to dry summer and frozen winter conditions.

5 WASTE ROCK STORAGE AREA DESIGN

5.1 GENERAL ARRANGEMENTS AND MINE SEQUENCING

The Eagle Gold project requires two WRSAs to accommodate the volume of waste rock expected to be generated from mining the open pit. The Eagle Pup and Platinum Gulch WRSAs will be located to the north/northeast and south of the proposed open pit, respectively (Figure 5.1-1). The layout and sequencing of the WRSAs was initially developed by Tetra Tech Wardrop in conjunction with preliminary recommendations provided by BGC. Since then, adjustments to the WRSA geometries and dump sequencing have been made by Victoria Gold (Appendix 4) to optimize the mine plan and to increase offset distance from the toe of the Eagle Pup Waste dump to the main conveyor line.



Legend:

Facility

Site Power

▨ Reserved Area

Perennial

Ephemeral

Intermittent

Waterbody

Contour (25m)

StrataGold Corporation

0 125 250 500

Metres

Projection:

NAD 83 UTM
Zone 8N

Drawn By:

JK

Date:

2019/01/24

Figure:

5.1-1

EAGLE GOLD PROJECT
YUKON TERRITORY

Site General Arrangement

5.1.1 Platinum Gulch Waste Rock Storage Area

The PG WRSA will be developed early in the mine life from Year 0 to Year 3 as a valley fill using haul trucks. At its ultimate configuration the PG WRSA will cover an area of approximately 38 ha and will contain approximately 23.6 million tonnes of waste rock and overburden. It will be constructed in 45 m lift heights from an elevation of approximately 1,027 m asl to 1,298 m asl, resulting in an overall height of approximately 368 m. At the end of its construction the waste rock pile surface will have an overall slope of approximately 2.4H:1V. The Platinum Gulch drainage is moderately steep with the valley bottom sloping at approximately 21° in the WRSA footprint. As a result, the WRSA will only attain a maximum vertical thickness of approximately 50 m. The ultimate configuration of the WRSA is provided in plan in Figure 5.1-2 and in cross-section in Figure 5.1-3.

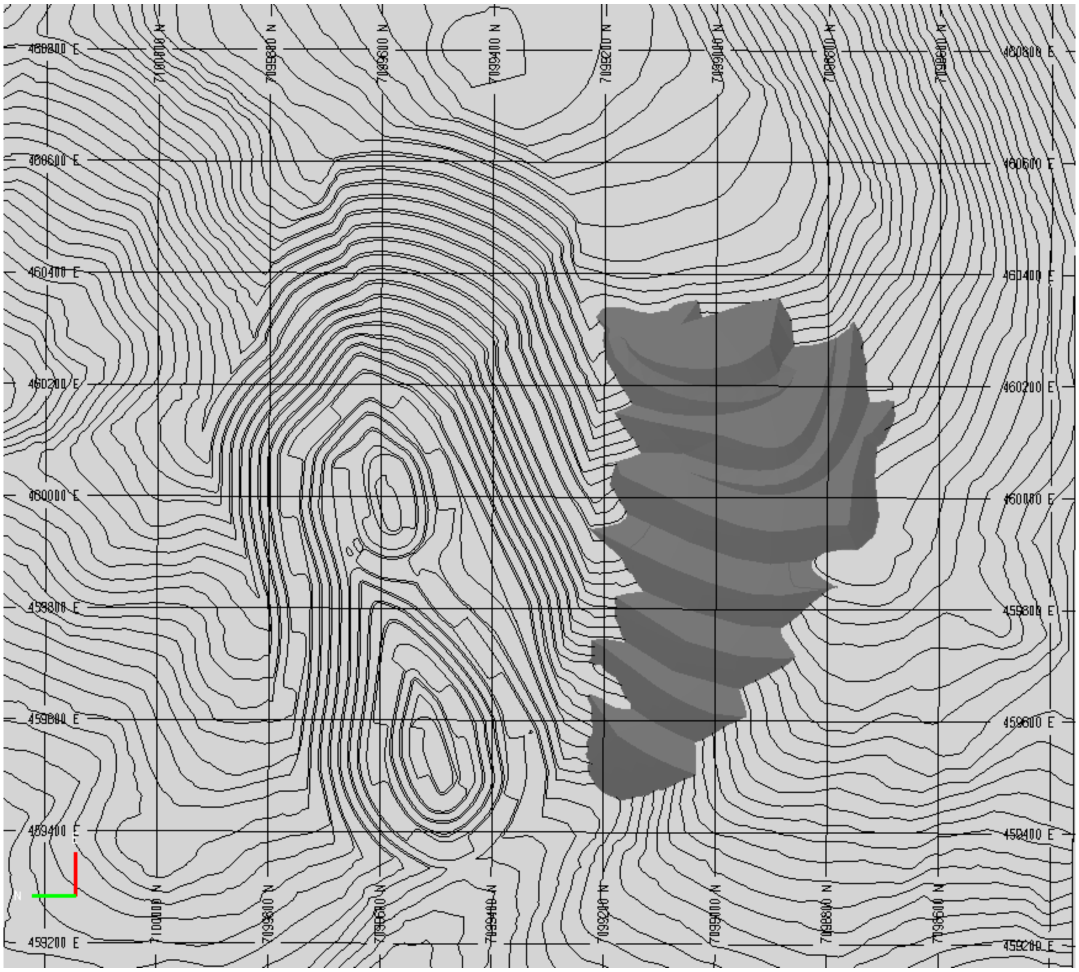


Figure 5.1-2: Plan View of the Platinum Gulch Waste Rock Storage Area at Full Build-Out

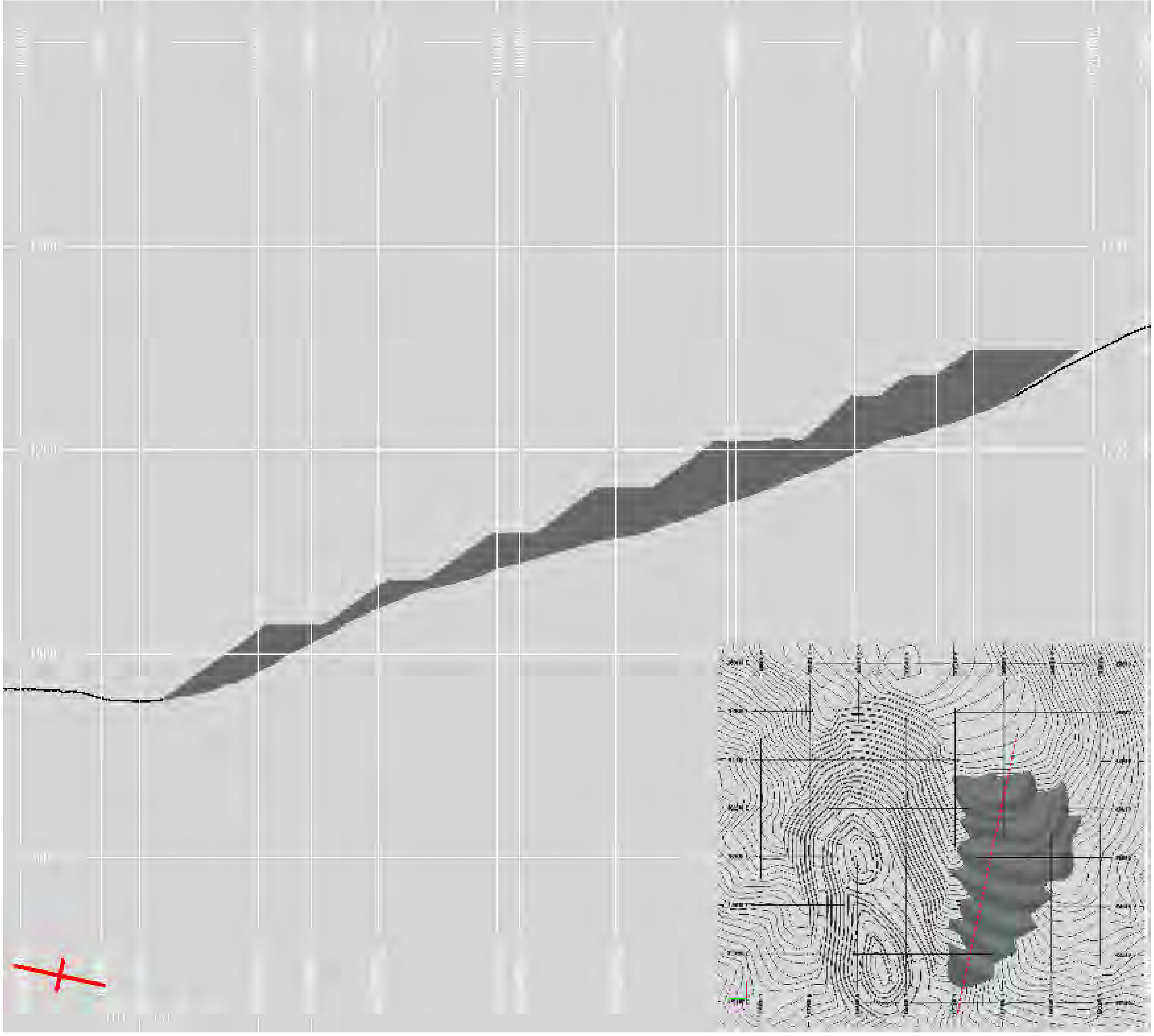


Figure 5.1-3: Sectional View of the Platinum Gulch Waste Rock Storage Area at Full Build-Out

Based on the dump sequencing from the mine plan iteration completed in November 2018, construction of the Platinum Gulch WRSA will be initiated in the upper reaches of the drainage in Year 0 at elevation 1,253 m asl. Independent lifts will then be constructed both above and below this in Year 1. In Year 2 the final toe will be established and the lower lifts expanded outwards. Finally, in Year 3 the upper lifts will be expanded outwards to the final overall surface slope of 2.4H:1V. A series of plans showing the progression of the WRSA is provided in Appendix 4.

5.1.2 Eagle Pup Waste Rock Storage Area

The EP WRSA will contain most of the waste rock generated from the open pit and will be developed as a valley fill using haul trucks. At its ultimate configuration the Eagle Pup WRSA will cover an area of approximately 80 ha and will contain approximately 70.6 million tonnes of waste rock and overburden. The WRSA will be constructed in 45 m lift heights from an elevation of approximately 948 m asl to 1,208 m asl, resulting in an overall height of approximately 280 m. At the end of its construction the waste rock pile will have an overall angle of approximately 2.5H:1V. Within the footprint of the WRSA the valley bottom of the Eagle Pup drainage ranges in slope from approximately 8° to 25°. As a result, the WRSA will obtain a maximum vertical thickness of approximately 90m. The ultimate configuration of the WRSA is provided in plan in Figure 5.1-4 and in cross-section in Figure 5.1-5.

Figure 5.1-4: Plan View of the Eagle Pup Waste Rock Storage Area at Full Build-Out

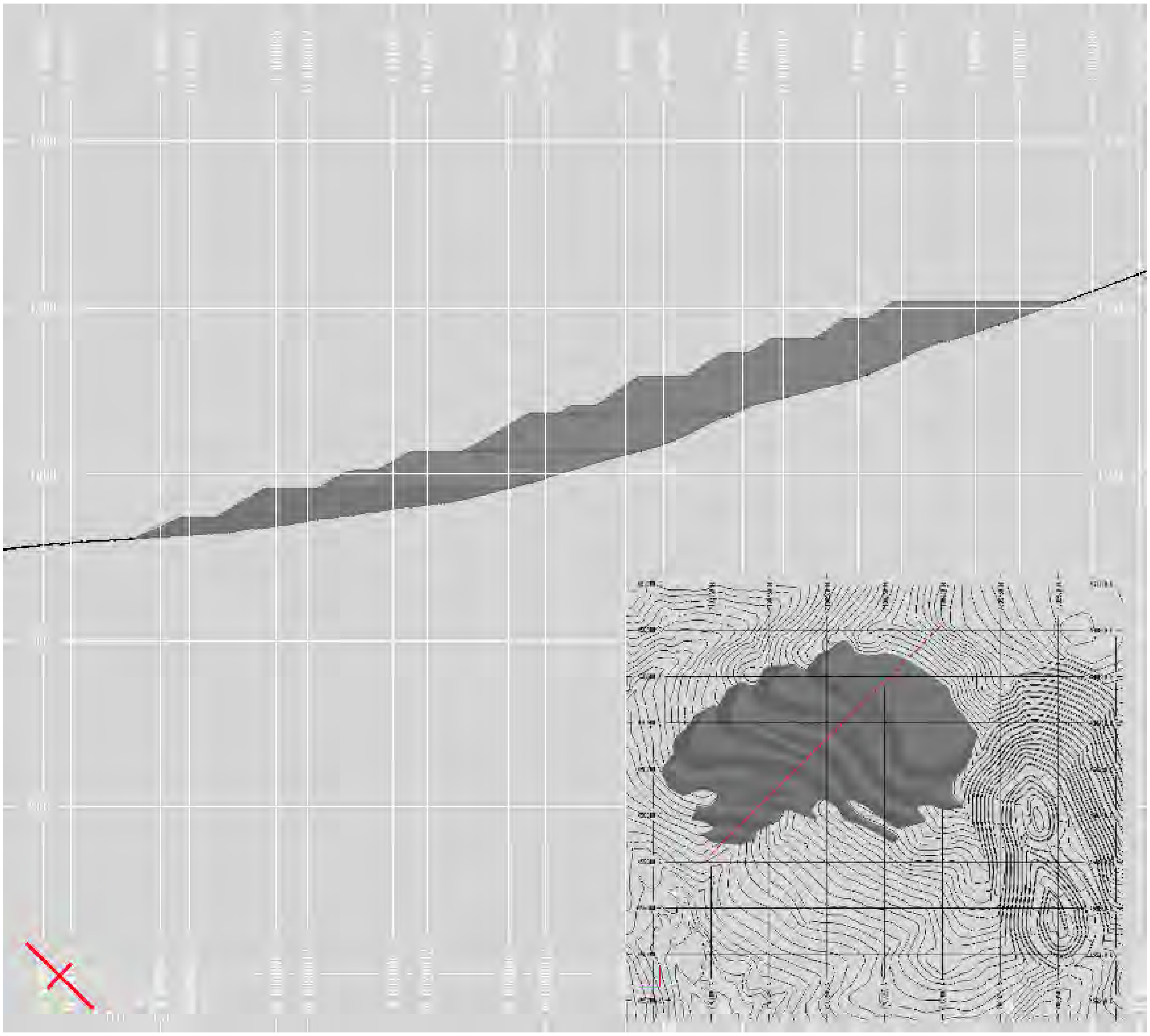


Figure 5.1-5: Sectional View of the Eagle Pup Waste Rock Storage Area at Full Build-Out

Based on the dump sequencing provided from the mine plan iteration completed in November 2018, construction of the Eagle Pup WRSA will start at the base lift at elevation 983 m asl in Year 3 after the Eagle Pup rock drain has been constructed. The base lift will establish the final toe of the EP WRSA and ensure a setback distance of 60 m from the main conveyor line, a distance partially determined based on the results of stability analyses. Bottom up construction will then be utilized to advance the WRSA upslope progressively bench by bench until it reaches the final height at 1208 m asl. This sequence ensures that the ice lobate feature identified in BGC 2012d is adequately buttressed to continue building the remainder of the dump. The construction sequence for each 45m high bench may be broken down into 5m sub lifts to maximize the use of trucks to free dump and to minimize the dozing requirements. The upper lifts will then continue to be pushed out until the overall angle is increased to a final surface slope of approximately 2.5H:1V in Year 10. A series of plans showing the progression of the WRSA is provided in Appendix 4.

5.2 WASTE ROCK CHARACTERIZATION

In general, waste rock to be placed in the WRSAs will consist of a mixture of metasediments from the Hyland Group and intrusives related to the Dublin Gulch granodiorite stock. Based on WRSA sequencing plans from the November mine plan, the waste rock will be primarily comprised of metasediments. The intact strengths of these rocks have been estimated from laboratory testing of drill core samples, point load testing, and core logging observations completed for the open pit design studies (BGC 2012b). The laboratory tests provide relatively precise strengths for a small number of samples which can then be used to calibrate the strength estimates from the larger point load testing database. The resulting strength estimates based on the point load testing are then checked against the more general estimates of strength from the core logging observations to arrive at an average strength for each unit. Based on laboratory testing, point load testing, and core logging observations the design uniaxial compressive strengths (UCS) of the metasediments and the intrusives are estimated to be 80 MPa and 135 MPa, respectively.

In-situ fracture spacing of the rocks have been measured as part of open pit design studies (BGC 2012b) and have been used to estimate average dimensions of the rock block sizes, prior to blasting. The waste rock block size will be heavily influenced by the length of the various discontinuity sets; the available information on the discontinuity lengths are deduced mainly from core, which are small in diameter and likely have a sampling bias due to their orientation, thus perhaps leading to smaller block size estimates Preliminary estimates indicate that the metasediments and intrusives will have average in-situ block sizes of about 0.1 and 0.2 m in diameter, respectively. Blasting induced fractures during mining operations will also have an impact on block size.

5.3 WATER MANAGEMENT

5.3.1 Rock Drains

To minimize the potential for hydrostatic pressures to build up at the bottom of the WRSA's, BGC (2012a) recommended rock drains to be constructed in the bottoms of the natural valleys within the footprints of both the proposed WRSAs. As a follow-up to BGC's recommendations, Tetra Tech/NELLPCO completed a detailed assessment of the rock drains and then prepared detailed rock drain designs for both WRSAs (Tetra Tech/NELPCO 2018b, Appendix 3). This section summarizes the key findings in Tetra Tech's report.

Site investigations indicated that the existing ground in Eagle Pup and Platinum Gulch consists of a thin layer of organics overlying colluvium over completely weathered bedrock and bedrock. In combination with the available groundwater data and the gradation and texture of colluvial soils in the Eagle Pup and Platinum Gulch valleys, and while there are losing reaches in both streams, it is reasonable and conservative to assume that the groundwater table in the proposed WRSAs is close to the original ground surface in the valley bottom areas.

The waste rock to be stored in the WRSAs will primarily comprise phylittic metasediments and bedded quartzites. The metasediments are known to be susceptible to weathering and mechanical breakdown during and after placement, especially when interacting with drainage water. In addition, some waste rock may be highly weathered and fractured with some fines and may have a low hydraulic conductivity. This fine-grained waste rock with low hydraulic conductivity should not be placed in the channel bottoms to minimize the potential for hydrostatic pressure buildup, which could have an adverse effect on the physical stability of the structure. Thus the rock drains, which will be placed in the valley bottoms, should be constructed with coarser, durable waste rock to minimize the potential degradation of rock over time and to encourage more rapid subsurface flow.

5.3.1.1 Rock Drain Peak Flows

A hydrological model was built for each of the EP and PG WRSAs to estimate peak flow rates for the rock drain design. The hydrological model was developed using PCSWMM® (Personal Computer Stormwater Management Model), an advanced tool that allows simulation of both distributed hydrological processes (both surface water and groundwater) and system hydraulics.

The model was set up to integrate surface runoff and subsurface (referred to in the model as groundwater) processes. The model accounts every time step for precipitation, depression storage, infiltration, and surface runoff. Surface hydrology is modelled using a non-linear reservoir routing method which combines the continuity and Manning's equations. Water that infiltrates into the WRSA feeds the groundwater model component. The remaining surface water is runoff that does not enter the rock drain.

The groundwater model represents the vertical movement of water infiltrating through the waste rock. Groundwater processes are characterized in the model by using such parameters as soil porosity, hydraulic conductivity, evapotranspiration depth, bottom elevation, and loss rate to deeper groundwater. Groundwater flows are routed through the dump in stages until reaching the rock drain outlet. The peak outflow at the rock drain outlet is the peak flow for the rock drain design for each WRSA.

The design criteria adopted is the 1 in 200-year 24-hour storm event (58 mm) as per Table 2-12 of Lorax (2017). Two scenarios were modelled for each WRSA: a) before open pit development (no waste rock placed in WRSA), and b) closure (completed open pit and WRSA with a topsoil and colluvium closure cover). Table 5.3-1 presents the estimated peak flow rates at the rock drain outlet locations. These values were used in the rock drain design. For comparison, Lorax (2017) computed much lower peak units rates the 24 hour 200 year storm for streams in the area (i.e., 0.26 to 0.32 $m^3/s/km^2$), which suggests that the estimated peak flow rates included here are high and conservative.

Table 5.3-1: Estimated Peak Flow Rates at Rock Drain Outlet Locations

WRSA	Estimated Peak Flow Rate for Scenario A (m^3/s)	Peak Unit Rates ($m^3/s/km^2$)	Estimated Peak Flow Rate for Scenario B (m^3/s)	Peak Unit Rates ($m^3/s/km^2$)
Eagle Pup	1.18	1.06	0.73	0.75
Platinum Gulch	0.60	1.06	0.34	0.64

5.3.1.2 Rock Drain Dimensions

The rock drain cross-sectional areas, which vary with locations along the rock drain longitudinal profiles, were estimated based on the design flow rates, which increase moving downgradient to the peak flows estimated for the rock drain outlets. Drawing C02 in Appendix 3 shows the locations of the longitudinal profiles (with stations) along the proposed rock drains for the EP and PG WRSAs. The design flow rates at various stations (typically every 100 m along the rock drain longitudinal profile) were proportioned to the corresponding catchment area at each of the stations using the estimated peak design flow rates (see Table 5.3-1) and the overall catchment areas at each of the rock drain outlet locations. The hydraulic gradient at each of the stations was estimated by assuming that the water surface in the rock drain conveying the design flows would be parallel to the existing ground surface. The existing ground surface slope gradient at each of the stations was estimated from the existing ground contour base drawing.

The porosity of rock drain materials was assumed to be 0.3, which is the same as used by BGC (2012a). The representative particle size for the rock drain materials was assumed to be 0.1 m during construction and mine operation before mine closure. The value was adopted after discussion with StrataGold to consider possible gradations of the materials after finer particles are removed by processing. A representative particle size of 0.05 m was adopted to consider the lower bound of the rock drain particle size gradation and potential particle break-down in the long term after mine closure.

Using the equations in Section 5.1 of Appendix 3 (Tetra Tech/NELPCO 2018b), the rock drain cross-section area that is required to convey the pro-rated design flow at each of the selected stations has been estimated. To provide additional contingency against potential rock drain performance reduction due to various uncertainties and risks, a multiplier (factor of safety) is applied to the calculated areas to estimate the design cross-section area at each of the selected stations. JDS's stability analyses of the WRSAs (Appendix 5) indicated that the toe area of the lowermost bench of the WRSAs is considered as a critical zone and is relatively sensitive to the assumed groundwater levels. Therefore, a higher factor of safety is adopted for the toe areas. In addition, a set of higher factors of safety are selected for the long-term closure case. Table 5.3-2 summarizes the factors of safety adopted.

Table 5.3-2: Factors of Safety Adopted for Rock Drain Update

Case		Eagle Pup WRSA	Platinum Gulch WRSA
Construction and operation before mine closure	Critical zone (from rock drain outlet at the toe area to approximately 100 m inwards)	3	3
	The remaining area beyond the critical zone	2	2
Long term after mine closure	Critical zone (from rock drain outlet at the toe area to approximately 100 m inwards)	4	4
	The remaining area beyond the critical zone	3	3

The factors of safety are used to consider the following uncertainties and risks:

- Potential migration of fine grained materials into the voids of rock drains;
- Potential degradation of the rock drain materials over time;
- Temporarily freezing of a portion of the drains; and
- Minor deficiencies during construction.

5.3.1.3 Recommended Rock Drain Cross-section Areas

Calculations described in Appendix 3 indicate that the rock drain cross-section areas for the closure case are greater than those for the case during construction and operation. Further, to compensate for the expected settlement of the foundation materials, the as-built elevations of the rock drains should be at least 0.3 m higher than the design values shown on the cross-section drawings. Table 5.3-3 summarizes the estimated rock drain in-place volumes.

Table 5.3-3: Estimated Rock Drain Material In-place Volumes

WRSA	Estimated Rock Drain In-place Volume for Design (without considering foundation settlement) (m^3)	Estimated Rock Drain In-place Volume for Construction (considering foundation settlement of 0.3 m) (m^3)
Eagle Pup	49,950	55,316
Platinum Gulch	14,086	16,157

Tables 5.3-4 and 5.3-5 summarize the required construction (as-built) areas and dimensions at selected locations for each rock drain for the Eagle Pup and Platinum Gulch WRSAs, respectively.

Table 5.3-4: Required As-built Rock Drain Areas and Dimensions for Eagle Pup WRSA

Rock Drain Location (Station)	Required Minimum As-built Rock Drain Cross-Section Area (m^2)	Required Minimum Top Crest Width of Rock Drain (m)	Estimated Bottom Width of As-built Rock Drain (m)	Minimum As-built Crest Elevation of Rock Drain (m)	Minimum As-built Height at Centerline (m)
0+044 (lowermost toe of WRSA)	123.2	32	36.0	923.2	4.0
0+100	127.1	32	37.6	930.4	3.4
0+150	119.0	32	36.2	936.4	4.2
0+200	85.8	24	26.6	942.0	5.0
0+250	76.4	18	22.2	948.4	4.0
0+300	70.0	16	21.2	956.1	3.8
0+350	68.5	16	22.0	962.8	3.7
0+400	66.3	14	22.1	969.9	3.5
0+450	59.1	14	18.7	975.8	4.0
0+500	52.6	12	18.1	984.4	3.6
0+550	48.4	10	16.5	992.9	3.8
0+600	44.0	10	15.7	1,001.2	3.9
0+650	37.7	9	14.4	1,009.7	3.4
0+700	32.1	8	12.6	1,019.2	3.8
0+750	30.6	7	12.7	1,029.6	3.1
0+800	27.2	6	12.0	1,041.0	3.0
0+850	21.9	4	10.2	1,053.8	3.1
0+900	17.2	4	9.0	1,067.4	2.7
0+950	16.7	4	9.3	1,087.0	2.5
0+1000	16.3	4	8.8	1,100.6	2.5

Table 5.3-5: Required As-built Rock Drain Areas and Dimensions for Platinum Gulch WRSA

Rock Drain Location (Station)	Required Minimum As-built Rock Drain Cross-Section Area (m^2)	Required Minimum Top Crest Width of Rock Drain (m)	Estimated Bottom Width of As-built Rock Drain (m)	Minimum As-built Crest Elevation of Rock Drain (m)	Minimum As-built Height at Centerline (m)
0+062 (lowermost toe of WRSA)	47.8	11	17.3	954.8	3.4
0+100	43.4	10	16.3	963.4	3.3
0+150	38.5	10	14.4	974.8	3.4
0+200	26.5	7	11.0	989.8	3.2
0+250	25.7	7	10.8	1,006.5	3.6
0+300	24.7	6	10.5	1,023.7	3.1
0+350	22.8	6	9.7	1,038.9	3.3
0+400	20.6	6	9.0	1,055.7	3.6
0+450	20.5	5	10.4	1,073.7	2.7
0+500	20.3	5	10.3	1,091.6	2.7
0+550	17.4	4	9.3	1,109.0	2.6
0+600	14.9	4	8.5	1,124.5	2.4
0+650	13.1	4	8.2	1,138.2	2.1
0+700	11.3	4	7.7	1,148.6	1.9

5.3.1.4 Foundation Preparation

For the rock drain footprint, the overburden layer will be excavated to weathered bedrock in the toe area (50 m to 100 m from the toe) of the lowest bench for each of the WRSAs to increase overall slope stability. It is not planned to excavate the existing organic layer and underlying overburden soils in the remaining footprints of the WRSAs.

The spring 2018 site investigation and previous investigations cited above in Section 1.1 indicate that the organic layer in the WRSAs consists of fibrous peat up to 0.3 m thick. Beneath the organic layer, poorly to well graded, silt, sand, and gravel mixtures with cobbles disseminated throughout make up the bulk of the colluvial overburden. Any of these may be the dominant soil component.

In BGC’s 2012 feasibility design, it was recommended to strip the 0.3 m organic layer from the footprints of the rock drains. Stripping the organic layer along the valley bottoms, outside of the noted 50 m to 100 m area from the toe would expose colluvial overburden that may be susceptible to surface erosion when drainage water flows through the rock drain materials. It is more likely, however, that the existing surface materials, including the surficial organic material would provide better resistance to potential surface erosion since they have been subjected to natural surface processes for a long time. Therefore, the rock drain materials (upgradient of the toe area) will be placed directly over the existing ground surface without stripping the organic layer. Settlement of the rock drain materials into the organic layer and underlying overburden soils upon loading from waste rock is expected, As noted above in section 5.3.1.3, the as-built top elevation of the rock drain should be approximately 0.3 m higher than the design elevation to compensate for the expected settlement after construction.

5.3.1.5 Rock Drain Materials

The rock drains will be constructed of non-metal leaching, non-acid generating, clean, hard, durable rock, resistant to weathering; free from organic matter, frozen soil, snow, ice, and overburden soil materials; and shall meet the gradation requirements as specified in Table 5.3-6.

Table 5.3-6: Rock Drain – Particle Size Distribution Limits

Particle Size (mm)	% Passing
1,000	100
500	50 - 100
200	10 - 100
100	0 - 20
50	0 - 10

Based on available information, candidate rock sources include fresh or slightly weathered granodiorite, quartzite, or hornfels. Most of the rock drain materials will be sourced from waste rock encountered during open pit development. Processing such as running select waste rock materials through a screening system (or a grizzly) may be required to meet design criteria. A grizzly may be used to screen the rock drain material and achieve the required gradation.

The risk of degradation of the rock drain materials can be limited by using durable materials for construction under adequate quality control. Particle gradation assessments and durability tests for the materials to be used for rock drain construction will be conducted to evaluate the suitability of the materials. This is outlined in the Rock Drain Durability Testing Plan (SGC 2019). Many laboratory tests have been used to evaluate rock durability. Recently developed tests (Micro-Deval Abrasion and Resistance to Unconfined Freezing and Thawing) will be conducted to differentiate between marginal and durable aggregates. Highly absorptive rock is rarely durable. The following criteria are preliminarily adopted at this stage for the rock drain evaluation/confirmation:

- non-metal leaching, non-acid generating, clean, hard, durable rock, resistant to weathering, free from organic matter, frozen soil, snow, ice, and overburden soil materials;
- particle size distribution as specified in Table 5.3-6;
- strong rock with a rock grade R4 or higher, a uniaxial compressive strength (UCS) of greater than 50 MPa, point load index of greater than 2.0 MPa, or equivalent;
- absorption (ASTM D6473) of no greater than 2%; and
- Micro-Deval abrasion (CSA A23.2-29A) loss of no greater than 21%.
- Resistance to unconfined freeze-thaw test (CSA A23.2-24A) of no greater than 10%.

The construction quality control/quality assurance (QA/QC) and monitoring program (SGC 2019) will help guide the construction of the rock drains to ensure that design and construction requirements for the rock drains are met.

5.3.1.6 Mine Waste Placement on Rock Drains

Fine-grained overburden soils or completely weathered waste rock should not be placed within 20 m of the rock drain's outside surface.

Select good quality waste rock with minimal fines should be placed within 10 m distance of the rock drain outside surface to reduce the risk of potential fines migrating into the rock drain. Alternatively, the select waste rock zone over each rock drain may be replaced with a coarse rock fill zone above the rock drain. This coarse rock fill zone can be placed by end-dumping good quality waste rock material over a minimum 20 m high repose angle face to yield a well-graded filter zone above the drain that should prevent the migration of fines (Hawley and Cunning 2017).

5.3.1.7 Permafrost and Freezing Associated with Rock Drain Outlets

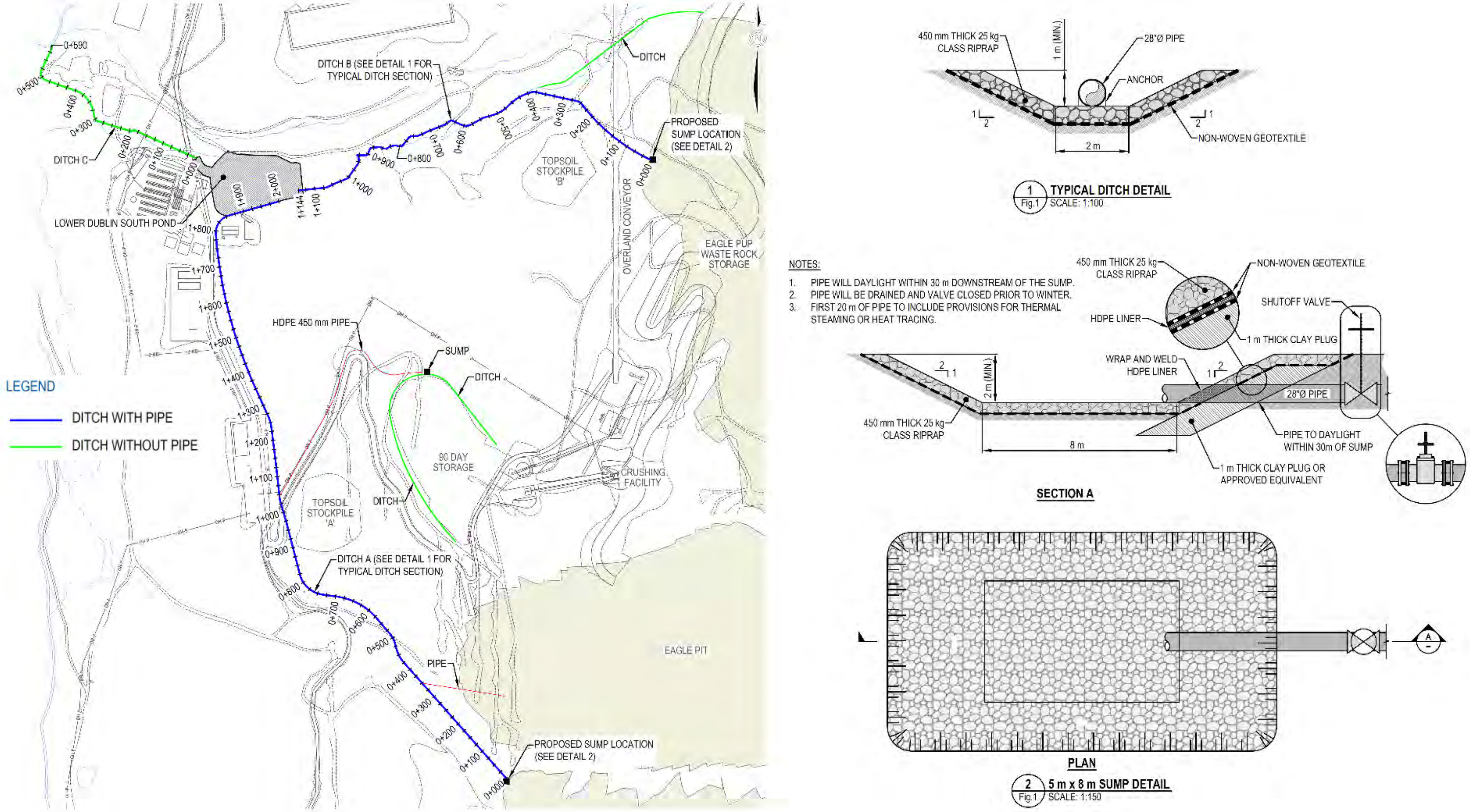
The April 2018 site investigation and follow-up ground temperature measurements of the EP and PG WRSA footprints indicated either permafrost-free conditions or very warm permafrost (with measured temperatures equal to or warmer than -0.5°C). Results of the efforts to fine tune the understanding of the distribution of permafrost-free or warm permafrost conditions is depicted in Figure 2 of Appendix 2, which shows that the majority of the Eagle Pup and Platinum Gulch footprints are either permafrost free or with ice poor warm permafrost. Since the permafrost in these areas is discontinuous and very warm, the risk of freezing the drains due to permafrost development into the rock drains is low.

Without mitigation, seasonal freezing of a small portion of the rock drain close to the downstream slope toe of the lowest bench for each WRSA may occur. Therefore, the design includes an extension of the rock drain outlet to at least 5 m beyond the slope toe for each WRSA, and a select waste rock thermal cover of 4 m over the extended portion of the rock drain. This will limit seasonal freezing to the extended portion beyond the slope toe.

Portions of the rock drains may be constructed in winter. In that case, the rock drain materials may temporarily be in a frozen condition after construction. The temperature of the rock drain after construction will gradually come to equilibrium with the surrounding ground. The voids of the materials would be generally ice-free since the materials will be placed in relatively dry conditions. In the following thawing season, drainage water will flow through the voids and raise the rock drain temperature. Freezing water requires removing a significant amount of the latent heat from the water that is flowing through the voids of rocks. The rocks are not expected to be cold enough and therefore will not have the cooling capacity to freeze the flowing water.

5.3.2 Water Management

Flow from the rock drains in both WRSAs will drain into a rip-rap HDPE-lined sump and then into a pipe/ditch configuration (Ditches A and B) which will convey the water to the Lower Dublin South Pond. The pipes will have a shutoff valve that will be closed during winter to prevent freeze-up in the pipe. The sump and pipe configuration is depicted in Figure 5.3-1. All rainfall or snowmelt runoff from the WRSAs will be directed to collection ditches situated along the toe and perimeter of the dumps and then also conveyed to the sump, such that all water emanating from the WRSAs (both surface flow and drain flow) will report to Ditch A (Platinum Gulch) or Ditch B (Eagle Pup) and then ultimately to the Lower Dublin South Pond.



NOTES:
1. PIPE WILL DAYLIGHT WITHIN 30 m DOWNSTREAM OF THE SUMP.
2. PIPE WILL BE DRAINED AND VALVE CLOSED PRIOR TO WINTER.
3. FIRST 20 m OF PIPE TO INCLUDE PROVISIONS FOR THERMAL STEAMING OR HEAT TRACING.

Figure 5.3-1: Ditch/Pipe Configuration and Design

5.4 PHYSICAL STABILITY ASSESSMENT

5.4.1 Material Properties

5.4.1.1 Waste Rock

The waste rock material that will be stored in the EP and PG WRSAs is anticipated to consist mostly of competent granodiorite and metasediments. A portion of the metasediments bedrock has potential to be anisotropic with the foliation or relict bedding forming planes of weakness. UCS testing carried out as part of the BGC (2012b) pit slope evaluation indicated average design UCS values of 83 and 135 MPa for the metasediments and granodiorite, respectively.

Due to the large particle size (i.e., typically greater than 10 cm) of typical waste rock materials, laboratory testing is very rarely able to be carried out at the actual particle size as the overall test sample size required would greatly exceed the size and loading capacities of conventional testing equipment. Research investigations conducted by Linero and Palma (2007), Marsal and Resendiz (1975), Leps (1970) and others have carried out large-scale testing of dumped rock fill samples and demonstrated that, for high rock fill dumps such as the EP and PG WRSAs, the shear strength envelope is non-linear, being more frictional at lower confinement stresses (or depths) and more cohesive at higher confinement. This non-linear shear strength relationship is commonly represented using the two-component power law:

$$\tau = A\,{\sigma_n}^b$$

where τ is the shear strength (kPa), σ_n is the normal stress (kPa) and A and b are material constants which are estimated based on large-scale triaxial or direct shear test results. The material constants are affected by size, strength and angularity of the intact waste rock particles as well as the density of the material after being placed.

Based on the large-scale triaxial tests carried out by Leps (1970) recommendations for material constants A and b were developed by Hawley & Cunning (2017). The recommended shear strength functions range from an upper bound shear strength behavior for high-density, well-graded, strong particles to a lower bound strength for low density, poorly graded, weak particles. The function developed by Hawley & Cunning (2017) to represent lower quartile shear strength (A of 1.576 and b of 0.899 kPa) was selected to represent waste rock for the slope stability analyses.

This strength function is conservative for the WRSAs because it assumes top-down construction which would result in a lower density and weaker shear strength. The WRSAs will be constructed in a mostly bottom-up sequence resulting in a higher density and strength.

5.4.1.2 Organic Soils

The thin layer of organic materials on the ground surface has not been incorporated into the stability analysis models as it is assumed that it is not thick enough to control large-scale failures. In addition, it is anticipated that these materials may be removed in some areas and stockpiled for reclamation purposes.

5.4.1.3 Ice-Rich Colluvium

Based on the Tetra Tech/NELPCO (2018a) geotechnical investigation, permafrost mapping program (Tetra Tech/NELPCO 2017), and previous work by BGC (2010, 2011a, 2012a and 2012c) the highest potential for ice-rich materials within the WRSA footprints is along the Platinum Gulch drainage bottom as well as some of the drainage bottoms in the upper Eagle Pup valley.

Where present in an appreciable concentration, ice-rich colluvium was modeled conservatively using a zero friction, undrained shear strength of 80 kPa. This value is based on published shear strength test results for clayey silts and silty clays with high or medium ice content at a temperature of approximately -2° C (Johnson, 1981). Long-term climate warming may thaw some ice-rich materials but would occur at a sufficiently slow rate to allow adequate dissipation of pore water pressures potentially created by melt water and would unlikely to lead to instabilities.

5.4.1.4 Ice-Poor and Unfrozen Colluvium

Colluvium shear strength was initially tested by Knight Piesold (1996) on a sample obtained from a proposed heap leach pad. The proposed heap leach pad at that time was further up the Dublin Gulch drainage nearer the headwaters and east of the current EP WRSA. However, the grain size distribution of the sample tested closely approximates those of the colluvium in the Eagle Pup WRSA (BGC 2012d). The sample consisted of 45% gravel, 23% sand, 26% silt, and 6% clay.

A multi-stage consolidated-undrained (CU) triaxial test was conducted on the sample which was remolded to 95% Modified Proctor maximum dry density at approximately the natural moisture content. The sample was tested under confining stresses ranging from 35 to 1000 kPa. The results of the triaxial testing indicated an effective friction angle (φ’) of 38° with 68 kPa cohesion (c’).

In addition to the Knight Piesold (1996) triaxial test, four direct shear tests were conducted on samples of colluvium obtained from the Tetra Tech/NELPCO (2018a) field investigation. The 2018 direct shear tests yielded very similar results with effective friction angles (φ’) ranging between 31° and 40° with 13 to 71 kPa cohesion (c’). The average effective shear strength of the four tests is 35° with 46 kPa which is consistent with the previous triaxial test. The percentages of gravel, sand, silt and clay for the 2018 direct shear samples are also quite similar to the 1996 test sample.

An effective strength of φ’ = 34° and c’ = 0 kPa was conservatively selected for the ice-poor and unfrozen colluvium in the slope stability models. Both direct shear and triaxial test results indicate a cohesive component to the shear strength envelopes of the tested colluvium samples. Cohesion values from the tests ranged between 13 and 71 kPa which is considered reasonable for coarse, colluvial soils such as those tested. The use of a zero cohesion shear strength envelop for the colluvial soils was initially adopted by BGC (2012d) and is considered representative of a long term, residual shear strength. JDS (Appendix 5) notes that this is a conservative approach but feels it is appropriate in this case to account for potential uncertainties in the foundation strength.

The colluvium layer was modeled as a 10 m thick continuous layer, parallel to the pre-mine ground surface for the WRSA analyses. The 10 m thick colluvium layer used for the WRSA analyses is also a conservative model assumption and likely represents an upper bound colluvium thickness. Much of the WRSA footprints will have less than 10 m of colluvium soils which would result in more stable conditions. Reducing the layer to 5 m thick was tested for certain models and resulted in a slight increase in safety factor for some cases.

5.4.1.5 Weathered Bedrock

Bedrock beneath the colluvium is typically moderately to completely weathered with the rock becoming less weathered and more competent with depth. The weathered bedrock typically consists of densely fractured bedrock that can be highly friable readily breaking down to sand and gravel. In the WRSAs fresh rock (i.e., essentially non-weathered) is typically encountered at depths between 1 and 13 m below the base of colluvium.

Based on visual classifications, field observations, and limited in-situ penetration testing BGC (2012d) assigned the completely weathered bedrock an effective strength of φ’ = 35° and c’ = 50 kPa. Given the variability in thickness and geotechnical characteristics, the weathered bedrock zone was conservatively modeled as a continuous 20 m thick layer beneath the colluvial soils using the BGC (2012d) completely weathered bedrock strength.

The transition from colluvium soils to weathered bedrock is gradational and difficult to distinguish in the field. Similarly the contact between weathered and fresh bedrock is typically irregular and difficult to consistently and accurately log across a site. As such, the 20 m weathered bedrock thickness is a conservative estimate based on the borehole and test pit logs but most likely represents a maximum thickness beneath the facilities. Reducing the weathered bedrock thickness in the slope stability models would have negligible effects on the calculated safety factors in this case given, all but one, of the critical slip surfaces were above bedrock, within the colluvium soil layer. The final EP WRSA configuration was the only case where shear stresses were high enough to result in shearing of the weathered bedrock layer.

5.4.1.6 Fresh Bedrock

Fresh bedrock was modeled as an ‘infinite strength’ material in the analyses. As a result of the dramatic differences in strength between the in-situ fresh bedrock and the overburden soils at Eagle, critical slip surfaces generated by the model preferentially occur through the much weaker overburden soils or (potentially) the upper, weathered bedrock layer. This assumption was also confirmed with the modeling results.

5.4.1.7 Pore Water Pressures

Piezometric surfaces were constructed in the slope stability models as a means of estimating hydrostatic pore water pressures. The piezometric surface was assumed to be coincident with the pre-mine ground surface for portions of slope stability cross sections near or in drainage valley bottoms. The water table was considered to be 5 m below the pre-mine ground surface for portions of slope stability sections that are on hillsides, up slope and out of the drainage bottoms.

The piezometric surface was used by the model to calculate hydrostatic pore water pressures within all foundation materials. It was assumed by BGC and for the analyses reported on herein that the waste rock and rock drains are sufficiently coarse to allow free drainage without the building of pore water pressures within the base of the WRSA.

JDS (Appendix 5) notes that the assumed piezometric levels used for the analyses represent an artificial and isolated occurrence.

5.4.2 Effects of Ground Thawing on Physical Stability

A layer of transported soils above bedrock referred to as colluvium exists across most of the site. The depth of the colluvium soils typically ranges from 1 to 10 m within the WRSAs. Colluvium depth is typically shallow near the upper valleys and ridge tops and deepens towards lower elevations and valley bottoms.

According to the Permafrost Map of Canada, the Dublin Gulch area is located within the zone of extensive discontinuous permafrost, where 50% to 90% of the area is expected to be perennially frozen (Heginbottom et al.1995). When analyzing slope stability in permafrost areas, it is important to distinguish between frozen and unfrozen states as well as the actual ice content of the frozen soils and the time of year the observations are being made.

Frozen soils with low ice content (ice-poor) typically have a very low risk of becoming unstable if suddenly thawed due to the low amount of melt water. Ice-rich soils on the other hand can experience drastic strength reductions, becoming unstable when thawed. Whether or not an ice-rich soil is potentially thaw-unstable depends primarily on the particle size distribution of the material. Coarse grained soils generally have adequate pore space with hydraulic connectivity to dissipate the water as it forms from thawing, whereas fine grained soils do not drain as readily due to lower hydraulic connectivity within the pore spaces; this can lead to a sudden increase in pore water pressure and strength reduction. It is possible that some of the saturated or over saturated soils would displace/squeeze up into the waste rock voids and some would consolidate under the waste rock load, regaining strength. However, it would be very difficult to predict how much strength could be regained or where this would occur. Given the uncertainty this strength should not be relied upon in the WRSA design.

The threshold between ice-poor and ice-rich material is not exact but good rule of thumb may be 15 to 20 % ice. Fine grained soils with greater than 15 to 20 % ice content have a high risk of being thaw-unstable. For the purpose of the slope stability analyses, the boundary for ice-rich materials was conservatively considered to be 10 % ice content to be consistent with the Tetra Tech/NELPCO (2017) permafrost characterization map (depicted in Appendix 1). Materials with less than 10 % ice content (classified as Fn according to Tetra Tech/NELPCO, 2017) were considered low risk of being thaw-unstable and having low creep potential. Soils with greater than 10 % ice content (classified as Fv or Fi according to Tetra Tech/NELPCO, 2017) were considered to have a high potential for being thaw-unstable and having high creep potential. The areas of ice-rich (Fv and Fi) and ice-poor (Fn) or unfrozen (UF) are shown for the PG WRSA and EP WRSA footprints on Figure 5.4-1 and Figure 5.4-2 respectively.

5.4.3 Slope Stability Model Methodology

Based on the anticipated foundation materials and the proposed interim and ultimate WRSA design configurations, critical cross-sections were selected for detailed stability analyses. The cross-section locations were selected to represent idealized worst-case geometries and foundation conditions for the interim and final WRSA designs. The traces of the slope stability cross-sections are shown in **Error! Reference source not found.** and **Error! Reference source not found.** for the Platinum Gulch and Eagle Pup WRSAs, respectively.

The cross-section geometries were input into the software program Slide® 8.018 (Rocscience, 2018). Slide® is a two-dimensional, limit equilibrium slope stability analysis program that evaluates safety factors by various methods of slices in terms. The analysis results are reported herein for the Spencer (1967) method of slices because it satisfies both force and moment equilibrium, leading to more realistic safety factor calculations. Because rigorous methods such as Spencer's satisfy all conditions of static equilibrium, they implicitly provide more realistic models of the physical mechanics of failure than do simplified methods (Hawley & Cunning, 2017).

Each section was analyzed for static and pseudostatic loading conditions. Pseudostatic analyses simulate seismic forces in terms of a horizontal acceleration expressed as a coefficient (or percent) of gravity (g). As recommended by the B.C. Mine Waste Rock Pile Research Committee (1991), the peak ground acceleration (PGA) corresponding to a 1:475 year event (or 10% probability of exceedance in 50 years) was used for the pseudostatic stability analyses. Based on the BGC (2011b) Seismic Design report, the peak horizontal ground acceleration for the site corresponding to a 1:475 year return interval is 0.14 g.

A total of 147 cases were simulated each for static and pseudostatic loading conditions, between 13 separate models created along the 7 critical cross-sections analyzed[2]. The geometry of each model is shown for each section and model in JDS (2018; Appendix 5).

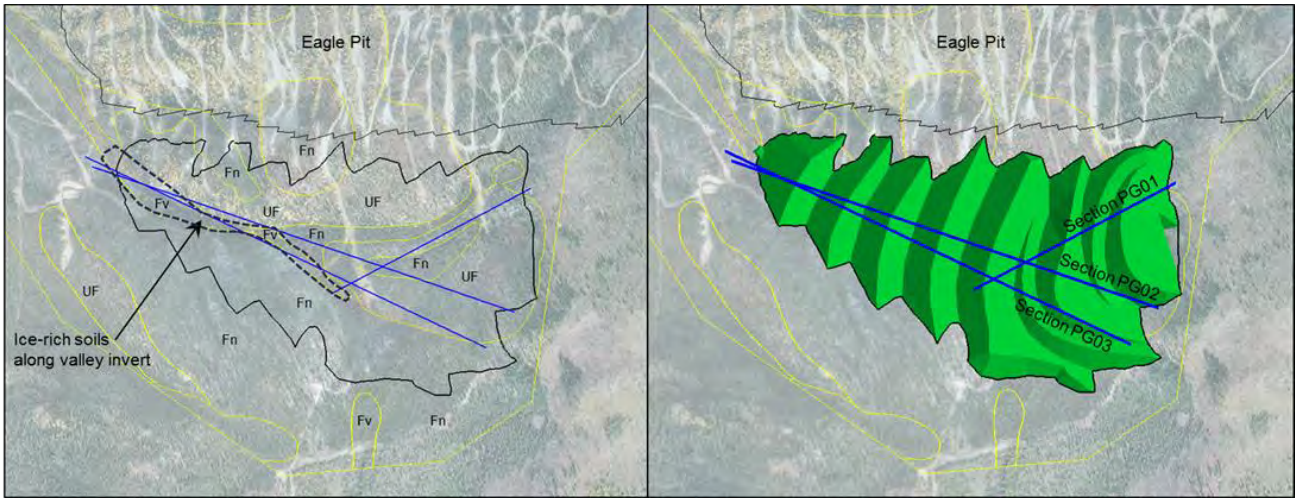


Figure 5.4-1: Location of Platinum Gulch WRSA Slope Stability Cross Sections

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[2] The number of cases simulated as described in the JDS (2018; Appendix 5) includes analyses for the Eagle Pup and Platinum Gulch WRSAs, as well as the 90-day Storage Area.

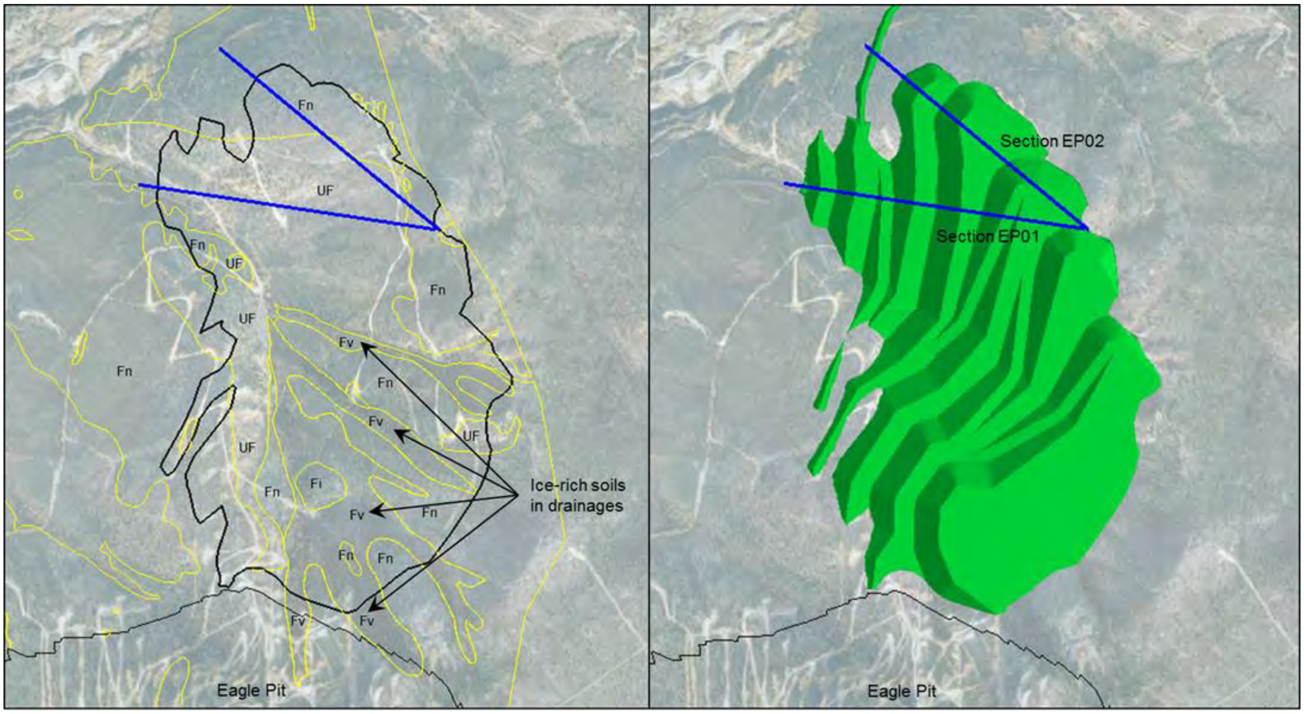

Figure 5.4-2: Location of Eagle Pup WRSA Slope Stability Cross Sections

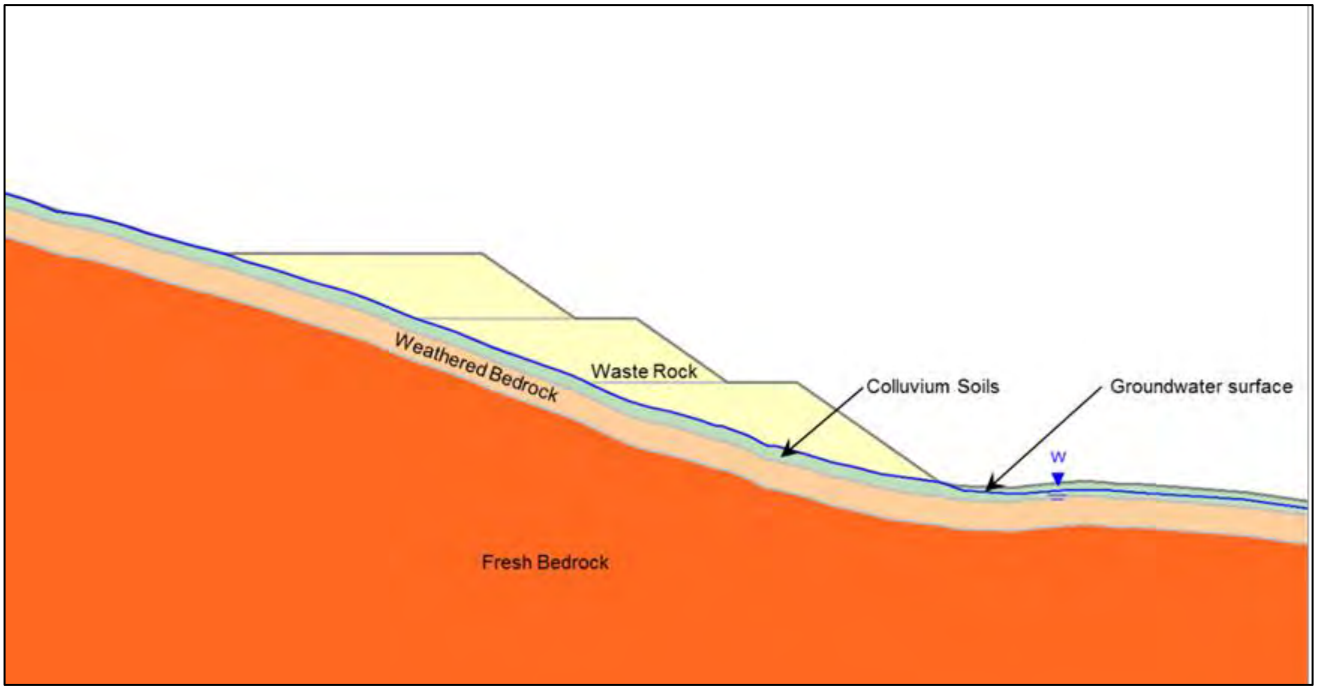

Figure 5.4-3: Slope Stability Cross Section Model (PG-M6-SE-C03)

When incorporating PGA in a slope stability model, it is common practice to reduce the PGA by a factor of 0.5 based on the research conducted by the U.S. Army Corps of Engineers (Hynes-Griffen and Franklin 1984). In summary, this reduction in acceleration is justified for earth and rock structures for the following reasons:

- Realization that sustained ground acceleration is typically less than half of the PGA, which is an instantaneous acceleration; and,
- Consideration that earth and rock structures effectively attenuate earthquake-induced accelerations; and,
- Determination that deformations of less than one meter would result with this criterion.

Based on these guidelines, a pseudostatic seismic coefficient of 0.07 g was selected for the analyses.

5.4.4 Design Acceptability Criteria

Design acceptability criteria for the analyses are based on the "*Guidelines for Mine Waste Dump and Stockpile Design*" (Hawley & Cunning, 2017). The suggested minimum factor of safety (FoS) presented in the guidelines are re-produced in Table 5.4-1 with the each minimum FoS reflecting different levels of confidence in the understanding of site conditions, material parameters, and consequences of instability. As previously discussed, the recently published Hawley & Cunning (2017) guidelines are considered an update and improvement to the previous (BCMWRPRC 1991) interim design acceptability criteria, which did not distinguish between important factors such as the size of facility, consequence of failure or confidence in foundation conditions.

JDS (2018; Appendix 5) considers the current EP and PG WRSA designs to fall within the moderate consequence and high confidence categories. Corresponding minimum recommended factors of safety are 1.2 to 1.3 for static and 1.0 to 1.05 for pseudostatic loading conditions according to the guidelines.

Table 5.4-1: Suggested WRSF Stability Acceptance Criteria (Hawley & Cunning, 2017)

Consequence[1,3]	Confidence[2,3]	Static analysis		Pseudostatic	Maximum allowable strain
		Minimum FoS	Maximum PoF	Minimum FoS	
Low	Low	1.3 - 1.4	10 - 15%	1.05 - 1.1	≤ 1%
	Medium	1.2 - 1.3	15 - 25%	1.0 - 1.05	≤ 1.5%
	High	1.1 - 1.2	25 - 40%	1.0	≤ 2%
Moderate	Low	1.4 - 1.5	2.5 - 5%	1.1 - 1.15	≤ 0.75%
	Medium	1.3 - 1.4	5 - 10%	1.05 - 1.1	≤ 1%
	High	**1.2 - 1.3**	**10 - 15%**	**1.0 - 1.05**	**≤ 1.5%**
High	Low	≥ 1.5	≤ 1%	1.15	≤ 0.5%
	Medium	1.4 - 1.5	1 - 2.5%	1.1 - 1.15	≤ 0.75%
	High	1.3 - 1.4	2.5 - 5%	1.05 - 1.1	≤ 1%

Notes:

1. **Consequence**

   Low Consequence: waste dumps and stockpiles with overall fill slopes less than 25° and less than 100 m high and repose angle slopes less than 50 m high. No critical infrastructure or unrestricted access within potential runout shadow. Limited potential for environmental impact. Long-term (> 5 years) exposure for sites subject to very low to low (< 350 mm) annual precipitation; medium-term (1-5 years) exposure for sites subject to moderate (350-1000 mm) annual precipitation; short-term (< 1 year) exposure for sites subject to high (1000-2000 mm) annual precipitation; dry season construction/operation only for sites subject to very high (> 2000 mm) annual precipitation or intensive rainy season(s).

   Moderate Consequence: waste dumps with overall fill slopes less than 30° and less than 250 m high, or with repose angle slopes less than 100 m high. No critical infrastructure or unrestricted access, or robust containment/mitigative measures to protect critical infrastructure and access within potential runout shadow. Potential for moderate environmental impact, but manageable. Long-term (> 5 years) exposure for sites subject to moderate (350-1000 mm) annual precipitation; medium-term

(1-5 years) exposure for sites subject to high (1000-2000 mm) annual precipitation; short-term (< 1 year) exposure for sites subject to very high (> 2000 mm) annual precipitation or intensive rainy season(s).

High Consequence: waste dumps with overall fill slopes more than 30° and more than 250 m high, or with repose angle slopes more than 200 m high. Critical infrastructure or unrestricted access within potential runout shadow with limited runout mitigation/containment measures. Potential for high environmental impact that would be difficult to manage. Long-term exposure (> 5 years) for sites subject to high (1000 – 2000 mm) annual precipitation; medium (1-5 years) exposure for sites subject to very high (> 2000m) annual precipitation or intensive rainy season(s).

2. **Confidence**

Low Confidence: limited confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Poorly defined or optimistic input parameters; high data variability. For proposed structures, investigations at the conceptual level with limited supporting data. For existing structures, poorly documented or unknown construction and operational history; lack of monitoring records; unknown or poor historical performance.

Moderate Confidence: – moderate confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Input parameters adequately defined; moderate data variability. For proposed structures, investigations at the pre-feasibility level with adequate supporting data. For existing structures, reasonably complete construction documentation and monitoring records; fair historical performance.

High Confidence: high confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Well-defined, conservative input parameters; low data variability. For proposed structures, investigations at the feasibility level with comprehensive supporting data. For existing structures, well documented construction and monitoring records and good historical performance.

3. In cases where the guidance for consequence or confidence conflicts or is unclear, selection of the appropriate level should be based on judgment, and the rational for the selection should be documented.

5.4.5 Slope Stability Modeling Results

Results of the stability analysis are tabulated and discussed below. The results are in terms of FoSs for each model and section for static and pseudostatic loading conditions.

Graphical outputs of each model analyzed for each of stability section are contained in JDS (2018; Appendix 5). Each result also contains a graphic illustrating the location of the respective cross-section and the construction stage for the respective model.

5.4.5.1 Platinum Gulch WRSA

Results of the Platinum Gulch WRSA stability analysis are summarized in Table 5.4-2. The analysis results indicate acceptable safety factors and can be summarized as follows:

- The critical portions of the PG WRSA are the toes of individual lifts founded on colluvium soils. The analyses demonstrate static safety factors of 1.3 (1.1 to 1.2 pseudostatic) for these cases except for the upper (1552.5 m and 1297.5 m benches) which yielded static safety factors of 1.2 (1.0 pseudostatic) due to the steeper natural topography in the upper PG drainage valley;
- Individual lifts placed above existing waste rock rather than native foundation soils indicate a safety factor of 1.5 for static loading conditions and 1.3 for pseudostatic loading;
- Safety factors for failures through multiple (2 or 3) benches ranged between 1.4 and 1.6 for static loading and from 1.1 to 1.3 for pseudostatic loading conditions. Multi-bench failures involving 4 or more benches would result in greater safety factors.

Table 5.4-2: Factors of Safety Results: Platinum Gulch WRSA

Section	Model	Mine Period	FoS (Static)	FoS (Pseudostatic)	Critical Failure Description
PG01	M1	2019 - 1	1.2	1.0	Failure of 1252.5 m bench

Section	Model	Mine Period	FoS (Static)	FoS (Pseudostatic)	Critical Failure Description
	M2	2019 - 2	1.2	1.0	Failure of lowest (1252.5 m) bench only
		2019 - 2	1.4	1.1	Through both 1252.5 & 1297.5 m benches
		2019 - 2	1.5	1.3	Failure of upper (1297.5 m) bench only
PG02	M3	2019 - 3	1.3	1.1	Failure of lowest (1162.5 m) bench
	M4	2020 - 1	1.3	1.1	Failure of lowest (1162.5 m) bench only
		2020 - 1	1.5	1.3	Failure of middle (1207.5 m) bench only
		2020 - 1	1.5	1.2	Failure through 1162.5 and 1207.5 m benches
	M7	2021/ Final	1.3	1.2	Failure of lowest (1027.5 m) bench
		2021/ Final	1.5	1.3	Failure through 1027.5 & 1072.5 m benches
		2021/ Final	1.5	1.3	Failure through 1027.5, 1072.5 & 1117.5 m benches
PG03	M5	2020 - 2	1.3	1.1	Failure of lowest (1027.5 m) bench
	M6	2020 - 3	1.3	1.1	Failure of lowest (1027.5 m) bench only
		2020 - 3	1.4	1.3	Failure through 1027.5 & 1072.5 m benches
		2020 - 3	1.6	1.3	Failure through 1027.5, 1072.5 & 1117.5 m benches

5.4.5.2 Eagle Pup WRSA

Results of the Eagle Pup WRSA stability analysis are summarized in Table 5.4-3. The analysis results indicate acceptable safety factors and can be summarized as follows:

- The critical areas of the EP WRSA are the toes of individual lifts founded on colluvium soils. The analyses demonstrate static safety factors of 1.3 (1.1 pseudostatic) for these cases;
- Safety factors for a double bench failure were 1.6 and 1.3 for static and pseudostatic loading conditions, respectively;
- Large-scale failures were evaluated for slip surfaces through the lower approximately 50 % of the final WRSA and then for the full final WRSA height. The results indicate a 1.9 static safety factor for and 1.6 for pseudostatic loading conditions.

Table 5.4-3: Factors of Safety Results: Eagle Pup WRSA

Section	Model	Mine Period	FoS (Static)	FoS (Pseudostatic)	Critical Failure Description
EP01	M1	2021 - 1	1.3	1.1	Failure of 947.5 m bench
	M2	2021 - 2	1.3	1.1	Failure of lowest (947.5 m) bench only
		2021 - 2	1.6	1.3	Failure through 947.5 & 982.5 m benches
	M3	2029 / Final	1.3	1.1	Failure of lowest (947.5 m) bench only

Section	Model	Mine Period	FoS (Static)	FoS (Pseudostatic)	Critical Failure Description
		2029 / Final	1.9	1.6	Failure through 947.5, 982.5 & 1027.5 m benches
		2029 / Final	1.9	1.6	Failure of full height, all benches
EP02	M4	2027 - 1	1.3	1.1	Failure of lowest (1027.5 m) bench only

5.4.6 Liquefaction Considerations

As described by Hawley & Cunning (2017), liquefiable soils are those that experience significant strength loss when pore pressures in the soil approach or exceed the overburden or confining stress. The increase in pore water pressures and subsequent liquefaction can be triggered by static loading (e.g. excessive rate of loading) or by dynamic loading (e.g. earthquake shaking). In either case, saturation (or near-saturation) and generation of excess pore pressures under undrained conditions are required. Liquefied soils have extremely low shear strength and behave more like a fluid than a soil.

Soils with high liquefaction susceptibility are very uniform (poorly graded) with rounded sand and silt particles, low clay content and are very loose with high void ratios. Well graded (non-uniform) soils are less susceptible to liquefaction than uniformly graded soils because the voids between the coarse particles in a well-graded soil are more likely to be filled with fines. Well graded soils are typically subject to less volume change, and hence lower pore pressure generation, when subject to shear loading in undrained conditions (Hawley & Cunning 2017).

Geologically, the most liquefaction susceptible soils are recently deposited sediments such as finer-grained alluvial, fluvial, marine, deltaic and windblown deposits. Pleistocene-age colluvial soils such as those that cover slopes beneath the WRSA and stockpile at Eagle, which are non-uniform and well graded would be classified as low susceptibility to liquefaction during strong seismic shaking according to Youd & Perkins (1978) and Idriss & Boulanger (2008).

No cases of liquefaction of waste rock dump or stockpile foundations are noted in literature (Hawley & Cunning 2017). However, there may be cases where, given the right set of circumstances, liquefaction failure could also occur in a waste dump or stockpile foundation; consequently the potential for liquefaction failure was considered in the design process.

Liquefaction potential was evaluated according to the simplified procedures described by Idriss & Boulanger (2008) for the 475 year and maximum credible earthquake (MCE) events using the measured SPT N-values and the unsaturated groundwater conditions encountered with the SPT tests performed as part of site investigations, as well as a second (worst) case scenario, assuming fully saturated conditions.

During the BGC (2011 and 2012) field investigations a total of 33 SPT tests were carried out in colluvium soils across the site. Of the 33 tests, only 21 yielded valid results; the remaining 12 tests resulted in refusal from very stiff ground conditions. The 21 valid tests ranged from ‘Medium Dense’ to ‘Very Dense’ based on the SPT $N_{(60)}$ values. Using the simplified procedures described by Idriss & Boulanger (2008), safety factors against liquefaction exceeded 2.0 for all 21 colluvium tests indicating very low liquefaction potential.

Given that the Idriss & Boulanger (2008) methods are based heavily on the SPT $N_{(60)}$ values and that some of the values could have been impacted by frozen temperatures or ice within the samples, laboratory test results were also evaluated independent of the SPT tests. In particular, samples with low bulk density or high excess ice content could indicate liquefaction potential in the event they were rapidly thawed and were sufficiently poorly graded.

Bulk densities were measured for 4 colluvium samples during the Tetra Tech/NELPCO (2018a) field investigation: one each within the EP and PG WRSA footprints. Bulk densities of 1,860 kg/m^3 for a clayey silt sample and 2,076 kg/m^3 for a gravelly sand sample were measured for from the PG and EP WRSA samples, respectively. Frozen samples with bulk densities greater than approximately 1.6 to 1.7 kg/m^3 are generally considered ‘ice-poor’ indicating that they would be likely have low liquefaction potential if thawed.

Seven samples tested for excess ice within the PG and EP WRSA footprints indicated 0% excess ice. One sample obtained within the PG WRSA indicated 16% excess ice but was obtained from a local area within the PG drainage invert where higher ice content from permafrost and/or seasonal freezing would be expected.

5.4.7 Conclusions

JDS (2018; Appendix 5) concludes the following from the results of the slope stability analyses:

- Stability of the bottom lifts, founded on colluvium soils control stability of both the PG (1027.5 m bench) and EP (947.5 m bench) WRSAs with static safety factors of 1.3 calculated for the lowest bench of each facility. Safety factors for the initial, temporary waste rock benches planned in the upper PG valley (1252.5 m and 1162.5 m benches) indicate static safety factors of 1.2 due to the steeper natural ground surface;
- Individual lifts placed over existing waste rock rather than native foundation soils indicate significantly higher safety factor of 1.5 for static loading which exceeds the minimum acceptable safety factor;
- Safety factors for large-scale failures involving multiple waste rock benches exceed minimum requirements with safety factors of 1.4 to 1.9 for the EP and PG WRSAs;
- The minimum acceptable safety factor for pseudostatic analyses of 1.05 was met or exceeded for all cases except the initial, temporary PG 1252.5 m bench which yielded a 1.03 safety factor;
- Sensitivity analyses indicate that WRSA stability is sensitive to pore water pressures within the bottom waste rock benches and foundation soils beneath the toes for both the PG (1027.5 m bench) and EP (947.5 m bench) facilities. The stability analyses have been conducted assuming that the rock drains beneath the bottom benches will work as designed and drain freely, and that static water levels will not exceed more than 1 or 2 meters above the pre-mine ground surface;
- Potentially thaw-unstable ice-rich materials have also been identified in the upper Eagle Pup drainage. The EP WRSA has been re-designed since the Tetra Tech/NELPCO (2018a) field investigation to be constructed in a bottom-up sequence, thereby buttressing the upper lifts potentially founded on ice-rich materials; and,
- Liquefaction potential of colluvium soils beneath the WRSAs is considered to be low.

6 CLOSURE

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

StrataGold Corporation

per:

PROFESSIONAL
YUKON
STEVE TANG
TERRITORY
ENGINEER

Steve Tang

Steve Tang, P.Eng.
Manager of Mining Engineering, StrataGold Corporation

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APPENDIX 1

Permafrost Distribution Mapping within the Dublin Gulch Area

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TECHNICAL MEMO

ISSUED FOR REVIEW

To:	Michael Levy, MSc., P.E., P.G., P.Eng. Geotechnical Manager	**Date:**	October 6, 2017
c:	Kevin Jones, P.Eng., Vice President	**Memo No.:**	1
From:	V. Roujanski, Ph.D., P.Geol. S. McCuaig, Ph.D., P.Geo.	**File:**	704-ENG.EARC03103-01
Subject:	Permafrost Distribution Mapping within the Dublin Gulch Area		

This 'Issued for Review' document is provided solely for the purpose of client review and presents our interim findings and recommendations to date. Our usable findings and recommendations are provided only through an 'Issued for Use' document, which will be issued subsequent to this review. Final design should not be undertaken based on the interim recommendations made herein. Once our report is issued for use, the 'Issued for Review' document should be either returned to NELPCo or destroyed.

1.0 INTRODUCTION

NND EBA Land Protection Corp. operating as NELPCo Limited Partnership (NELPCo) has been retained by JDS ENERGY & MINING INC. (JDS) to conduct permafrost distribution mapping of the Dublin Gulch area (Figure 1) of the Eagle Gold Project, which is located 85 km from Mayo, in the central Yukon.

This technical memo provides a summary of NELPCO's detailed PurVIEW-based mapping of the spatial distribution of permafrost with variable ground ice content (percent by volume of visible ice) within the Dublin Gulch area. Information provided in this memo can be used to plan handling of ice laden frozen materials, plan additional geotechnical investigations, and be used in the assessment of stability at the waste rock dumps, the ore stockpile, and the reclamation soil stockpile.

2.0 METHODS

Permafrost distribution mapping within the Dublin Gulch area was carried out by Dr. Shirley McCuaig, P.Geo. and Dr. Vladislav E. Roujanski, P.Geol. Mr. Kevin Jones, P.Eng. provided technical input for the permafrost data review and interpretation and conducted senior review of the mapping.

The mapping was accomplished with NELPCo's PurVIEW system. This software incorporates 3D visualization and ArcGIS technologies, which allows viewing traditional aerial photography in a digital environment with the aid of specialized 3D glasses. Digital colour air photos provided by JDS were georeferenced, and merged with DEM data in PurVIEW. The mapper then zoomed in and out to observe and map the landscape in detail. Traditional air photos captured at 1:60,000 scale, for example, can be viewed at scales as large as 1:2,000 or greater, thereby allowing the mapper to do a much better job of identifying and delineating critical landscape features. Mapping was done directly on a computer screen with no need for hand-drawn linework.

The draft version of the permafrost distribution map was compiled in the ArcGIS format and is provided in Figure 1 as a PDF file. Figure 1 displays the interpreted spatial distribution of permafrost in the Dublin Gulch area at a scale of 1:10,000.

To assist with the permafrost mapping, NELPCO reviewed the historical borehole and testpit logging records (BGC, Knight Piesold, and EBA Engineering/Tetra Tech) and the ground temperature data recently collected on site by NELPCo's field personnel.

Permafrost terrain units (map polygons) were delineated according to geobotanical indicators (stunted black spruce stands on shallow permafrost vs. deciduous (dominantly aspen) stands within predominantly permafrost-free terrain), slope aspect (north-facing vs. south-facing slopes), and extrapolated surface appearance (texture, colour, hue etc.) compared to terrain units where permafrost conditions were identified and in some instances confirmed by ground temperature measurements from thermistor cables installed in boreholes.

3.0 PERMAFROST DISTRIBUTION MAPPING RESULTS

According to the Permafrost Map of Canada, the Dublin Gulch area is located within the zone of extensive discontinuous permafrost, where 50% to 90% of the area is expected to be perennially frozen (Heginbottom et al. 1995).

Permafrost map compiled in this study divides the Dublin Gulch area into the following permafrost terrain units:

- perennially frozen ground – predominantly very ice-rich with ground ice content locally exceeding 50% by volume of visible ice not visible (ICE and SOIL) labeled as "**Fi**" on Figure 1;
- perennially frozen ground – predominantly ice-rich with ground ice content generally ranging between 10% and 50% by volume of visible ice labeled as "**Fv**" on Figure 1;
- perennially frozen ground – predominantly ice-poor with ground ice content generally less than 10% by volume of visible ice or not visible ground ice labeled as "**Fn**" on Figure 1; and
- ground with thermal condition uncertain, or, if perennially frozen, ground ice content (% by volume of visible ice) is uncertain labeled as "**F**" on Figure 1.

If an area is not identified with one of these four labels (no label), it is considered to be predominantly permafrost-free. However, such areas may contain patches of permafrost in areas where conditions are favourable for permafrost aggradation.

The following describes each of the identified ground types in more detail:

Areas labelled as "Fi" (perennially frozen, predominantly very ice-rich) may include large accumulations of ground ice, such as ice wedges and other massive ice bodies, e.g. two boreholes drilled within a pingo-like feature in the project area (Figure 1) encountered significant accumulations of ground ice.

Areas labelled as "Fv" include perennially frozen soils with large amounts of visible excess ground ice but its content does not generally exceed 50% by volume. This ice-rich permafrost is well-bonded but rarely includes large ground ice bodies. The ice-rich areas may include patches of ice-poor permafrost with ground ice that is not visible to the unaided eye (**Fn**) and patches of permafrost-free ground. Ice content is estimated to range from 10% to 50% by volume of visible ice.

Areas labelled as "Fn" are generally ice-poor with ground ice content generally less than 10% by volume of visible ice or non-visible ground ice. These consist of perennially frozen ground that is well-bonded to friable and typically does not contain visible excess ice. However, these areas may include patches of permafrost with visible ground ice (Fv) exceeding 10% by volume, as well as patches of unfrozen ground.

Areas labelled as "F" include terrain units with ground thermal condition uncertain, or, if perennially frozen condition confirmed, ground ice content (% by volume of visible ice) being uncertain. This results from insufficient descriptions of subsurface conditions in some of the historical borehole or testpit logging record.

NELPCo recommends that coring permafrost with chilled drilling fluid (brine) with subsequent installation of thermistor cables in some of the completed boreholes be applied for future geotechnical investigations in the project area to increase the level of confidence in thermal condition of the ground and the total ground ice content estimates for detailed engineering.

4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of JDS ENERGY & MINING INC. and their agents. NELPCo Limited Partnership does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than JDS ENERGY & MINING INC., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached or Contractual Terms and Conditions executed by both parties.

5.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
NELPCo Limited Partnership

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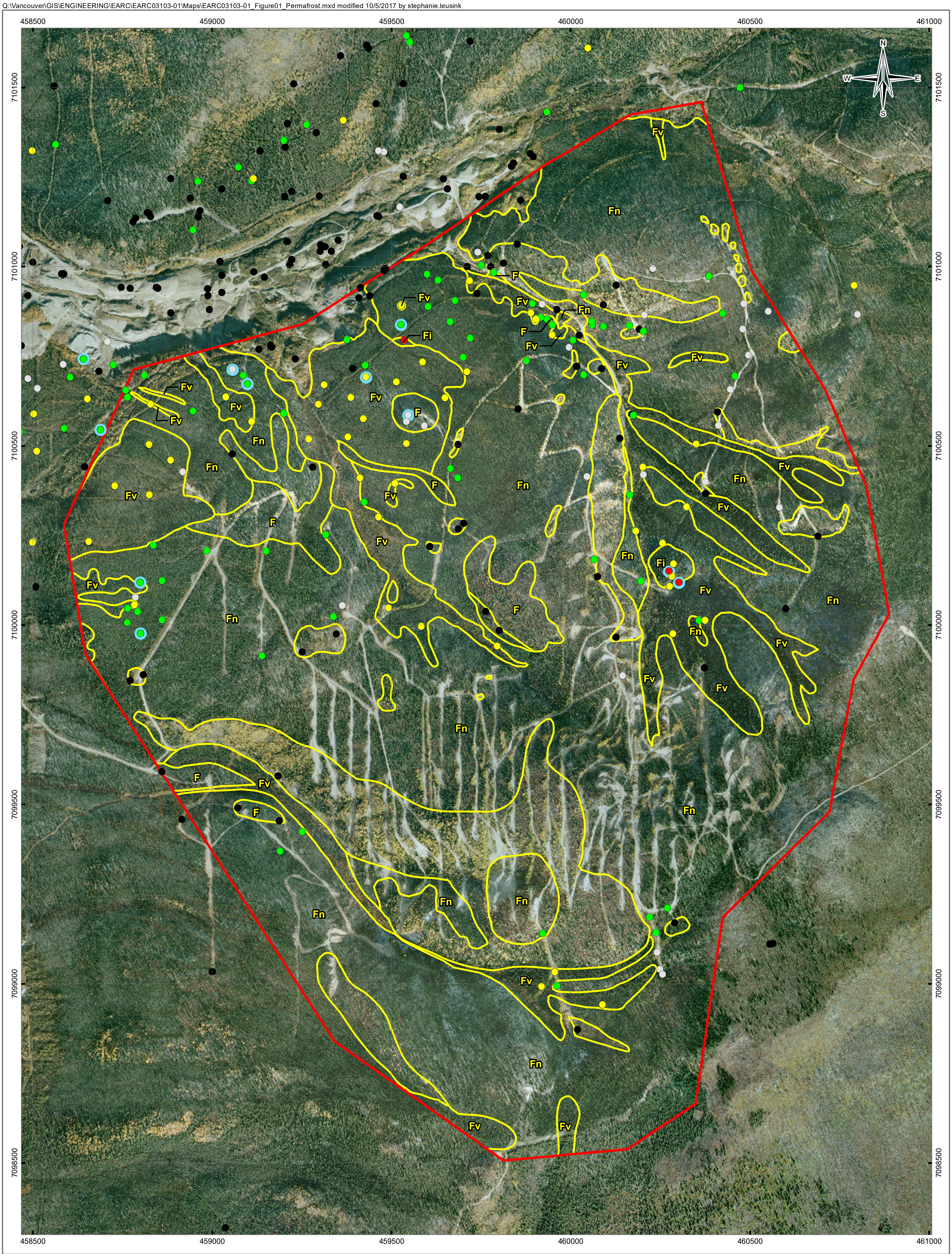
/jf

Attachments: Figure 1
NELPCo's Limitations on Use of this Document

REFERENCES

Heginbottom, J.A., Dubreuil, M.A., and Harker, P.T. 1995. Canada Permafrost. In: The National Atlas of Canada 5th Edition, Sheet MCR 4177, Plat 2.1, Scale 1:7,500,000. National Atlas Information Services, Canada Centre for Mapping Geomatics Canada, Terrain Sciences Division, Geological Survey of Canada, Natural Resources Canada, Ottawa.

Q:\Vancouver\GIS\ENGINEERING\EARC\EARC03103-01\Maps\EARC03103-01_Figure01_Permafrost.mxd modified 10/5/2017 by stephanie.leusink



LEGEND

⭕ Permafrost Study Area

Fi Perennially frozen ground – predominantly very ice-rich with ground ice content locally exceeding 50% by volume of visible ice

Fv Perennially frozen ground – predominantly ice-rich with ground ice content generally ranging between 10% and 50% by volume of visible ice

Fn Perennially frozen ground – predominantly ice-poor with ground ice content generally less than 10% by volume of visible ice or not visible ground ice

F Ground thermal condition uncertain, or, if perennially frozen, ground ice content (% by volume of visible ice) is uncertain

▭ Predominantly permafrost-free terrain

○ Thermistor indicating permafrost condition

Historical Testhole, Classified by Permafrost Presence

- 🔴 Very ice-rich
- 🟡 Ice-rich
- 🟢 Ice-poor
- ⚪ Uncertain
- ⚫ Unfrozen

NOTES
Base data source:
Imagery provided by the client (2010).

STATUS
ISSUED FOR REVIEW

EAGLE GOLD PROJECT
PERMAFROST DISTRIBUTION MAPPING

Permafrost Distribution in Dublin Gulch Area

PROJECTION
UTM Zone 8

DATUM
NAD83

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

FILE NO.
EARC03103-01_Figure01_Permafrost.mxd

CLIENT
JDS Energy & Mining Inc.
NELPCo NND-EBA LAND PROTECTION CORP.

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	SL	MEZ	SMC/ VER	0

DATE
October 5, 2017

PROJECT NO.
ENW.EARC03103-01

Figure 1

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the “Professional Document”).

The Professional Document is intended for the sole use of NELPCo Limited Partnership’s (NELPCo) Client (the “Client”) as specifically identified in the NELPCO Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the “Contract” herein). NELPCO does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by NELPCO.

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Where NELPCO has expressly authorized the use of the Professional Document by a third party (an “Authorized Party”), consideration for such authorization is the Authorized Party’s acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the “Limitations on Liability”). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party’s express acceptance of, and agreement to, the Limitations on Liability.

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1.2 ALTERNATIVE DOCUMENT FORMAT

Where NELPCO submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed NELPCO’s “Instruments of Professional Service”), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by NELPCO shall be deemed to be the original. NELPCO will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of NELPCO’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except NELPCO. NELPCO’s Instruments of Professional Service will be used only and exactly as submitted by NELPCO.

Electronic files submitted by NELPCO have been prepared and submitted using specific software and hardware systems. NELPCO makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by NELPCO for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of NELPCO.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with NELPCO with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for NELPCO to properly provide the services contracted for in the Contract, NELPCO has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO NELPCO BY OTHERS

During the performance of the work and the preparation of this Professional Document, NELPCO may have relied on information provided by third parties other than the Client.

While NELPCO endeavours to verify the accuracy of such information, NELPCO accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to NELPCO at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

NELPCO is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, NELPCO has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. NELPCO does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. NELPCO does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

NELPCO will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client’s expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. NELPCO cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

APPENDIX 2

Spring 2018 Geotechnical Investigation Data Report

Spring 2018 Geotechnical Investigation Data Report Eagle Gold Project

PRESENTED TO

Victoria Gold Corp.

SEPTEMBER 26, 2018
ISSUED FOR USE
FILE: ENG.EARC03103-02

Tetra Tech Canada Inc.
14940 - 123 Avenue
Edmonton, AB T5V 1B4 CANADA
Tel 780.451.2121 Fax 780.454.5688

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EXECUTIVE SUMMARY

NND EBA Land Protection Corp. operating as NELPCo Limited Partnership (NELPCo) was retained by Victoria Gold Corp. (Victoria Gold) to provide consulting services for a geotechnical permafrost investigation program at the Eagle Gold Project (the Project) site. The Project is located in the Dublin Gulch area of central Yukon Territory approximately 45 km (85 km via road) north-northeast of Mayo and 370 km (485 km by road) north of Whitehorse. A primary focus of the spring 2018 investigation was to acquire geotechnical and permafrost data, including frozen and unfrozen overburden soil and bedrock conditions, that would provide important data and information for input to the design of mine infrastructure, in particular to support the final design of the mine waste rock storage areas (WRSA): Eagle Pup WRSA, Platinum Gulch WRSA, the 90 Day Storage area, and the potential run-of-mine (ROM) stockpile area.

This data report has been prepared by Tetra Tech Canada Inc. (Tetra Tech), NELPCo's engineering service provider.

Several previous geotechnical site investigations were carried out by BGC Engineering Inc. (BGC) in 2009, 2010, 2011, and 2012. The previous site investigations were comprehensive and included numerous geotechnical drillholes, test pits, and subsequent laboratory testing programs. Based on a detailed review of the previous investigations (BGC 2009; 2010; 2011a,b; and 2012b,c) it was determined that additional information was necessary to confirm the characteristics and extent of permafrost (including frozen materials with excess ice) within the WRSA and ore stockpile footprints. The spring 2018 geotechnical investigation was designed specifically to augment the previous investigations by characterizing permafrost conditions in foundation areas critical to physical stability of the facilities.

The 2018 geotechnical site investigation program was carried out from April 5 to 15, 2018 and consisted of coring and testing frozen and unfrozen overburden soil and bedrock. A total of 13 boreholes with depths ranging from 7.9 m to 21.3 m were sonic-drilled and logged at the mine site facility locations.

An important objective of the spring 2018 program was to characterize permafrost conditions, including ground temperatures and ground ice contents (e.g., excess ice). Cores were logged according to appropriate geotechnical and permafrost standards. A total of six multi-bead ground temperature (thermistor) cables (GTCs) and seven single-bead thermistor strings were installed in the completed boreholes. GTCs were installed to 15 m to 20 m depths while single-bead thermistor strings to 8 m to 9 m depths.

This report presents the most recent geotechnical and permafrost data collected during the spring 2018 investigation, including borehole logs, geotechnical laboratory test results, GTC, and single-bead thermistor string readings collected from newly installed ground temperature monitoring instrumentation. This report is not intended to be a comprehensive summary of all geotechnical information used as the basis of the WRSA and ore stockpile designs. The BGC 2010, 2011 and 2012 site geotechnical investigation reports should be referenced for details regarding information collected from those investigations. Subsurface conditions at the WRSAs: the 90 Day Storage area, and the potential ROM stockpile area are summarized from the new data.

The new permafrost data was used to update the permafrost distribution map of the project area which was originally developed based on the previous BGC investigations and detailed air photo analysis by Tetra Tech in 2017. A discussion regarding the review of previous investigations and preparation of the initial permafrost map can be found in Tetra Tech's October 6, 2017 technical memo (issued for review) entitled “Permafrost Distribution Mapping within the Dublin Gulch Area” (Tetra Tech 2017).

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
BGL	Below Ground Level
bgs	below ground surface
FF	Fracture Frequency
GTC	Ground Temperature Cable (Multi-Bead Thermistor Cable)
HLF	Heap Leach Facility
JDS	JDS Energy and Mining Inc.
JSN	Joint Set Number
MSD	Midnight Sun Drilling Ltd.
NAD83	North American Datum 1983
Nbe	Well bonded perennially frozen soil with non-visible excess ice
Nbn	Well bonded perennially frozen soil with, no excess ice
NELPCo	NELPCo Limited Partnership
Nf	Poorly bonded or friable frozen soil, no excess ice
PLT	Point Load Test
ROM	Run-of-Mine
RQD	Rock Quality Designation
SBTS	Single-Bead Thermistor String
Tetra Tech	Tetra Tech Canada Inc.
UCS	Unconfined Compressive Strength
UTM	Universal Transverse Mercator
Vc	Perennially frozen soil with excess ice visible as ice coating on particles
Victoria Gold	Victoria Gold Corp.
Vr	Perennially frozen soil with excess ice visible as random or irregularly oriented ice formations
Vs	Perennially frozen soil with excess ice visible as stratified or distinctly oriented ice formations
Vu	Perennially frozen soil with excess ice visible as ice formations uniformly distributed throughout
Vx	Perennially frozen soil with excess ice visible as individual ice crystals or inclusions
WRSA	Waste Rock Storage Area

GLOSSARY OF TERMS

ACTIVE LAYER – the top layer of ground that is subject to annual thawing and freezing in areas underlain by permafrost. The thickness of the active layer varies from year to year, depending on such factors as the ambient air temperature, vegetation, drainage, soil and rock type, water content, snow cover, slope degree, and aspect.

CRYOSTRUCTURE – the structural characteristics of frozen earth materials determined by the amount and distribution of pore ice and lenses of segregated ice. Can be described as massive, layered, reticulate etc.

DEPTH ALONG AXIS (m) – depth measured along the borehole axis from its collar.

DEPTH OF ZERO ANNUAL AMPLITUDE (*depth of zero seasonal temperature variations*) – the distance from the ground surface downward to the level beneath which there is practically no annual fluctuation in ground temperature (NRCC 1988).

EXCESS ICE – the volume of ice in the ground that exceeds the total pore volume that the ground would have under natural unfrozen conditions (NRCC 1988).

GROUND ICE – a general term referring to all types of ice (segregated, intrusive, vein etc.) formed in freezing and frozen ground. Occurs in pores, cavities, voids, cracks, fractures, and other openings in soil or rock.

ICE + SOIL TYPE (ICE and SILT etc.) – ice with soil inclusions: discrete visible ice formations in frozen soils that are greater than 50% by volume. Frozen core interval that contains more ice (>50% by volume of visible ice) than soil particles.

ICE COATINGS – discernible layers of ice found on or below the larger soil particles in a frozen soil mass.

ICE CONTENT – the amount of ice contained in frozen or partially frozen soil or rock. Ice content is normally expressed in one of two ways:

- On a dry-weight basis (gravimetric), as the ratio of the mass of the ice in a sample to the mass of the dry sample, expressed as a percentage; or
- On a volume basis (volumetric), as the ratio of the volume of ice in a sample to the volume of the whole sample, expressed as a percentage.

ICE LENS – a dominantly horizontal, lens-shaped body of ice ranging in thickness from hairline to 0.3 m. Ice layers more than 0.3 m in thickness are better termed massive ice beds.

ICE WEDGE – a massive, generally wedge-shaped body of foliated or vertically banded, commonly white, ground ice with its apex pointing downward.

MASSIVE ICE – A comprehensive term used to describe large masses of ground ice, including ice wedges, pingo ice, buried ice, and predominantly horizontal beds of segregated ice. Massive ice layers have a minimum thickness of 0.3 m. Ice layers less than 0.3 m in thickness are better termed ice lenses. Some massive ice beds are more than 40 m thick and extend several kilometres laterally (Mackay 1973; NRCC 1988; Tetra Tech WM4102).

MASSIVE ICE BED – a predominantly horizontal layer of ground ice with a minimum thickness of 0.3 m, a minimum lateral extent of at least 10 m, and an ice content of at least 250% (on an ice-to-dry-soil weight basis). If the ice content is less than 250%, the beds are termed "**massive icy beds**". The largest ice beds exceed 1 km^2 in area and are more than 40 m thick. Massive ice beds show every possible gradation from icy muds to pure ice (Mackay 1973; NRCC 1988; Tetra Tech WM4102).

PERMAFROST – ground (soil and/or rock) that remains at or below 0ºC for at least two consecutive years. Permafrost is defined exclusively on the basis of temperature. It does not necessarily contain ground ice.

PERMAFROST BASE – the lower boundary surface of permafrost, above which temperatures are perennially below 0°C and below which temperatures are perennially above 0°C.

PERMAFROST, ICE-RICH – permafrost containing excess ice.

PERMAFROST TABLE – the upper boundary of permafrost.

SUPRAPERMAFROST WATER – water occurring in the active layer above the permafrost table.

SUBPERMAFROST WATER – water occurring in the unfrozen ground below the permafrost base.

TALIK – a layer or body of unfrozen ground in a permafrost area. Several types of taliks can be distinguished on the basis of their relationship to the permafrost: closed, open, lateral, isolated etc. (NRCC 1988).

TRUE DEPTH (m) – depth measured from the borehole collar perpendicular (normal) to the ground surface.

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Victoria Gold Corp. and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Victoria Gold Corp., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

NND EBA Land Protection Corp. operating as NELPCo Limited Partnership (NELPCo) was retained by Victoria Gold Corp. (Victoria Gold) to provide consulting services for a geotechnical permafrost investigation program at the Eagle Gold Project (the Project) site. The Project is located in the Dublin Gulch area of central Yukon Territory approximately 45 km (85 km by road) north-northeast of Mayo and 370 km north of Whitehorse (485 km by road) (Figure 1; “Figures” Section of this report).

This data report has been prepared by Tetra Tech Canada Inc. (Tetra Tech), NELPCo’s engineering service provider.

Several previous geotechnical site investigations were carried out in the Project area by BGC Engineering Inc. (BGC) in 2009, 2010, 2011, and 2012. The previous site investigations were comprehensive and included numerous geotechnical drillholes, test pits, and subsequent laboratory testing programs. Based on a detailed review of the previous investigations (BGC 2009; 2010; 2011a,b; and 2012b,c) it was determined that additional information was necessary to confirm the characteristics and extent of permafrost (including frozen materials with excess ice) within the WRSA and ore stockpile footprints. The spring 2018 geotechnical investigation was designed specifically to augment the previous investigations by characterizing permafrost conditions in foundation areas critical to physical stability of the facilities. Specifically, the final toes and first few years of interim toes were targeted.

The 2018 geotechnical investigation program consisted of coring and testing of frozen and unfrozen overburden soil and bedrock. Although BGC (2012a) defines the overburden soil as including completely weathered bedrock, for the purpose of this report, overburden soil is described as all soils above bedrock, including organic and/or inorganic (mineral) soils in both frozen and unfrozen states.

An important objective of the spring 2018 program was to characterize the permafrost conditions as accurately as possible, including ground temperatures and ground ice contents (percent by volume of visible ice). Cores were logged according to appropriate geotechnical and permafrost standards (ASTM D4083; WM4102; WM4105; WM4400). Every completed borehole was instrumented by either a multi-bead ground temperature (thermistor) cable (GTC) installed to 15 m to 20 m depth or a single-bead thermistor string (SBTS) installed to 8 m to 9 m depth.

This report presents the most recent geotechnical and permafrost data collected during the spring 2018 site investigation, including borehole logs, geotechnical laboratory test results, ground temperatures measured with GTC and SBTS. Subsurface conditions at the two proposed WRSA locations, the 90 Day Storage area, and potential ROM stockpile area are summarized from the data collected from this study only. This report is not intended to be a comprehensive summary of all geotechnical information used as the basis for the WRSA and ore stockpile designs. The BGC 2010, 2011, and 2012 geotechnical site investigation reports (BGC 2009; 2010; 2011a,b; and 2012b,c) and the waste rock storage design report (BGC 2012a) should be referred to for details regarding information collected from the previous investigations.

The new permafrost data was used to update the permafrost distribution map of the project area. The updated map is provided as the background for Figure 2. The permafrost map was originally developed by using data from the previous BGC investigations (BGC 2009; 2010; 2011a,b; and 2012b,c) and detailed air photo analysis by Tetra Tech (Tetra Tech 2017). It has now been further refined with the subsurface data collected as part of this study.

This report incorporates and is subject to Tetra Tech’s Limitations on Use of this document, which are included in Appendix A.

2.0 GEOTECHNICAL INVESTIGATION

2.1 General

The spring 2018 geotechnical site investigation program was completed from April 5 to 15, 2018 and was managed by Dr. Vladislav E. Roujanski, P.Geol., a senior project geologist-geocryologist based in Tetra Tech's Edmonton office. Field core logging, sampling, and on-site geotechnical soil core testing was conducted by Dr. Roujanski, Mr. Ernest Palczewski, P.Geo., and Mr. Ryan Okkema, E.I.T. (all based in Tetra Tech's Edmonton Office).

Technical support for the field program was provided by Mr. Kevin Jones, P.Eng., Tetra Tech's Vice President for Arctic Development, while logistical support for the field program was provided by Mr. Chad Cowan, Tetra Tech's Yukon Geotechnical Manager based in Tetra Tech's Whitehorse Office.

Victoria Gold had representatives on site helping to coordinate the drilling program. Midnight Sun Drilling Ltd. (MSD) was the drilling contractor.

Existing site roads were plowed and cleared of snow by a bulldozer where necessary to allow access to the drill pad locations. Drill pads were cleared and flattened by an excavator prior to rig mobilization. Crew access to the drill pad locations was provided by light vehicles. Construction of drill pads often required cut and fill to make a level surface for the sonic drill to move into position. To recover representative core samples of the uppermost ground layer and install thermistor cables within undisturbed terrain, the drill rig was positioned on the edge of the pad, when possible, to drill into the undisturbed native ground. However, due to space and accessibility constrains, Boreholes GT18-05, GT18-09, and GT18-10 required drilling through fill material, advancing into the cut on the original slope or otherwise previously disturbed ground.

2.2 Borehole Locations

To characterize the WRSA foundation materials, 20 borehole locations were initially selected for the spring 2018 program based on permafrost distribution maps and mine development plans. Thirteen boreholes were drilled as seven of the originally proposed borehole locations were inaccessible due to deep snow cover, slope steepness, or other challenging ground conditions (e.g. accumulations of large boulders).

The project area is located within Zone 8 of the Universal Transverse Mercator (UTM) Grid. The horizontal datum for this project is the North American Datum 1983 (NAD83).

Survey control for the geotechnical site investigation was provided by Tetra Tech field personnel using a handheld GPS unit (Garmin GPSMAP 62) to locate and verify the borehole locations that were staked by Victoria Gold prior to the investigation. The coordinates, depth to bedrock, and completion depth for each of the boreholes are presented on borehole logs in Appendix B and are summarized in Table 1 below. Borehole locations are also presented on Figure 2.

Table 1: Borehole Information Summary

Site Infrastructure	Borehole	UTM Zone			Depth to Bedrock (m)	Completion Depth (m)
		Northing (m)	Easting (m)	Elevation (m)		
Eagle Pup WRSA	GT18-01	7,100,952	459,831	913.0	4.8	21.3
	GT18-02	7,100,945	459,925	932.0	2.1	7.9
	GT18-04	7,100,787	459,854	961.0	2.1	9.0
	GT18-05	7,100,814	460,006	944.0	3.5	21.0
	GT18-06	7,100,852	460,088	968.0	3.8	12.0
	GT18-07	7,100,709	460,139	965.0	12.0	21.0
Platinum Gulch WRSA	GT18-08	7,099,141	459,517	990.0	N/A	17.4
	GT18-09	7,098,981	459,925	1,117.0	9.5	21.0
	GT18-10	7,098,851	459,968	1,175.0	9.0	12.0
	GT18-11	7,098,964	460,080	1,181.0	10.0	12.0
Potential ROM Stockpile Area	GT18-15	7,100,583	459,597	961.0	18	21.0
	GT18-16	7,100,308	459,607	982.0	3.5	9.0
90 Day Storage	GT18-17	7,100,290	459,263	944.0	5.5	9.0

2.3 Drilling and Coring Methodology

Thirteen completed boreholes were drilled using a Compact Crawler TerraSonic CC150 Sonic drill rig operated by MSD (Photo 1). A sonic drill was selected for the program due to its ability to consistently recover high percentages of samples in the overburden. Sonic drilling is not particularly effective in coring bedrock but this was not a concern given that the program was designed with the primary focus of soil and permafrost sampling. Bedrock was already well sampled and characterized using diamond core drilling during the previous BGC investigations (BGC 2009; 2010; 2011a,b; and 2012b,c). The maximum depth drilled by the sonic drill was 21.25 m. Overburden soil and bedrock core samples were recovered using an HQ bit (4” ID and 4.75” OD) for all boreholes.

Photo 1: Compact crawler TerraSonic CC150 Drill Rig, Borehole GT18-05 site. Eagle Pup WRSA, looking north. Photo taken April 9, 2018

Overburden soil recovery ranged from 90% to 100%, but in some cases, core was thermally and mechanically disturbed from the drilling process. Holes were typically only drilled far enough into bedrock to confirm that competent bedrock had been reached. Rock core recovery was variable, depending on the use of water to aid in the drilling process. Rock core recovery ranged from 90% to 100% without the use of water and decreased to 10% to 20% recovery with water aided drilling.

2.4 Geotechnical Logging and Sampling

Frozen and unfrozen overburden soil and bedrock core examination and logging was conducted immediately following core recovery to ensure that there was minimal thermal disturbance to the frozen core samples. This allowed accurate identification, logging, and sampling of frozen and unfrozen overburden core.

Overburden soils were logged according to the Modified Unified Soil Classification System guidelines (Appendix B) and Tetra Tech's methodology for logging frozen and unfrozen overburden, which includes soil composition, particle shape, moisture, colour, and consistency of soil (WM4400 – see Appendix E) and classify frozen soil based on whether ice is visible or not (WM4102 – see Appendix E).

All recovered core samples were placed in wooden core boxes and photographed immediately upon recovery, prior to sample removal. Close-up photographs were taken of ground ice formations and cryostructures where present. Photographs of the recovered core samples are included in the "Photographs" Section of this report, as are selected photographs (Photos 1 to 48) of the recovered overburden soil and bedrock core.

Representative disturbed soil samples were placed in plastic bags, double-bagged for moisture preservation, and transported to the onsite geotechnical laboratory.

Representative undisturbed frozen core samples were wrapped in several layers of plastic wrap and aluminum foil. The wrapped samples were temporarily stored at the drill sites in insulated coolers with ice packs to maintain their frozen undisturbed state until they were transferred to a freezer located at the Eagle Camp.

2.5 Geotechnical Laboratory Testing

2.5.1 General

Eight samples were tested in the onsite laboratory located at the camp, which was equipped with a microwave oven, electronic scale, and other basic testing equipment. On-site laboratory testing included measurements of excess ground ice content, moisture content, and porewater salinity. The remainder of the frozen core samples were shipped to Whitehorse and Edmonton for testing and storage at Tetra Tech's geotechnical laboratories. The off-site testing included natural moisture and excess ice contents, grain size analysis, bulk densities, and direct shear tests.

The testing results are summarized below in Tables 2 and 3. The results are also presented in Appendix C and are detailed on the borehole logs in Appendix B.

2.5.2 Classification Laboratory Testing

On-site Moisture Content, Excess Ice Content, and Salinity Analysis

On-site excess ice content analyses were completed on eight samples, as these samples showed potential for the presence of excess ice. Five of the selected eight samples were also tested on-site for moisture content. Salinity analysis was completed on one sample. The results are summarized in Table 2.

Table 2: Summary of On-site Laboratory Test Results

Borehole No.	Sample No.	Depth		Moisture Content (%)	Excess Ice Content (% by volume)	Porewater Salinity (ppt)
		From (m)	To (m)			
GT18-02	S1	0.47	0.64	29.0	0.0	-
GT18-05	S1	0.40	0.55	48.1	0.0	-
	S2	0.80	0.90	23.0	0.0	-
	S5	1.35	1.50	29.0	0.0	-
GT18-08	S2	0.70	0.75	139.4	>0.0*	-
	S5	3.45	3.50	-	15.6	0
GT18-17	S1	0.60	0.75	-	52.2	-
	S4	2.30	2.40	-	0.0	-

*Organic material present in the sample expanded in volume on thawing and absorbed excess water lowering the actual excess ice content (% by volume) compared to that estimated visually in the field.

Off-site Moisture Content, Bulk Density, Excess Ice Content, and Particle Size Analysis

Moisture content testing was completed on 32 samples from 12 boreholes. Hydrometer (particle size) analyses were completed on 12 samples, bulk density analysis was performed on 4 samples, and a wash sieve analysis was completed on 13 samples. The number of samples selected for testing and their locations along the vertical borehole profile depends on the variability of the overburden materials encountered during drilling. The intent of the laboratory testing program was to fill in information gaps and provide sufficient geotechnical characterization of the overburden soils. The test results are summarized in Table 3.

Table 3: Summary of Off-site Laboratory Test Results

Borehole No.	Sample No.	Depth		Moisture Content (%)	Bulk Density (kg/m^3)	Excess Ice Content (% by volume)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)
		From (m)	To (m)							
GT18-01	S1	1.50	2.50	9.4	-	-	39.0		41.0	20.0
	S2	3.80	4.20	10.2	-	-	33.0		35.0	32.0
GT18-02	S2	1.20	1.50	9.7	-	-	39.0		25.0	36.0
GT18-04	S2	0.95	1.25	7.1	-	-	29.0		31.0	40.0
GT18-05	S3	0.90	1.00	20.9	-	-	35.0		34.0	31.0
	S4	1.12	1.34	-		0.0	12.0	73.0	13.0	2.0
	S6	3.30	3.40	7.1	2076	-	8.0	14.0	39.0	39.0
GT18-06	S1	0.60	1.00	4.3	-	-	19.0		30.0	51.0
	S2	2.50	3.10	11.5	-	0.0	33.0		27.0	40.0
	S3	5.20	5.60	9.3	-	-	19.0		37.0	44.0
GT18-07	S1	0.60	0.90	12.4		-	30.0		36.0	34.0
	S2	2.20	2.60	12.4	-	-	41.0		27.0	32.0
	S3	4.00	4.40	4.0	-	-	8.0		41.0	51.0
	S5	11.10	11.40	8.0	-	-	23.0		32.0	45.0
GT18-08	S1	0.55	0.70	29.6	-	-	22.0		41.0	37.0
	S4	2.45	2.60	11.8	-	-	17.0		29.0	54.0
	S6	3.50	3.70	28.3	-		70.0		30.0	0.0
	S8	5.60	5.80	10.8		-	12.0	31.0	26.0	31.0
	S10	13.70	14.00	7.7	-	-	15.0	22.0	42.0	21.0
GT18-09	S1	2.00	2.20	4.5		-	23.0		38.0	39.0
	S2	5.00	5.20	5.7	-	-	20.0		30.0	50.0
GT18-10	S1	2.70	3.00	27.5	1860	-	17.0	68.0	11.0	3.0
	S2	6.50	6.70	7.7	-	-	35.0		23.0	43.0
GT18-11	S1	2.00	2.20	5.5	-	-	23.0		31.0	46.0
GT18-15	S1	1.00	1.10	7.7	-	-	12.0	32.0	37.0	19.0
	S2	8.80	9.00	14.5	-	-	12.0	24.0	41.0	23.0
	S5	12.70	13.00	10.0	2228	-	14.0	28.0	34.0	24.0
	S7	17.50	17.80	11.1	2353	-	22.0	36.0	27.0	15.0
GT18-16	S1	0.50	0.80	12.1		-	42.0		32.0	26.0
	S2	2.50	2.80	10.3	-	-	35.0		32.0	33.0
GT18-17	S2	1.10	1.30	76.6		51.3	20.0	24.0	35.0	21.0
	S3	1.60	1.80	29.8		21.3	17.0	28.0	37.0	18.0
	S5	3.70	3.90	10.9	-	-	19.0	34.0	35.0	12.0

2.5.3 Geomechanical Laboratory Testing

Direct Shear Testing

Direct shear tests were carried out at Tetra Tech's Edmonton geotechnical laboratory on four test specimens reconstituted from seven samples following ASTM D3080. Samples GT18-01-S1 and GT18-04-S2 and samples

GT18-02-S2, GT18-06-S2, and GT18-07-S2 were reconstituted together to produce two separate test specimens. A test specimen was reconstituted from disturbed sample GT18-08-S4, and another test specimen was trimmed from sample GT18-08-S6. The samples were selected based on a high percentage of fines and high excess ice contents.

Table 4 presents a summary of the direct shear test results. The sample ring and thickness of all the test specimens was 18.92 mm.

Table 4: Direct Shear Test Results

Borehole and Sample Number	**Sample Depth (m)**	**Sample ID**	**Wet Density (Mg/m^3)**	**Dry Density (Mg/m^3)**	**Normal Stress (kPa)**	**Shear Stress (kPa)**	**Inferred Shear Strength Parameters – Peak**	
							Cohesion Intercept (kPa)	**Shearing Resistance Angle (°)**
GT18-01-S2 & 04-S2	1.50–2.50, 0.95–1.25	DS-1	2.220	1.989	500	368	71.0	32.0
		DS-2	2.221	1.994	1,000	721		
		DS-3	2.222	1.994	2,000	1,315		
GT18-02-S2 & 06-S2 & 07-S2	1.20-1.50, 2.5–3.10, 2.20–2.60	DS-4	2.225	1.951	500	349	54.0	30.6
		DS-5	2.225	1.954	1,000	648		
		DS-6	2.225	1.956	2,000	1,238		
GT18-08-S6	3.50-3.70	DS-7	2.051	1.775	250	189	23.5	33.3
		DS-8	2.051	1.792	500	351		
		DS-9	2.051	1.789	1,000	682		
GT18-08-S4	2.45–2.60	DS-10	2.213	1.961	250	221	12.5	39.6
		DS-11	2.213	1.967	500	423		
		DS-12	2.214	1.966	1,000	840		

2.6 Ground Temperature Cable Instrumentation Installations

Six multi-bead GTCs were installed to determine ground temperatures in locations where there is no or limited ground temperature data. GTCs were installed in the following boreholes: GT18-01 (TT# 2665), GT18-05 (TT# 2666), GT18-07 (TT# 2663), GT18-08 (TT# 2668), GT18-09 (TT# 2669), and GT18-15 (TT#2667).

The GTC boreholes were drilled to a minimum target depth of 21.0 m. A 25 mm I.D. flush couple threaded watertight PVC pipe with a bottom cap was threaded and glued together and lowered into the borehole. The annulus between the 25 mm PVC pipe and the borehole wall was backfilled with clean, dry sand to hold the PVC pipe in place. Several bags of bentonite chips were used to backfill the annulus at intervals within the sand to create a plug, preventing water from flowing down the borehole causing possible thermal irregularities along the thermistor string. GTCs were inserted inside the watertight PVC pipes at depth where the first thermistor bead is 0.5 m below ground level (BGL). An exception is Borehole GT18-08 where the drill bit hit refusal on hard granite boulders at 17.4 m depth, 3.6 m short of the minimum required depth. Therefore, GTC at this location was placed to a depth of 15.15 m, with the first thermistor bead below ground surface being the eighth thermistor bead on the string at 0.65 m BGL). Backfill was not used inside of PVC pipes. A 50 mm I.D. PVC pipe with a metal housing cabinet attached at the top was set over the 25 mm PVC pipe to protect the GTC lead. Metal housings were attached to two 2” by 4” by 4’ wood planks to provide stability. GTC cable installation reports are provided in Appendix D.

Initial GTC readings were taken immediately after installation to confirm that all the thermistor beads were working properly. Ground temperature readings were taken again several days after installation. Two subsequent sets of readings were taken by Victoria Gold site personnel on May 15 and June 8, 2018. The measured ground temperatures at the depth of zero annual amplitude appear to have reached equilibrium and show either very warm permafrost with ground temperatures ranging from approximately 0°C at GT18-15 (Potential ROM Storage Area) to -0.5°C at GT18-08 (Platinum Gulch WRSA) or non-permafrost conditions with ground temperatures above the freezing point. Ground temperature profiles showing changes in temperatures with depth are presented in Appendix D.

Sacrificial SBTSs were installed in the remaining seven completed boreholes to depths ranging from 7.9 m to 9.0 m BGL to confirm the ground thermal condition, i.e. the presence or absence of permafrost. Borehole numbers, thermistor bead depths, installation dates, and the most recent ground temperature readings collected on June 8, 2018 are given in Table 5. Manual ground temperature readings from SBTSs were collected three times, i.e. several days after installation and again on May 15 and June 8, 2018.

Table 5: Single Bead Thermistor Readings

Borehole No.	Single Bead No.	Northing (m)	Easting (m)	Elevation (m)	Bead Depth (m)	Date Installed	Most Recent Date Measured	Ground Temperature (°C)
GT18-02	14	7,100,945	459,925	932.0	7.9	7-Apr-18	8-Jun-18	1.21
GT18-04	18	7,100,787	459,854	961.0	8.5	10-Apr-18	8-Jun-18	1.32
GT18-06	13	7,100,852	460,088	968.0	9.0	8-Apr-18	8-Jun-18	0.21
GT18-10	10	7,098,851	459,968	1,175.0	8.5	14-Apr-18	8-Jun-18	-0.08
GT18-11	11	7,098,964	460,080	1,181.0	8.5	13-Apr-18	8-Jun-18	-0.05
GT18-16	2	7,100,308	459,607	982.0	8.2	11-Apr-18	8-Jun-18	0.92
GT18-17	7	7,100,290	459,263	944.0	8.5	12-Apr-18	8-Jun-18	-0.12

2.7 Permafrost Distribution Mapping

The subsurface data collected during the spring 2018 geotechnical drilling program, as well as continued monitoring of the site ground thermal regime with GTCs and SBTSs installed in April 2018 have been used to update a preliminary map of permafrost distribution in the Dublin Gulch area that was compiled by Dr. Roujanski and Dr. McCuaig (Tetra Tech 2017). The map is provided as the background for Figure 2.

3.0 SUBSURFACE CONDITIONS

3.1 General

Observed terrain conditions are discussed in the following sections. The discussions are based on the drill site terrain observations and the data collected during the drilling, logging, field and laboratory testing phases of the investigation. Subsurface conditions are not uniform; it is expected that conditions between and surrounding the boreholes may vary from the subsurface conditions identified within the boreholes described in this report. However, the borehole data does give a general indication of the range of subsurface properties to be expected in the area.

Based on data from previous site investigations (BGC 2009; 2010; 2011a, b; and 2012b,c), the results of the current geotechnical investigation and updated permafrost distribution mapping, we find that permafrost generally occurs on north-facing slopes, and on some west- and east-facing slopes at higher elevations, and within poorly-drained areas lower in the valleys. The distribution of permafrost is highly variable within the project area – changing from patchy occurrence and permafrost-free areas on south-facing slopes to more prevalent presence on north-facing slopes. More data is needed to refine the permafrost distribution patterns within the project area.

Permafrost conditions are very warm, even at higher elevations – hovering close to 0°C (Table 5 and Appendix D).

3.2 Eagle Pup WRSA

Six boreholes (GT18-01, GT18-02, GT18-04, GT18-05, GT18-06, GT18-07) were drilled within the footprint of the proposed Eagle Pup WRSA (Figure 2). These boreholes were drilled along and adjacent to the Eagle Pup Gulch.

The general terrain and subsurface conditions of the proposed Eagle Pup WRSA footprint are discussed in the following sections and are summarized in Table 6.

Table 6: Overburden Soil Condition Summary, Eagle Pup WRSA

Borehole No.	Overburden Thickness (m)	Organic Layer Thickness (m)	Major Overburden Soil Types	Active Layer Thickness (m)*	Permafrost Conditions
GT18-01	4.2 (not including 0.6 m fill)	0.22	Peat; Sand and Gravel; Cobble	~2.5; (a seasonally frozen layer)	Permafrost-free with a seasonally frozen layer (Vx up to 5%)
GT18-02	2.1	0.3	Sand and Gravel; Cobble	~1.5 to 2.0; (a seasonally frozen layer)	Permafrost-free with a seasonally frozen layer Vx 15-20%
GT18-04	2.1	N/A	Sand and Gravel	~2.0 to 2.5; (a seasonally frozen layer)	Permafrost-free with a seasonally frozen layer (Nbn)
GT18-05	3.15 (not including 0.35 m fill)	0.45	Sand and Gravel, Silt	~2.0; (a seasonally frozen layer)	Permafrost-free with a seasonally frozen layer (Vx, Vc, Vs up to 10%)
GT18-06	9.0	0.3	Peat; Gravel; Boulders	~3.5; (a seasonally frozen layer)	Permafrost-free with a seasonally frozen layer (Vx up to 10%)
GT18-07	12.0	0.6	Sand and Gravel, Silt	~2.3; (a seasonally frozen layer)	Permafrost-free with a seasonally frozen layer (Vx 1-3%)

* - measurements of the active layer thickness are based on interpretation of the ground temperature data and examination of the core immediately after its recovery.

3.2.1 General

The terrain of the proposed Eagle Pup WRSA was observed and drilled between April 7 to 10, 2018. Its footprint lies within a drainage basin with an overall northerly aspect. The drainage basin converges into Eagle Pup which drains into Eagle Creek.

Boreholes GT18-01, GT18-02, GT18-06, and GT18-07 are located on the eastern side of Eagle Pup, where the slope has a southwesterly to westerly aspect. Vegetation consists of relatively healthy aspen, pine, and spruce trees and shrub birch and willow. Boreholes GT18-04 and GT18-05 are located on the southwestern slope, where the slope has a northern to northeastern aspect. Vegetation here lacks aspen trees and consists of moderately sparse pine, black spruce trees and shrubs.

The slope of Eagle Pup stream is on average 3° to 5°. The slope northeast of it dips 15° to 25° where the boreholes are (but more steeply above them), while the southwestern slope is mainly 15° but slope angle increases farther up the incline.

3.2.2 Overburden Soils

The organic layer consists mainly of dark brown to black fibrous peat up to 0.3 m thick. A trace of rootlets were found up to 0.6 m BGL into till material.

Poorly to well graded, grey to dark brown silt, sand and gravel mixtures with cobbles disseminated throughout make up the bulk of the colluvial overburden. Any of these may be the dominant soil component. Rubble zones of angular gravel and cobble make up the coarse component.

Gravimetric moisture content of the overburden material varied from 4.0% in gravel and sand at a depth of 4.0 m in GT18-07 to 48.1% at a depth of 0.4 m in GT18-05 (Tables 2 and 3).

Frozen conditions with visible excess ice (Vx, Vc, Vs, Vr) were observed in the upper 3.0 m of the overburden in four out of six boreholes. Thermistor cables installed in these boreholes confirmed non-permafrost conditions below the seasonally frozen layer (Appendix D and Table 5). Therefore, visible ice observed in these boreholes is seasonal ice present within the active layer.

3.2.3 Bedrock

Bedrock in all six boreholes consisted of metasedimentary rock with varying levels of oxidation. Due to the heavily mechanically disturbed condition of the recovered rock core from the Sonic drilling process, RQDs, fracture frequencies, and strength designations could not be determined. As previously discussed, RC drilling is not particularly effective at coring bedrock. Bedrock has previously been well characterized in the Eagle Pup WRSA area during the BGC 2010 and 2011 geotechnical field investigations (BGC 2010 and 2011a,b).

3.3 Platinum Gulch WRSA

Four boreholes (GT18-08, GT18-09, GT18-10, GT18-11) were drilled within the proposed footprint for the Platinum Gulch WRSA (Figure 2).

The general terrain and subsurface conditions of the Platinum Gulch WRSA are discussed in the following sections and are summarized in Table 7.

Table 7: Overburden and Bedrock Condition Summary, Platinum Gulch WRSA

Borehole No.	Overburden Thickness (m)	Organic Layer Thickness (m)	Major Overburden Soil Types	Active Layer Thickness (m)*	Permafrost Conditions
GT18-08	>17.4	1.1	Peat; Sand and Gravel; Cobble; boulders	Undetermined	Permafrost (Vs up to 15%)
GT18-09	9.5	0.5	Sand and Gravel	~3.0 (a seasonally frozen layer)	Permafrost-free with a seasonally frozen layer (Nbn)
GT18-10	7.9 (not including 1.1 m of fill)	N/A	Sand and Gravel	Undetermined	Permafrost (Vx 1%)
GT18-11	10.0	0.4	Sand and Gravel	Undetermined	Permafrost Confirmed by thermistor (-0.1°C)

* - measurements of the active layer thickness are based on interpretation of the ground temperature data and examination of the core immediately after its recovery.

3.3.1 General

The proposed Platinum Gulch WRSA was drilled on April 11, 13, and 14, 2018. Its footprint lies within a watershed with an overall northerly and westerly aspect. The watershed narrows into the Platinum Gulch outlet that feeds into Haggart Creek.

Borehole GT18-08 is located at the west end of the proposed footprint, just north of Platinum Gulch stream. A granite boulder field is located 20 m south of the borehole location on the opposite bank of Platinum Gulch stream. Vegetation near the bottom of the gulch is sparse black spruce trees.

Boreholes GT18-09, GT18-10, and GT18-11 are located farther up the gulch, east of borehole GT18-08. The surrounding vegetation includes dense pine and spruce forest, but aspen dominates the west-facing slopes.

3.3.2 Overburden Soils

The organic layer in the area consists of dark red to brown to black fibrous peat up to 0.3 m thick. Borehole GT18-09 and GT18-10 were drilled on previously disturbed ground, resulting in removed or altered organic material. A trace of rootlets were found up to 0.6 m BGL into the till material.

Poorly to well graded, grey to dark brown silt, sand and gravel mixtures with cobbles disseminated throughout make up the bulk of the colluvial overburden. Any of these may be the dominant soil component. Angular gravel and cobble make up the coarse component.

Borehole GT18-08 encountered granite boulders at 17.4 m depth into overburden material, which caused refusal for the drill. A drill rod, shoe, and bit were damaged, so drilling at this location was terminated before the planned depth of 21.0 m could be reached.

Borehole GT18-09 was positioned on the edge of an old access road that appeared to have been unused for years. Fill material for the road contributed to the top 0.5 m of the core, with root systems, moss, and young vegetation growing in the road surface, which can be defined as native overburden for this report.

Gravimetric moisture content of the overburden material varied from 4.5% at a depth of 2.0 m in GT18-09 to 29.6% at a depth of 0.55 m in GT18-08.

Permafrost conditions with visible excess ice (Vx, Vc, Vs, Vr) were confirmed in two of the four boreholes. Excess ice contents found in GT18-08 ranged from 0.0% to 15.6%, with no excess ice measured in the remaining boreholes. Permafrost conditions were confirmed using GTC and SBTSs in boreholes GT18-08, GT18-10, and GT18-11 (Appendix D and Table 5).

3.3.3 Bedrock

Bedrock consisted of metasedimentary rock with varying levels of oxidation. Due to the heavily mechanically disturbed condition of the recovered rock core as part of the Sonic drilling process, RQDs, fracture frequencies, and strength designations could not be determined. As previously discussed, RC drilling is not particularly effective at coring bedrock. Bedrock has previously been characterized in the Platinum Gulch WRSA area during the BGC 2010 and 2011 geotechnical field investigations (BGC 2010 and 2011a,b).

Bedrock in borehole GT18-08 was not reached due to refusal on granite boulders.

3.4 90 Day Storage Area

Borehole GT18-17 was drilled within the proposed footprint for the 90 Day Storage (Figure 2).

The general terrain and subsurface conditions of the proposed 90 Day Storage area are discussed in the following sections and are summarized in Table 8.

Table 8: Overburden and Bedrock Condition Summary, 90 Day Storage Area

Borehole No.	Overburden Thickness (m)	Organic Layer Thickness (m)	Major Overburden Soil Types	Active Layer Thickness (m)*	Permafrost Conditions
GT18-17	5.5	0.3	Peat; Sand and Silt; Sand and Gravel	Undetermined	Ice-Rich Permafrost (ICE + Soil, Vx 3-5%, Nbn)

* - measurements of the active layer thickness are based on interpretation of the ground temperature data and examination of the core immediately after its recovery.

3.4.1 General

The proposed 90 Day Storage area was investigated on April 12, 2018. Its footprint lies on a slope that dips towards Suttles Gulch and has an overall northerly aspect.

Suttles Gulch is densely forested with spruce, pine, and dense shrubs. Trees on the western slope of Suttles Gulch are noticeably more stunted and withered compared to trees on the eastern side of the gulch. Both slopes range from 10° to 20° in slope angle.

Borehole GT18-17 is located at the northeast corner of the 90 Day Storage area footprint, on the west bank of Suttles Gulch.

3.4.2 Overburden Soils

The organic layer consists of a 0.3 m thick dark brown to black peat layer with interspersed rootlets and moss. Well graded, light brown to grey silt, sand and gravel mixtures make up the bulk of the colluvial overburden. Sand is the dominant soil component, while angular gravel makes up the coarse component. The colluvium is underlain by boulders.

Gravimetric moisture contents of the overburden material varied from 10.9% in frozen silty sand with some gravel at a depth of 3.7 m to 76.6% in frozen silty, gravelly sand at a depth of 1.1 m.

Warm permafrost conditions (-0.1°C) with excess ice (Vx, Vc, Vs, Vr) were observed in the borehole and were confirmed by SBTS installed at a depth of 8.5 m (Table 5). A layer of ice with sand and silt approximately 1.3 m thick was observed at a depth of 0.3 m BGL (Photo 2). The ice mass was clear to cloudy. It is believed that this ice is a result of the borehole being located within a depression on the slope face that channels runoff, resulting in higher than normal water content. Ice coatings and inclusions (Vc, Vx 21%) were observed in silty sand with some gravel from 1.6 m to 1.8 m. Excess ice (Vx 3.0% to 5.0%) was logged in sand and gravel from 1.8 m to 2.5 m. Well-bonded permafrost (Nbn) was observed in sand and gravel from 2.5 m to the top of bedrock, which was encountered at a depth of 5.5 m.

Photo 2: Ice and sand, silty between 1.05 m and 1.2 m in GT18-07.

3.4.3 Bedrock

Bedrock in this borehole consists of metasedimentary rock. Due to the heavily mechanically disturbed condition of the recovered rock core due to the Sonic drilling process, RQDs, fracture frequencies, and strength designations could not be determined. As previously discussed, RC drilling is not particularly effective at coring bedrock. Bedrock has previously been characterized in the 90 day Storage Area during the BGC 2009 and 2011 geotechnical field investigations (BGC 2009 and 2011a,b).

3.5 Potential ROM Stockpile Area

Two boreholes (GT18-15, GT18-16) were drilled within the potential ROM Stockpile Area. An actual footprint for the ROM stockpile has not been developed yet in the mine facility design, therefore it is not shown on Figure 2.

The general terrain and subsurface conditions of the Potential ROM Stockpile Area are discussed in the following sections and are summarized in Table 9.

Table 9: Overburden and Bedrock Condition Summary, Potential ROM Stockpile Area

Borehole No.	Overburden Thickness (m)	Organic Layer Thickness (m)	Major Overburden Soil Types	Active Layer Thickness (m)*	Permafrost Conditions
GT18-15	18.0	0.4	Sand; Sand and Gravel; Silt; Cobble	~2.0	Permafrost (Vx 1-3%, Nbn)
GT18-16	3.5	0.3	Peat; Sand and Gravel	Undetermined	Permafrost-free with a seasonally frozen layer (Nbn)

* - measurements of the active layer thickness are based on interpretation of the ground temperature data and examination of the core immediately after its recovery.

3.5.1 General

The potential ROM Stockpile area lies east of the 90 Day Storage area, within the Suttles Gulch drainage area. Suttles Gulch is densely forested with spruce, pine, and dense shrubs. Trees situated on the west slope of Suttles Gulch are noticeably more stunted and withered compared to trees on the east side of the gulch. The slopes on either side of Suttles Gulch range from 10° to 20° in angle.

Boreholes GT18-15 and GT18-16 were drilled on the eastern slope of the gulch on April 10 and 11, 2018.

3.5.2 Overburden Soils

The organic layer consists of 0.3 m brown peat with rootlets down to 0.4 m into the underlying sand and gravel. Overburden consists of well to poorly graded, brown to dark grey sand and angular gravel, with increasing silt and clay content at depth in GT18-15. This material is interpreted as colluvium.

Gravimetric moisture contents of the overburden material varies from 7.7% in frozen silt and sand at a depth of 1.0 m to 14.5% in frozen sand with some silt and gravel at a depth of 8.8 m in GT18-15.

Permafrost conditions were confirmed in one of the two completed boreholes. In GT18-15, visible ice (up to 3% by volume) was observed in the frozen active layer, with well-bonded permafrost (Nbn) below. GTC installed in GT18-15 confirmed very warm permafrost conditions (0°C to -0.1°C; Appendix D), while SBTS installed in GT18-16 revealed non-permafrost ground (Table 5).

3.5.3 Bedrock

Bedrock encountered in these two boreholes comprises metasedimentary rock. Due to the heavily mechanically disturbed condition of the recovered rock core because of the Sonic drilling process, RQDs, fracture frequencies, and strength designations could not be determined. As previously discussed, RC drilling is not particularly effective at coring bedrock. Bedrock has previously been well characterized in the ROM Stockpile area during the BGC 2009, 2010, 2011, and 2012 geotechnical field investigations.

4.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE
Date SEPT. 26, 2018
PERMIT NUMBER PP003
Association of Professional
Engineers of Yukon

/jf

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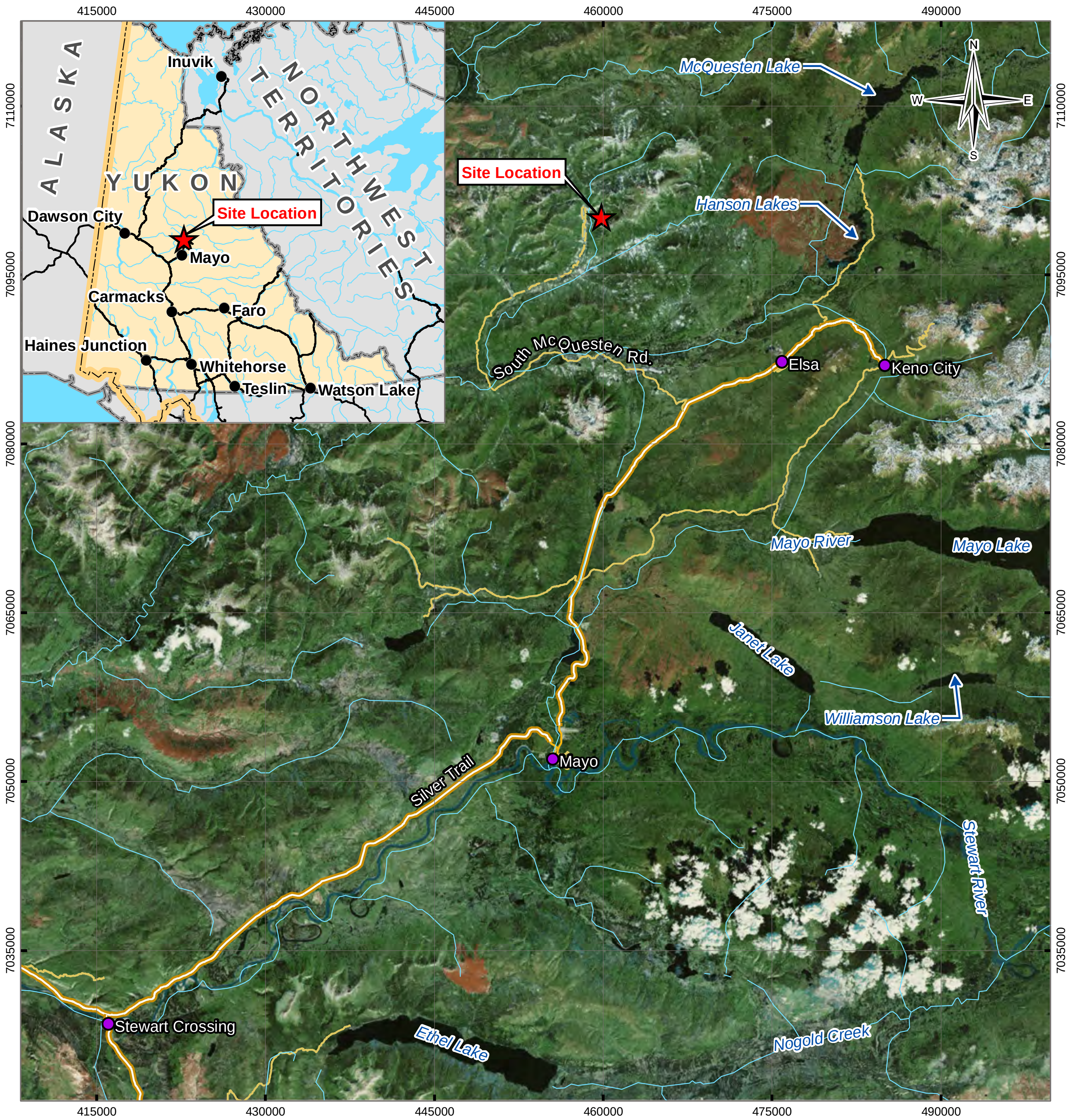
FIGURES



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LEGEND

★ Site Location

● Community

═ Highway

— Main Road

— Local Road

– – Resource/Recreational Road

〰 Watercourse

NOTES
Base data source: CanVec 1:1,000,000
Base imagery source: DigitalGlobe, 2010-2015

EAGLE GOLD PROJECT
SPRING 2018
GEOTECHNICAL INVESTIGATION

Site Location

PROJECTION
UTM Zone 8

DATUM
NAD83

CLIENT
Victoria GOLD CORP

Scale: 1:500,000
10 5 0 10
Kilometres

TETRA TECH

FILE NO.
EARC03103-02_Figure01_SiteLocation.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-EDM	MRV	SL	SM	0

DATE
September 19, 2018

PROJECT NO.
ENG.EARC03103-02

Figure 1

STATUS
ISSUED FOR USE

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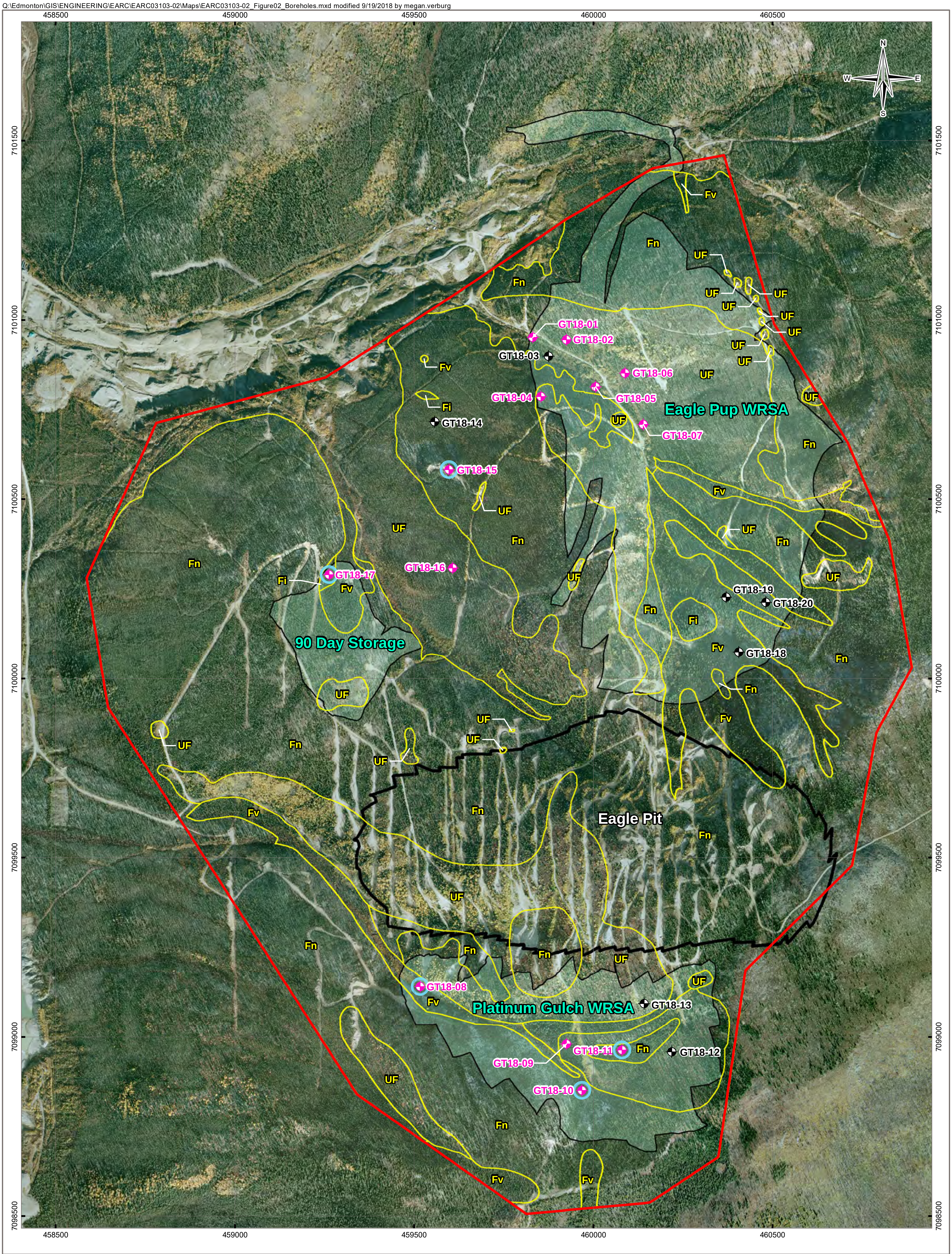


LEGEND

- ● As-Drilled TT 2018 Geotechnical Borehole
- ◎ As-Drilled TT 2018 Geotechnical Borehole Thermistor Indicating Permafrost Condition
- ● Proposed Spring 2018 Geotechnical Borehole
- ▭ WRSA and 90 Day Storage Areas
- ▭ Pit
- ○ Permafrost Study Area
- ▨ Boundary of Permafrost Distribution
- Fi Perennially frozen ground – predominantly very ice-rich with ground ice content locally exceeding 50% by volume of visible ice
- Fv Perennially frozen ground – predominantly ice-rich with ground ice content generally ranging between 10% and 50% by volume of visible ice; may include patches of ice-poor permafrost (FN) and/or unfrozen ground (UF)
- Fn Perennially frozen ground – predominantly ice-poor with ground ice content generally less than 10% by volume of visible ice or not visible ground ice; may include patches of ice-rich permafrost (FV) and/or unfrozen ground (UF)
- UF Predominantly permafrost-free terrain; may include patches of permafrost (Fv, Fn)

STATUS
ISSUED FOR USE

NOTES
Base data source:
Imagery provided by the client (2010).

EAGLE GOLD PROJECT
SPRING 2018
GEOTECHNICAL INVESTIGATION

As-Drilled and Proposed Borehole Locations Dublin Gulch Area, Discontinuous Permafrost Region

PROJECTION: UTM Zone 8
DATUM: NAD83
CLIENT: Victoria Gold Corp

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

TETRA TECH

FILE NO.: EARC03103-02_Figure02_Boreholes.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-EDM	MRV	SL	SMC/ VER	0

DATE: September 19, 2018
PROJECT NO.: ENG.EARC03103-02

Figure 2

PHOTOGRAPHS

Photo 1-5	Borehole GT18-01
Photo 6-8	Borehole GT18-02
Photo 9-11	Borehole GT18-04
Photo 12-15	Borehole GT18-05
Photo 16-19	Borehole GT18-06
Photo 20-22	Borehole GT18-07
Photo 23-26	Borehole GT18-08
Photo 27-30	Borehole GT18-09
Photo 31-32	Borehole GT18-10
Photo 33-34	Borehole GT18-11
Photo 35-41	Borehole GT18-15
Photo 42-44	Borehole GT18-16
Photo 45-48	Borehole GT18-17

Photo 1: Borehole GT18-01; Depth 0.0 - 3.0 m

Photo 2: Borehole GT18-01; Depth 3.0 - 6.0 m

Photo 3: Borehole GT18-01; Depth 6.0 - 9.0 m

Photo 4: Borehole GT18-01; Depth 9.0 - 18.3 m

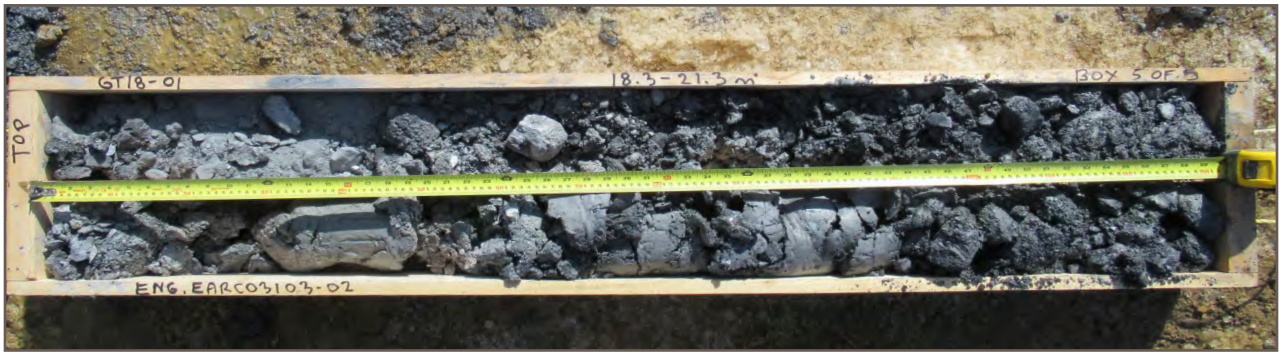


Photo 5: Borehole GT18-01; Depth 18.3 - 21.3 m

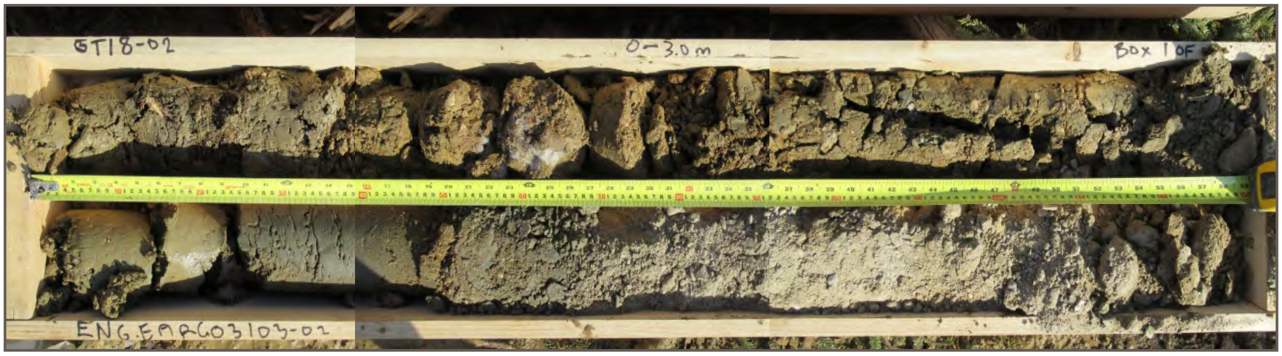


Photo 6: Borehole GT18-02; Depth 0.0 - 3.0 m

Photo 7: Borehole GT18-02; Depth 3.0 - 6.0 m

Photo 8: Borehole GT18-02; Depth 6.0 - 7.9 m

Photo 9: Borehole GT18-04; Depth 0.0 - 3.0 m

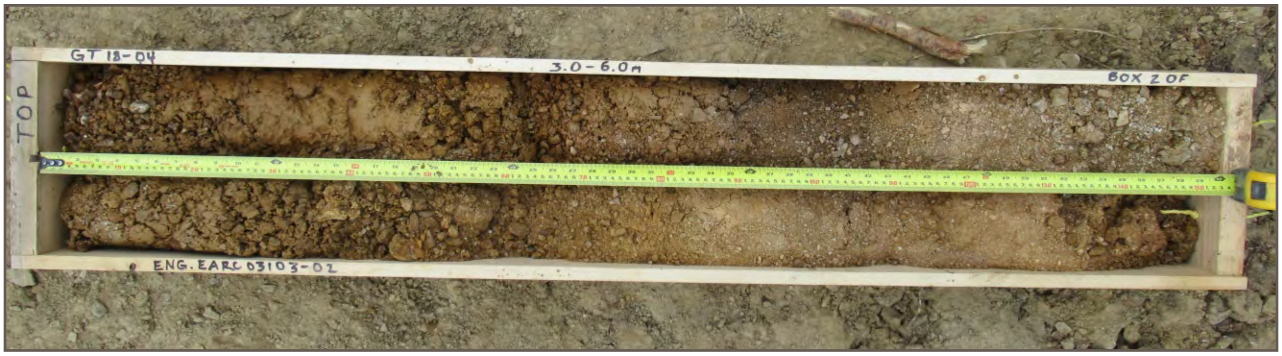


Photo 10: Borehole GT18-04; Depth 3.0 - 6.0 m

Photo 11: Borehole GT18-04; Depth 6.0 – 9.0 m

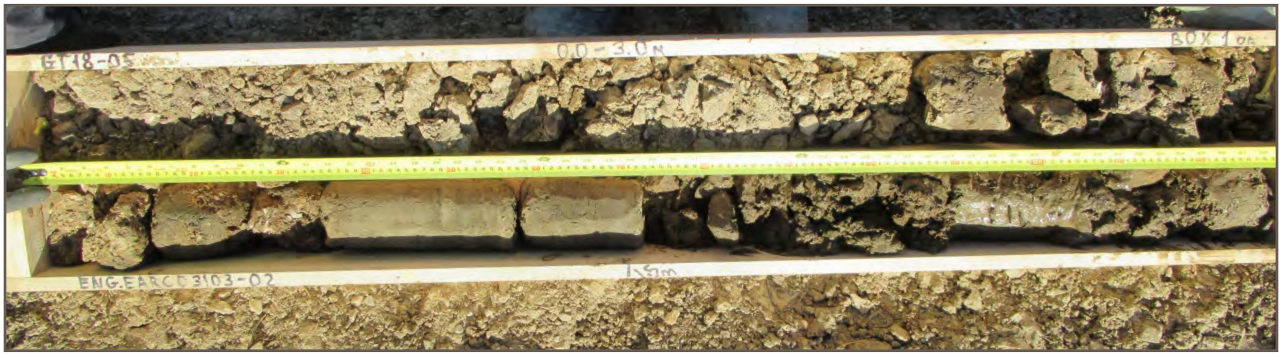


Photo 12: Borehole GT18-05; Depth 0.0 - 3.0 m

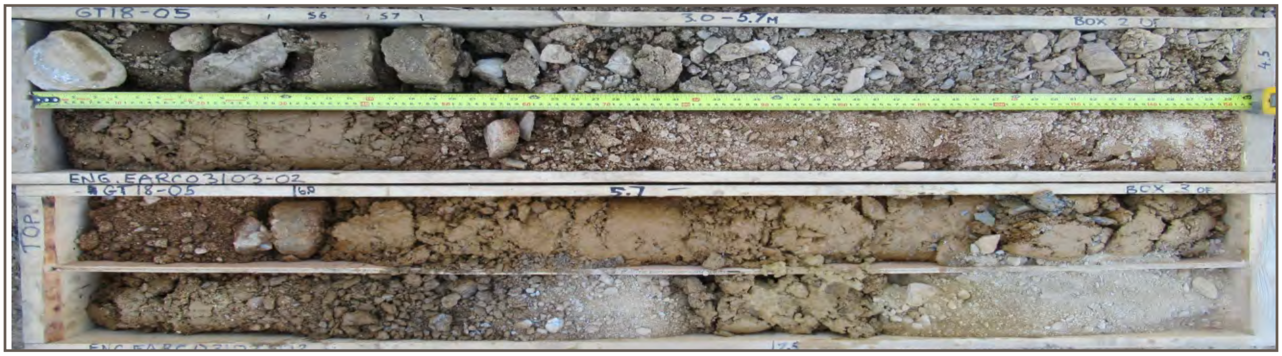


Photo 13: Borehole GT18-05; Depth 3.0 - 8.1 m

Photo 14: Borehole GT18-05; Depth 8.1 - 10.9 m

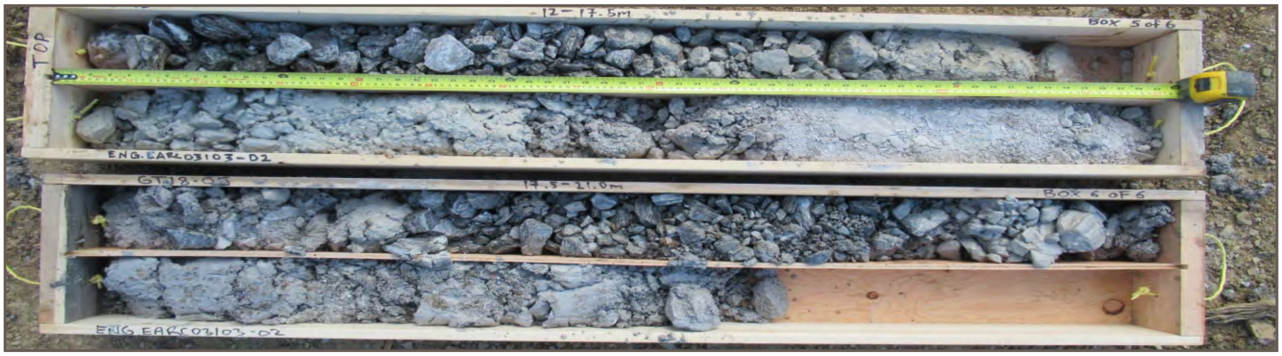


Photo 15: Borehole GT18-05; Depth 10.9 - 21.0 m

Photo 16: Borehole GT18-06; Depth 0.0 - 2.5 m

Photo 17: Borehole GT18-06; Depth 2.5 - 5.0 m

Photo 18: Borehole GT18-06; Depth 5.0 - 7.5 m

Photo 19: Borehole GT18-06; Depth 7.5 - 12.5 m

Photo 20: Borehole GT18-07; Depth 0.0 - 6.0 m

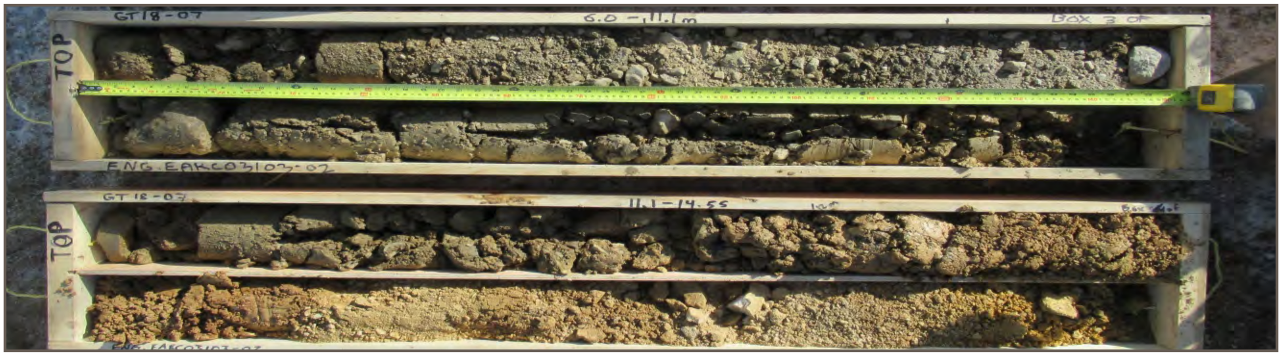


Photo 21: Borehole GT18-07; Depth 6.0 - 14.55 m

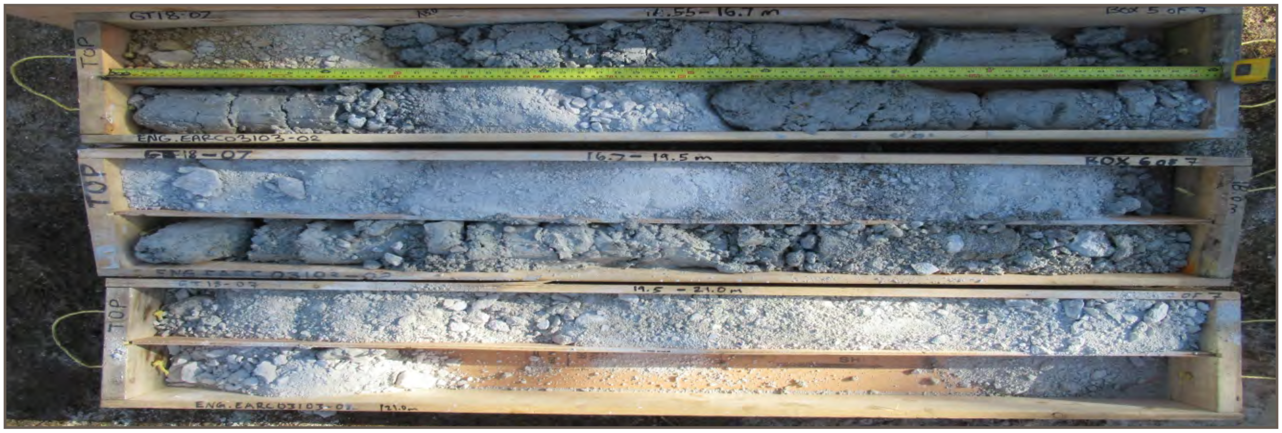


Photo 22: Borehole GT18-07; Depth 14.55 - 21.0 m

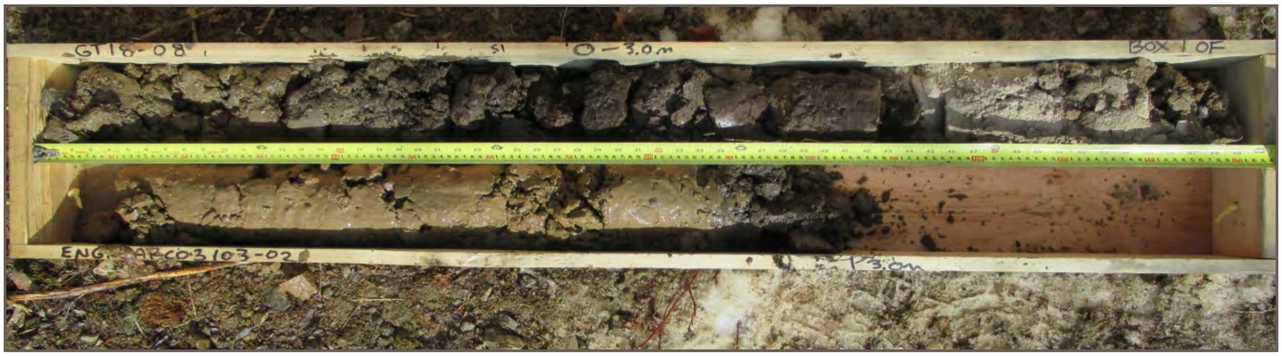


Photo 23: Borehole GT18-08; Depth 0.0 - 3.0 m

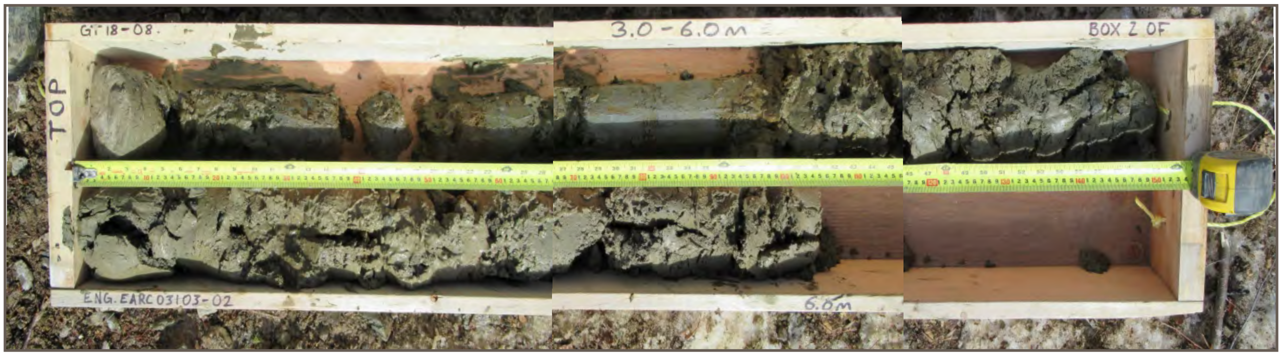


Photo 24: Borehole GT18-08; Depth 3.0 - 6.0 m

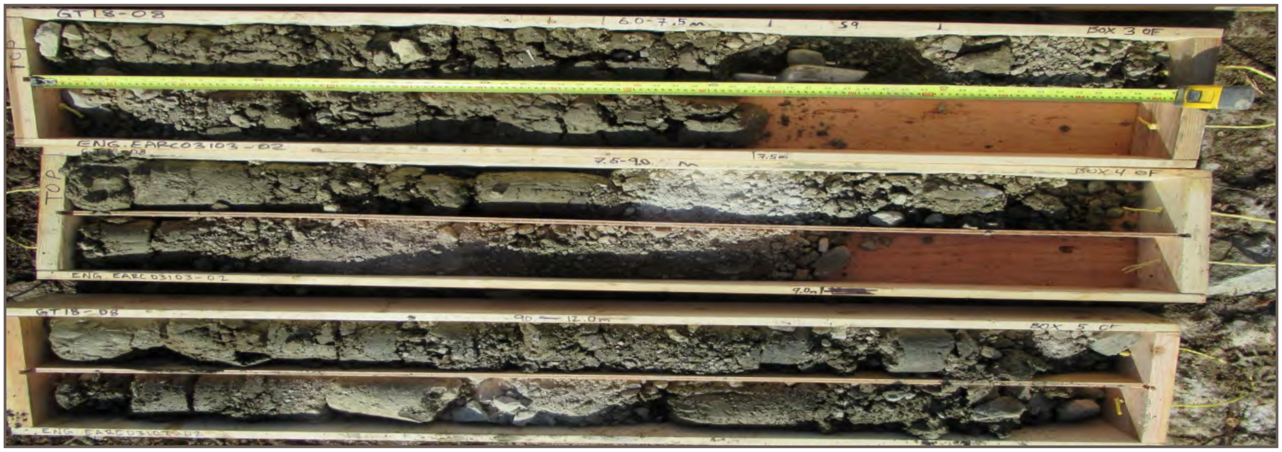


Photo 25: Borehole GT18-08; Depth 6.0 - 12.0 m

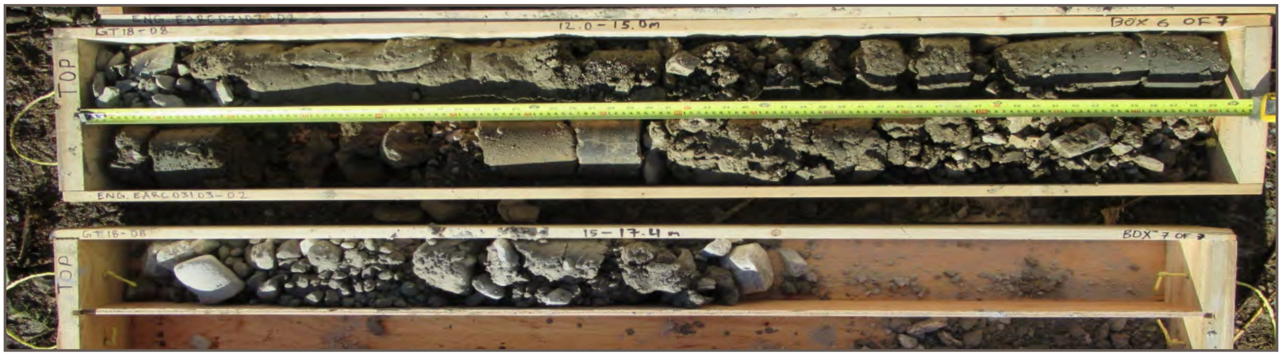


Photo 26: Borehole GT18-08; Depth 12.0 - 17.4 m

Photo 27: Borehole GT18-09; Depth 0.0 - 3.0 m

Photo 28: Borehole GT18-09; Depth 3.0 - 9.0 m

Photo 29: Borehole GT18-09; Depth 9.0 - 15.0 m

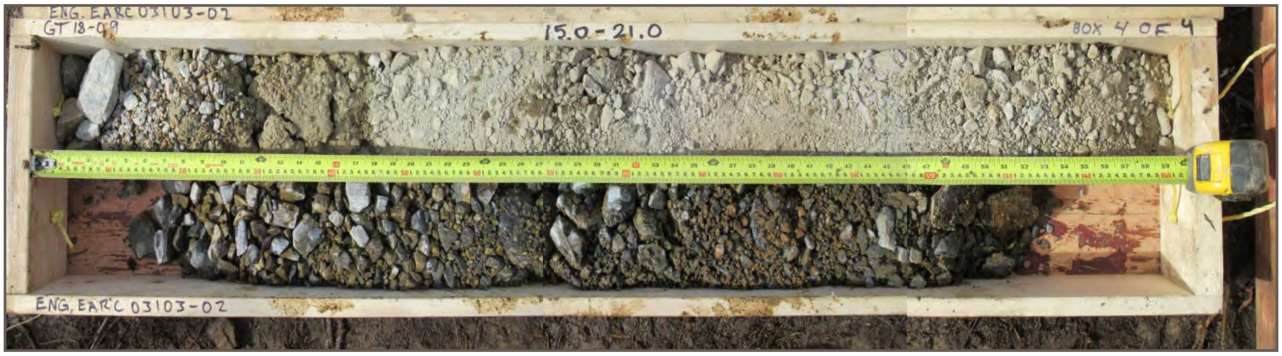


Photo 30: Borehole GT18-09; Depth 15.0 - 21.0 m

Photo 31: Borehole GT18-10; Depth 0.0 - 4.5 m

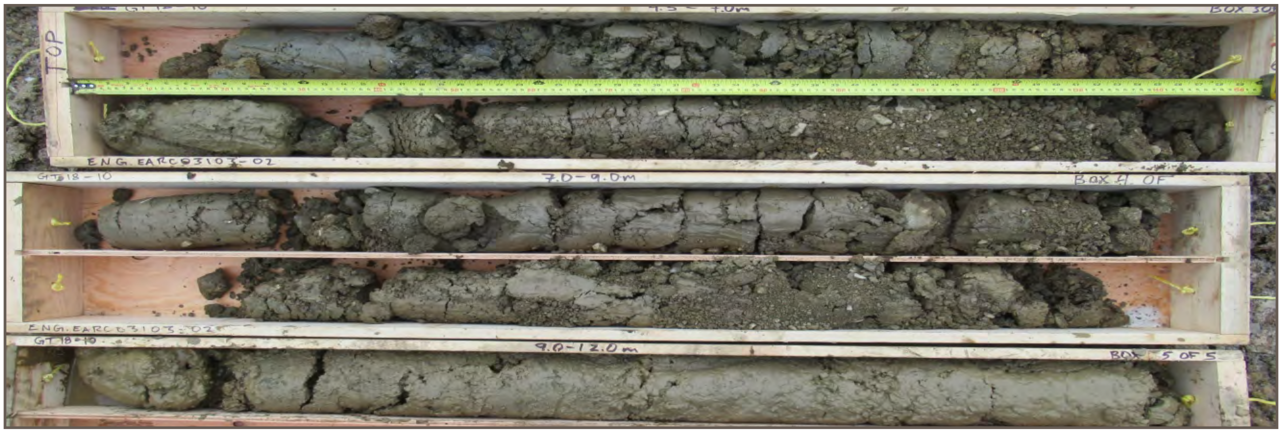


Photo 32: Borehole GT18-10; Depth 4.5 - 12.0 m

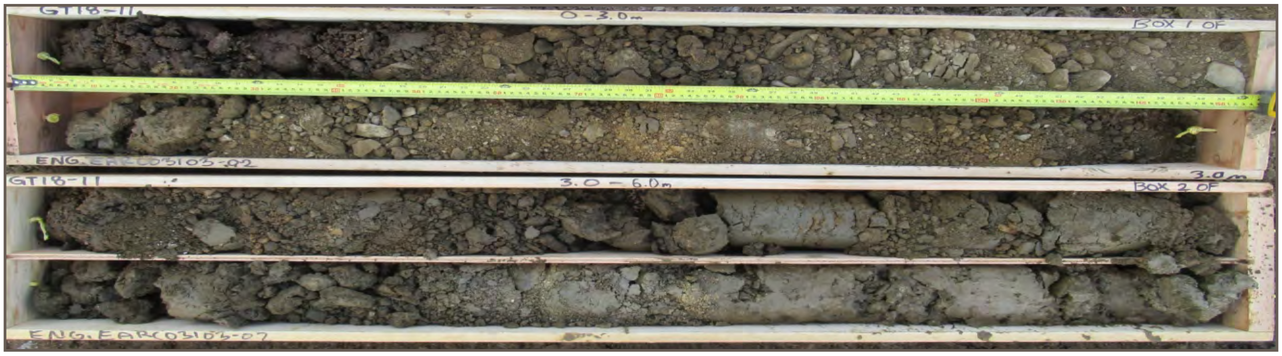


Photo 33: Borehole GT18-11; Depth 0.0 - 6.0 m

Photo 34: Borehole GT18-11; Depth 6.0 - 12.0 m

Photo 35: Borehole GT18-15; Depth 0.0 - 4.0 m

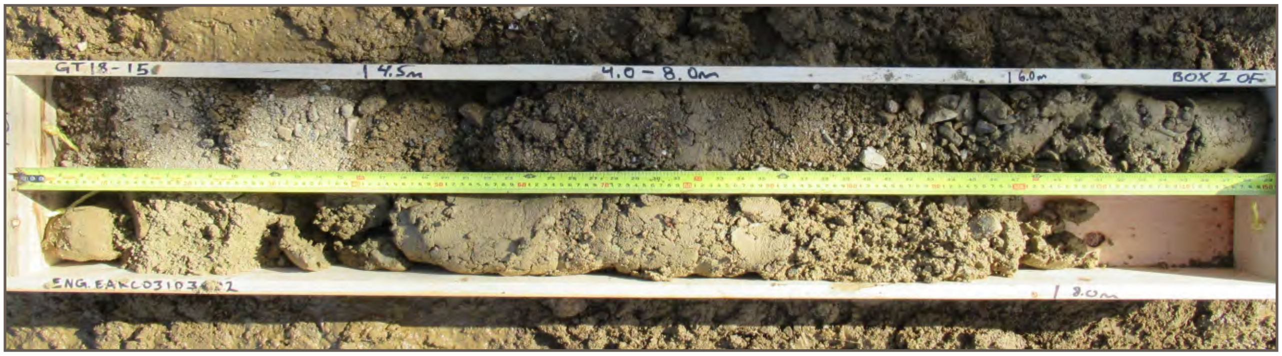


Photo 36: Borehole GT18-15; Depth 4.0 - 8.0 m

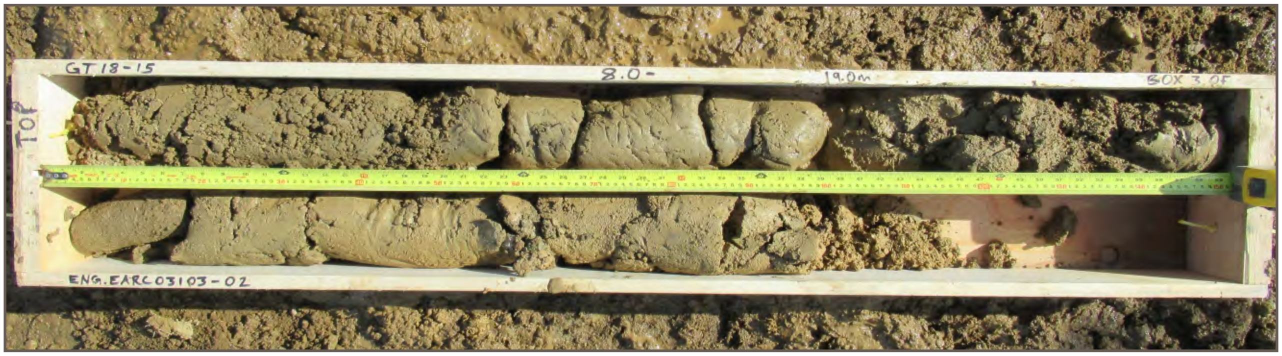


Photo 37: Borehole GT18-15; Depth 8.0 - 10.5 m

Photo 38: Borehole GT18-15; Depth 10.5 - 13.5 m

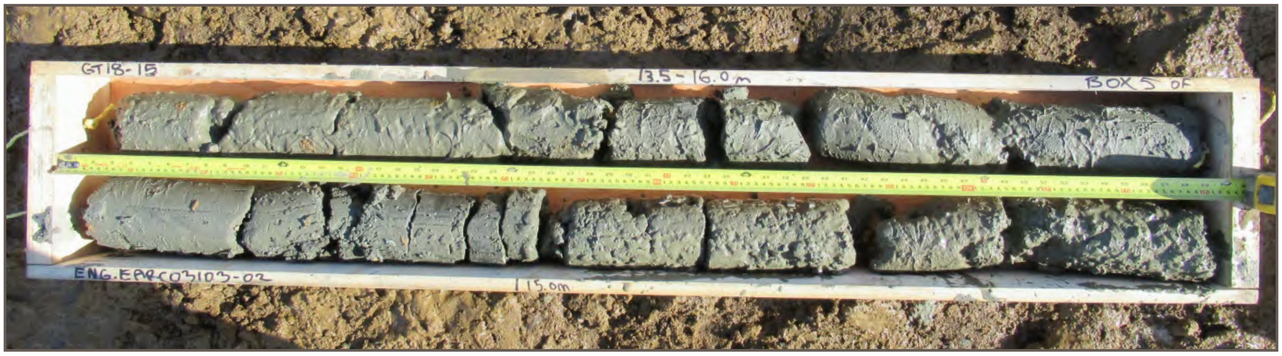


Photo 39: Borehole GT18-15; Depth 13.5 - 16.0 m

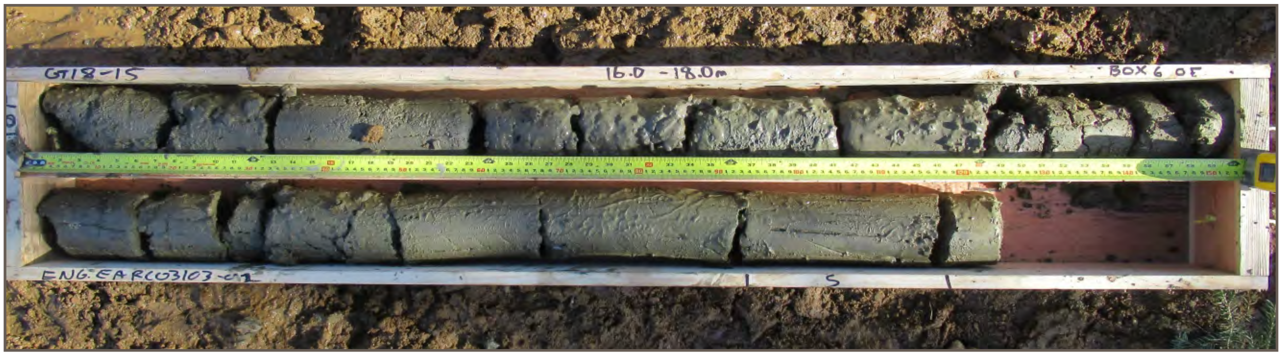


Photo 40: Borehole GT18-15; Depth 16.0 - 18.0 m

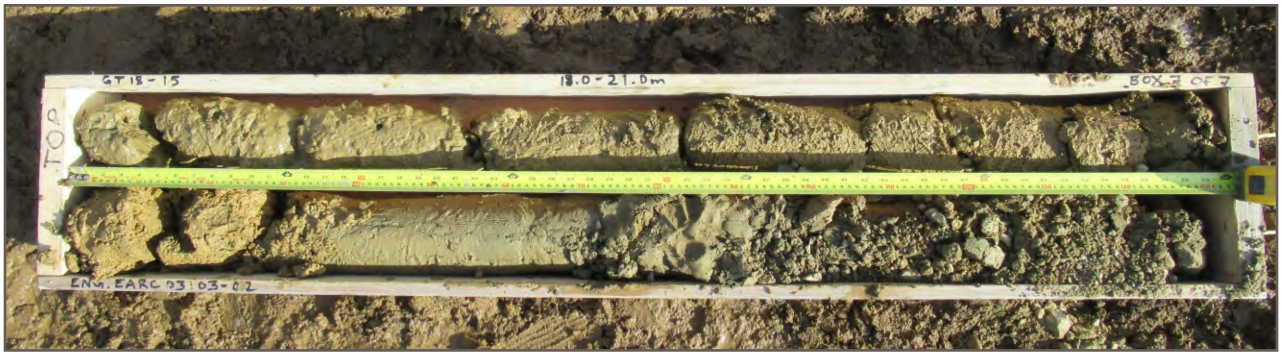


Photo 41: Borehole GT18-15; Depth 18.0 - 21.0 m

Photo 42: Borehole GT18-16; Depth 0.0 - 3.0 m

Photo 43: Borehole GT18-16; Depth 3.0 - 6.0 m

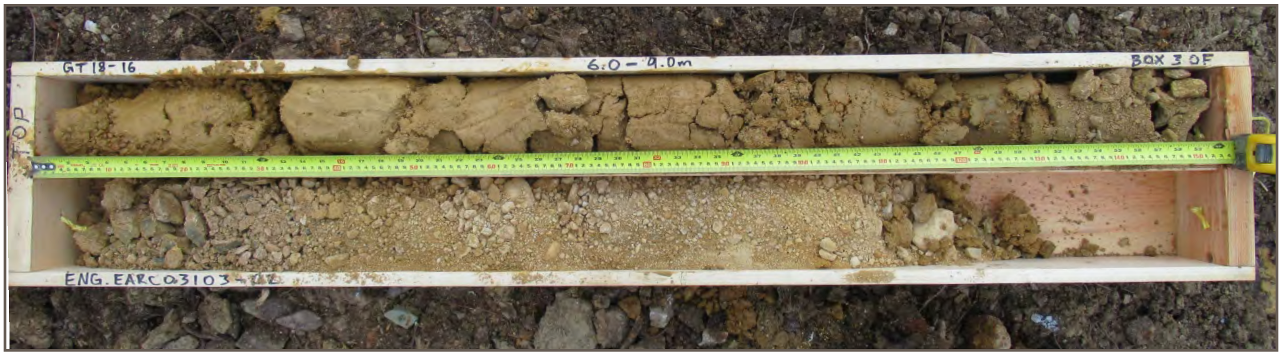


Photo 44: Borehole GT18-16; Depth 6.0 - 9.0 m

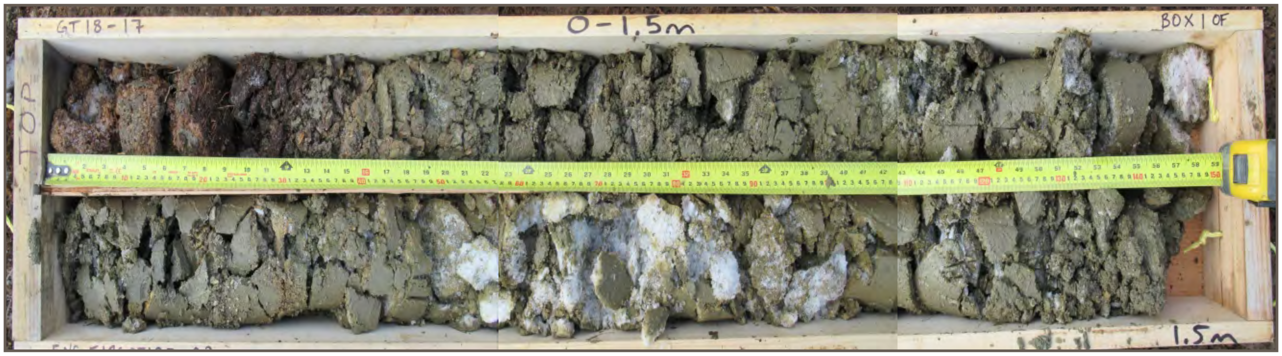


Photo 45: Borehole GT18-17; Depth 0.0 - 1.5 m

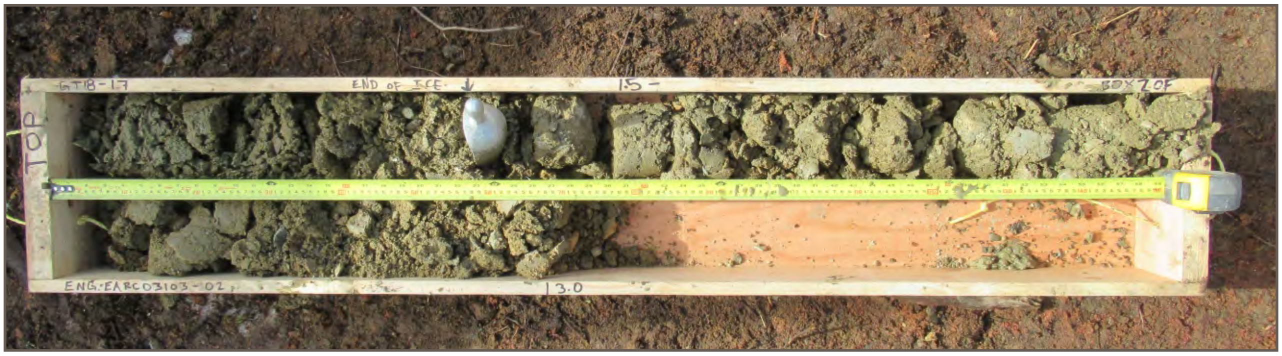


Photo 46: Borehole GT18-17; Depth 1.5 - 3.0 m

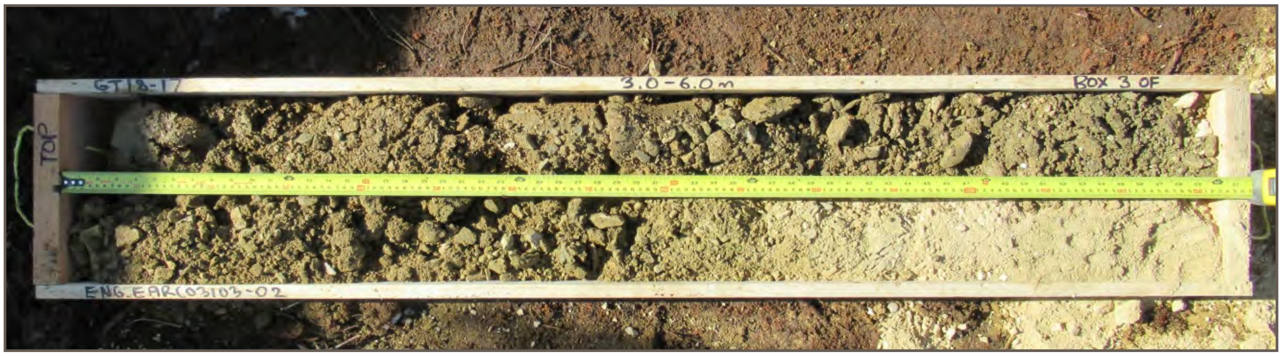


Photo 47: Borehole GT18-17; Depth 3.0 - 6.0 m

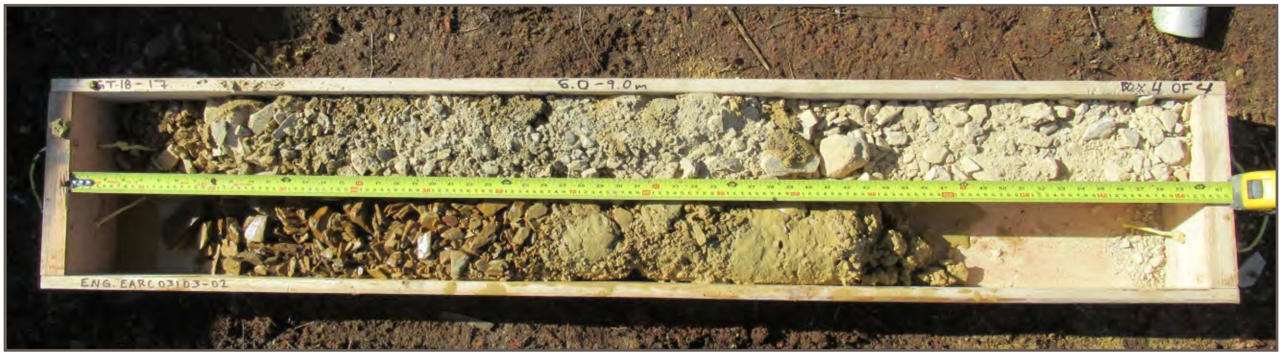


Photo 48: Borehole GT18-17; Depth 6.0 - 9.0 m

APPENDIX A

TETRA TECH’S LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the “Professional Document”).

The Professional Document is intended for the sole use of TETRA TECH’s Client (the “Client”) as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the “Contract” herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an “Authorized Party”), consideration for such authorization is the Authorized Party’s acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the “Limitations on Liability”). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party’s express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH’s professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH’s “Instruments of Professional Service”), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH’s Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

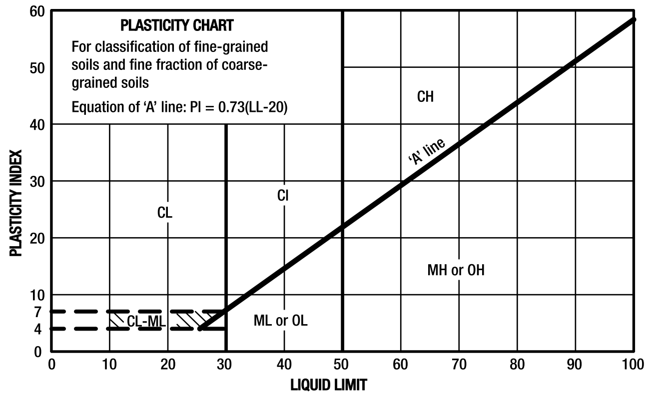
TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client’s expense upon written request, otherwise samples will be discarded.

APPENDIX B

BOREHOLE LOGS

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	**GRAVELS** 50% or more of coarse fraction retained on 4.75 mm sieve	**CLEAN GRAVELS**	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	**Classification on basis of percentage of fines** Less than 5% Pass 75 µm sieve — GW, GP, SW, SP More than 12% Pass 75 µm sieve — GM, GC, SM, SC 5% to 12% Pass 75 µm sieve — Borderline Classification requiring use of dual symbols	$C_U = D_{60} / D_{10}$ Greater than 4 $C_C = \frac{(D_{30})2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below “A” line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above “A” line or plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	**CLEAN SANDS**	SW	Well-graded sands and gravelly sands, little or no fines		$C_U = D_{60}/D_{10}$ Greater than 6 $C_C = \frac{(D_{30})2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below “A” line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above “A” line or plasticity index greater than 7	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	**SILTS**	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity			
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
	CLAYS Above “A” line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays			
		Liquid limit 30-50	CI	Inorganic clays of medium plasticity, silty clays			
		Liquid limit >50	CH	Inorganic clays of high plasticity, fat clays			
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity			
		Liquid limit >50	OH	Organic clays of medium to high plasticity			
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils			



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* Based on the material passing the 75 mm sieve

† ASTM Designation D 2487, for identification procedure see D 2488 USC as modified by PFRA

SOIL COMPONENTS

FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENTAGE	DESCRIPTOR
GRAVEL coarse fine	 75 mm 19 mm	 19 mm 4.75 mm	>35 % 21 to 35 % 11 to 20 % >0 to 10 %	“and” “y-adjective” “some” “trace”
SAND coarse medium fine	 4.75 mm 2.00 mm 425 µm	 2.00 mm 425 µm 75 µm		
SILT (non plastic) or CLAY (plastic)	75 µm		as above but by behavior	

OVERSIZE MATERIAL

Rounded or subrounded

COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm

Not rounded

ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

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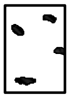
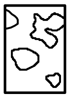
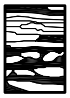
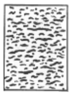
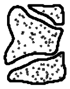
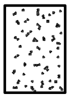
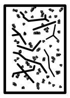
GROUND ICE DESCRIPTION

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	SKETCH	PHOTOGRAPH
V	Vx	Individual ice crystals or inclusions		
	Vc	Ice coatings on particles		
	Vr	Random or irregularly oriented ice formations		
	Vs	Stratified or distinctly oriented ice formations		
	Vu	Ice formations uniformly distributed throughout frozen soil		

ICE NOT VISIBLE

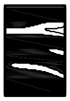
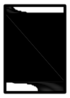
GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	SKETCH	PHOTOGRAPH
N	Nf	Poorly-bonded or friable		
	Nbn	No excess ice, well-bonded		
	Nbe	Excess ice, well-bonded		

LEGEND: Soil ☐ Ice ■

NOTES:

1. Dual symbols are used to indicate borderline or mixed ice classifications.
2. Visual estimates of ice contents indicated on borehole logs ± 5%
3. This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

VISIBLE ICE GREATER THAN 50% BY VOLUME

ICE	ICE + Soil Type	Ice with soil inclusions (greater than 25 mm thick)		
	ICE	Ice without soil inclusions (greater than 25 mm thick)		

BOREHOLE KEYSHEET

Water Level Measurement

▼ Measured in standpipe, piezometer or well

▽ Inferred

Sample Types

- ▤ A-Casing
- ◫ Core
- ▒ Disturbed, Bag, Grab
- ▥ HQ Core
- ⧅ Jar
- ▧ Jar and Bag
- ⧓ 75 mm SPT
- ◢ No Recovery
- ☒ Split Spoon/SPT
- ▥ Tube
- ◥ CRREL Core

Backfill Materials

- ■ Asphalt
- ▒ Bentonite
- ░ Cement/ Grout
- ▧ Drill Cuttings
- ░ Grout
- ⁙ Gravel
- ░ Sand
- ▥ Slough
- ░ Topsoil Backfill

Lithology - Graphical Legend[1]

- ■ Asphalt
- ▧ Bedrock
- ◌ Cobbles/Boulders
- ▨ Clay
- ■ Coal
- ░ Concrete
- ▩ Fill
- ◌ Gravel
- ▦ Limestone
- ◇ Mudstone
- ≋ Organics
- ░ Peat
- ░ Sand
- ☒ Sandstone
- ▤ Shale
- ▥ Silt
- ☒ Siltstone
- ◌ Conglomerate
- ░ Topsoil
- ▩ Till

1. The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

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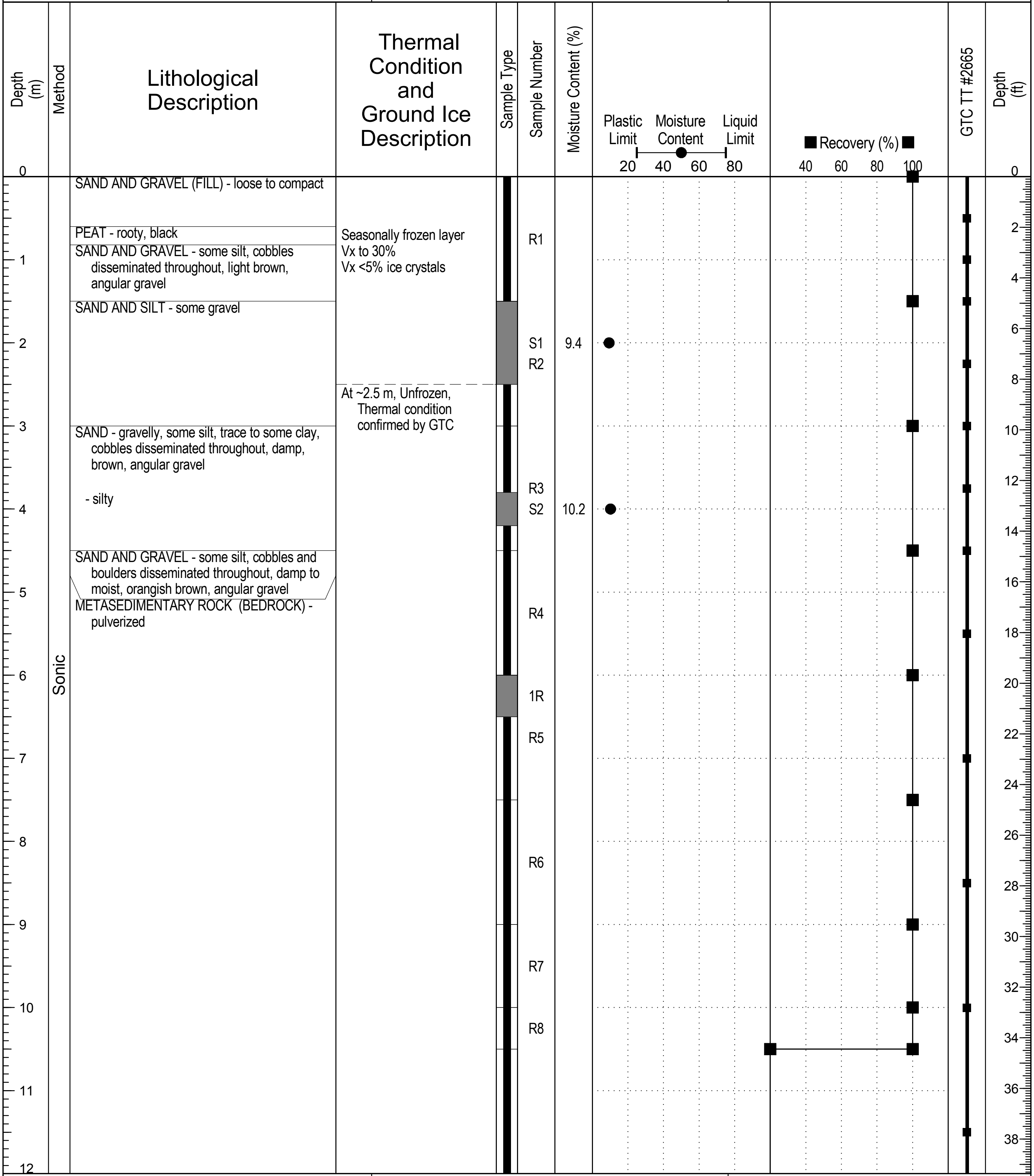
Borehole No: **GT18-01**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459831 E; 7100952 N; Z 8

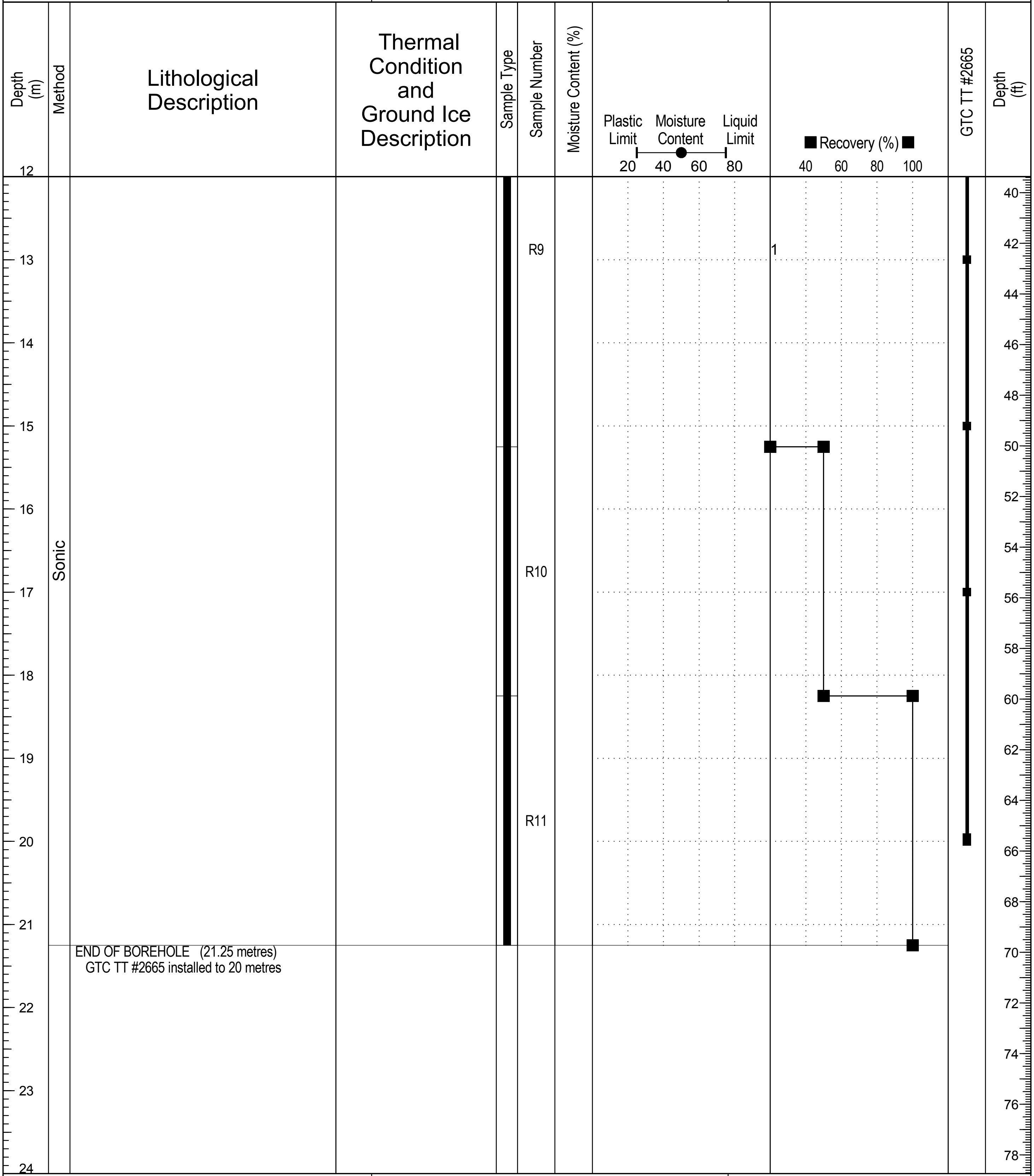


Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
SAND AND GRAVEL (FILL) - loose to compact			
PEAT - rooty, black			
SAND AND GRAVEL - some silt, cobbles disseminated throughout, light brown, angular gravel	Seasonally frozen layer Vx to 30% Vx <5% ice crystals	R1	
SAND AND SILT - some gravel		S1 R2	9.4
	At ~2.5 m, Unfrozen, Thermal condition confirmed by GTC		
SAND - gravelly, some silt, trace to some clay, cobbles disseminated throughout, damp, brown, angular gravel - silty		R3 S2	10.2
SAND AND GRAVEL - some silt, cobbles and boulders disseminated throughout, damp to moist, orangish brown, angular gravel			
METASEDIMENTARY ROCK (BEDROCK) - pulverized		R4 1R R5 R6 R7 R8	

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 21.25 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 7
Logged By: VER/EP	Completion Date: 2018 April 7
Reviewed By: VER	Page 1 of 2

Borehole No: **GT18-01**

Project: Eagle Gold | Project No: ENG.EARC03103-02
Location: Eagle Gold Mine
Yukon Territory | UTM: 459831 E; 7100952 N; Z 8



END OF BOREHOLE (21.25 metres)
GTC TT #2665 installed to 20 metres

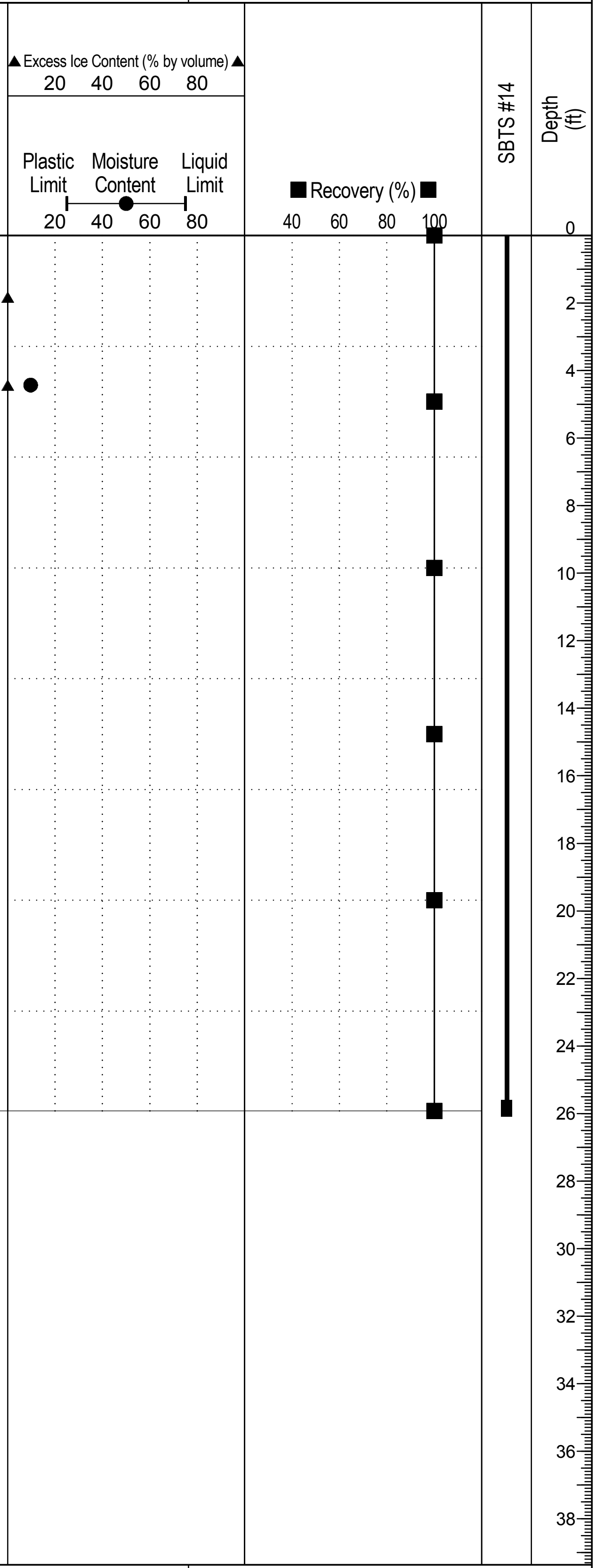
Contractor: Midnight Sun Drilling Inc. | Completion Depth: 21.25 m
Drilling Rig Type: Rig 9, Terrasonic | Start Date: 2018 April 7
Logged By: VER/EP | Completion Date: 2018 April 7
Reviewed By: VER | Page 2 of 2

Victoria GOLD CORP

Borehole No: **GT18-02**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459925 E; 7100945 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
0	Sonic	PEAT - woody, (300 mm thick)	Seasonally frozen layer Vx 5-10%		
		SAND AND GRAVEL - some silt, trace clay, cobbles disseminated throughout, angular gravel	Vx 15-20%, clear ice crystals to 3 mm thick/wide	S1 R1	
1		SILT AND GRAVEL - sandy		S2	9.7
			At ~ 1.5-2.0 m, Unfrozen. Thermal condition confirmed by single bead thermistor (+1.2° C, June 8, 2018)		
2		METASEDIMENTARY ROCK (BEDROCK) - crushed, fractured		R2	
3				R3	
4				R4	
6				R5	
8		END OF BOREHOLE (7.90 metres) Single bead thermistor #14 installed at 7.90 metres			



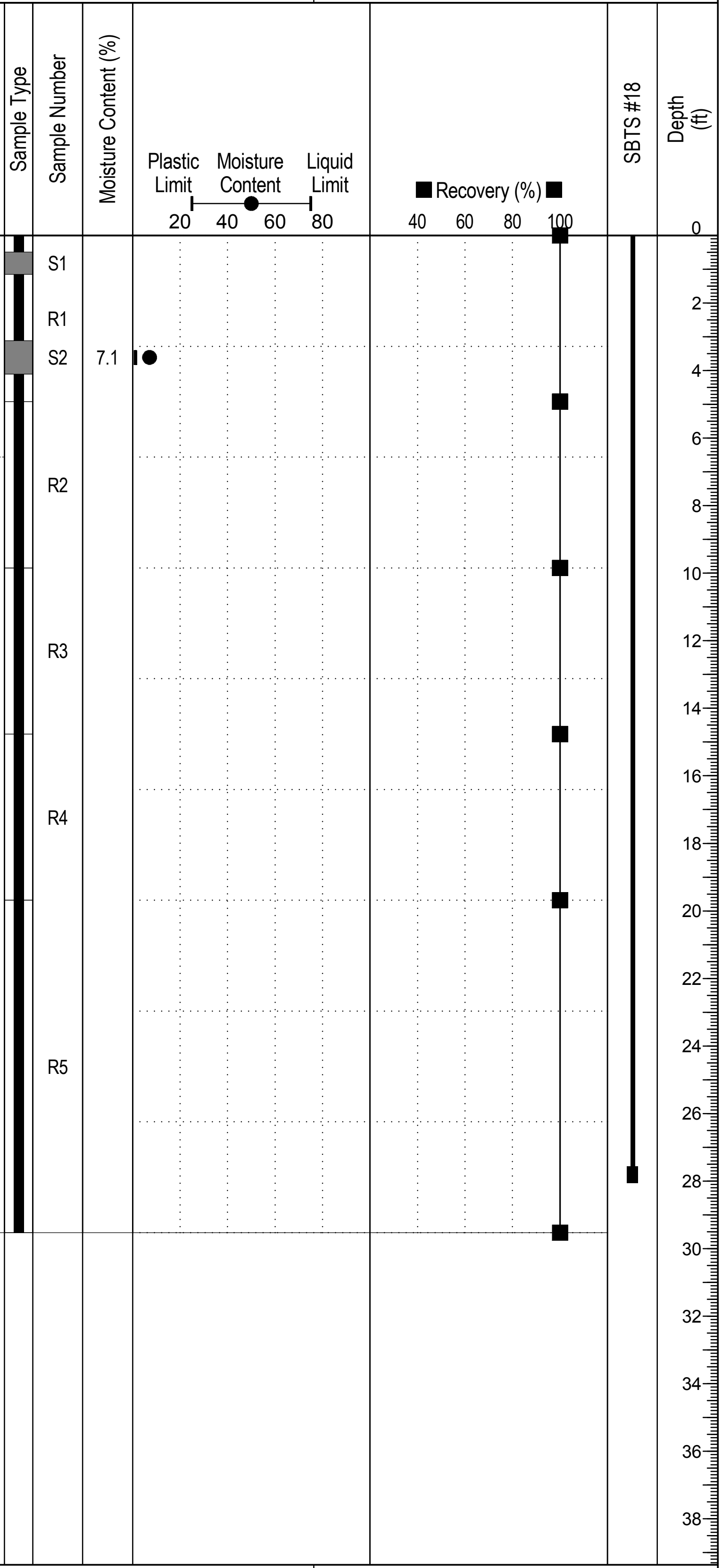
TETRA TECH

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 7.9 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 7
Logged By: VER/EP	Completion Date: 2018 April 7
Reviewed By: VER	Page 1 of 1

Borehole No: **GT18-04**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459854 E; 7100787 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
0	Sonic	SAND AND GRAVEL - silty, trace organics, dark brown, angular gravel	Seasonally frozen layer		
		- some silt, rootlets, light brown		S1	
				R1	
1		- sandy	Nbn	S2	7.1
2		METASEDIMENTARY ROCK (BEDROCK) - highly weathered, orange, oxidized, pulverized, angular	At ~ 2.0-2.5 m, Unfrozen. Thermal condition confirmed by single bead thermistor (+1.3° C, June 8, 2018)	R2	
3				R3	
5				R4	
7				R5	
9		END OF BOREHOLE (9.00 metres) Single bead thermistor #18 installed at 8.50 metres			



Contractor: Midnight Sun Drilling Inc.	Completion Depth: 9 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 10
Logged By: EP/RO	Completion Date: 2018 April 10
Reviewed By: VER	Page 1 of 1

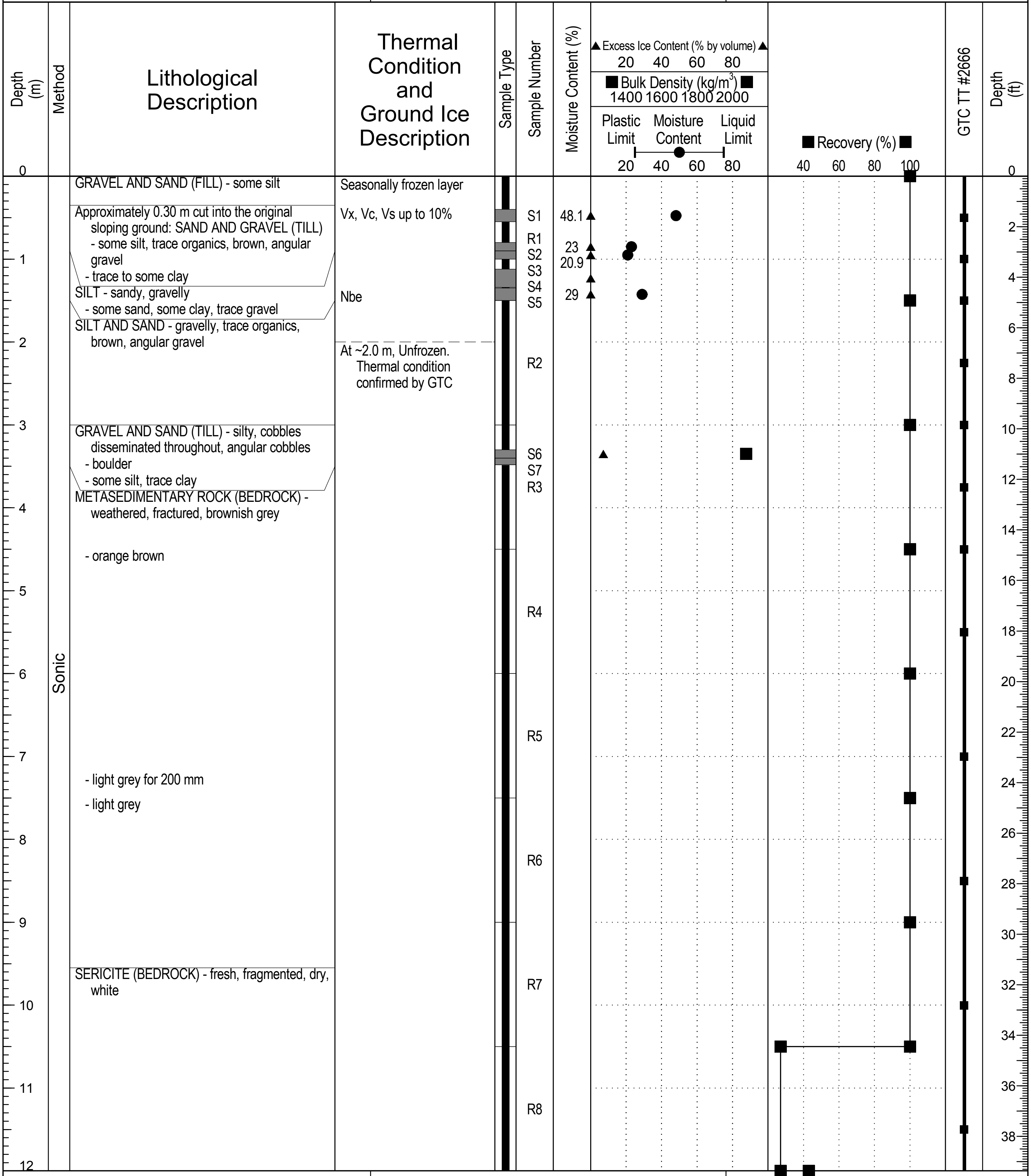
Victoria GOLD CORP

Borehole No: **GT18-05**

Project: Eagle Gold | Project No: ENG.EARC03103-02
Location: Eagle Gold Mine
Yukon Territory | UTM: 460006 E; 7100814 N; Z 8

Method: Sonic

Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
GRAVEL AND SAND (FILL) - some silt	Seasonally frozen layer		
Approximately 0.30 m cut into the original sloping ground: SAND AND GRAVEL (TILL) - some silt, trace organics, brown, angular gravel - trace to some clay	Vx, Vc, Vs up to 10%	S1	48.1
		R1	
		S2	23
		S3	20.9
		S4	
SILT - sandy, gravelly - some sand, some clay, trace gravel	Nbe	S5	29
SILT AND SAND - gravelly, trace organics, brown, angular gravel	At ~2.0 m, Unfrozen. Thermal condition confirmed by GTC	R2	
GRAVEL AND SAND (TILL) - silty, cobbles disseminated throughout, angular cobbles - boulder - some silt, trace clay		S6 S7 R3	
METASEDIMENTARY ROCK (BEDROCK) - weathered, fractured, brownish grey - orange brown		R4	
		R5	
- light grey for 200 mm - light grey		R6	
SERICITE (BEDROCK) - fresh, fragmented, dry, white		R7	
		R8	

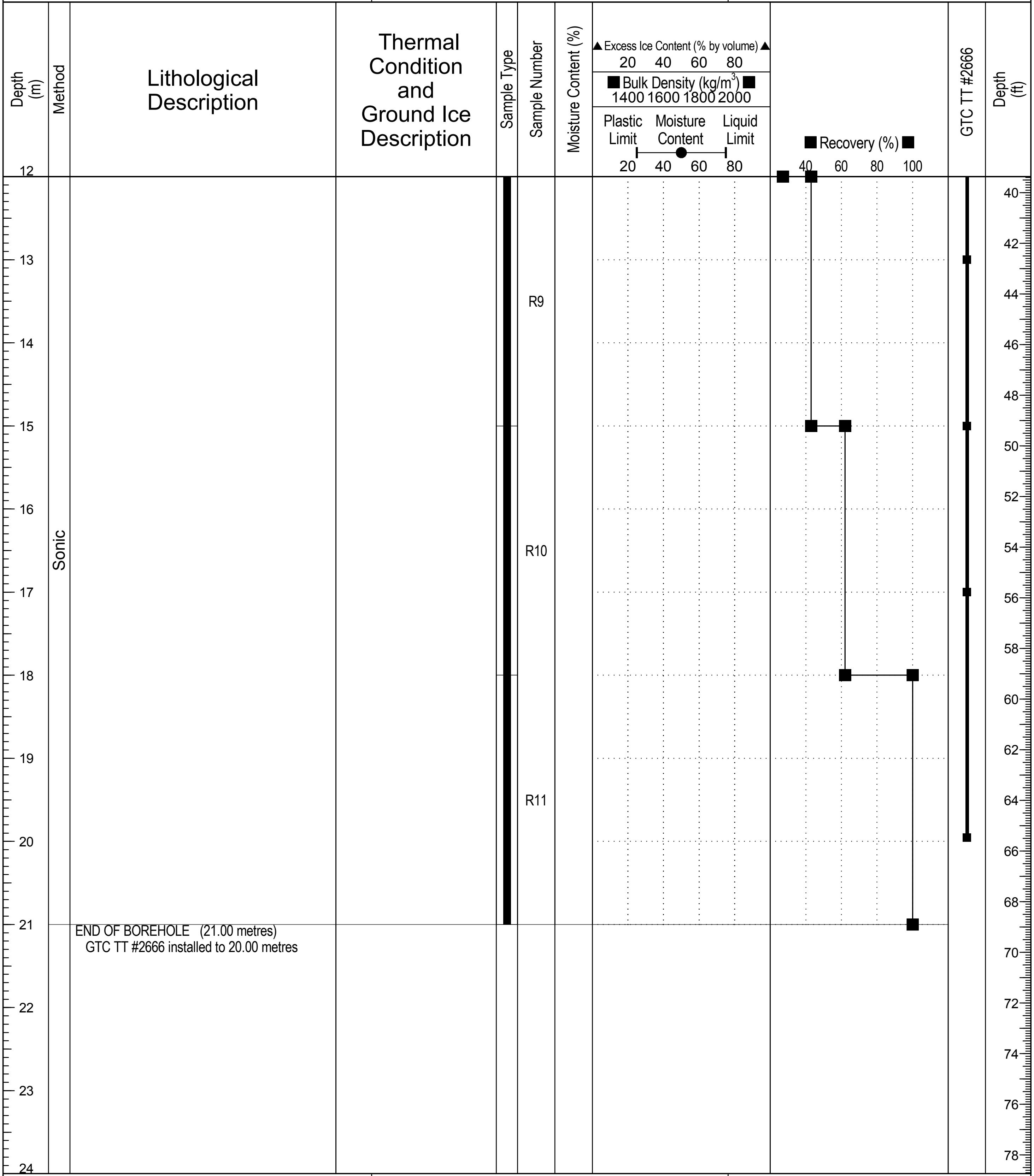


TETRA TECH

Contractor: Midnight Sun Drilling Inc. | Completion Depth: 21 m
Drilling Rig Type: Rig 9, Terrasonic | Start Date: 2018 April 9
Logged By: VER/EP/RO | Completion Date: 2018 April 9
Reviewed By: VER | Page 1 of 2

Borehole No: **GT18-05**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 460006 E; 7100814 N; Z 8



END OF BOREHOLE (21.00 metres)
GTC TT #2666 installed to 20.00 metres

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 21 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 9
Logged By: VER/EP/RO	Completion Date: 2018 April 9
Reviewed By: VER	Page 2 of 2

Victoria GOLD CORP

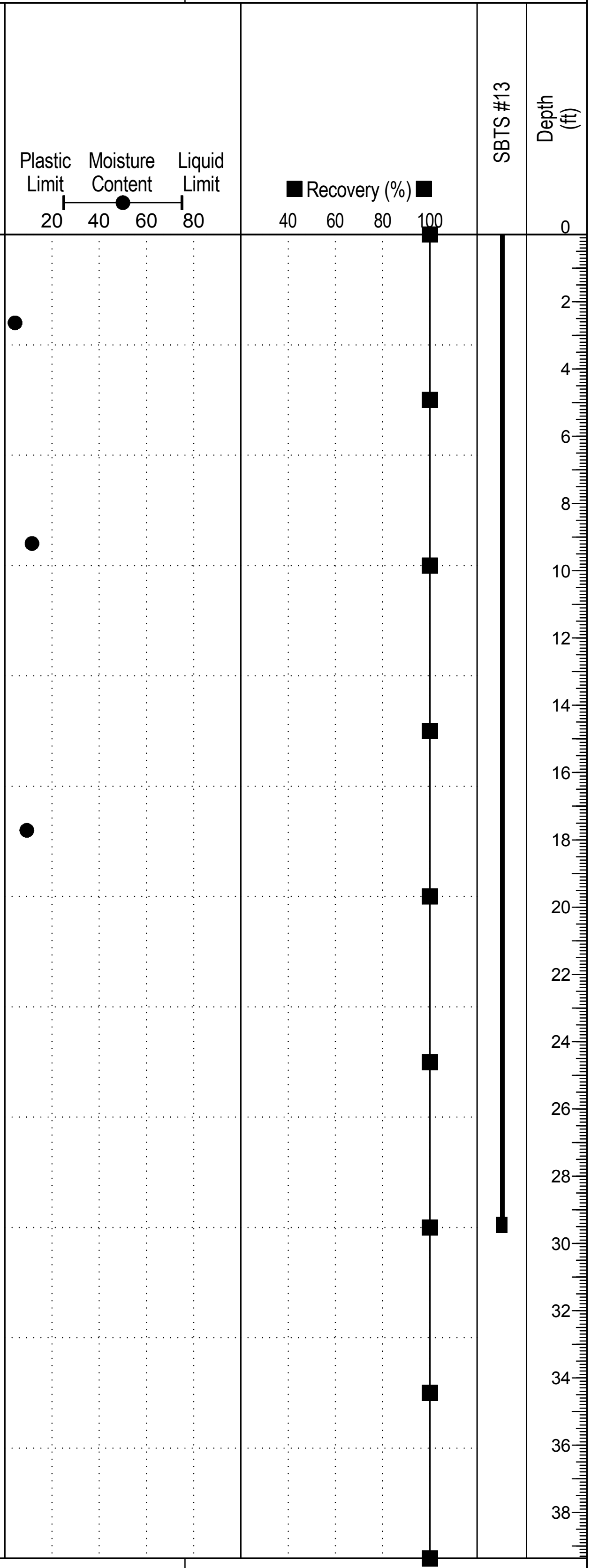
Borehole No: **GT18-06**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 460088 E; 7100852 N; Z 8

Method: Sonic

Depth (m): 0 – 12

Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
PEAT - rooty, dark brown to black, (300 mm thick)	Seasonally frozen layer Vx 20-30%		
GRAVEL - sandy, some silt, trace clay, grey brown, angular gravel	Vx 1-3% Nf		
GRAVEL (COLLUVIUM) - sandy, some silt, trace clay, dry to damp, light brown, fractured, angular gravel		R1 S1	4.3
- some clay			
		R2	
- silty		S2	11.5
	Vx ~5-10%, clear ice crystals		
	At ~3.5-4.0 m, Unfrozen. Thermal condition confirmed by single bead thermistor (+0.2° C, June 8, 2018)	R3	
METASEDIMENTARY BOULDER - weathered, fractured, brown, fine angular			
GRAVEL AND SAND (COLLUVIUM) - some silt, trace clay, dry to damp, light brown, fractured, angular gravel			
		R4 S3	9.3
- 300 mm boulder			
		R5	
METASEDIMENTARY BOULDER - weathered, fractured, brown, fine angular			
GRAVEL AND SAND (COLLUVIUM) - some silt, trace clay, dry to damp, light brown, fractured, angular gravel			
		R6	
- quartz cobble			
METASEDIMENTARY ROCK (BEDROCK) - highly weathered, fractured, orange, oxide weathering, angular			
		R7 1R	
		R8	



TETRA TECH

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 12 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 8
Logged By: VER/EP	Completion Date: 2018 April 8
Reviewed By: VER	Page 1 of 2

Victoria GOLD CORP

Borehole No: **GT18-06**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 460088 E; 7100852 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit — Moisture Content ● — Liquid Limit 20 40 60 80	■ Recovery (%) ■ 40 60 80 100	SBTS #13	Depth (ft)
12		END OF BOREHOLE (12.00 metres) Single bead thermistor #13 installed at 9.00 metres								40
										42
13										
										44
14										46
										48
15										
										50
										52
16										
										54
17										56
										58
18										
										60
										62
19										
										64
20										66
										68
21										
										70
22										72
										74
23										
										76
										78
24										

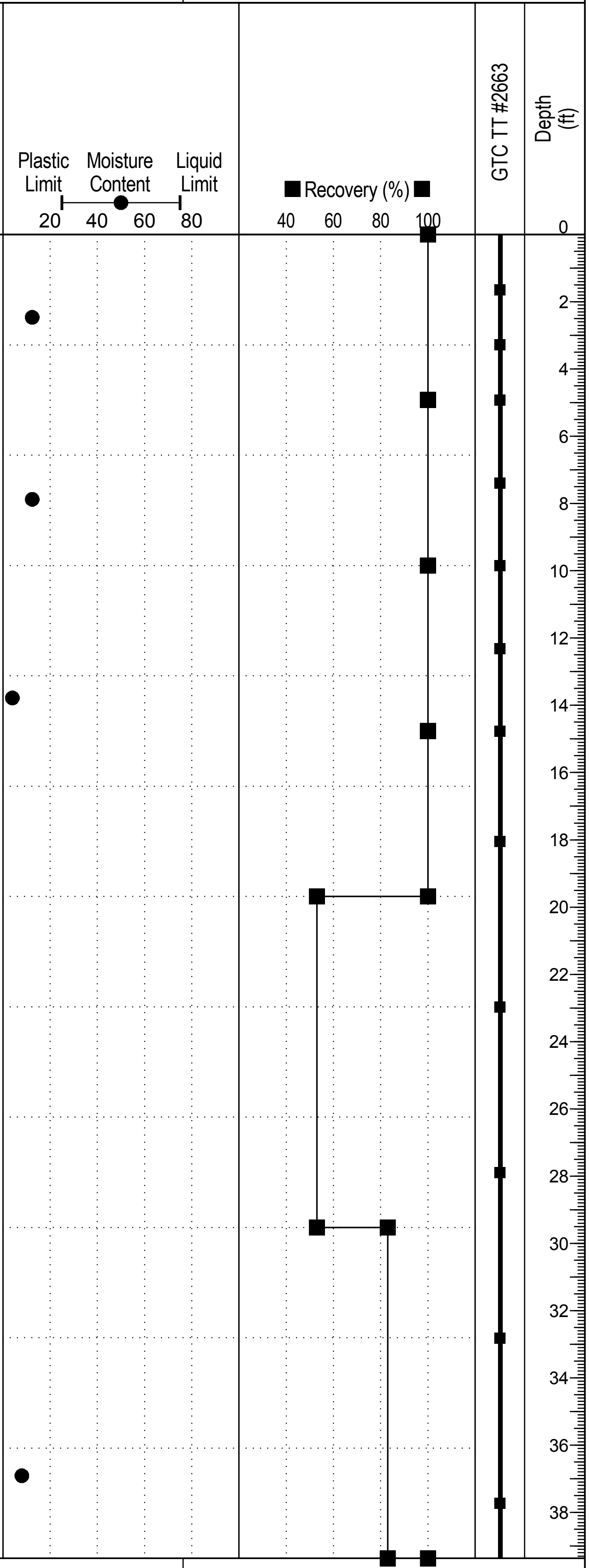
TETRA TECH

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 12 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 8
Logged By: VER/EP	Completion Date: 2018 April 8
Reviewed By: VER	Page 2 of 2

Borehole No: **GT18-07**

Project: Eagle Gold
Project No: ENG.EARC03103-02
Location: Eagle Gold Mine
Yukon Territory
UTM: 460139 E; 7100709 N; Z 8

Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
Sonic	SAND AND GRAVEL - silty, trace organics, brown, dark black organic inclusions, angular gravel	Seasonally frozen layer		
	- gravelly, less organics	Vx 1-3%, very small ice inclusions, bonded to 1.00 metre	R1 S1	12.4
	- some clay			
	SILT - gravelly, sandy	At ~2.3 m, Unfrozen. Thermal condition confirmed by GTC	R2 S2	12.4
	SAND - gravelly, silty			
	- trace clay		R3	
	- trace silt		S3	4
			R4	
			S4	
			R5	
			R6	
	GRAVEL - sandy, silty		S5	8



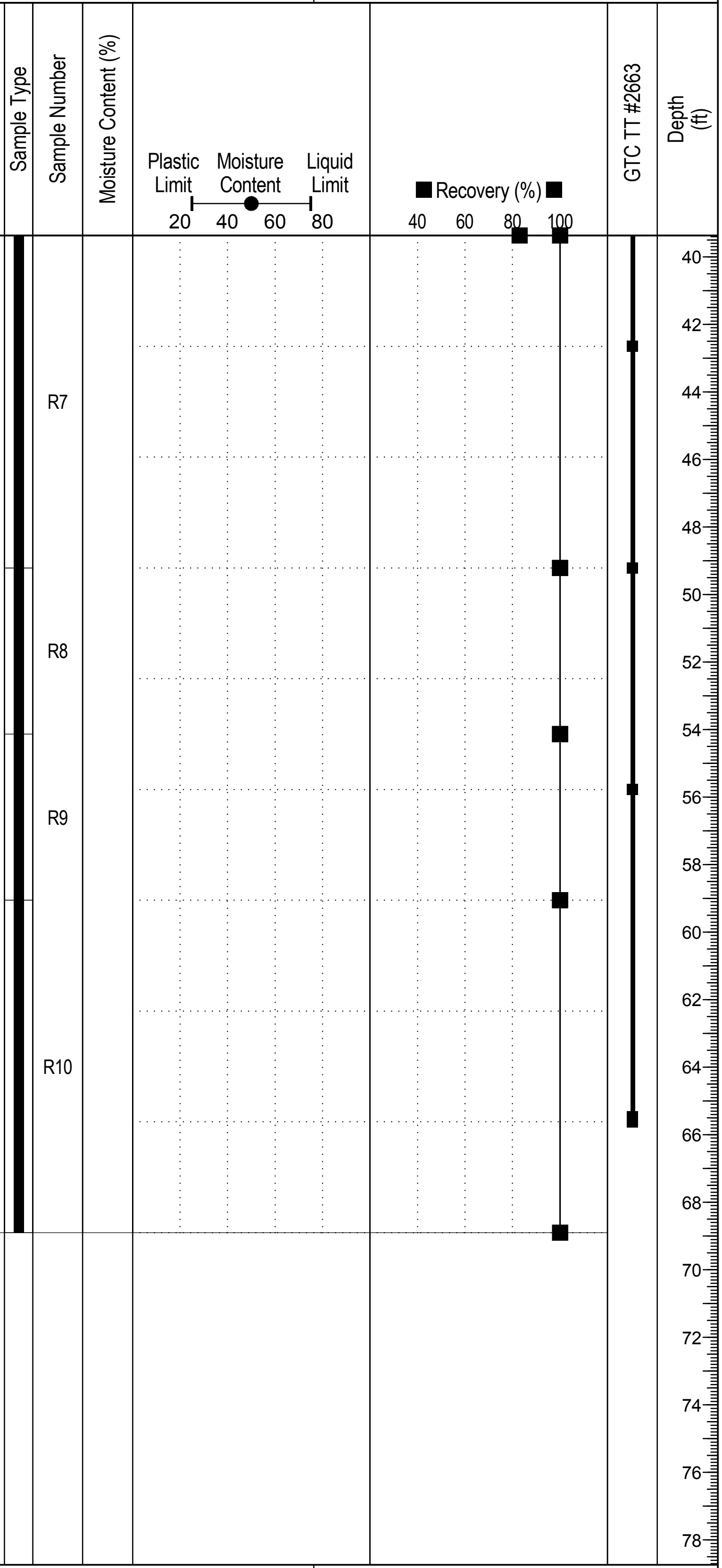
Contractor: Midnight Sun Drilling Inc.
Completion Depth: 21 m
Drilling Rig Type: Rig 9, Terrasonic
Start Date: 2018 April 8
Logged By: VER/EP/RO
Completion Date: 2018 April 8
Reviewed By: VER
Page 1 of 2

ROCK CORE ZONE8.GPJ EBA.GDT 18/9/26

Borehole No: **GT18-07**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 460139 E; 7100709 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description
12	Sonic	METASEDIMENTARY ROCK (BEDROCK) - highly weathered, fractured, orangish brown, orange oxide weathering, angular	
		- fresh, SERICITE, light grey, slight arsenopyrite alteration - quartz veins	
21		END OF BOREHOLE (21.00 metres) GTC TT #2663 installed to 20.00 metres	



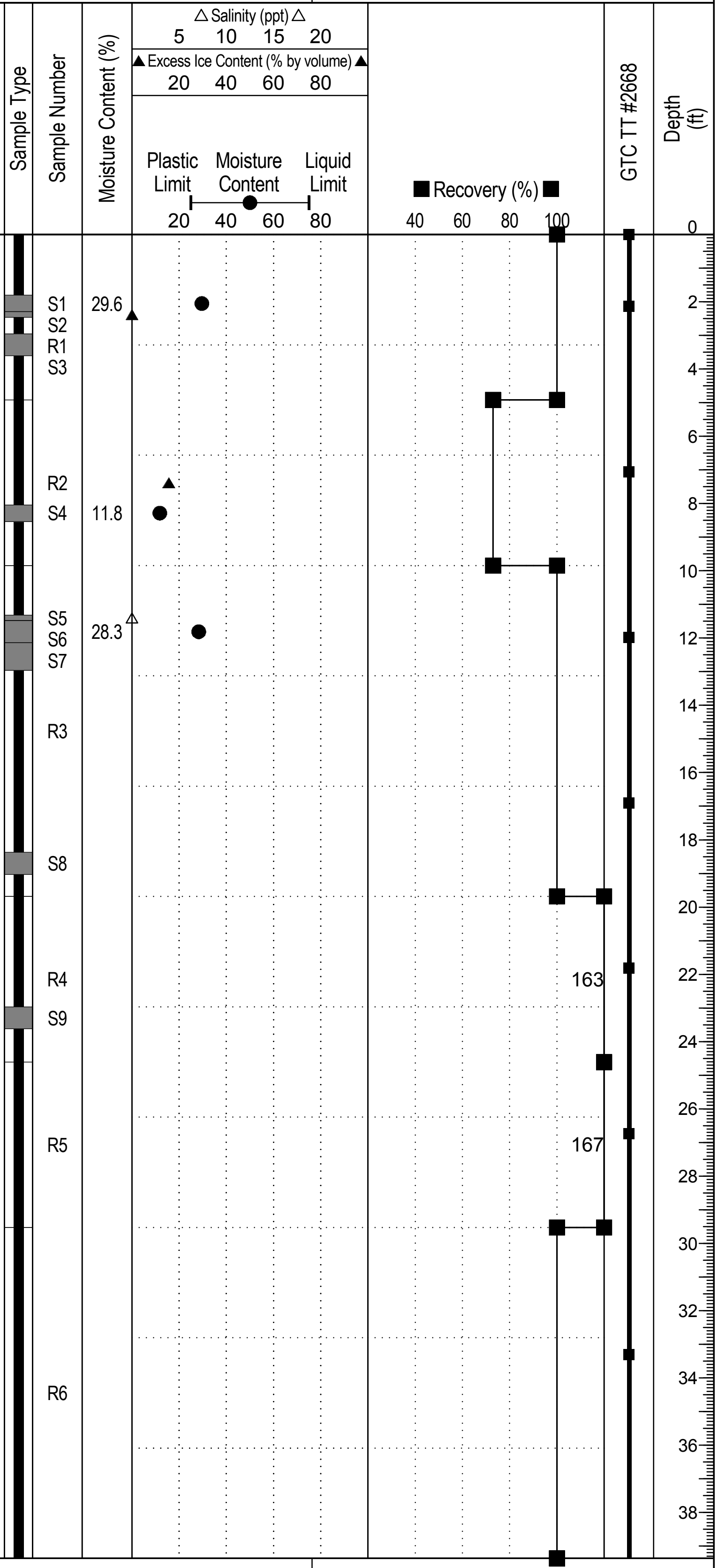
Contractor: Midnight Sun Drilling Inc.	Completion Depth: 21 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 8
Logged By: VER/EP/RO	Completion Date: 2018 April 8
Reviewed By: VER	Page 2 of 2

Borehole No: **GT18-08**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459517 E; 7099141 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description
0	Sonic	PEAT - sandy, some gravel, trace silt, cobbles disseminated throughout, roots, black to dark brown	Vx ~3%, clear ice crystal in frozen chunks of sample
		SAND AND GRAVEL - silty, cobbles disseminated throughout, dry	
		- dark brown, angular gravel	Nbn
		- sandy, some silt	
3		SILT AND SAND - some gravel, trace organics, dark grey to brown - sandy	Vx 15%, one ~3 mm wide ice lens
		SAND AND GRAVEL - silty, trace clay, cobbles disseminated throughout, dark grey	Nbn
		GRAVEL AND SILT - sandy, some clay	
		SAND AND GRAVEL - silty, trace clay, cobbles disseminated throughout, dark grey	

Sample Number	Moisture Content (%)
S1	29.6
S2	
R1	
S3	
R2	
S4	11.8
S5	
S6	28.3
S7	
R3	
S8	
R4	
S9	
R5	
R6	

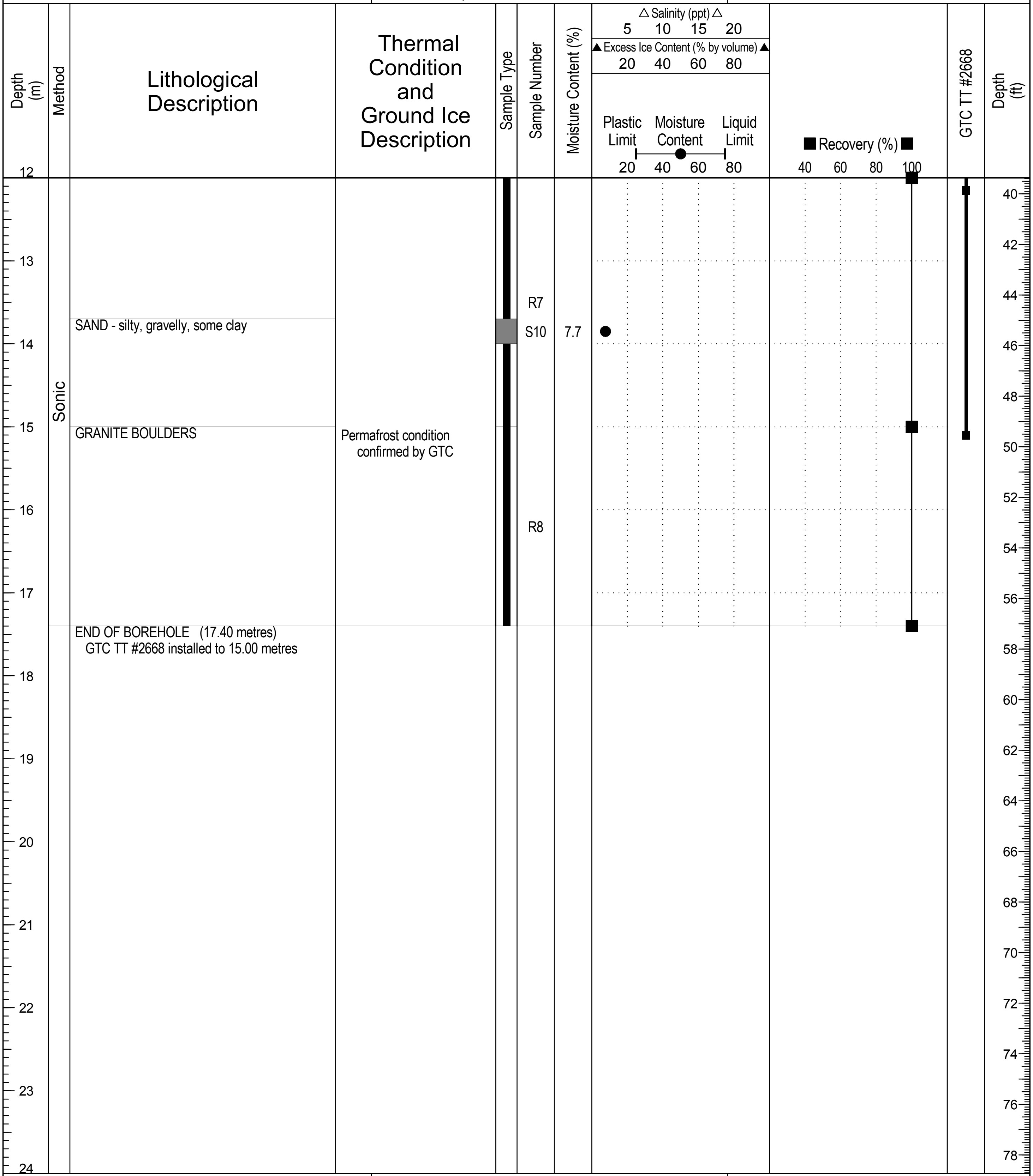


Contractor: Midnight Sun Drilling Inc.	Completion Depth: 17.4 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 11
Logged By: EP/RO	Completion Date: 2018 April 11
Reviewed By: VER	Page 1 of 2

ROCK CORE ZONE8.GPJ EBA.GDT 18/9/26

Borehole No: **GT18-08**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459517 E; 7099141 N; Z 8



SAND - silty, gravelly, some clay

GRANITE BOULDERS

Permafrost condition confirmed by GTC

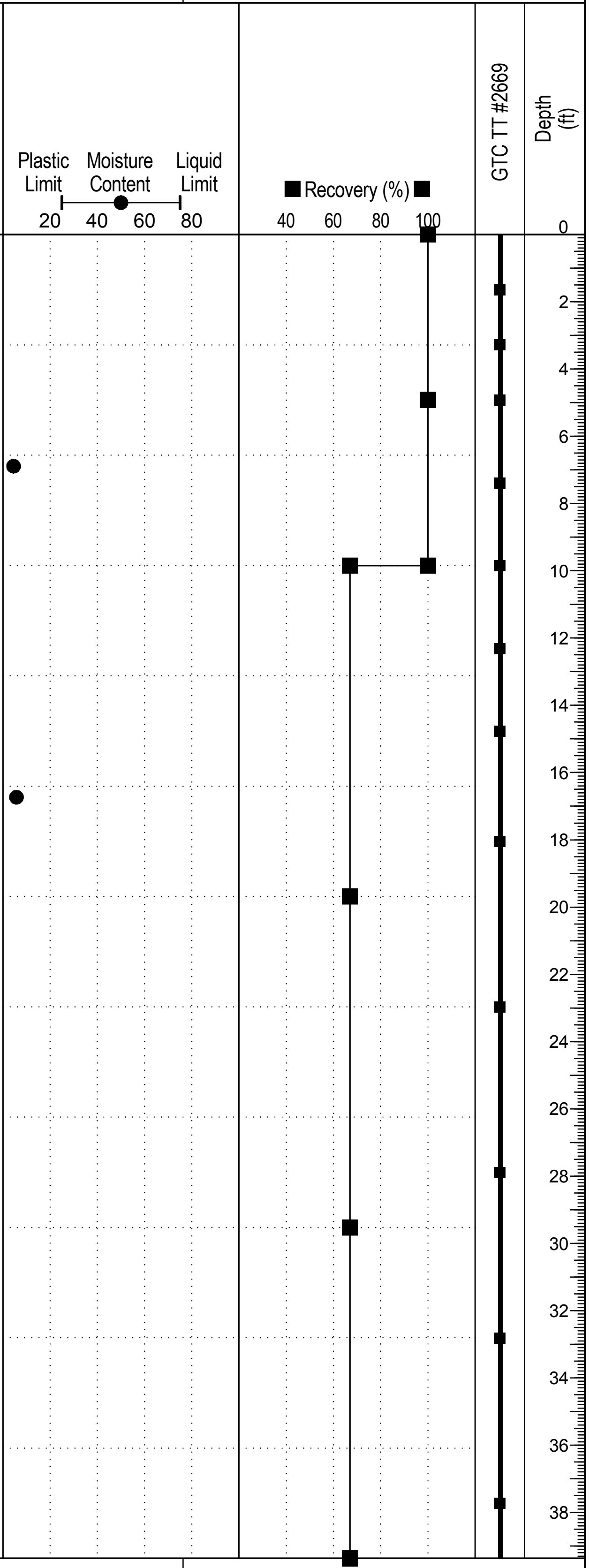
END OF BOREHOLE (17.40 metres)
GTC TT #2668 installed to 15.00 metres

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 17.4 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 11
Logged By: EP/RO	Completion Date: 2018 April 11
Reviewed By: VER	Page 2 of 2

Borehole No: **GT18-09**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459925 E; 7098981 N; Z 8

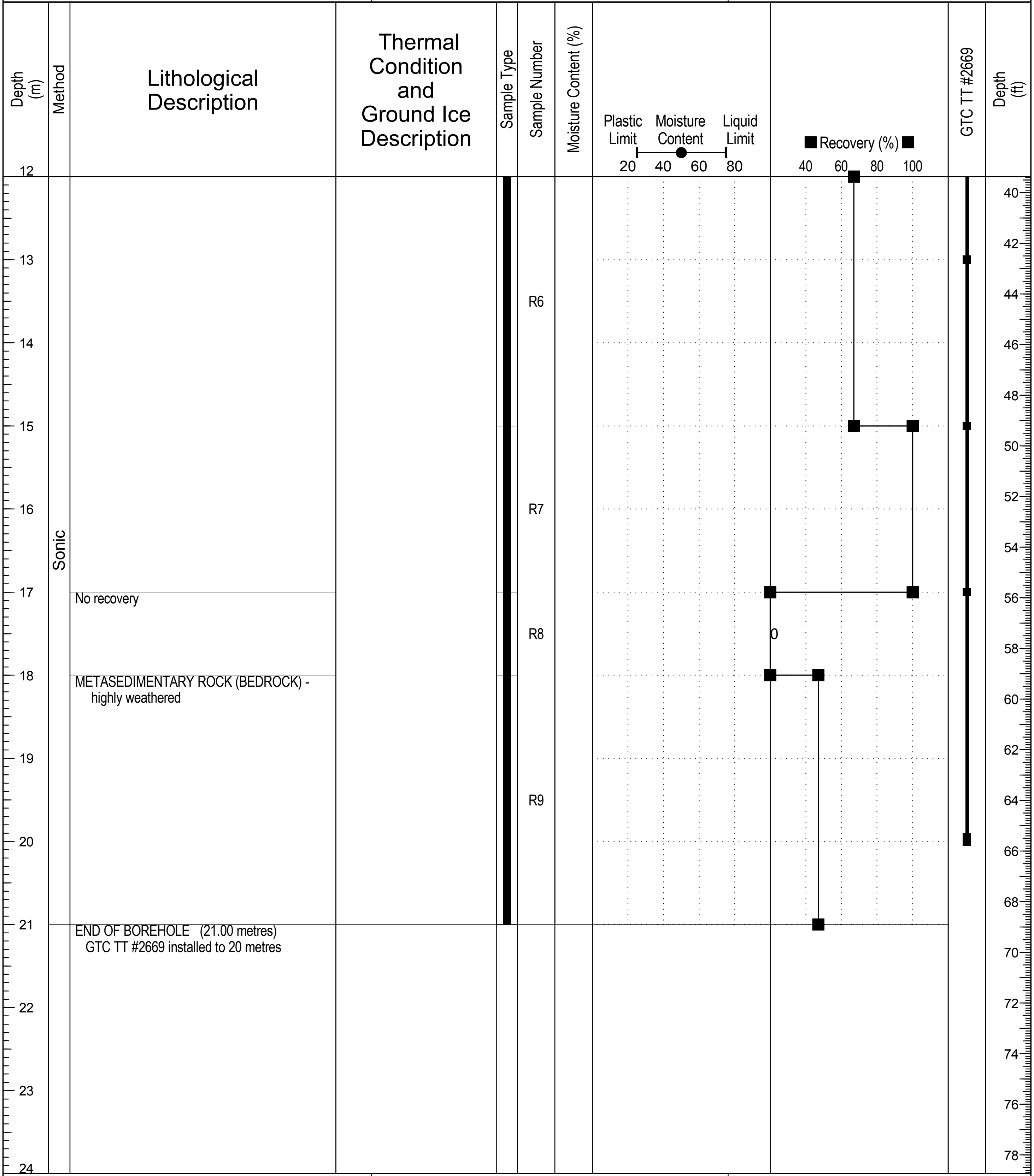
Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)
0	Sonic	SAND AND GRAVEL (FILL from old road) - some silt, includes organics, cobbles disseminated throughout				
~0.5		SAND AND GRAVEL - some silt, cobbles disseminated throughout, fragments, pulverized, dry, loose, orangish brown, angular gravel	Seasonally frozen layer		R1	
~2.1		- silty			S1 R2	4.5
~2.6		- trace clay for 200 mm				
~3.1		- trace clay for 100 mm	At ~3.0 m, Unfrozen. Thermal condition confirmed by GTC			
~4.5					R3	
5		GRAVEL - sandy, some silt			S2	5.7
~7.5					R4	
~9.5		METASEDIMENTARY ROCK (BEDROCK) - highly weathered				
~10.5					R5	
12						



Contractor: Midnight Sun Drilling Inc.	Completion Depth: 21 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 13
Logged By: EP/RO	Completion Date: 2018 April 13
Reviewed By: VER	Page 1 of 2

Borehole No: **GT18-09**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459925 E; 7098981 N; Z 8



17 No recovery

18 METASEDIMENTARY ROCK (BEDROCK) - highly weathered

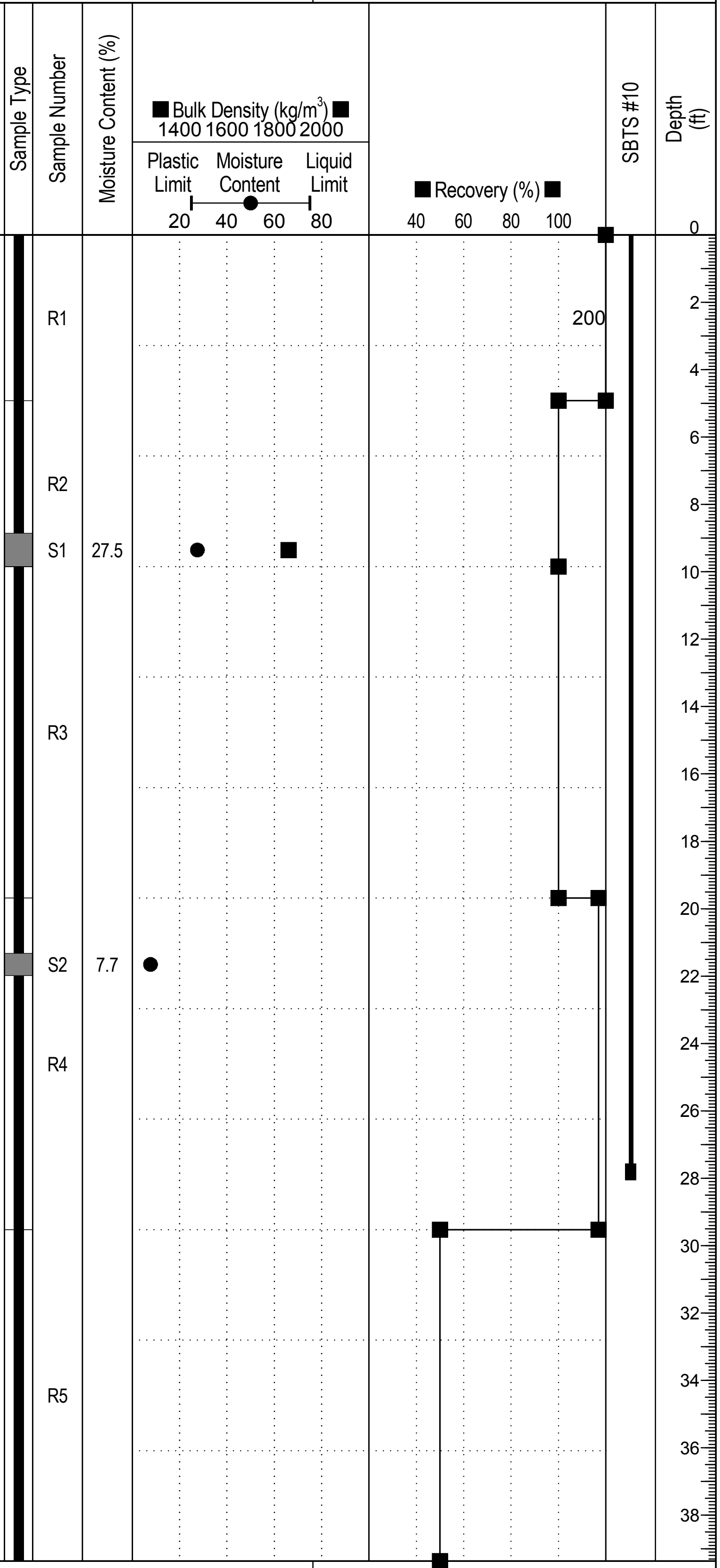
21 END OF BOREHOLE (21.00 metres)
GTC TT #2669 installed to 20 metres

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 21 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 13
Logged By: EP/RO	Completion Date: 2018 April 13
Reviewed By: VER	Page 2 of 2

Borehole No: **GT18-10**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459968 E; 7098851 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
0	Sonic	SAND AND GRAVEL (FILL) - trace clay, contains snow and ice		R1	
1		Cut into the original sloping ground: SAND AND GRAVEL - trace clay, brown, angular gravel - darker brown to grey	Vx 3% Vx 1%	R2	
2					
3		SILT - some clay, some sand, trace gravel		S1	27.5
4		- some clay for 200 mm	Nb Warm permafrost condition confirmed by single bead thermistor (-0.1° C, June 8, 2018)	R3	
5					
6					
7		GRAVEL - silty, sandy - some clay		S2 R4	7.7
8		- trace clay			
9		BEDROCK - highly weathered, slightly oxidized, angular			
10				R5	
11					
12					



Contractor: Midnight Sun Drilling Inc.	Completion Depth: 12 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 14
Logged By: EP/RO	Completion Date: 2018 April 14
Reviewed By: VER	Page 1 of 2

Victoria GOLD CORP

Borehole No: **GT18-10**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459968 E; 7098851 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	■ Bulk Density (kg/m³) ■ 1400 1600 1800 2000 Plastic Limit Moisture Content Liquid Limit 20 40 60 80	■ Recovery (%) ■ 40 60 80 100	SBTS #10	Depth (ft)
12		END OF BOREHOLE (12.00 metres) Single bead thermistor #10 installed to 8.50 metres								40
13										42 44
14										46 48
15										50
16										52 54
17										56 58
18										60
19										62 64
20										66 68
21										70
22										72 74
23										76 78
24										

TETRA TECH

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 12 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 14
Logged By: EP/RO	Completion Date: 2018 April 14
Reviewed By: VER	Page 2 of 2

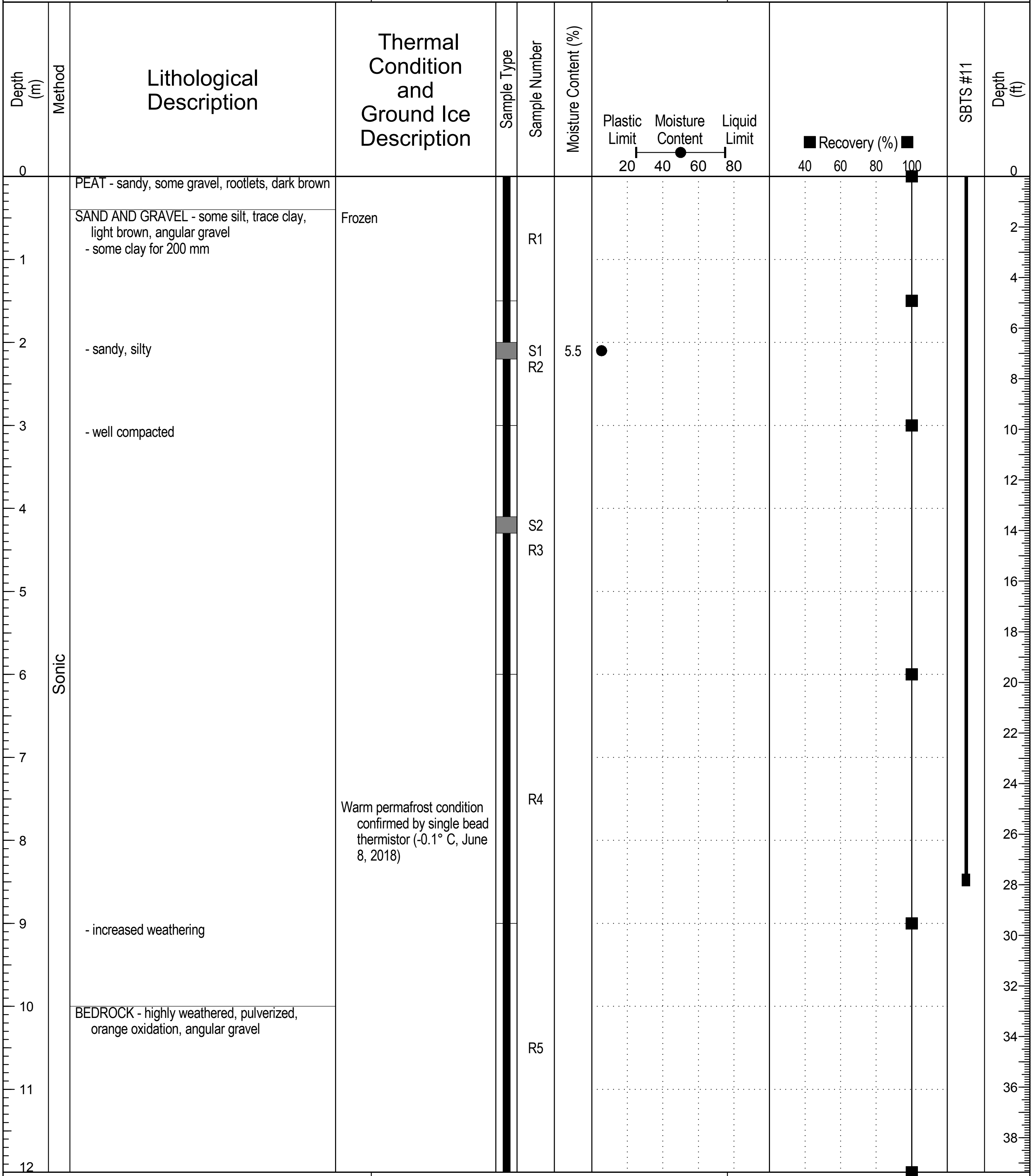
Borehole No: **GT18-11**

Project: Eagle Gold | Project No: ENG.EARC03103-02

Location: Eagle Gold Mine

Yukon Territory | UTM: 460080 E; 7098964 N; Z 8

Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
Sonic	PEAT - sandy, some gravel, rootlets, dark brown			
	SAND AND GRAVEL - some silt, trace clay, light brown, angular gravel - some clay for 200 mm	Frozen	R1	
	- sandy, silty		S1 R2	5.5
	- well compacted			
			S2 R3	
		Warm permafrost condition confirmed by single bead thermistor (-0.1° C, June 8, 2018)	R4	
	- increased weathering			
	BEDROCK - highly weathered, pulverized, orange oxidation, angular gravel		R5	



Contractor: Midnight Sun Drilling Inc. | Completion Depth: 12 m

Drilling Rig Type: Rig 9, Terrasonic | Start Date: 2018 April 13

Logged By: EP/RO | Completion Date: 2018 April 13

Reviewed By: VER | Page 1 of 2

Borehole No: **GT18-11**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 460080 E; 7098964 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)	Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	■ Recovery (%) ■ 40 60 80 100	SBTS #11	Depth (ft)
12		END OF BOREHOLE (12.00 metres) Single bead thermistor installed to 8.50 metres								40
										42
13										44
14										46
										48
15										50
16										52
										54
17										56
										58
18										60
19										62
										64
20										66
21										68
										70
22										72
										74
23										76
24										78

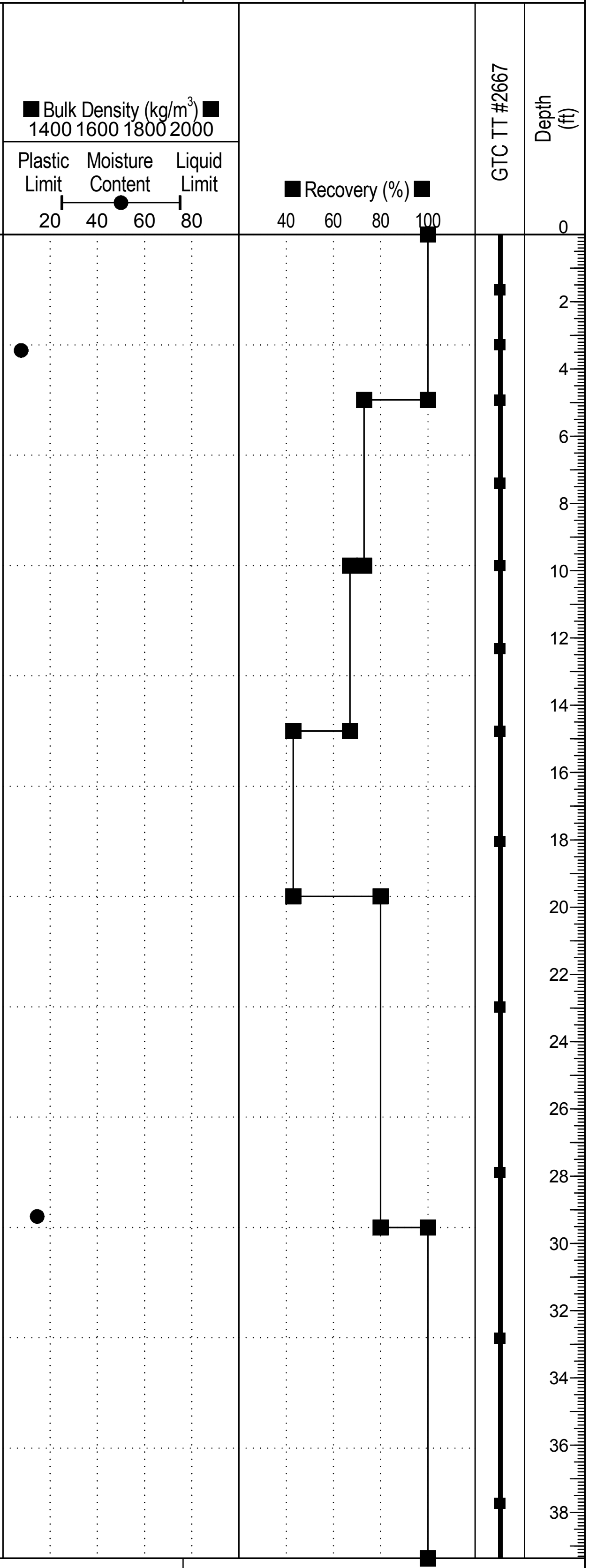
Contractor: Midnight Sun Drilling Inc.	Completion Depth: 12 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 13
Logged By: EP/RO	Completion Date: 2018 April 13
Reviewed By: VER	Page 2 of 2

Victoria GOLD CORP

Borehole No: **GT18-15**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459597 E; 7100583 N; Z 8

Depth (m)	Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Type	Sample Number	Moisture Content (%)
0	Sonic	SAND AND GRAVEL - silty, trace organics, roots, moss, angular gravel - loose	Vx 1-3%			
					R1	
1		SAND - silty, some gravel, some clay	Nbn		S1	7.7
		- slightly coarser sand				
2					R2	
3		- trace silt				
					R3	
4						
5					R4	
6		- cobble				
7					R5	
8						
9		- silty, gravelly, some clay			S2	14.5
					S3	
10					R6	
11		SILT - clayey, some gravel, some sand, quartz cobbles disseminated throughout, dark grey, angular gravel, frozen clay				
12					S4	



TETRA TECH

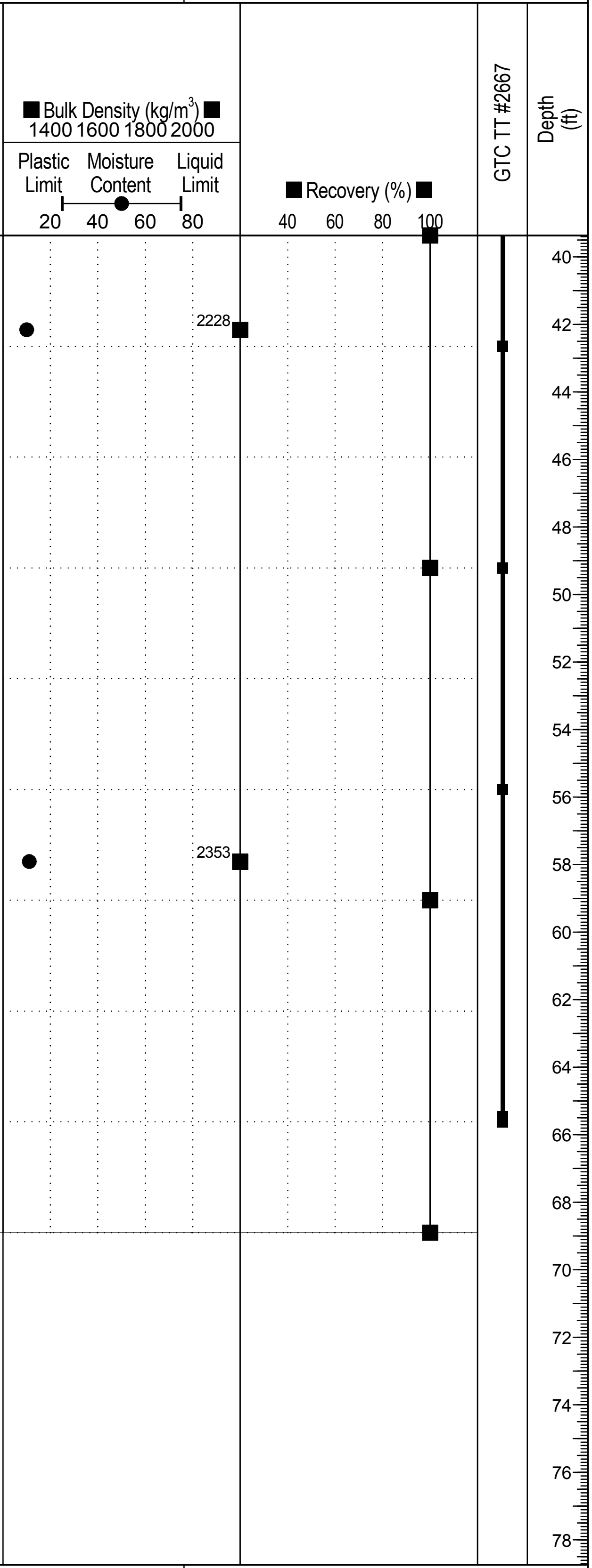
Contractor: Midnight Sun Drilling Inc.	Completion Depth: 21 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 10
Logged By: EP/RO	Completion Date: 2018 April 10
Reviewed By: VER	Page 1 of 2

Borehole No: **GT18-15**

Project: Eagle Gold | Project No: ENG.EARC03103-02
Location: Eagle Gold Mine
Yukon Territory | UTM: 459597 E; 7100583 N; Z 8

Depth (m): 12 – 24

Method	Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
Sonic	- slightly more clay			
	SAND - silty, gravelly, some clay		S5	10
			R7	
			S6	
			R8	
	SILT - sandy, clayey, some gravel		S7	11.1
	METASEDIMENTARY ROCK (BEDROCK) - highly weathered, fragmented, orangish brown, angular gravel	Very warm permafrost condition confirmed by GTC (0° to -0.1° C, June 8, 2018)		
			R9	
	END OF BOREHOLE (21.00 metres) GTC TT #2667 installed to 20.00 metres			

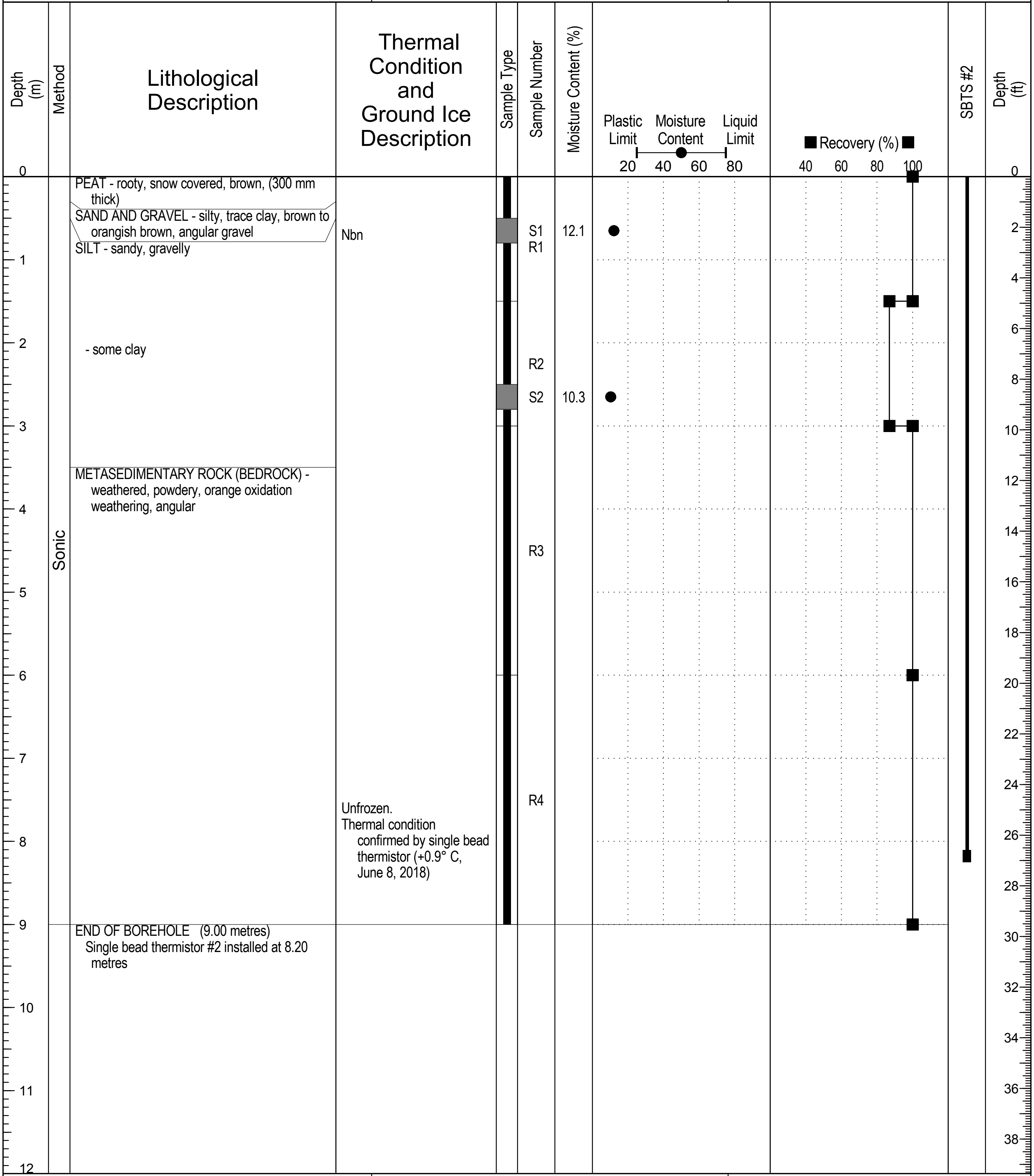


Contractor: Midnight Sun Drilling Inc. | Completion Depth: 21 m
Drilling Rig Type: Rig 9, Terrasonic | Start Date: 2018 April 10
Logged By: EP/RO | Completion Date: 2018 April 10
Reviewed By: VER | Page 2 of 2

Victoria GOLD CORP

Borehole No: **GT18-16**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459607 E; 7100308 N; Z 8



Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
PEAT - rooty, snow covered, brown, (300 mm thick)			
SAND AND GRAVEL - silty, trace clay, brown to orangish brown, angular gravel	Nbn	S1 R1	12.1
SILT - sandy, gravelly			
- some clay		R2	
		S2	10.3
METASEDIMENTARY ROCK (BEDROCK) - weathered, powdery, orange oxidation weathering, angular		R3	
	Unfrozen. Thermal condition confirmed by single bead thermistor (+0.9° C, June 8, 2018)	R4	
END OF BOREHOLE (9.00 metres) Single bead thermistor #2 installed at 8.20 metres			

TETRA TECH

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 9 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 11
Logged By: EP/RO	Completion Date: 2018 April 11
Reviewed By: VER	Page 1 of 1

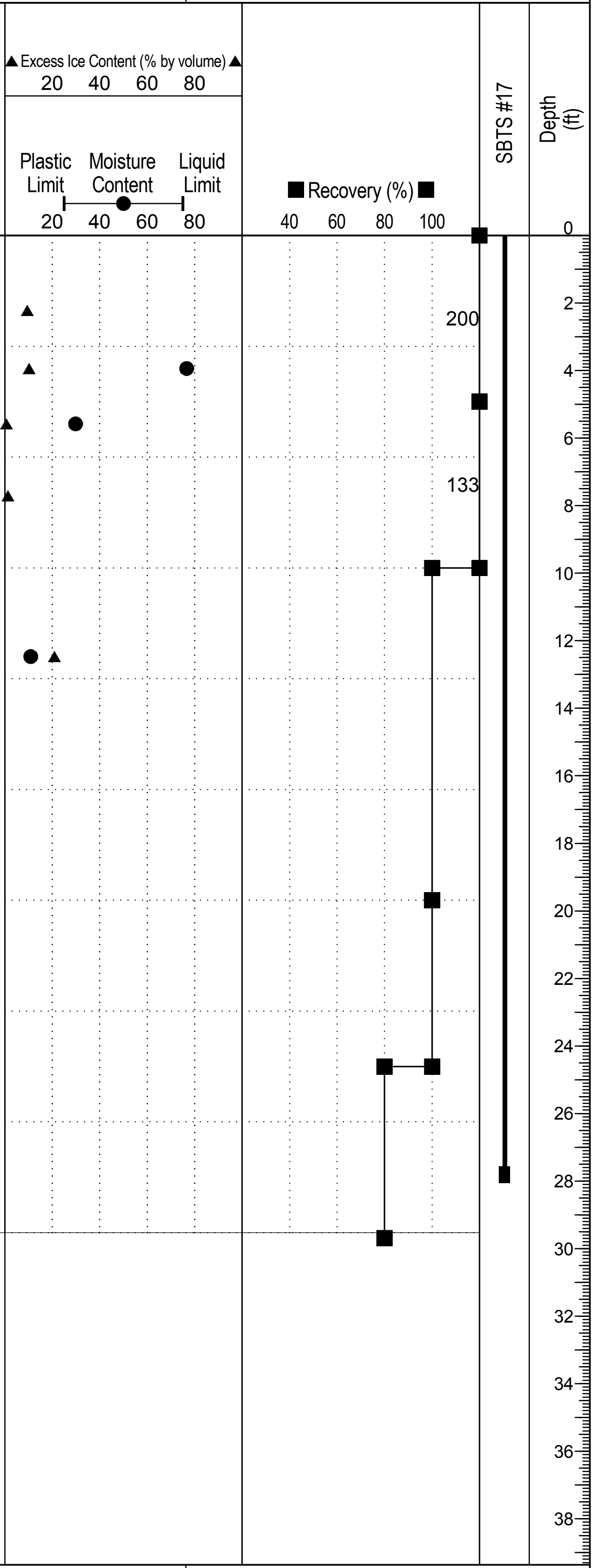
Victoria GOLD CORP

Borehole No: **GT18-17**

Project: Eagle Gold	Project No: ENG.EARC03103-02
Location: Eagle Gold Mine	
Yukon Territory	UTM: 459263 E; 7100290 N; Z 8

Method: Sonic

Lithological Description	Thermal Condition and Ground Ice Description	Sample Number	Moisture Content (%)
PEAT - rootlets, moss, dark brown to red black, (300 mm thick)	Vx 5%		
ICE AND SAND AND SILT - some gravel, very light brown, angular gravel	Clear and cloudy ice, expanded twice the length of run. Borehole appears to be in small drainage gully explaining ice content in active layer	S1 R1	
ICE AND SAND - silty, gravelly, some clay		S2	76.6
SAND - silty, some gravel	Vc,Vx	S3	29.8
SAND AND GRAVEL - some silt, trace clay, brown grey, angular gravel	Vc, Vx 3-5%		
		R2 S4	
	Nbn		
- silty, some clay, some gravel		S5	10.9
		R3	
METASEDIMENTARY ROCK (BEDROCK) - low oxidization, pulverized, fragments			
	Warm permafrost condition confirmed by single bead thermistor (-0.1° C, June 8, 2018)	R4	
		R5	
END OF BOREHOLE (9.00 metres) Single bead thermistor #17 installed at 8.50 metres			



TETRA TECH

Contractor: Midnight Sun Drilling Inc.	Completion Depth: 9 m
Drilling Rig Type: Rig 9, Terrasonic	Start Date: 2018 April 12
Logged By: EP/RO	Completion Date: 2018 April 12
Reviewed By: VER	Page 1 of 1

APPENDIX C

OFF-SITE GEOTECHNICAL LABORATORY SOIL TEST RESULTS

BULK DENSITY AND ICE CONTENT TEST RESULTS

Project: Eagle Gold – Spring 2018 Geotechnical Investigation
Sample No.: See below
Project No.: ENG.EARC03103-02
Date Tested: May 10, 2018
Client: Victoria Gold Corp.
Tested By: AMT
Address: Eagle Gold Mine, Yukon
Page: 1 of 1

B.H. & Sample Number	Mass of Sample (g)	Diameter (mm)	Width (mm)	Length (mm)	Bulk Density (kg/m^3)	Height of Supernatant Water (mm)	Height of Saturated Sediment (mm)	Excess Ice Content %
GT18-05-S4	-	-	-	-	-	0.0	150.0	0.0
GT18-05-S6	2242.5	109.1	105.0	120.0	2076.3	-	-	-
GT18-10-S1	3269.3	92.0	85.2	285.0	1860.6	-	-	-
GT18-15-S5	4657.5	102.2	97.0	268.3	2228.0	-	-	-
GT18-15-S7	4698.8	104.5	98.0	248.0	2353.2	-	-	-
GT18-17-S2	-	-	-	-	-	85.0	88.0	51.3
GT18-17-S3	-	-	-	-	-	29.0	117.0	21.3

Remarks:

Whitehorse, YT

Reviewed By: P.Geo.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

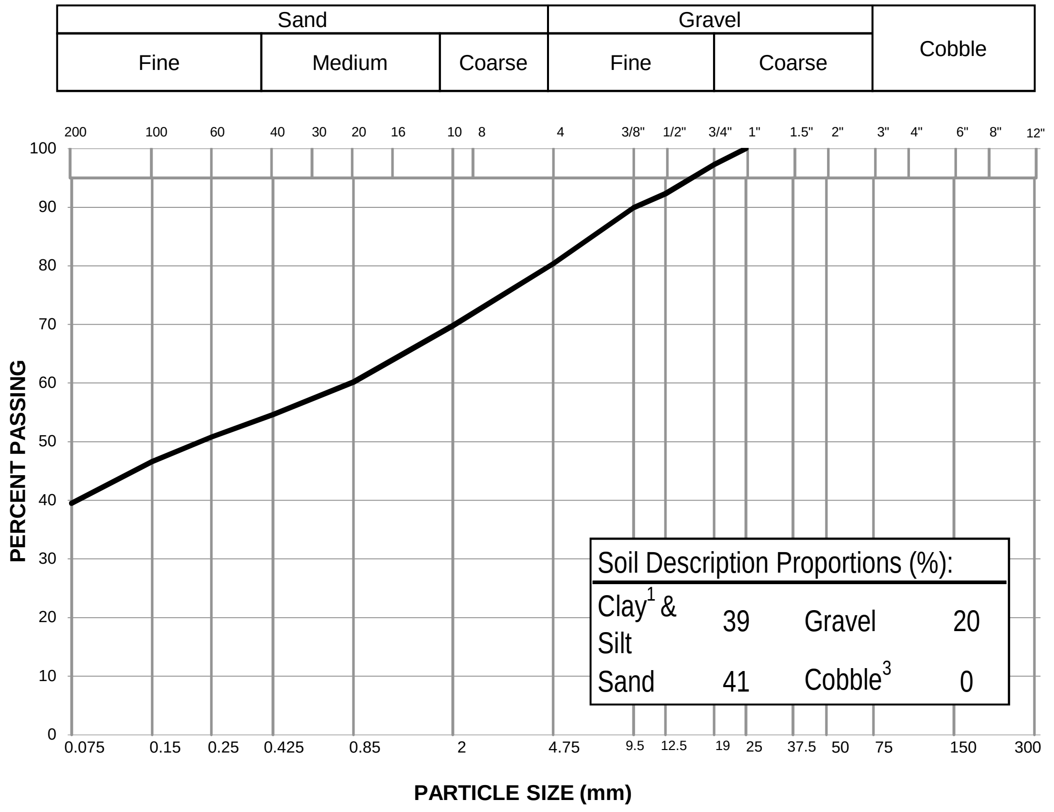
ASTM D7928 & C136

Project: Eagle Gold - Spring 2018 Geotechnical Investigation
Project No.: ENG.EARC03103-02
Site: Eagle Gold Mine, Yukon
Client: Victoria Gold Corp.
Client Rep.: Dr. Stephen Wilbur
Date Tested: May 23, 2018 By: OO
Soil Description[2]: SAND & SILT - some gravel

Sample No.: S1
Material Type:
Sample Loc.: GT18-01
Sample Depth: 1.5-2.5 m
Sampling Method: Grab
Date Sampled: April 7, 2018
Sampled By: EP
USC Classification:
Cu: #N/A
Cc: #N/A

Moisture Content: 9.4%

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
37.5	
25	100
19	97
12.5	92
9.5	90
4.75	80
2	70
0.85	60
0.425	55
0.25	51
0.15	47
0.075	39.5



Soil Description Proportions (%):

Clay[1] & Silt	39	Gravel	20
Sand	41	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: JDR P.Eng.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

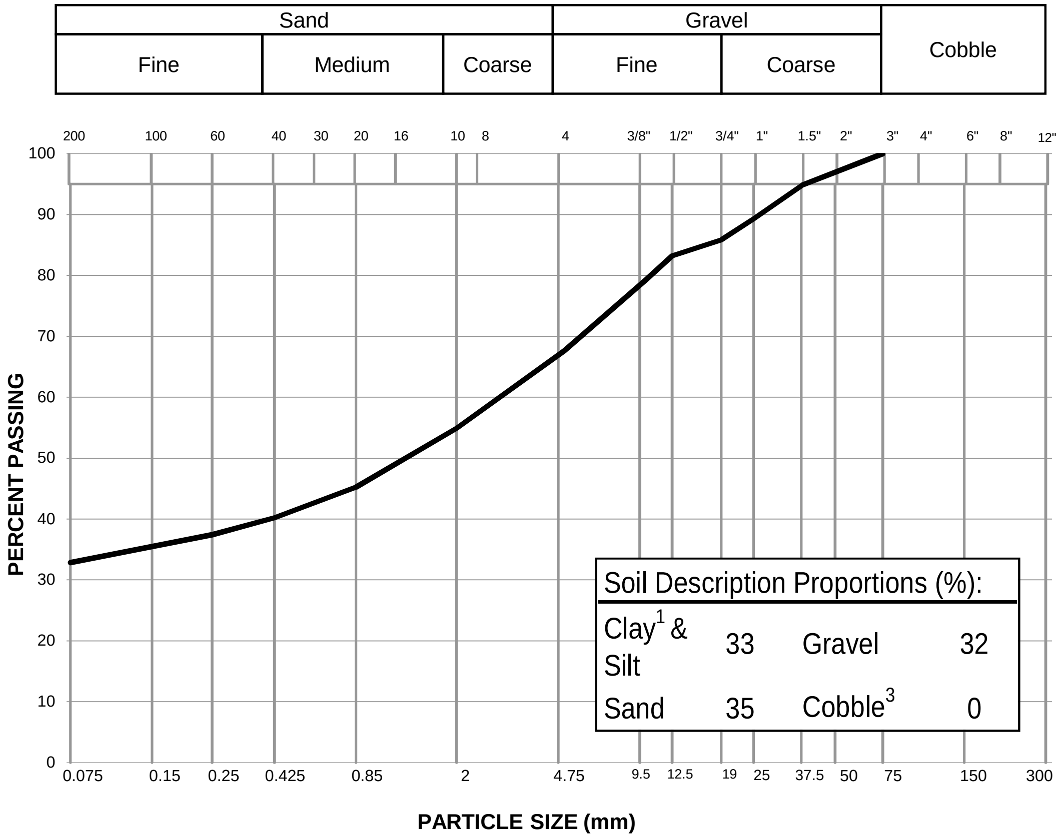
ASTM D7928 & C136

Project: Eagle Gold – Spring 2018 Geotech. Invest.
Project No.: ENG.EARC03103-02
Site: Eagle Gold Mine, Yukon
Client: Victoria Gold Corp.
Client Rep.: Dr. Stephen Wilbur
Date Tested: May 17, 2018 By: AH
Soil Description[2]: SAND - silty, gravelly

Sample No.: S2
Material Type: -
Sample Loc.: GT18-01
Sample Depth: 3.8 - 4.2 m
Sampling Method: Grab
Date Sampled: April 7, 2018
Sampled By: Tetra Tech Canada
USC Classification: - Cu: #N/A
Cc: #N/A

Moisture Content: 10.2%

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	95
25	89
19	86
12.5	83
10	79
5	68
2	55
0.85	45
0.425	40
0.25	37
0.15	35
0.075	32.9



Soil Description Proportions (%):

Clay[1] & Silt	33	Gravel	32
Sand	35	Cobble[3]	0

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: P.Geo.

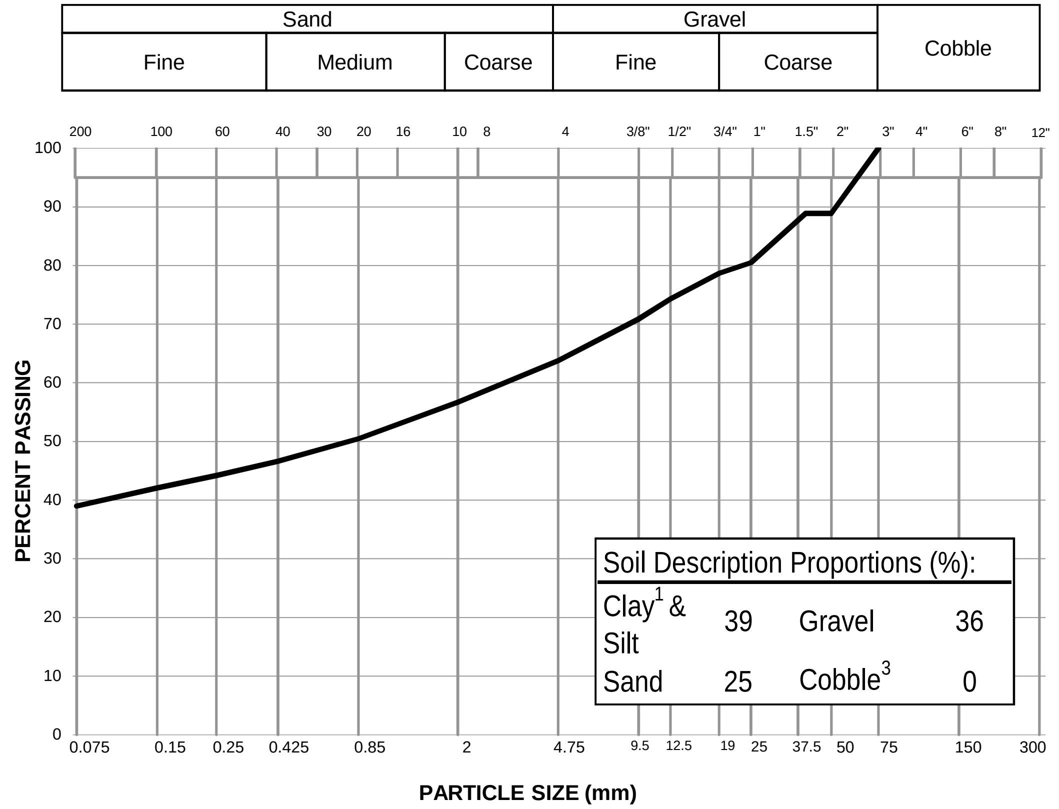
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold - Spring 2018 Geotechnical Investigation	Sample No.:	S2
Project No.:	ENG.EARC03103-02	Material Type:	
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-02
Client:	Victoria Gold Corp.	Sample Depth:	1.2-1.5 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 23, 2018 By: OO	Date Sampled:	April 7, 2018
Soil Description[2]:	SILT & GRAVEL - sandy	Sampled By:	EP
		USC Classification:	Cu: #N/A
Moisture Content:	9.7%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	89
40	89
25	81
19	79
12.5	74
9.5	71
4.75	64
2	57
0.85	51
0.425	47
0.25	44
0.15	42
0.075	39.0



Soil Description Proportions (%):

Clay[1] & Silt	39	Gravel	36
Sand	25	Cobble[3]	0

Notes:

[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ____________________

Remarks: ____________________

Reviewed By: ____________________ P.Eng.

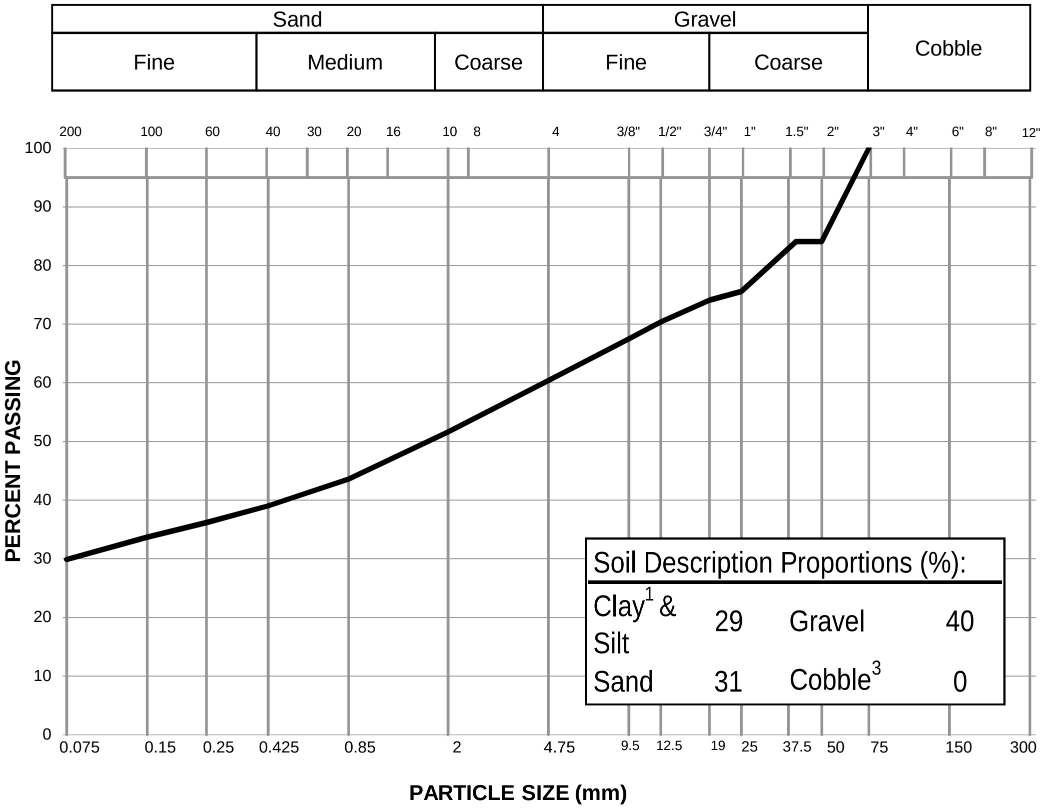
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold - Spring 2018 Geotechnical Investigation	Sample No.:	S2
Project No.:	ENG.EARC03103-02	Material Type:	
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-04
Client:	Victoria Gold Corp.	Sample Depth:	0.95-1.25 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 23, 2018 By: OO	Date Sampled:	April 10, 2018
Soil Description[2]:	GRAVEL - sandy, silty	Sampled By:	EP
		USC Classification:	Cu: #N/A
Moisture Content:	7.1%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	84
40	84
25	76
19	74
12.5	70
9.5	68
4.75	60
2	52
0.85	44
0.425	39
0.25	36
0.15	34
0.075	29.9



Soil Description Proportions (%):

Clay[1] & Silt	29	Gravel	40
Sand	31	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: P.Eng.

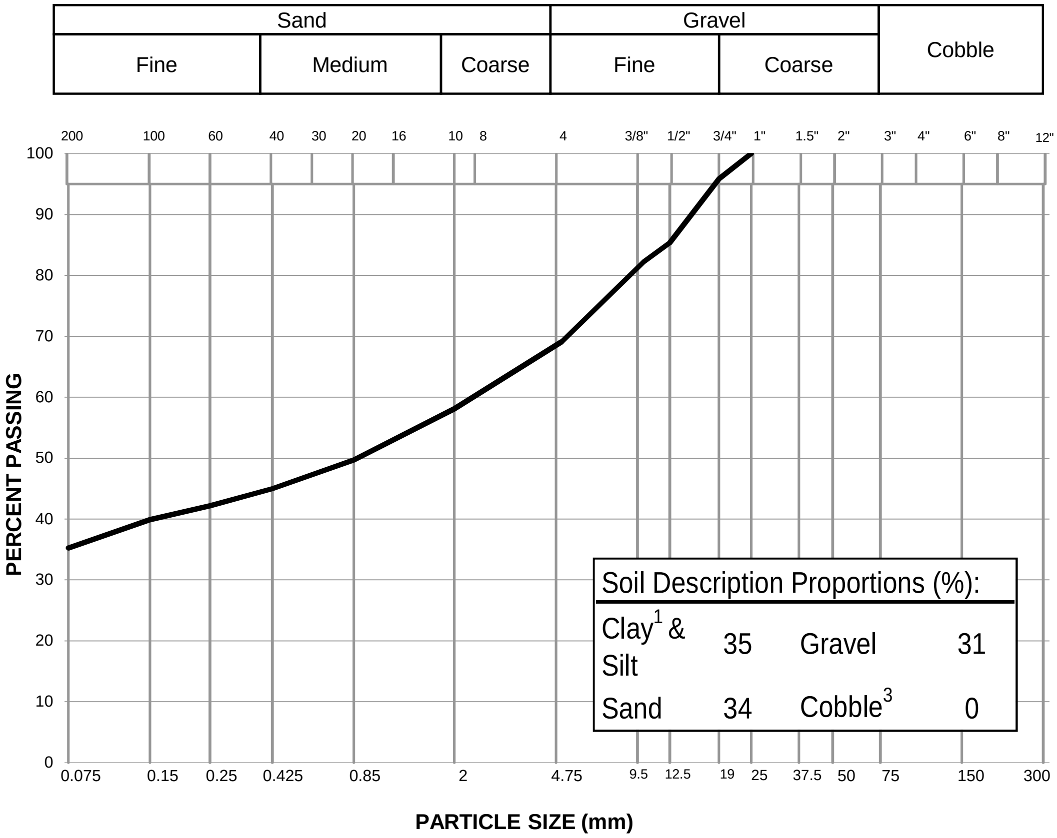
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S3
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-05
Client:	Victoria Gold Corp.	Sample Depth:	0.9 - 1.0 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 9, 2018
Soil Description[2]:	SILT - sandy, gavelly	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	20.9%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	100
19	96
12.5	85
10	82
5	69
2	58
0.85	50
0.425	45
0.25	42
0.15	40
0.075	35.3



Soil Description Proportions (%):

Clay[1] & Silt	35	Gravel	31
Sand	34	Cobble[3]	0

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ____________________

Remarks: ____________________

Reviewed By: ____________________ P.Geo.

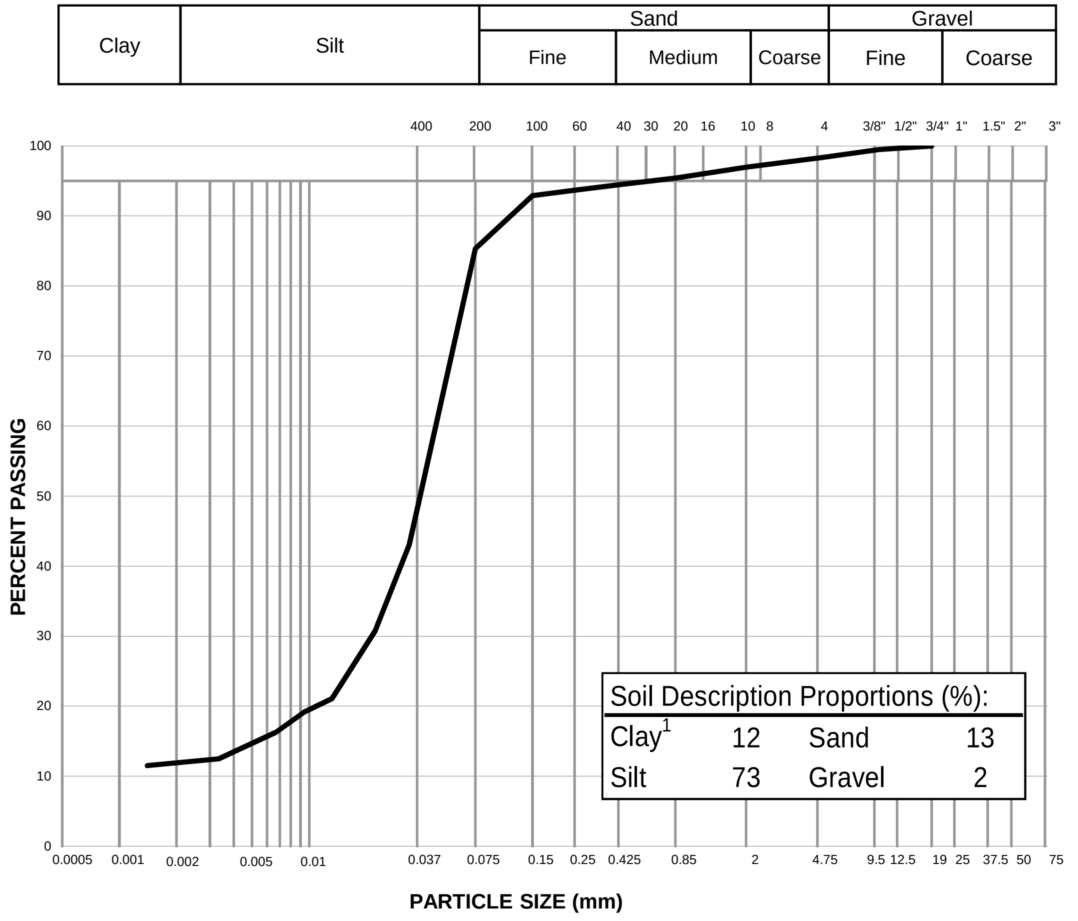
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S4
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-05
Client:	Victoria Gold Corp.	Sample Depth:	1.12 - 1.34 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 30, 2018 By: AT	Date Sampled:	April 18, 2018
Soil Description[2]:	SILT - some sand, some clay, trace gravel	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	N/A		Cc: #N/A

Particle Size (mm)	Percent Passing
75	
50	
38	
25	
19	100
12.5	100
10	99
5	98
2	97
0.85	95
0.425	94
0.25	94
0.15	93
0.075	85.3
0.0337	43.2
0.0222	30.7
0.0132	21.1
0.0094	19.2
0.0067	16.3
0.0033	12.5
0.0014	11.5



Soil Description Proportions (%):

Clay[1]	12	Sand	13
Silt	73	Gravel	2

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: __________

Remarks: __________

Reviewed By: __________ P.Geo.

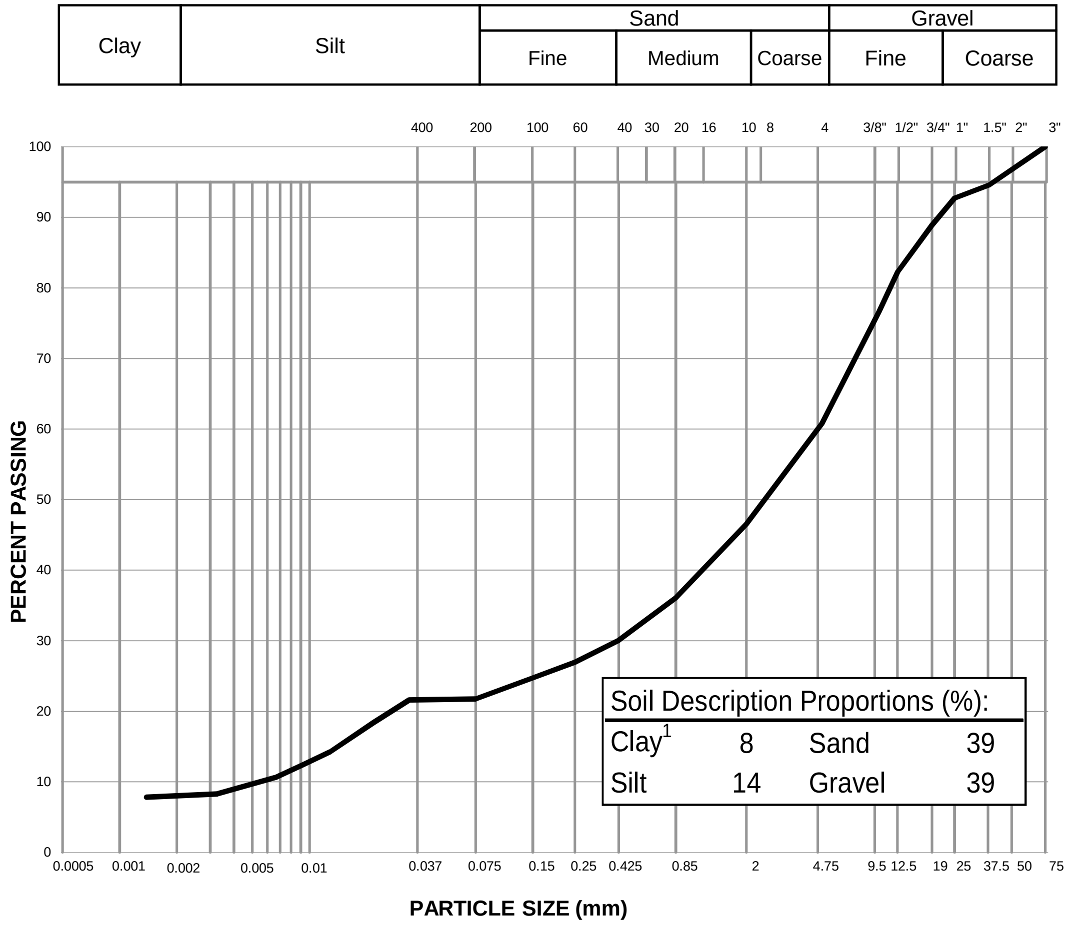
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S6
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-05
Client:	Victoria Gold Corp.	Sample Depth:	3.3 - 3.4 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 28, 2018 By: AT	Date Sampled:	April 18, 2018
Soil Description[2]:	GRAVEL and SAND - some silt, trace clay	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: 844.3
Moisture Content:	7.1%		Cc: 6.4

Particle Size (mm)	Percent Passing
75	100
50	
38	95
25	93
19	89
12.5	82
10	77
5	61
2	46
0.85	36
0.425	30
0.25	27
0.15	25
0.075	21.8
0.0335	21.6
0.0217	18.4
0.0129	14.3
0.0092	12.4
0.0066	10.6
0.0033	8.3
0.0014	7.8



Soil Description Proportions (%):

Clay[1]	8	Sand	39
Silt	14	Gravel	39

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: __________

Remarks: __________

Reviewed By: __________ P.Geo.

TETRA TECH

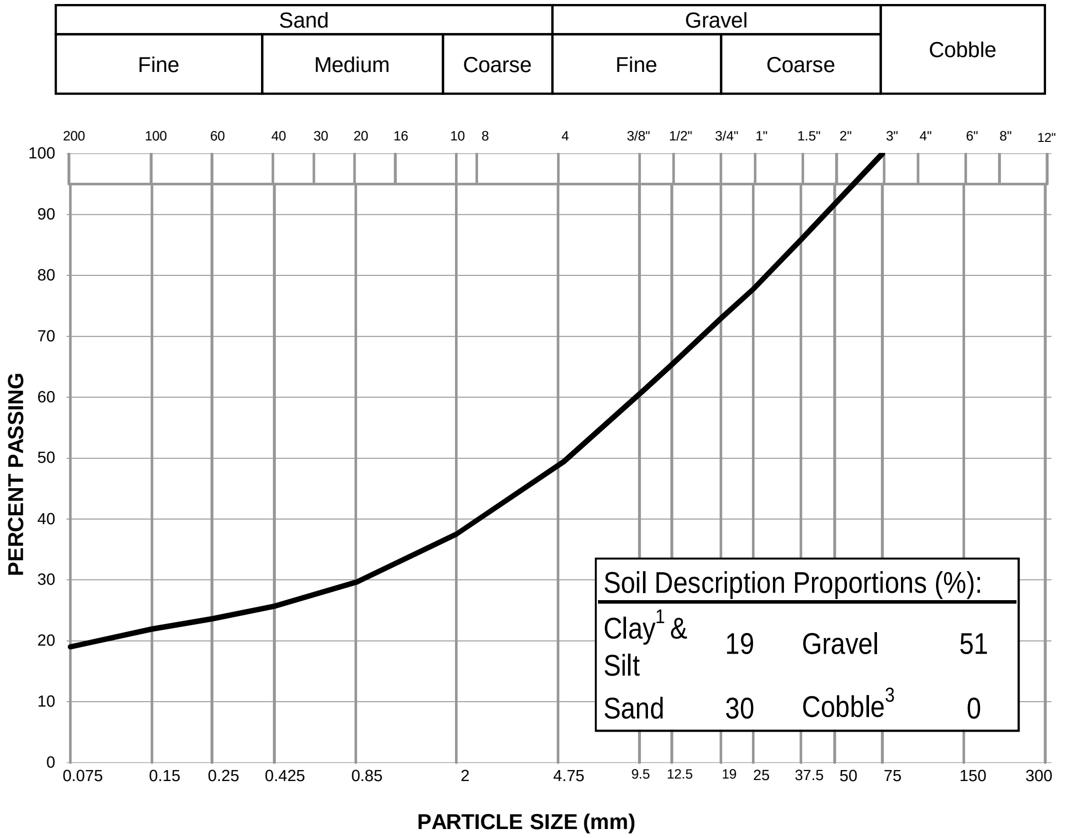
PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Eagle Gold – Spring 2018 Geotech. Invest.
Project No.: ENG.EARC03103-02
Site: Eagle Gold Mine, Yukon
Client: Victoria Gold Corp.
Client Rep.: Dr. Stephen Wilbur
Date Tested: May 17, 2018 By: AH
Soil Description[2]: GRAVEL - sandy, some silt
Moisture Content: 4.3%

Sample No.: S1
Material Type: -
Sample Loc.: GT18-06
Sample Depth: 0.6 - 1.0 m
Sampling Method: Grab
Date Sampled: April 8, 2018
Sampled By: Tetra Tech Canada
USC Classification: - Cu: #N/A
Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	86
25	78
19	73
12.5	65
10	61
5	49
2	38
0.85	30
0.425	26
0.25	24
0.15	22
0.075	19.0



Soil Description Proportions (%):

Clay[1] & Silt	19	Gravel	51
Sand	30	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: P.Geo.

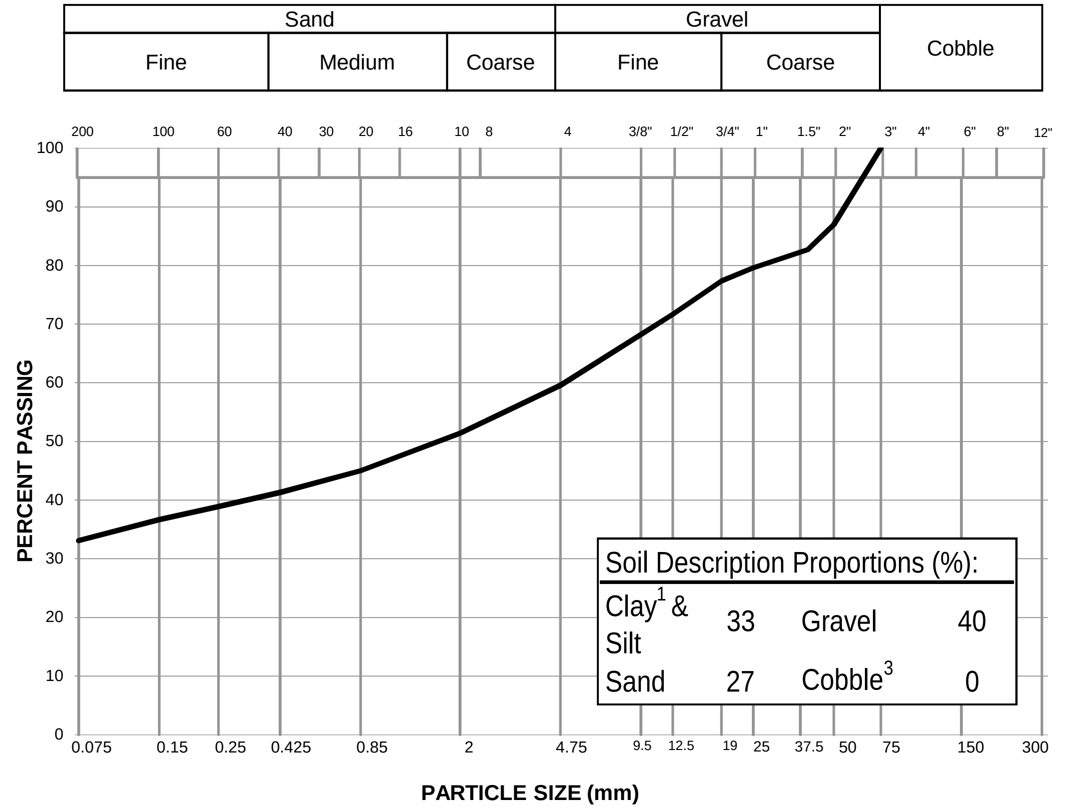
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold - Spring 2018 Geotechnical Investigation	Sample No.:	S2
Project No.:	ENG.EARC03103-02	Material Type:	
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-06
Client:	Victoria Gold Corp.	Sample Depth:	2.5-3.1 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 24, 2018 By: OO	Date Sampled:	April 8, 2018
Soil Description[2]:	GRAVEL - silty, sandy	Sampled By:	EP
		USC Classification:	Cu: #N/A
Moisture Content:	11.5%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	87
40	83
25	80
19	77
12.5	72
9.5	68
4.75	60
2	51
0.85	45
0.425	41
0.25	39
0.15	37
0.075	33.1



Soil Description Proportions (%):

Clay[1] & Silt	33	Gravel	40
Sand	27	Cobble[3]	0

Notes:

[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: P.Eng.

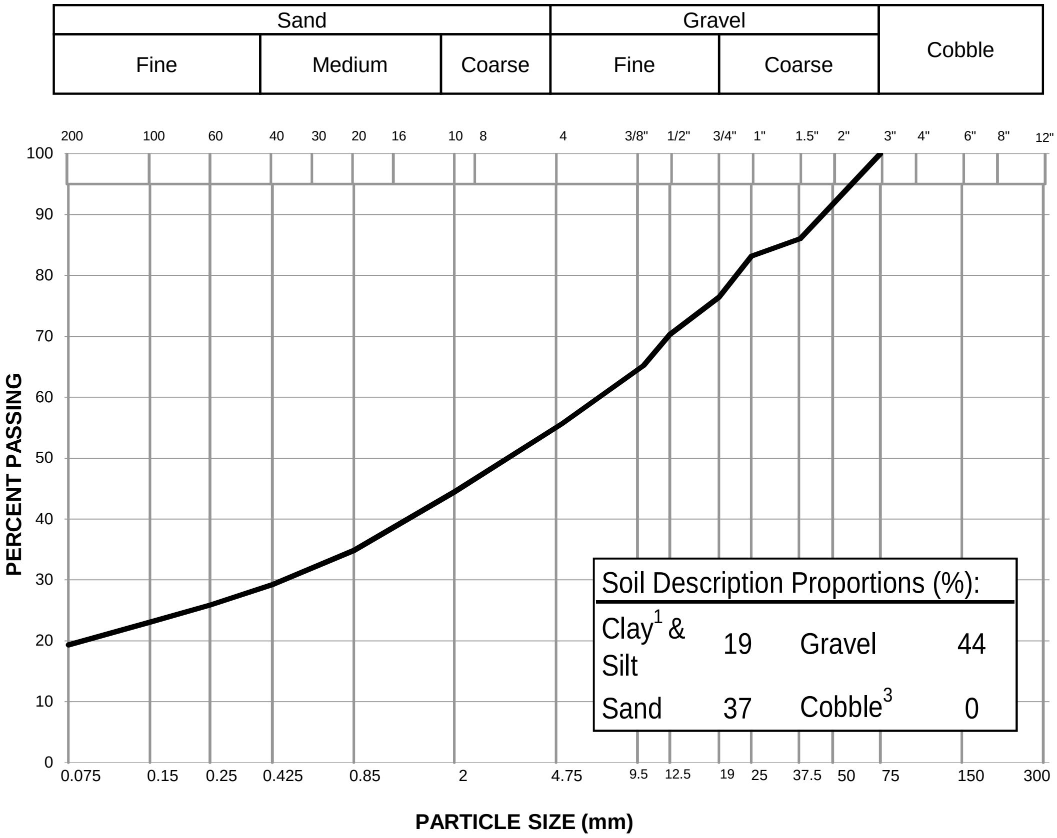
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S3
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-06
Client:	Victoria Gold Corp.	Sample Depth:	5.2 - 5.6 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 8, 2018
Soil Description[2]:	GRAVEL and SAND - some silt	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	9.3%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	86
25	83
19	76
12.5	70
10	65
5	56
2	44
0.85	35
0.425	29
0.25	26
0.15	23
0.075	19.3



Soil Description Proportions (%):

Clay[1] & Silt	19	Gravel	44
Sand	37	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: P.Geo.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

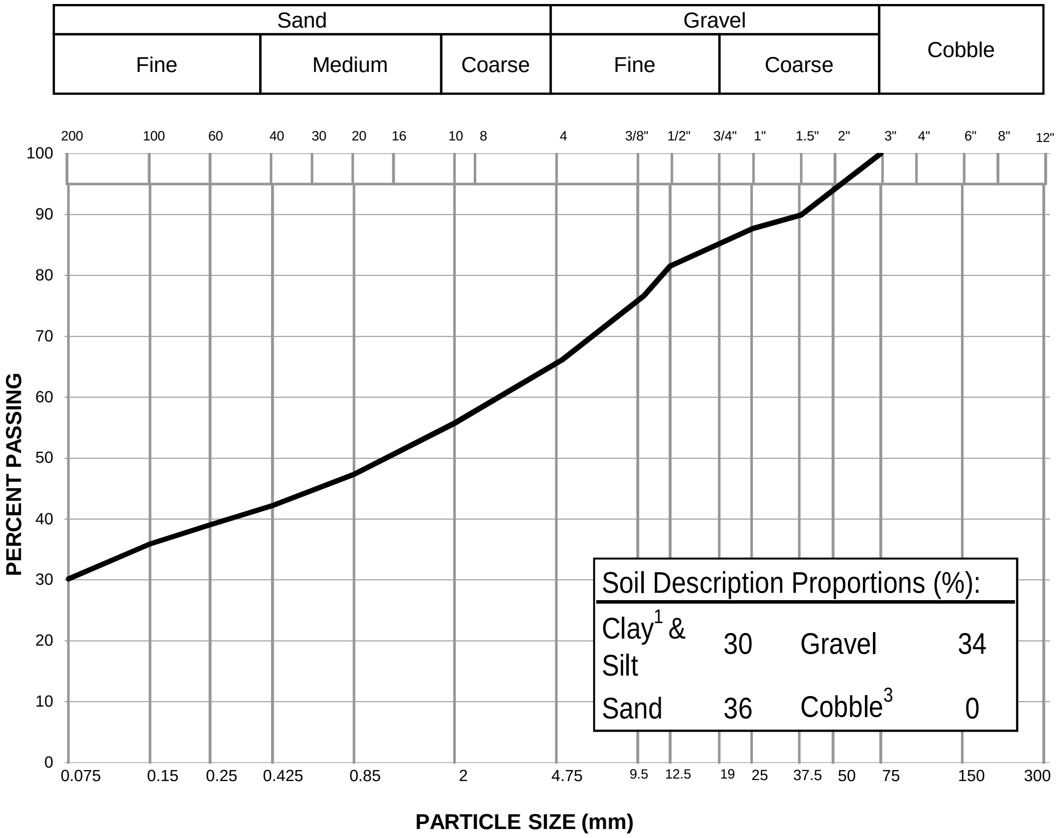
ASTM D7928 & C136

Project: Eagle Gold – Spring 2018 Geotech. Invest.
Project No.: ENG.EARC03103-02
Site: Eagle Gold Mine, Yukon
Client: Victoria Gold Corp.
Client Rep.: Dr. Stephen Wilbur
Date Tested: May 17, 2018 By: AH
Soil Description[2]: SAND - gravelly, silty

Sample No.: S1
Material Type: -
Sample Loc.: GT18-07
Sample Depth: 0.6 - 0.9 m
Sampling Method: Grab
Date Sampled: April 8, 2018
Sampled By: Tetra Tech Canada
USC Classification: - Cu: #N/A

Moisture Content: 12.4% Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	90
25	88
19	
12.5	82
10	77
5	66
2	56
0.85	47
0.425	42
0.25	39
0.15	36
0.075	30.2



Soil Description Proportions (%):

Clay[1] & Silt	30	Gravel	34
Sand	36	Cobble[3]	0

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ____________________

Remarks: ____________________

Reviewed By: ____________________ P.Geo.

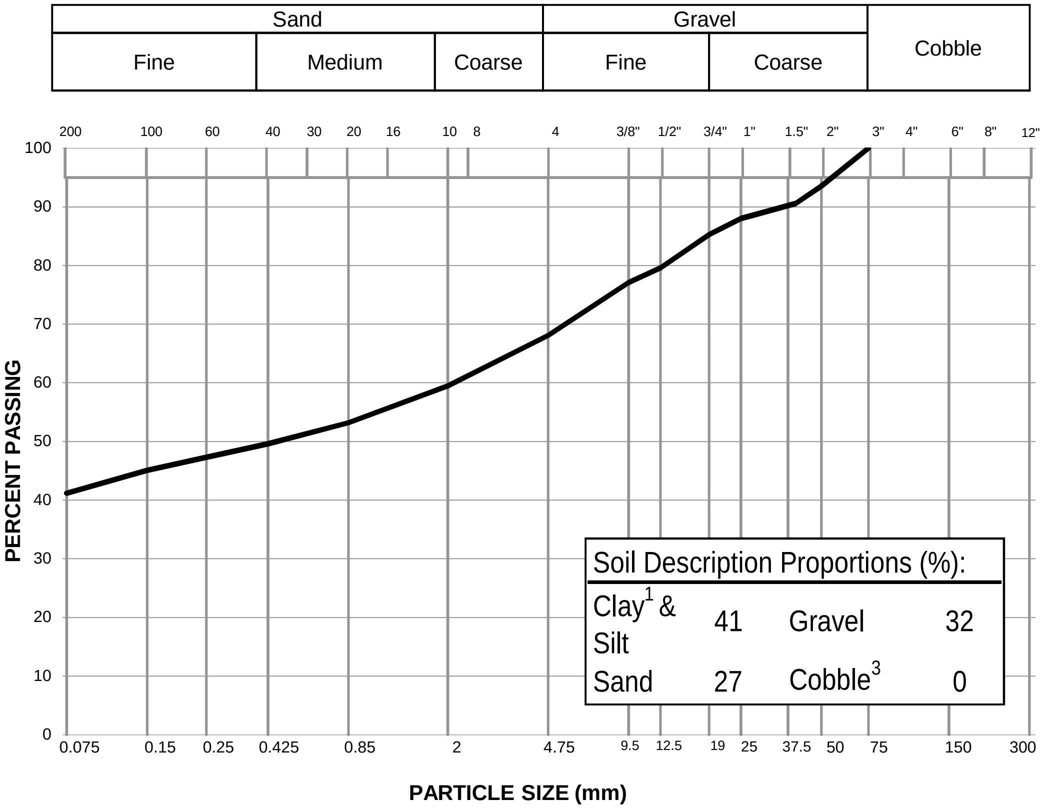
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold - Spring 2018 Geotechnical Investigation	Sample No.:	S2
Project No.:	ENG.EARC03103-02	Material Type:	
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-07
Client:	Victoria Gold Corp.	Sample Depth:	2.2-2.6 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 24, 2018 By: OO	Date Sampled:	April 8, 2018
Soil Description[2]:	SILT - gravelly, sandy	Sampled By:	EP
		USC Classification:	Cu: #N/A
Moisture Content:	12.4%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	94
40	91
25	88
19	85
12.5	80
9.5	77
4.75	68
2	60
0.85	53
0.425	50
0.25	47
0.15	45
0.075	41.2



Soil Description Proportions (%):

Clay[1] & Silt	41	Gravel	32
Sand	27	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks:

Reviewed By: ______________________ P.Eng.

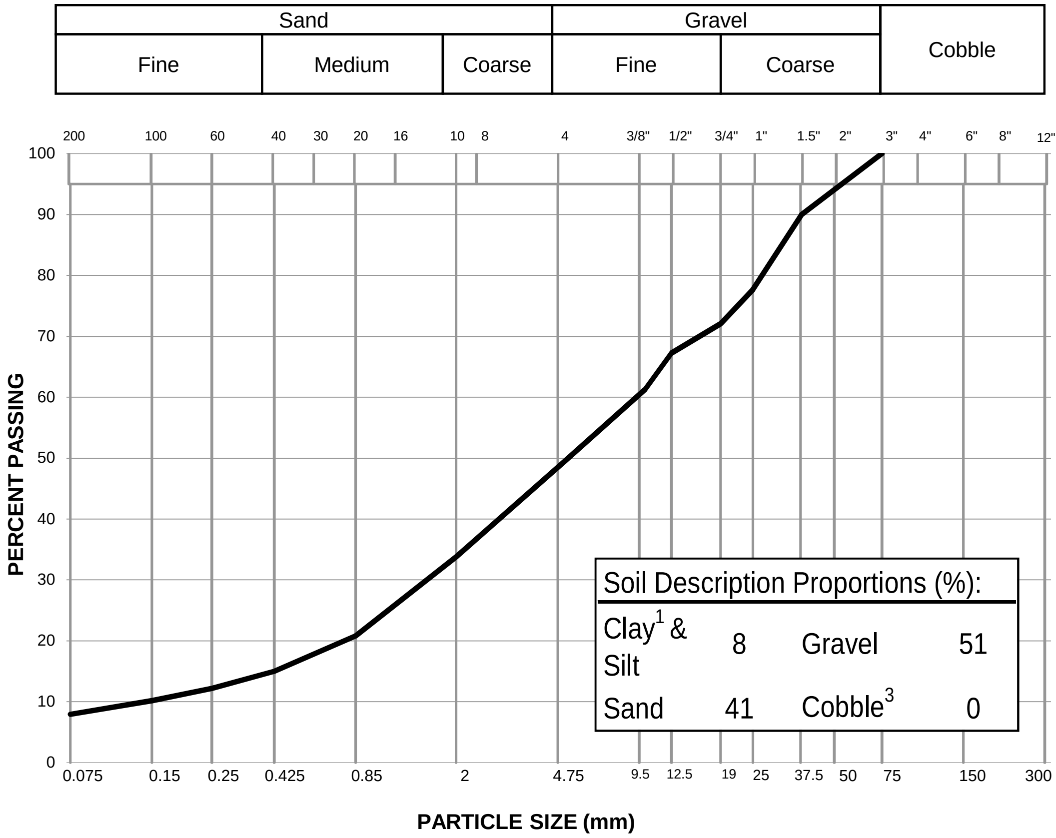
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S3
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-07
Client:	Victoria Gold Corp.	Sample Depth:	4.0 - 4.4 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 8, 2018
Soil Description[2]:	GRAVEL and SAND - trace silt	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: 65.6
Moisture Content:	4.0%		Cc: 2.0

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	90
25	78
19	72
12.5	67
10	61
5	49
2	34
0.85	21
0.425	15
0.25	12
0.15	10
0.075	7.9



Soil Description Proportions (%):

Clay[1] & Silt	8	Gravel	51
Sand	41	Cobble[3]	0

Notes:

[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ______

Remarks: ______

Reviewed By: ______ P.Geo.

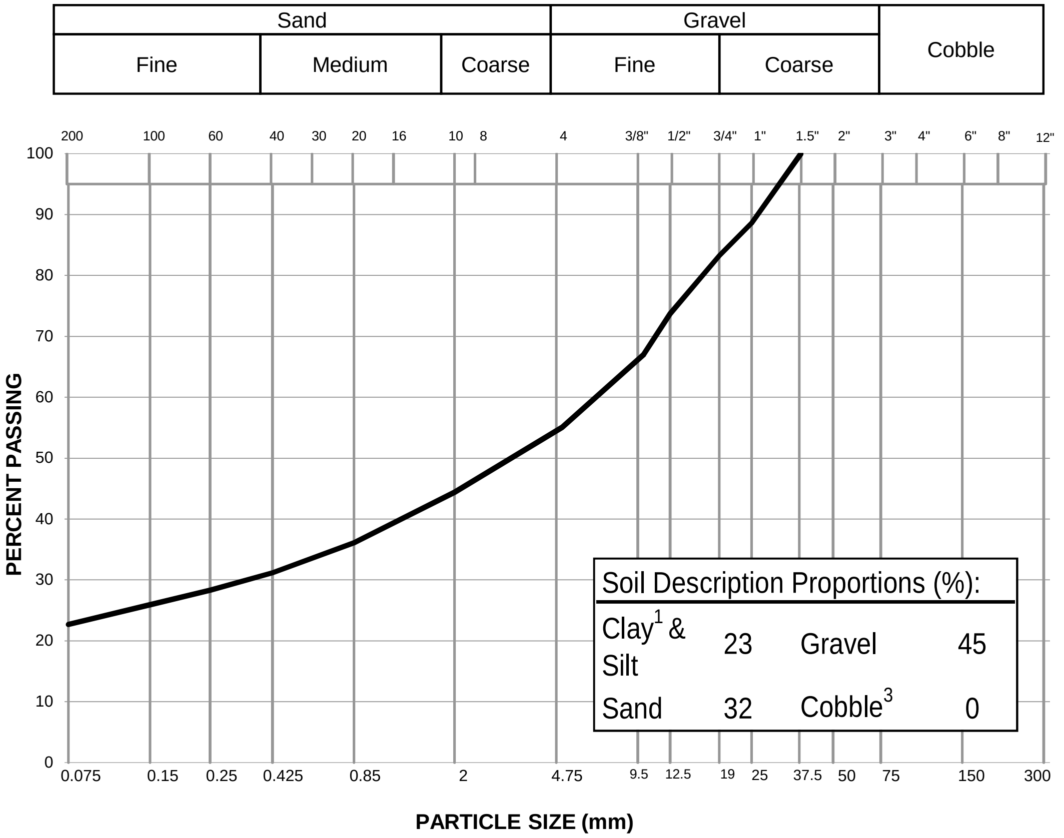
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S5
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-07
Client:	Victoria Gold Corp.	Sample Depth:	11.1 - 11.4 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 8, 2018
Soil Description[2]:	GRAVEL - sandy, silty	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	8.0%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	100
25	89
19	83
12.5	74
10	67
5	55
2	44
0.85	36
0.425	31
0.25	28
0.15	26
0.075	22.7



Soil Description Proportions (%):

Clay[1] & Silt	23	Gravel	45
Sand	32	Cobble[3]	0

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ______

Remarks: ______

Reviewed By: ______ P.Geo.

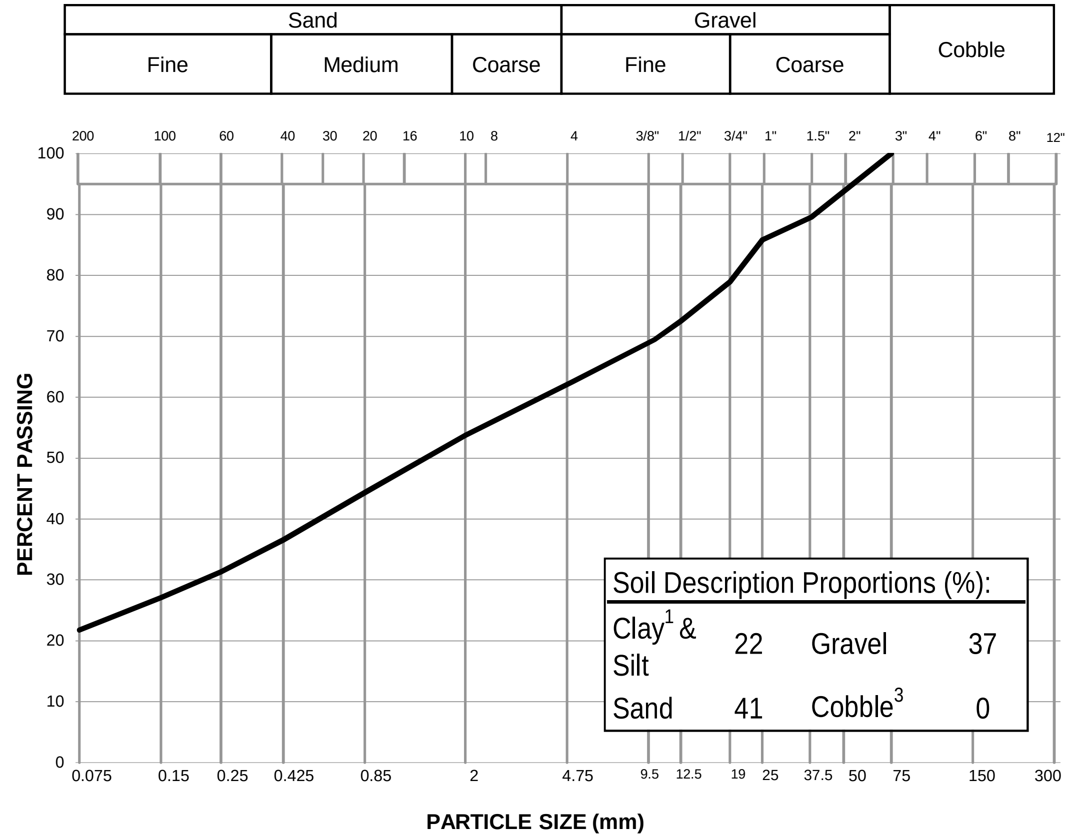
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S1
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-08
Client:	Victoria Gold Corp.	Sample Depth:	0.55 - 0.70 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 11, 2018
Soil Description[2]:	SAND and GRAVEL - silty	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	29.6%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	90
25	86
19	79
12.5	72
10	69
5	63
2	54
0.85	44
0.425	37
0.25	31
0.15	27
0.075	21.8



Soil Description Proportions (%):

Clay[1] & Silt	22	Gravel	37
Sand	41	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification:

Remarks: Contains Organic Material

Reviewed By: P.Geo.

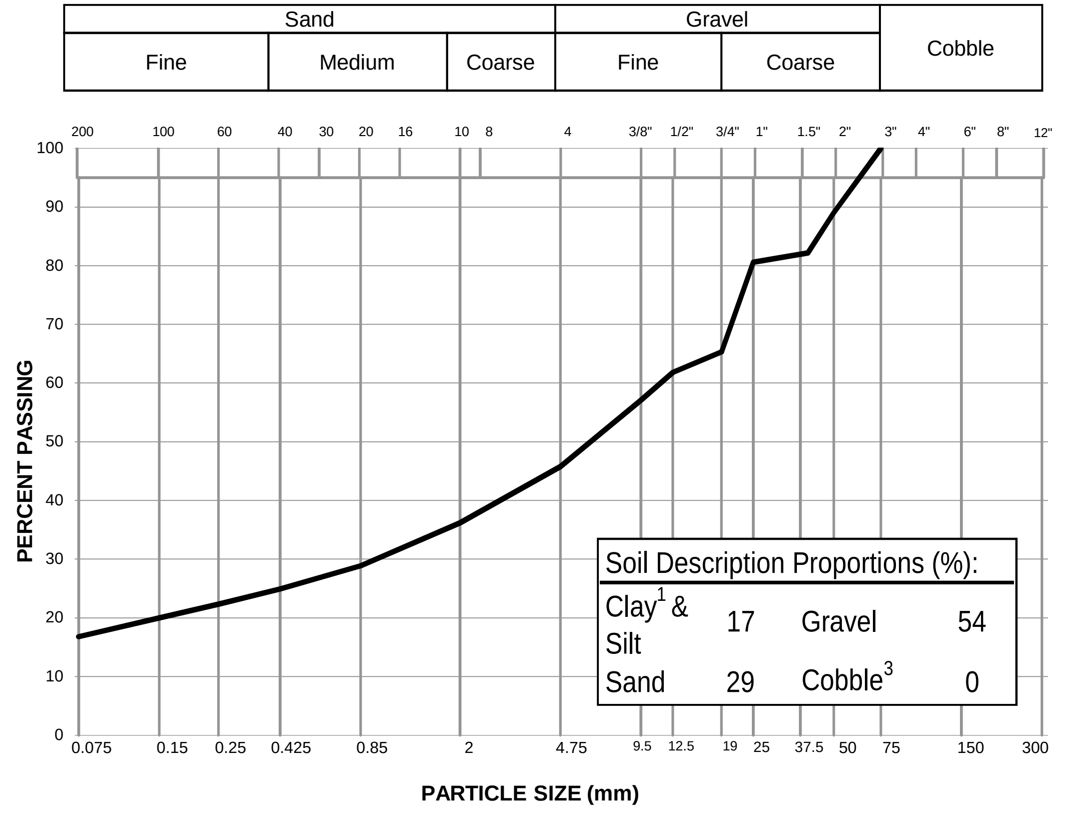
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold - Spring 2018 Geotechnical Investigation	Sample No.:	S4
Project No.:	ENG.EARC03103-02	Material Type:	
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-08
Client:	Victoria Gold Corp.	Sample Depth:	2.45-2.6 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 24, 2018 By: OO	Date Sampled:	April 11, 2018
Soil Description[2]:	GRAVEL - sandy, some silt	Sampled By:	EP
		USC Classification:	Cu: #N/A
Moisture Content:	11.8%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	89
40	82
25	81
19	65
12.5	62
9.5	57
4.75	46
2	36
0.85	29
0.425	25
0.25	22
0.15	20
0.075	16.8



Soil Description Proportions (%):

Clay[1] & Silt	17	Gravel	54
Sand	29	Cobble[3]	0

Notes:

[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ____________________

Remarks: ____________________

Reviewed By: ____________________ P.Eng.

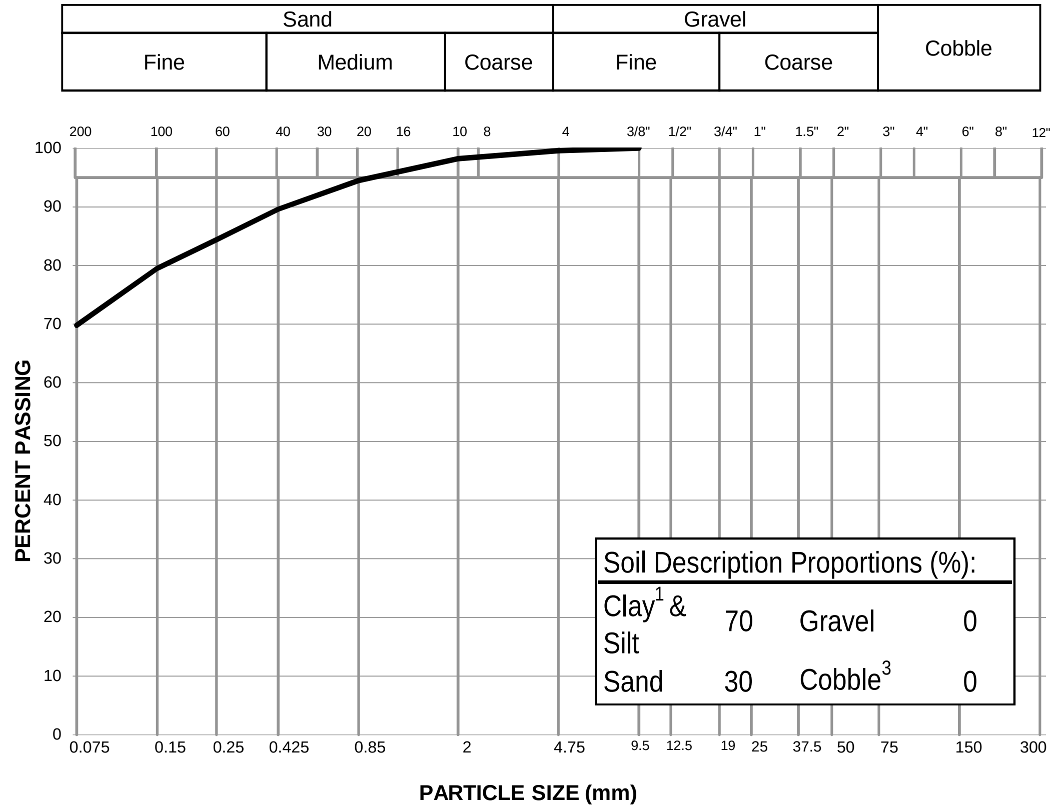
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold - Spring 2018 Geotechnical Investigation	Sample No.:	S6
Project No.:	ENG.EARC03103-02	Material Type:	
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-08
Client:	Victoria Gold Corp.	Sample Depth:	3.5-3.7 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 24, 2018 By: OO	Date Sampled:	April 11, 2018
Soil Description[2]:	SILT - sandy	Sampled By:	EP
		USC Classification:	Cu: #N/A
Moisture Content:	28.3%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
40	
25	
19	
12.5	
9.5	100
4.75	100
2	98
0.85	95
0.425	90
0.25	84
0.15	80
0.075	69.8



Soil Description Proportions (%):

Clay[1] & Silt	70	Gravel	0
Sand	30	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ______

Remarks: ______

Reviewed By: ______ P.Eng.

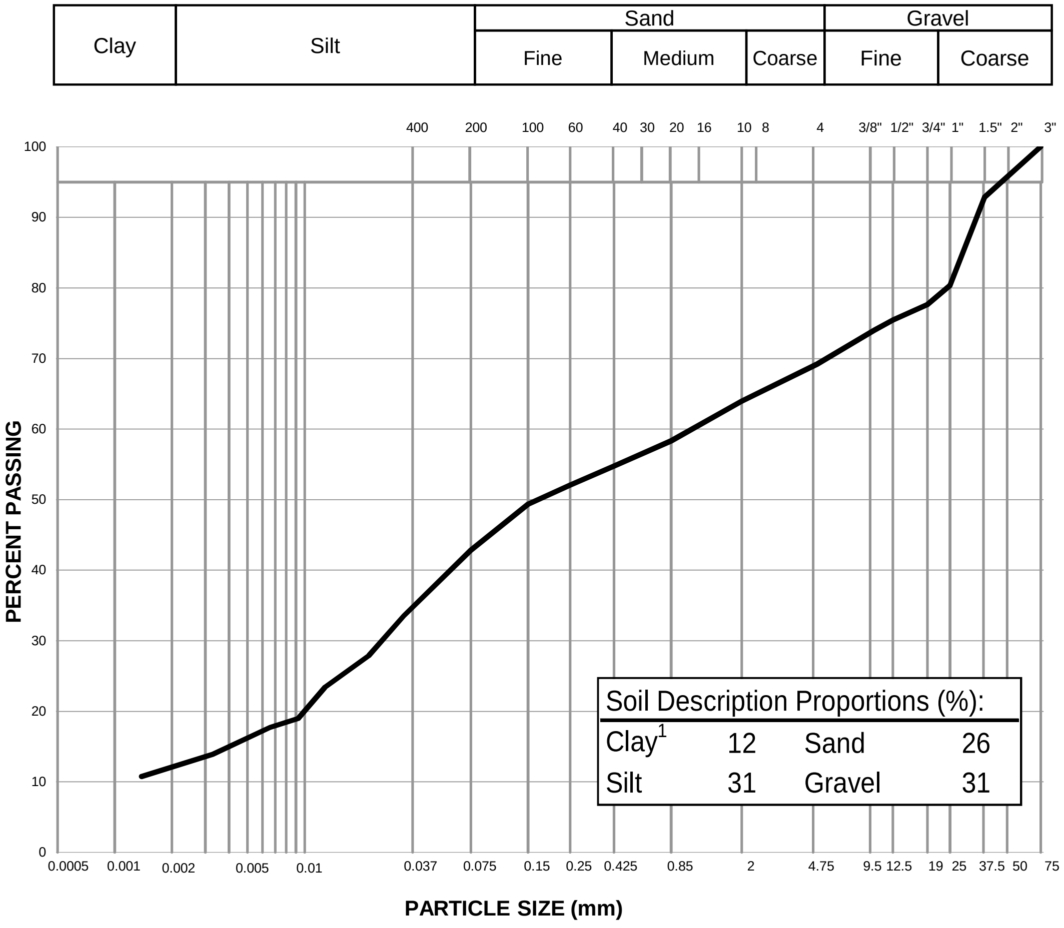
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S8
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-08
Client:	Victoria Gold Corp.	Sample Depth:	5.6 - 5.8 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 25, 2018 By: AT	Date Sampled:	April 11, 2018
Soil Description[2]:	GRAVEL and SILT - sandy, some clay	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	10.8%		Cc: #N/A

Particle Size (mm)	Percent Passing
75	100
50	
38	93
25	80
19	78
12.5	75
10	74
5	69
2	64
0.85	58
0.425	55
0.25	52
0.15	49
0.075	42.8
0.0333	33.6
0.0217	27.9
0.0128	23.4
0.0092	19.0
0.0066	17.7
0.0033	13.9
0.0014	10.8



Soil Description Proportions (%):

Clay[1]	12	Sand	26
Silt	31	Gravel	31

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: __________

Remarks: __________

Reviewed By: __________ P.Geo.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

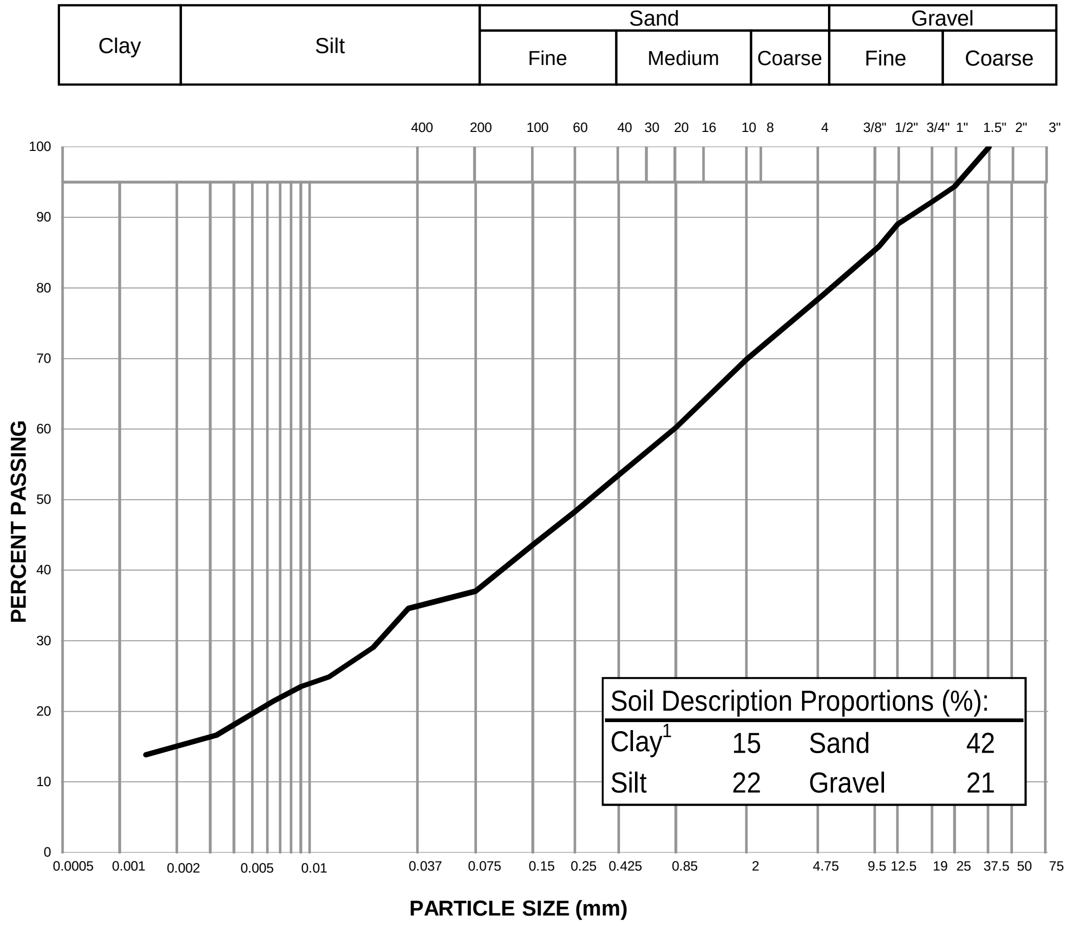
ASTM D7928 & C136

Project: Eagle Gold – Spring 2018 Geotech. Invest.
Project No.: ENG.EARC03103-02
Site: Eagle Gold Mine, Yukon
Client: Victoria Gold Corp.
Client Rep.: Dr. Stephen Wilbur
Date Tested: May 28, 2018 By: AT
Soil Description[2]: SAND - silty, gravelly, some clay

Sample No.: S10
Material Type: -
Sample Loc.: GT18-08
Sample Depth: 13.7 - 14.0 m
Sampling Method: Grab
Date Sampled: -
Sampled By: Tetra Tech Canada
USC Classification: - Cu: #N/A
Cc: #N/A

Moisture Content: 7.7%

Particle Size (mm)	Percent Passing
75	
50	
38	100
25	94
19	92
12.5	89
10	86
5	79
2	70
0.85	60
0.425	53
0.25	48
0.15	44
0.075	37.0
0.0332	34.6
0.0216	29.0
0.0127	24.9
0.0090	23.5
0.0064	21.4
0.0032	16.6
0.0014	13.8



Soil Description Proportions (%):

Clay[1]	15	Sand	42
Silt	22	Gravel	21

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: ____

Remarks: ____

Reviewed By: ____ P.Geo.

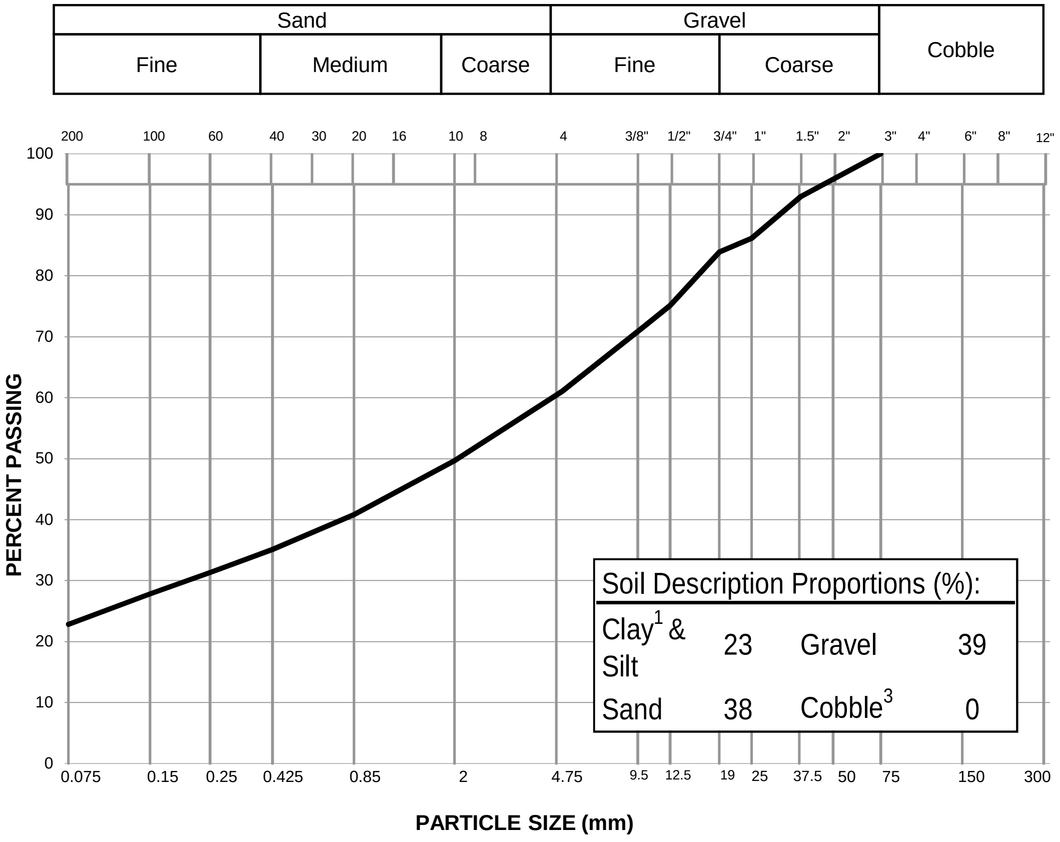
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S1
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-09
Client:	Victoria Gold Corp.	Sample Depth:	2.0 - 2.2 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 13, 2018
Soil Description[2]:	GRAVEL and SAND - silty	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	4.5%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	93
25	86
19	84
12.5	75
10	72
5	61
2	50
0.85	41
0.425	35
0.25	31
0.15	28
0.075	22.8



Soil Description Proportions (%):

Clay[1] & Silt	23	Gravel	39
Sand	38	Cobble[3]	0

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: __________

Remarks: __________

Reviewed By: __________ P.Geo.

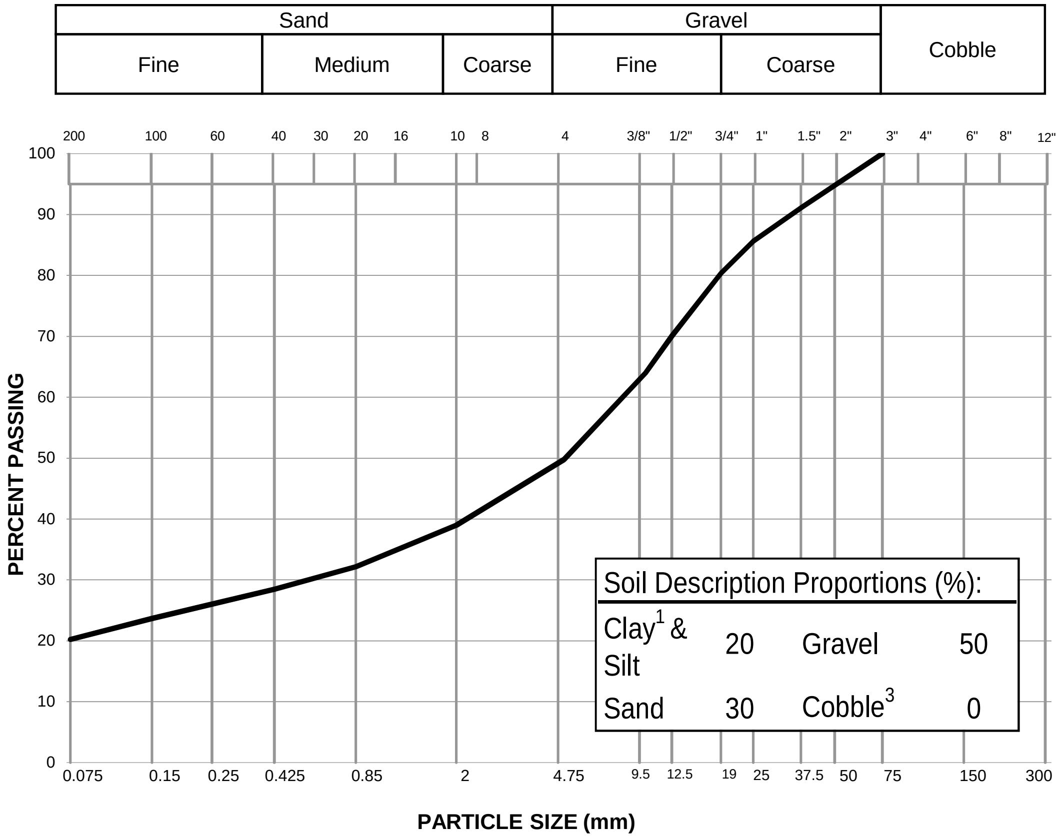
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S2
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-09
Client:	Victoria Gold Corp.	Sample Depth:	5.0 - 5.2 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 13, 2018
Soil Description[2]:	GRAVEL - sandy, some silt	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	5.7%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	91
25	86
19	80
12.5	70
10	64
5	50
2	39
0.85	32
0.425	28
0.25	26
0.15	24
0.075	20.2



Soil Description Proportions (%):

Clay[1] & Silt	20	Gravel	50
Sand	30	Cobble[3]	0

Notes:

[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ______

Remarks: ______

Reviewed By: ______ P.Geo.

TETRA TECH

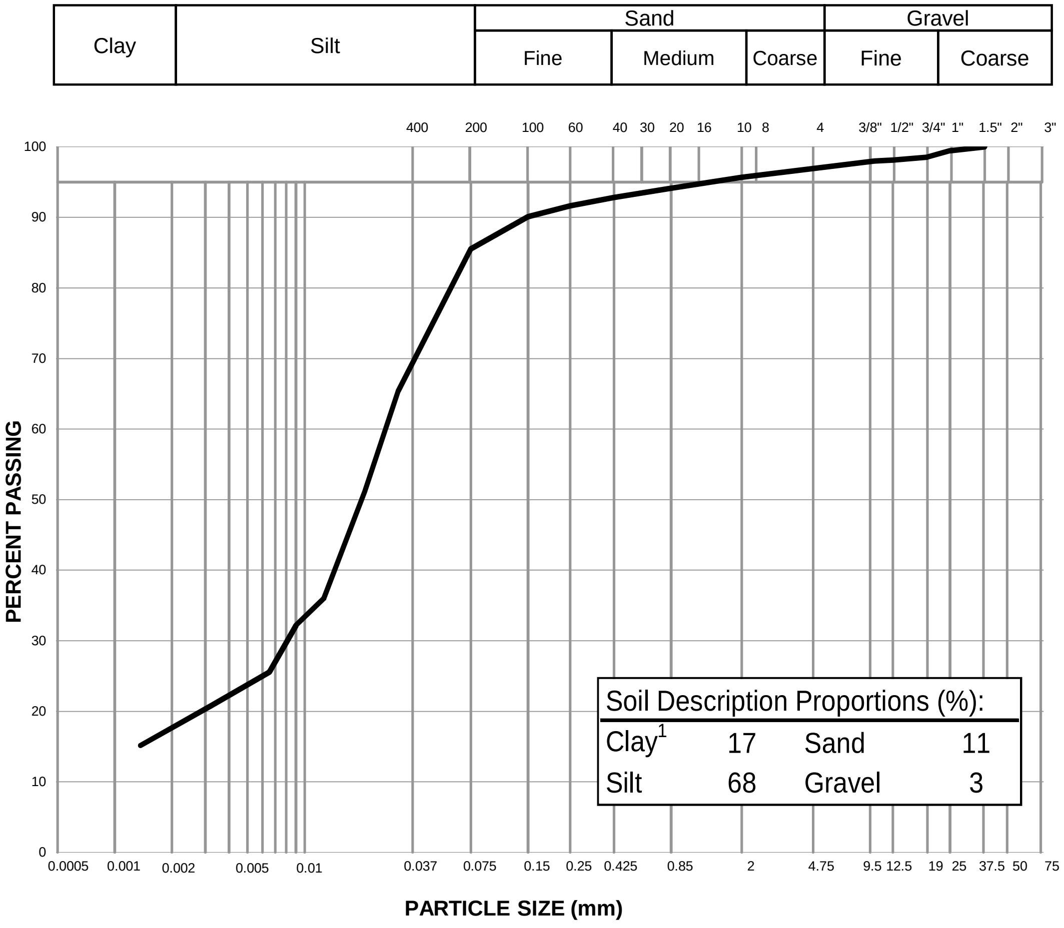
PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Eagle Gold – Spring 2018 Geotech. Invest.
Project No.: ENG.EARC03103-02
Site: Eagle Gold Mine, Yukon
Client: Victoria Gold Corp.
Client Rep.: Dr. Stephen Wilbur
Date Tested: May 28, 2018 By: AT
Soil Description[2]: SILT - some clay, some sand, trace gravel
Moisture Content: 27.5%

Sample No.: S1
Material Type: -
Sample Loc.: GT18-10
Sample Depth: 2.7 - 3.0 m
Sampling Method: Grab
Date Sampled: April 14, 2018
Sampled By: Tetra Tech Canada
USC Classification: - Cu: #N/A
Cc: #N/A

Particle Size (mm)	Percent Passing
75	
50	
38	100
25	99
19	99
12.5	98
10	98
5	97
2	96
0.85	94
0.425	93
0.25	92
0.15	90
0.075	85.5
0.0310	65.4
0.0207	51.1
0.0126	36.0
0.0090	32.2
0.0065	25.6
0.0032	20.8
0.0014	15.2



Soil Description Proportions (%):

Clay[1]	17	Sand	11
Silt	68	Gravel	3

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification:

Remarks:

Reviewed By: P.Geo.

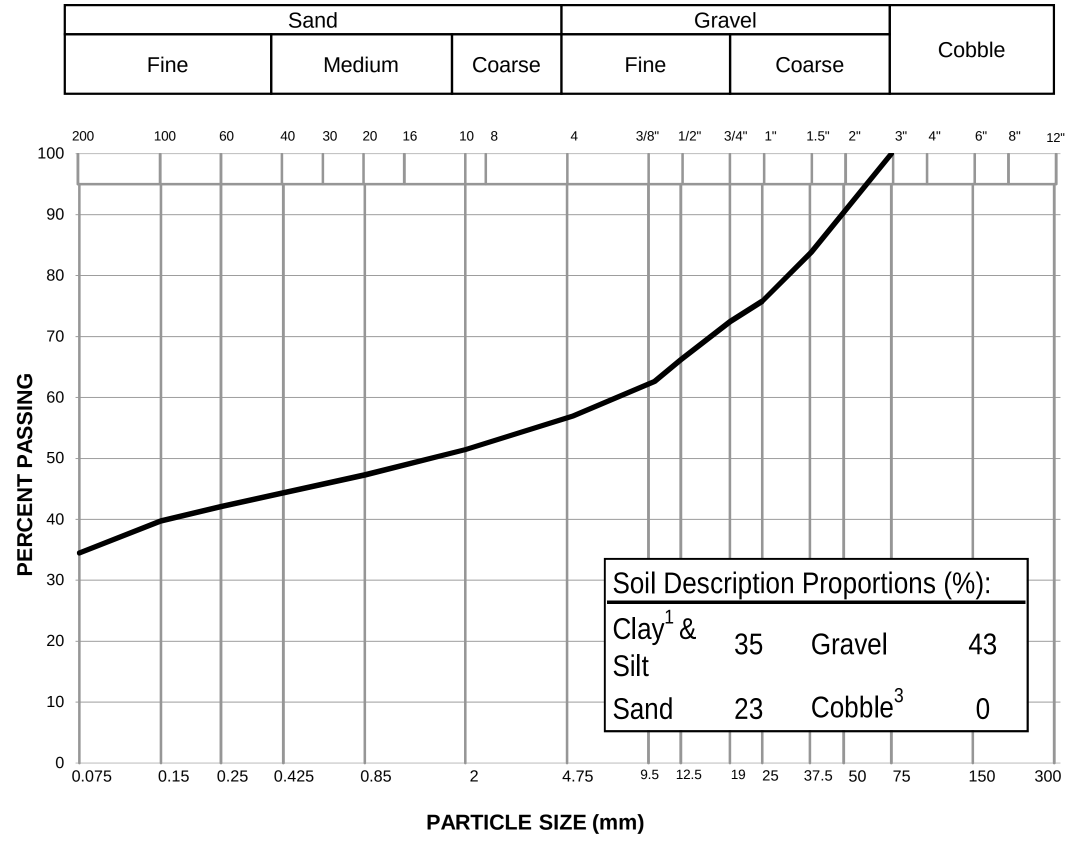
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S2
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-10
Client:	Victoria Gold Corp.	Sample Depth:	6.5 - 6.7 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 14, 2018
Soil Description[2]:	GRAVEL - silty, sandy	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	7.7%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	100
50	
38	84
25	76
19	72
12.5	66
10	63
5	57
2	51
0.85	47
0.425	44
0.25	42
0.15	40
0.075	34.5



Soil Description Proportions (%):

Clay[1] & Silt	35	Gravel	43
Sand	23	Cobble[3]	0

Notes:

[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ________________

Remarks: ________________

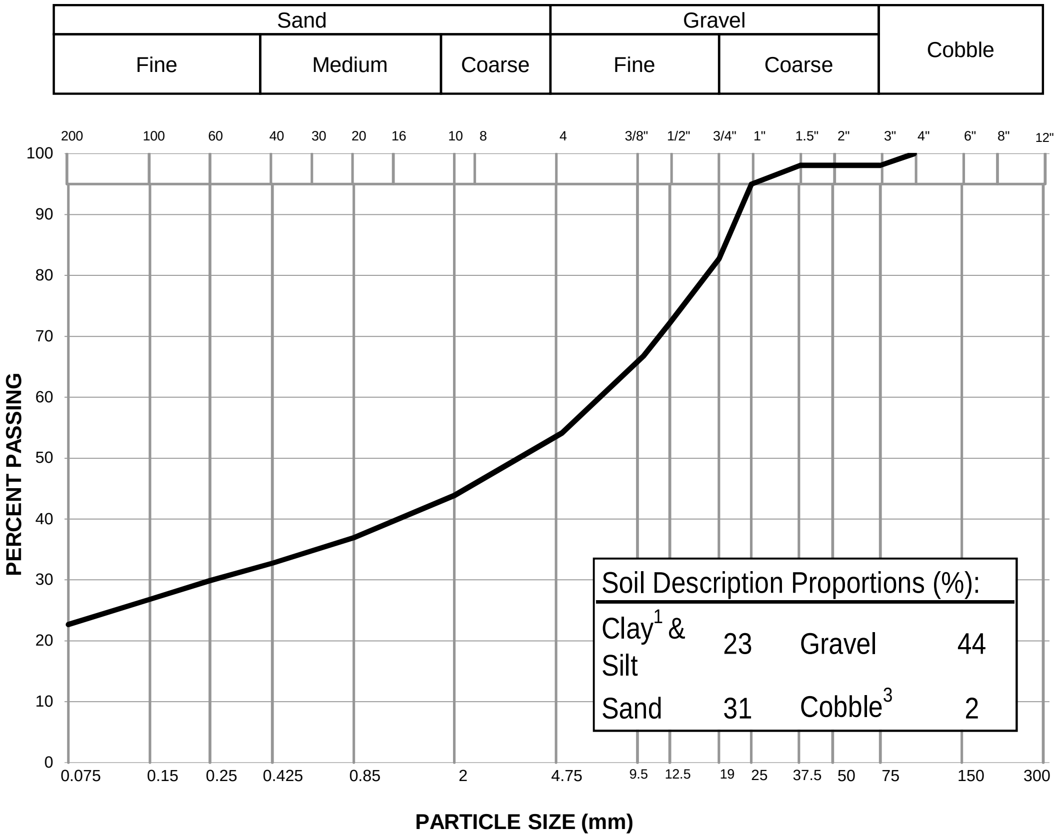
Reviewed By: ________________ P.Geo.

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S1
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-11
Client:	Victoria Gold Corp.	Sample Depth:	2.0 - 2.2 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 13, 2018
Soil Description[2]:	GRAVEL - sandy, silty, trace of cobbles	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	5.5%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	100
75	98
50	98
38	98
25	95
19	83
12.5	72
10	67
5	54
2	44
0.85	37
0.425	33
0.25	30
0.15	27
0.075	22.7



Soil Description Proportions (%):

Clay[1] & Silt	23	Gravel	44
Sand	31	Cobble[3]	2

Notes:

[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tt WM4400 description protocols

[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ______________________

Remarks: ______________________

Reviewed By: ______________________ P.Geo.

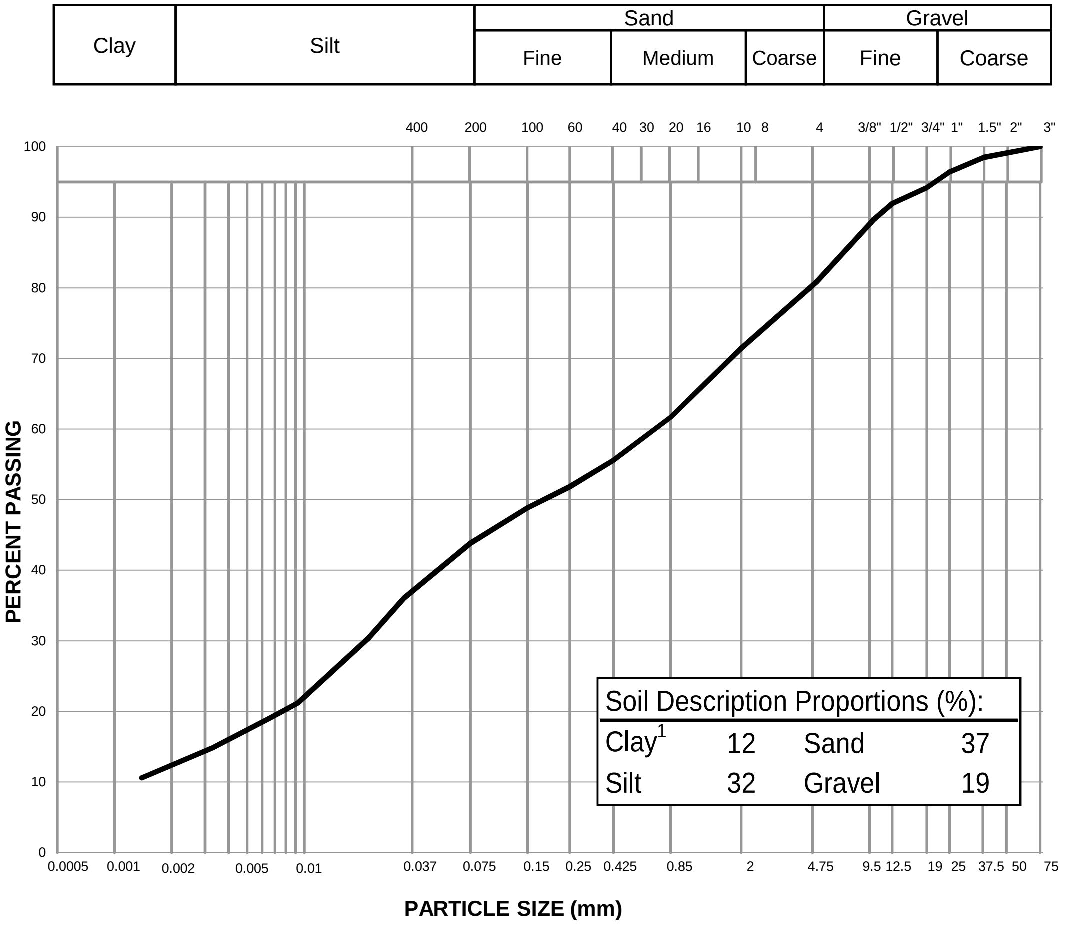
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S1
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-15
Client:	Victoria Gold Corp.	Sample Depth:	1.0 - 1.1 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 28, 2018 By: AT	Date Sampled:	April 10, 2018
Soil Description[2]:	SAND - silty, some gravel, some clay	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	7.7%		Cc: #N/A

Particle Size (mm)	Percent Passing
75	100
50	
38	98
25	96
19	94
12.5	92
10	90
5	81
2	71
0.85	62
0.425	56
0.25	52
0.15	49
0.075	43.8
0.0335	36.1
0.0218	30.4
0.0129	24.7
0.0092	21.2
0.0066	19.1
0.0033	14.8
0.0014	10.6



Soil Description Proportions (%):

Clay[1]	12	Sand	37
Silt	32	Gravel	19

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification:

Remarks:

Reviewed By: P.Geo.

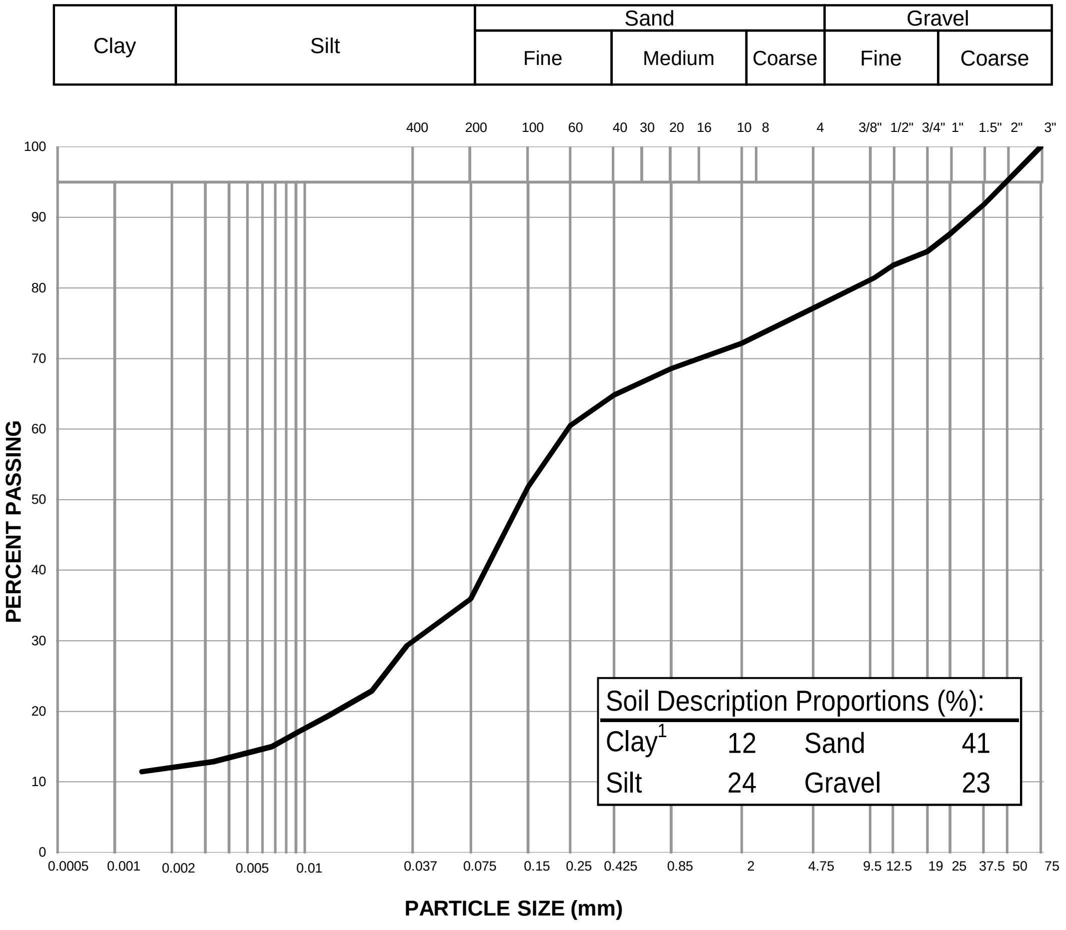
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S2
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-15
Client:	Victoria Gold Corp.	Sample Depth:	8.8 - 9.0 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 28, 2018 By: AT	Date Sampled:	April 10, 2018
Soil Description[2]:	SAND - silty, gravelly, some clay	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	14.5%		Cc: #N/A

Particle Size (mm)	Percent Passing
75	100
50	
38	92
25	88
19	85
12.5	83
10	81
5	77
2	72
0.85	69
0.425	65
0.25	60
0.15	52
0.075	35.9
0.0346	29.3
0.0225	22.9
0.0132	19.3
0.0094	17.2
0.0067	15.0
0.0033	12.9
0.0014	11.4



Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: ______________________

Remarks: ______________________

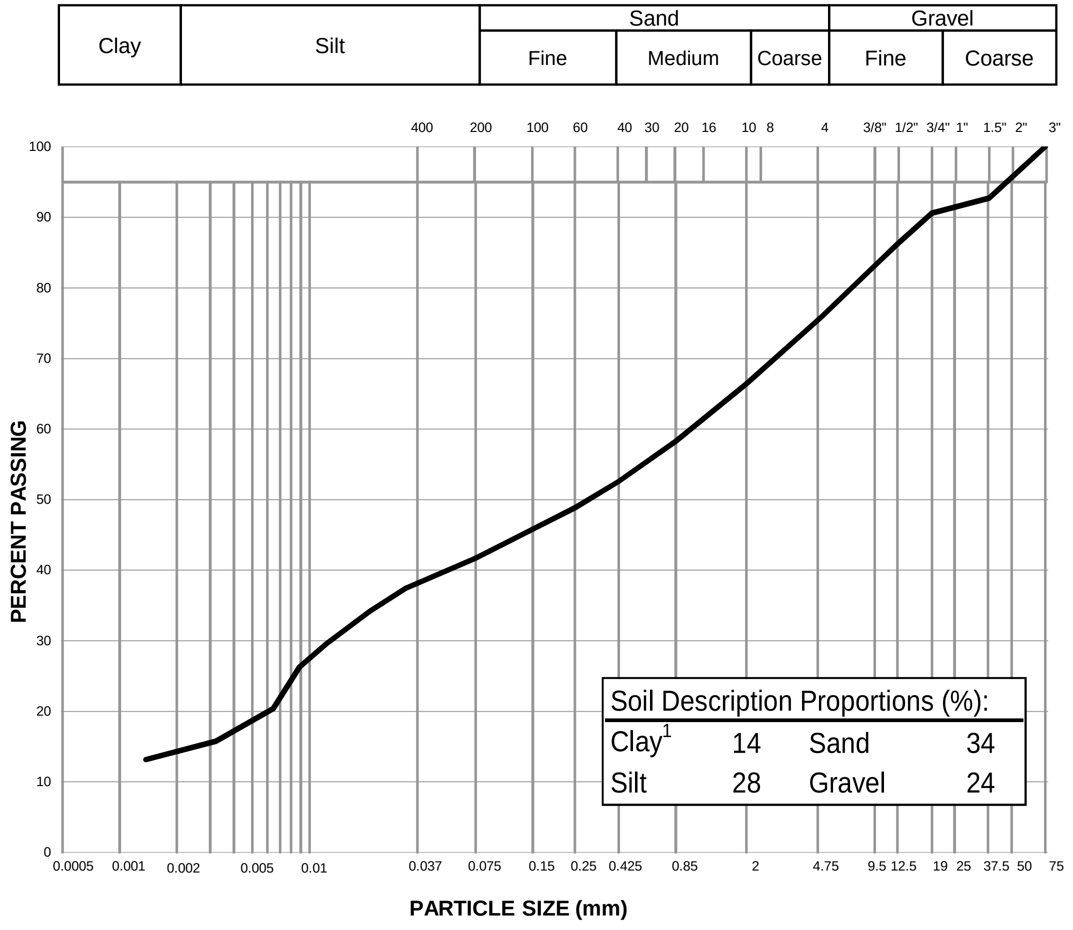
Reviewed By: ______________________ P.Geo.

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S5
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-15
Client:	Victoria Gold Corp.	Sample Depth:	12.7 - 13.0 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 28, 2018 By: AT	Date Sampled:	April 10, 2018
Soil Description[2]:	SAND - silty, gravelly, some clay	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	10.0%		Cc: #N/A

Particle Size (mm)	Percent Passing
75	100
50	
38	93
25	
19	91
12.5	86
10	84
5	76
2	66
0.85	58
0.425	53
0.25	49
0.15	46
0.075	41.7
0.0324	37.5
0.0208	34.2
0.0123	29.6
0.0088	26.3
0.0064	20.4
0.0032	15.8
0.0014	13.1



Soil Description Proportions (%):

Clay[1]	14	Sand	34
Silt	28	Gravel	24

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: __________

Remarks: __________

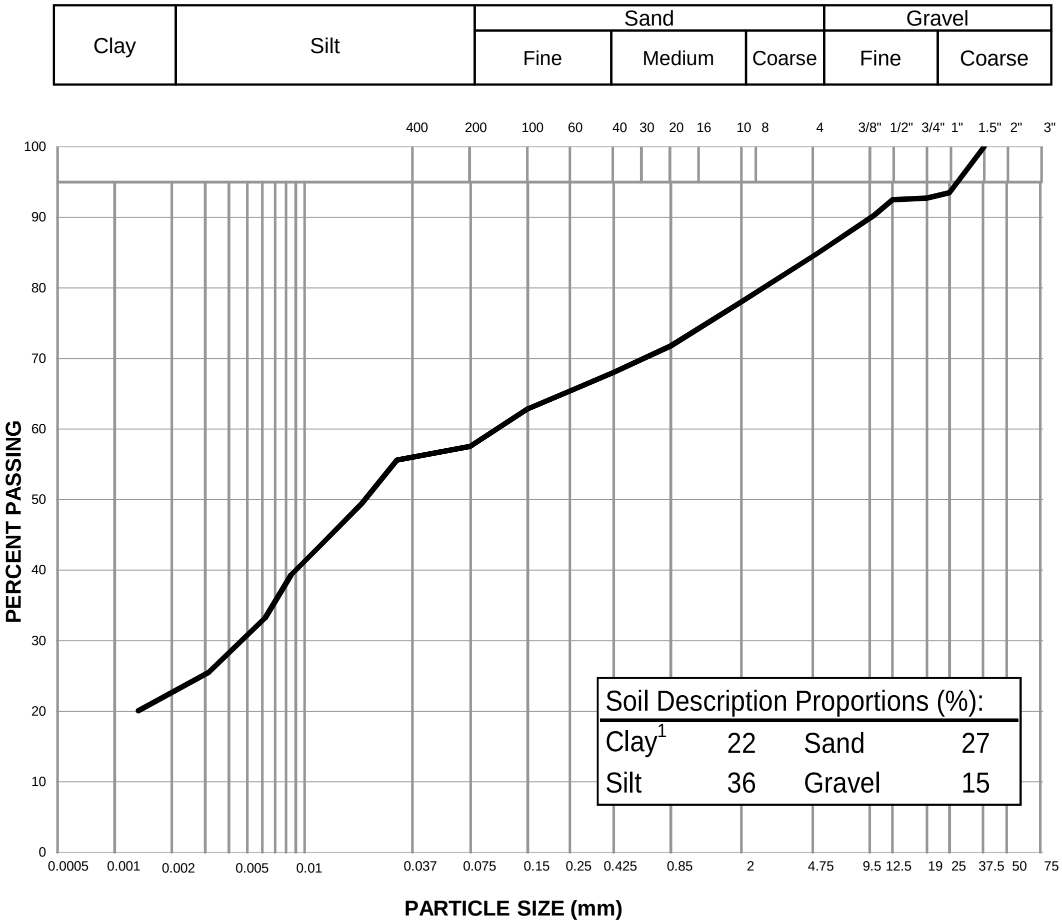
Reviewed By: __________ P.Geo.

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S7
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-15
Client:	Victoria Gold Corp.	Sample Depth:	17.5 - 17.8 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 26, 2018 By: AT	Date Sampled:	April 10, 2018
Soil Description[2]:	SILT - sandy, clayey, some gravel	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	11.1%		Cc: #N/A

Particle Size (mm)	Percent Passing
75	
50	
38	100
25	94
19	93
12.5	93
10	90
5	85
2	78
0.85	72
0.425	68
0.25	65
0.15	63
0.075	57.6
0.0306	55.6
0.0200	49.4
0.0119	43.3
0.0085	39.4
0.0062	33.2
0.0031	25.5
0.0013	20.1



Soil Description Proportions (%):

Clay[1]	22	Sand	27
Silt	36	Gravel	15

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: __________

Remarks: __________

Reviewed By: __________ P.Geo.

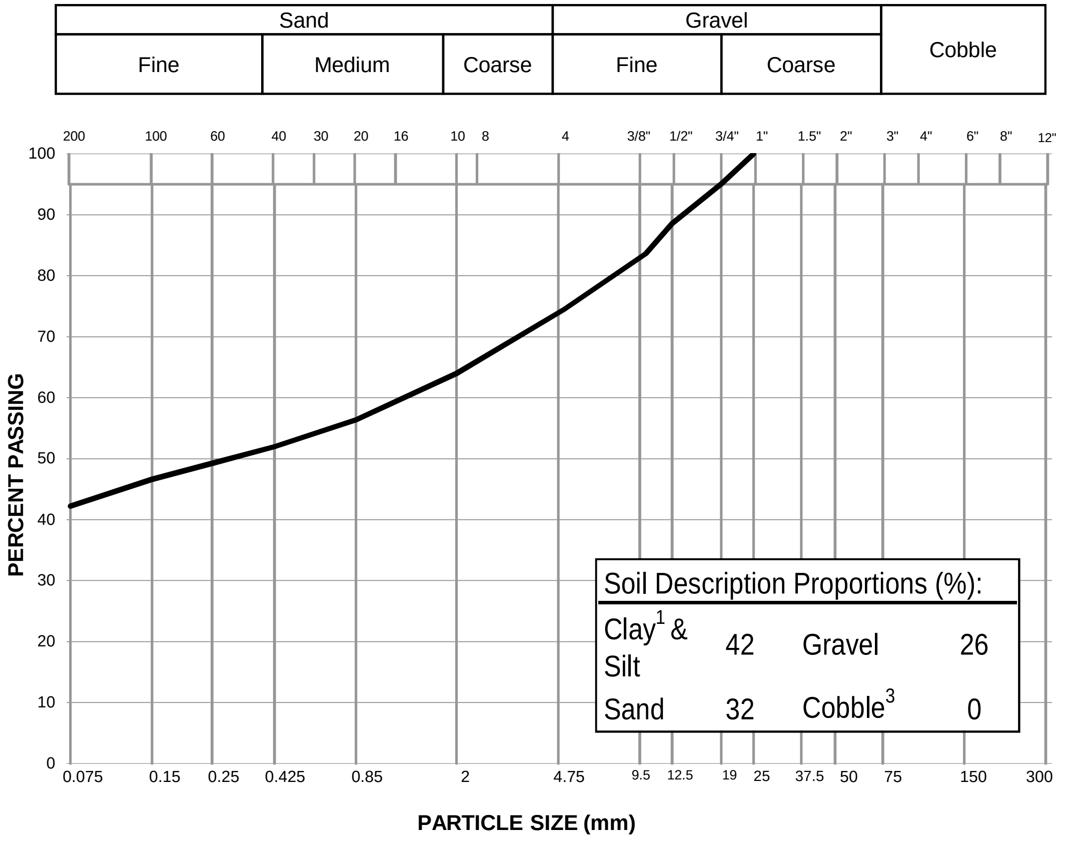
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S1
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-16
Client:	Victoria Gold Corp.	Sample Depth:	0.5 - 0.8 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 18, 2018 By: AH	Date Sampled:	April 11, 2018
Soil Description[2]:	SILT - sandy, gravelly	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	12.1%		Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	
25	100
19	95
12.5	89
10	84
5	74
2	64
0.85	56
0.425	52
0.25	49
0.15	47
0.075	42.2



Soil Description Proportions (%):

Clay[1] & Silt	42	Gravel	26
Sand	32	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ______

Remarks: ______

Reviewed By: ______ P.Geo.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

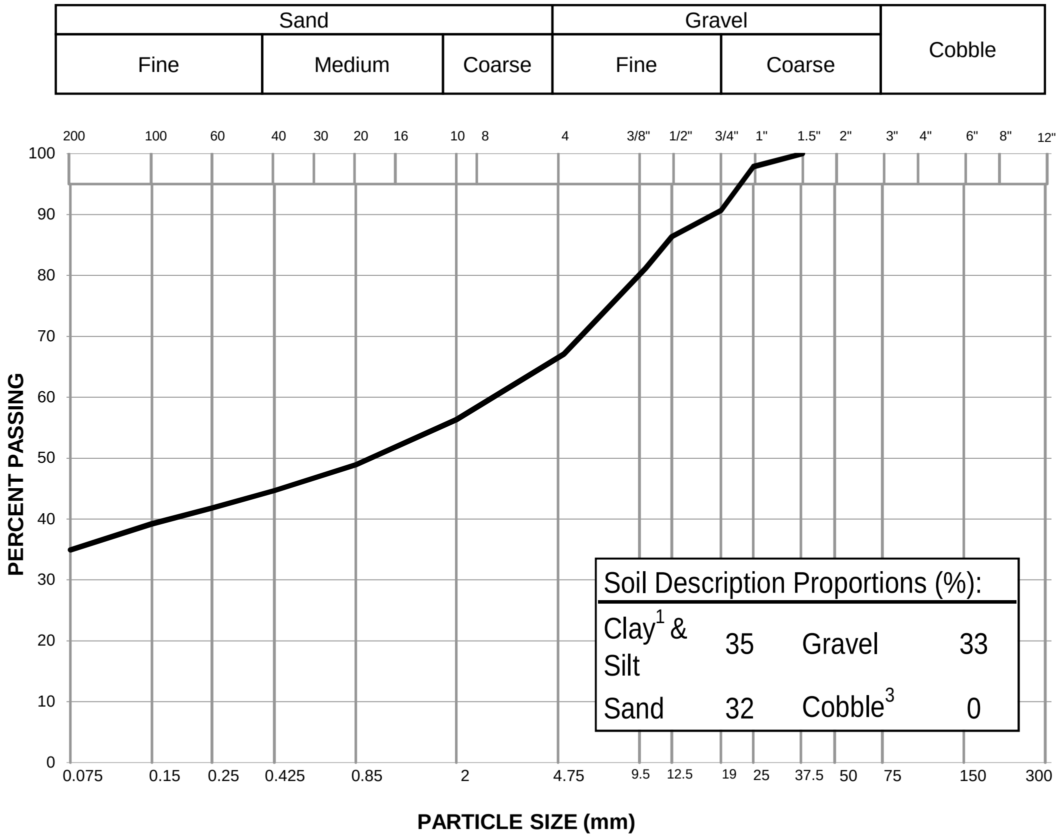
ASTM D7928 & C136

Project: Eagle Gold – Spring 2018 Geotech. Invest.
Project No.: ENG.EARC03103-02
Site: Eagle Gold Mine, Yukon
Client: Victoria Gold Corp.
Client Rep.: Dr. Stephen Wilbur
Date Tested: May 18, 2018 By: AH
Soil Description[2]: SILT - gravelly, sandy

Sample No.: S2
Material Type: -
Sample Loc.: GT18-16
Sample Depth: 2.5 - 2.8 m
Sampling Method: Grab
Date Sampled: April 11, 2018
Sampled By: Tetra Tech Canada
USC Classification: - Cu: #N/A

Moisture Content: 10.3% Cc: #N/A

Particle Size (mm)	Percent Passing
300	
200	
150	
100	
75	
50	
38	100
25	98
19	91
12.5	86
10	81
5	67
2	56
0.85	49
0.425	45
0.25	42
0.15	39
0.075	34.9



Soil Description Proportions (%):

Clay[1] & Silt	35	Gravel	33
Sand	32	Cobble[3]	0

Notes:
[1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tt WM4400 description protocols
[3] If cobbles are present, sampling procedure may not meet ASTM C702 & D75

Specification: ____

Remarks: ____

Reviewed By: ____ P.Geo.

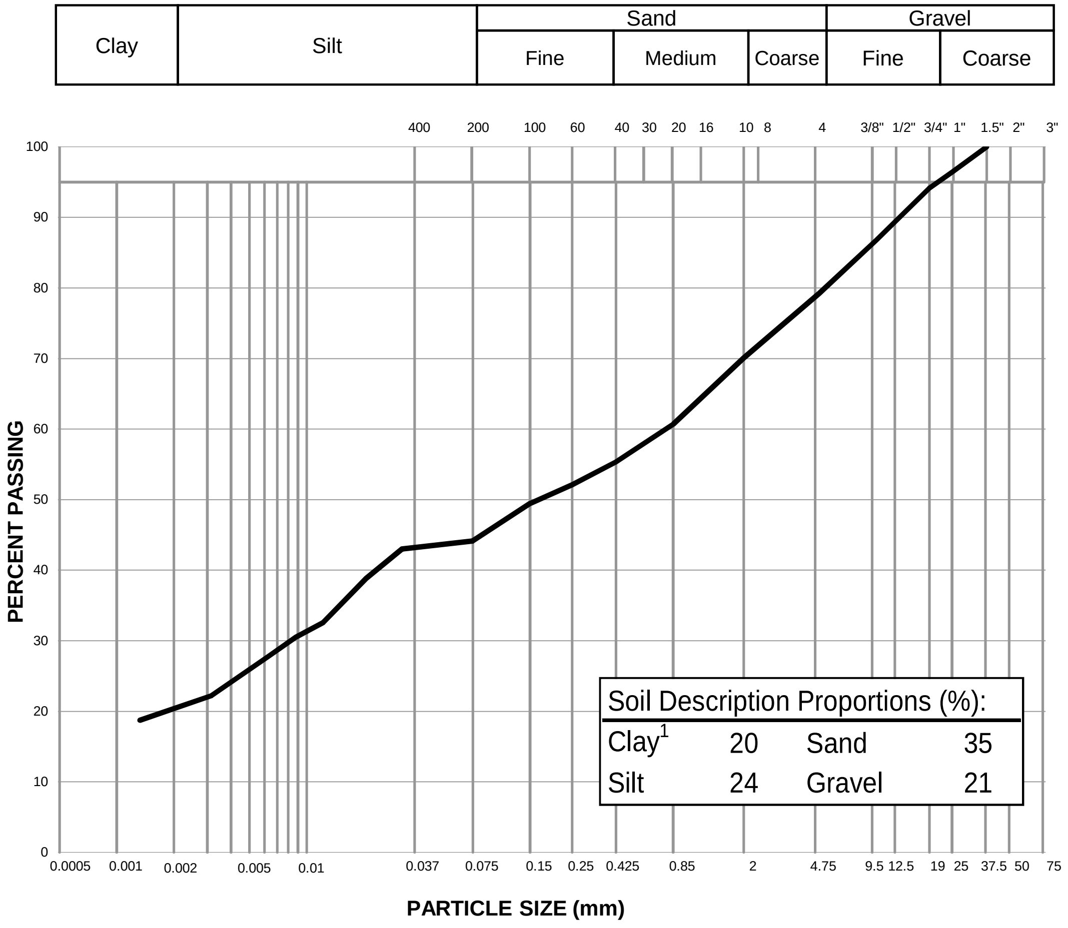
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S2
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-17
Client:	Victoria Gold Corp.	Sample Depth:	1.1 - 1.3 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 26, 2018 By: AT	Date Sampled:	April 12, 2018
Soil Description[2]:	SAND - silty, gravelly, some clay	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	76.6%		Cc: #N/A

Particle Size (mm)	Percent Passing
75	
50	
38	100
25	96
19	94
12.5	89
10	87
5	79
2	70
0.85	61
0.425	55
0.25	52
0.15	49
0.075	44.1
0.0318	43.0
0.0206	38.8
0.0122	32.6
0.0087	30.5
0.0063	27.7
0.0031	22.2
0.0013	18.7



Soil Description Proportions (%):			
Clay[1]	20	Sand	35
Silt	24	Gravel	21

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: ____________________

Remarks: ____________________

Reviewed By: ____________________ P.Geo.

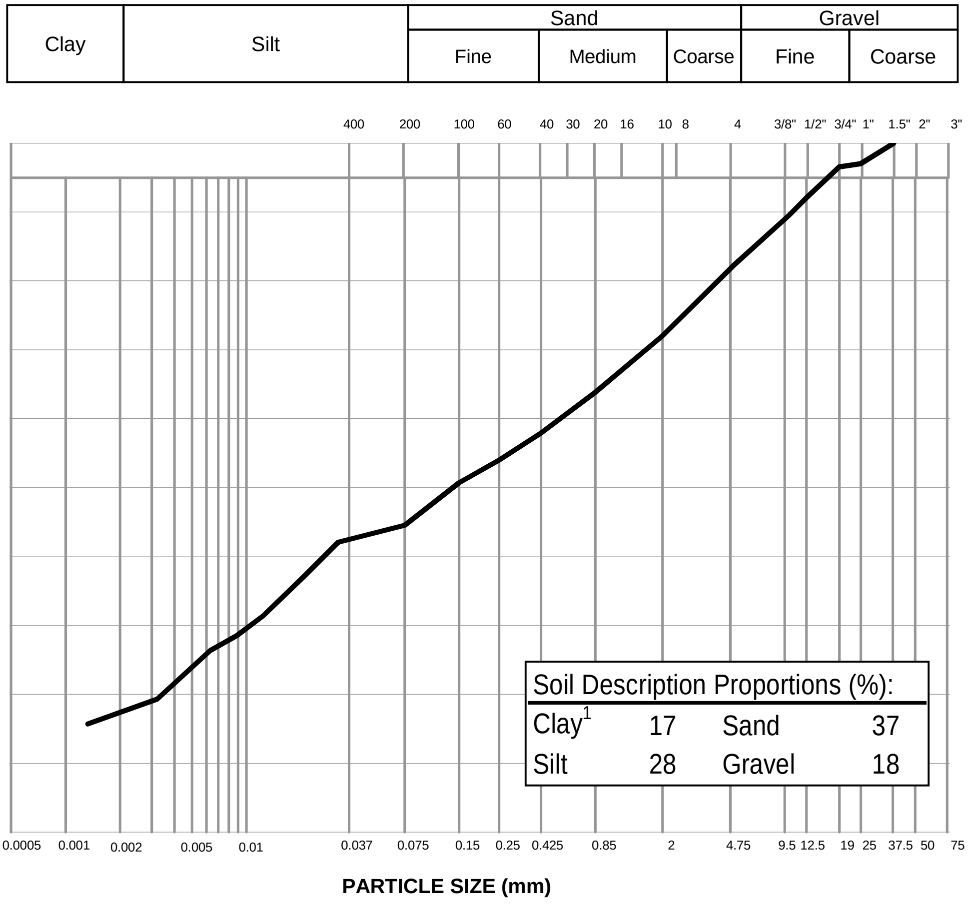
TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Eagle Gold – Spring 2018 Geotech. Invest.	Sample No.:	S3
Project No.:	ENG.EARC03103-02	Material Type:	-
Site:	Eagle Gold Mine, Yukon	Sample Loc.:	GT18-17
Client:	Victoria Gold Corp.	Sample Depth:	1.6 - 1.8 m
Client Rep.:	Dr. Stephen Wilbur	Sampling Method:	Grab
Date Tested:	May 26, 2018 By: AT	Date Sampled:	April 12, 2018
Soil Description[2]:	SAND - silty, some gravel, some clay	Sampled By:	Tetra Tech Canada
		USC Classification:	- Cu: #N/A
Moisture Content:	29.8%		Cc: #N/A

Particle Size (mm)	Percent Passing
75	
50	
38	100
25	97
19	97
12.5	92
10	90
5	82
2	72
0.85	64
0.425	58
0.25	54
0.15	51
0.075	44.5
0.0322	42.1
0.0208	37.1
0.0124	31.4
0.0088	28.5
0.0063	26.4
0.0032	19.3
0.0013	15.7



Soil Description Proportions (%):

Clay[1]	17	Sand	37
Silt	28	Gravel	18

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual

[2] The description is visually based & subject to Tetra Tech description protocols

Specification: ______________________

Remarks: ______________________

Reviewed By: ______________________ P.Geo.

TETRA TECH

PARTICLE SIZE ANALYSIS REPORT

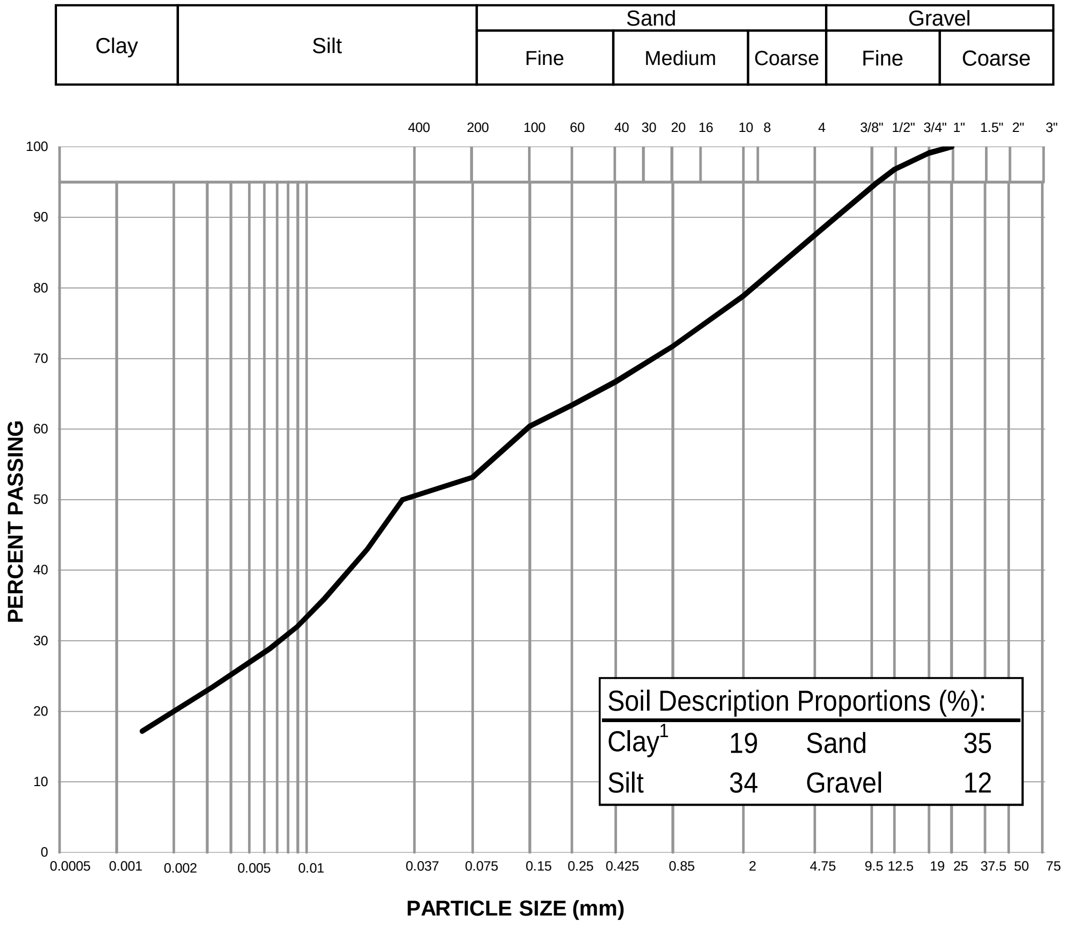
ASTM D7928 & C136

Project: Eagle Gold – Spring 2018 Geotech. Invest.
Project No.: ENG.EARC03103-02
Site: Eagle Gold Mine, Yukon
Client: Victoria Gold Corp.
Client Rep.: Dr. Stephen Wilbur
Date Tested: May 25, 2018 By: AT
Soil Description[2]: SAND - silty, some clay, some gravel

Sample No.: S5
Material Type: -
Sample Loc.: GT18-17
Sample Depth: 3.7 - 3.9 m
Sampling Method: Grab
Date Sampled: April 12, 2018
Sampled By: Tetra Tech Canada
USC Classification: - Cu: #N/A

Moisture Content: 10.9% Cc: #N/A

Particle Size (mm)	Percent Passing
75	
50	
38	
25	100
19	99
12.5	97
10	95
5	88
2	79
0.85	72
0.425	67
0.25	63
0.15	60
0.075	53.2
0.0321	50.0
0.0209	42.9
0.0124	35.9
0.0089	32.0
0.0064	28.9
0.0032	23.4
0.0014	17.2



Soil Description Proportions (%):

Clay[1]	19	Sand	35
Silt	34	Gravel	12

Notes: [1] The upper clay size of 2 um, per the Canadian Foundation Engineering Manual
[2] The description is visually based & subject to Tetra Tech description protocols

Specification: ______

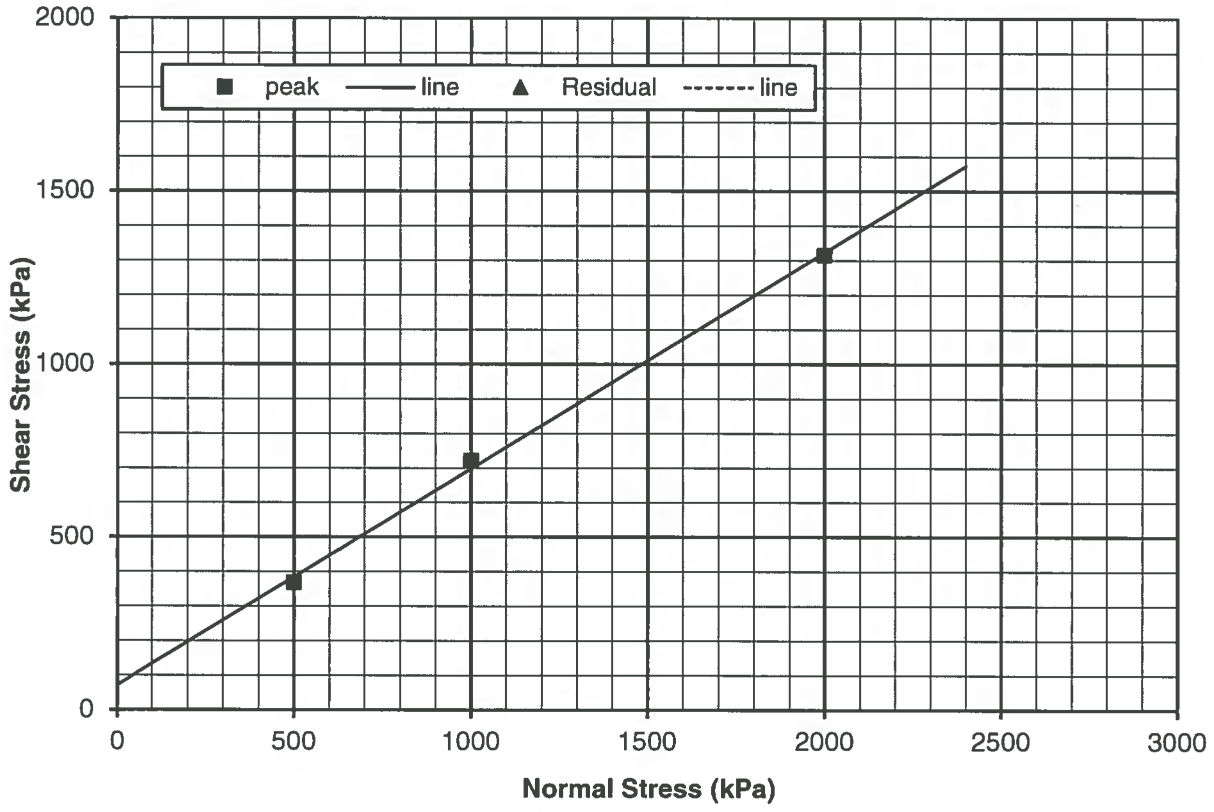
Remarks: ______

Reviewed By: ______ P.Geo.

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project:	Eagle Gold	Test Hole:	GT18-01-S1 & 04-S2 Comb.
Project No.:	**ENG.EARC03103-02**	Depth:	1.5-2.5 & 0.95-1.25 m
Client:	**Victoria Gold**	Date:	May 29, 2018
Attention:	**Dr. Stephen Wilbur**	Tested By:	TD/SK
Email:	SWilbur@vitgoldcorp.com	Office:	Edmonton



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	**71.0**	**32.0**
Residual Strength:	**N/A**	**N/A**

Reviewed By: ______________________ P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-01-S1/04-S2 Comb.
Project No.:	ENG.EARC03103-02	Depth:	1.5-2.5 and 0.95-1.25 m
Client:	Victoria Gold	Test No.:	DS-1
Date Tested:	May 16, 2018	Machine:	1
Descrition:	SAND & GRAVEL, clayey, some silt, brown	Preparation:	Remolded

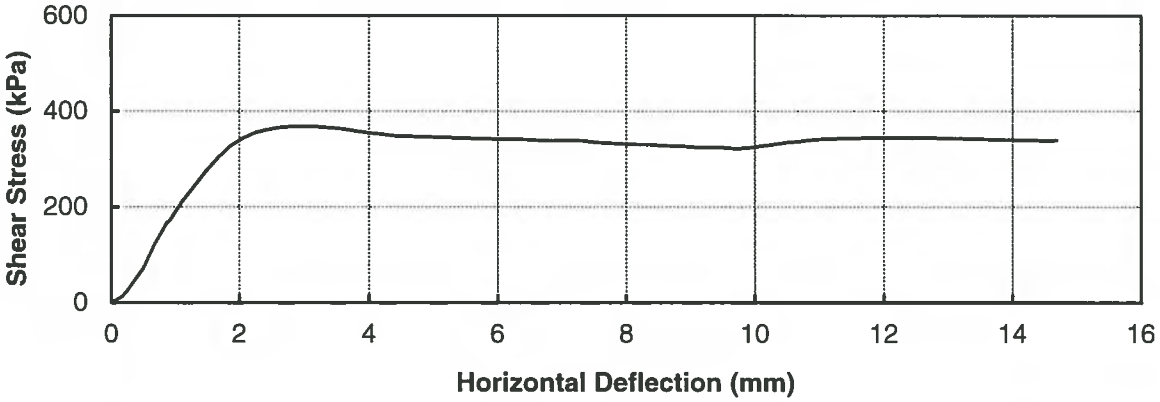
Normal Stress (kPa) = 500

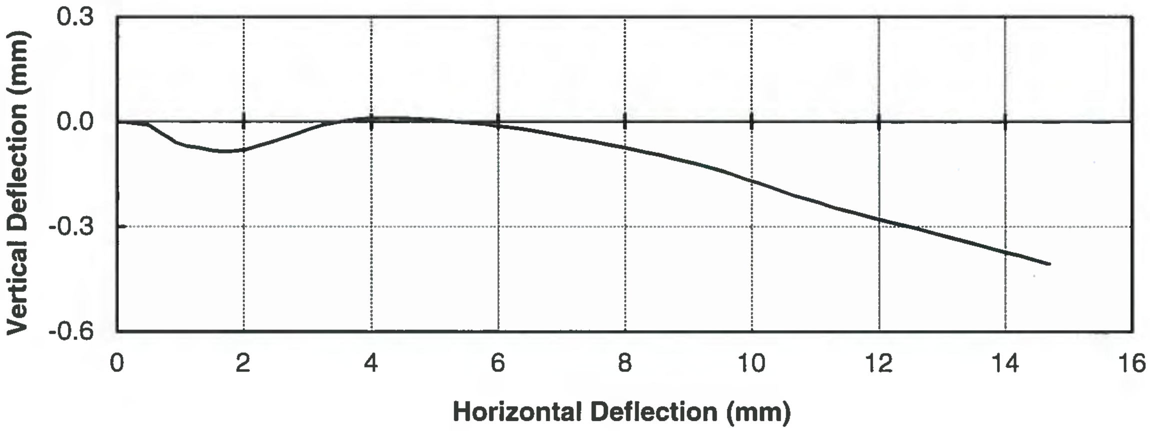
Peak Stress (kPa) = 368

Moisture Content (%) = 11.6

Wet Density (Mg/m^3) = 2.220

Dry Density (Mg/m^3) = 1.989





Remarks:

Reviewed By: ______________________ P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-01-S1/04-S2 Comb.
Project No.:	ENG.EARC03103-02	Depth:	1.5-2.5 and 0.95-1.25 m
Client:	Victoria Gold	Test No.:	DS-2
Date Tested:	May 16, 2018	Machine:	3
Descrition:	SAND & GRAVEL, clayey, some silt, brown	Preparation:	Remolded

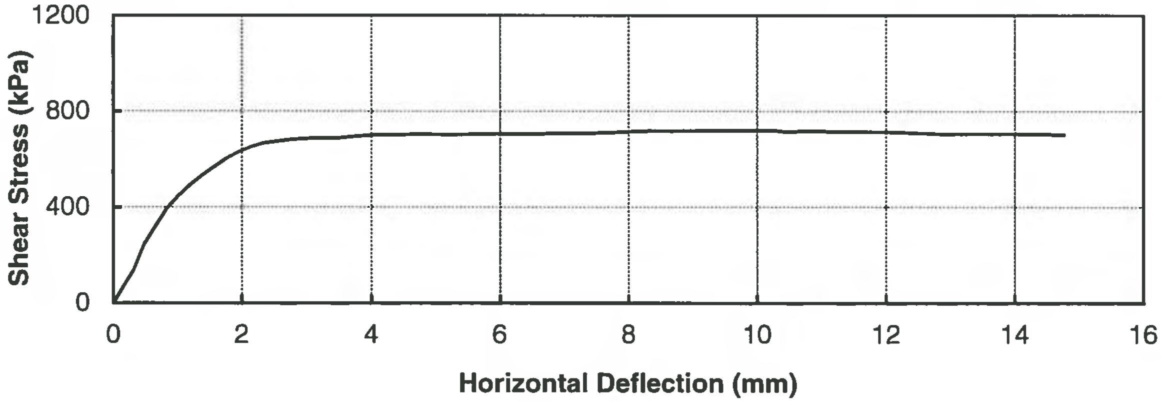
Normal Stress (kPa) = 1000

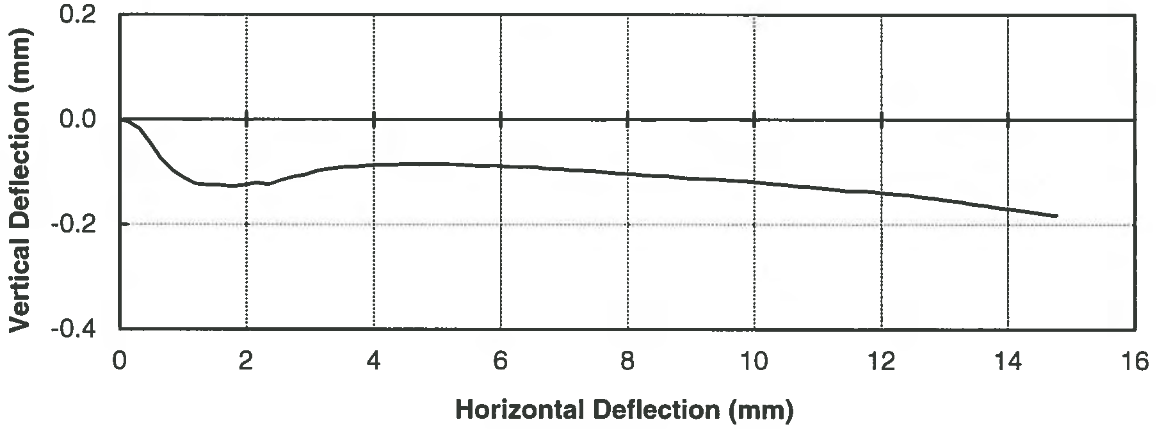
Peak Stress (kPa) = 721

Moisture Content (%) = 11.4

Wet Density (Mg/m^3) = 2.221

Dry Density (Mg/m^3) = 1.994





Remarks:

Reviewed By: ______________________ P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-01-S1/04-S2 Comb.
Project No.:	ENG.EARC03103-02	Depth:	1.5-2.5 and 0.95-1.25 m
Client:	Victoria Gold	Test No.:	DS-3
Date Tested:	May 16, 2018	Machine:	2
Descrition:	SAND & GRAVEL, clayey, some silt, brown	Preparation:	Remolded

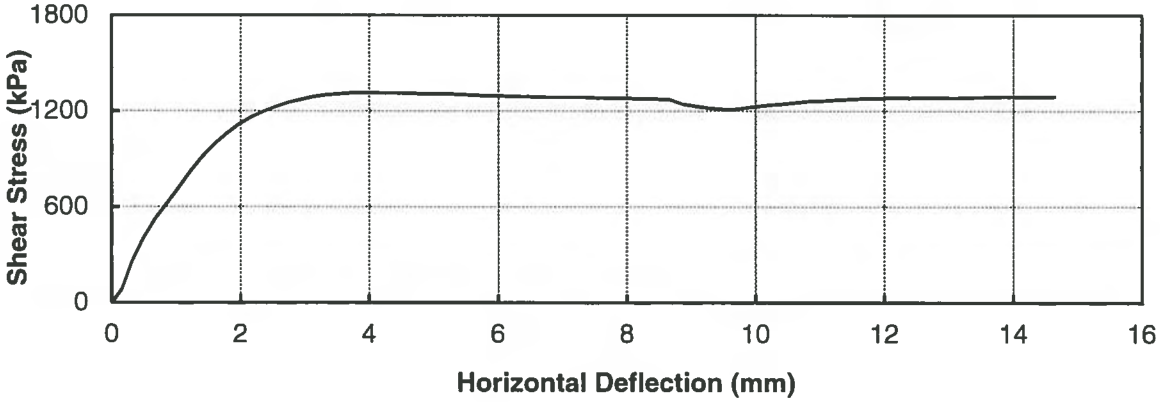
Normal Stress (kPa) = 2000

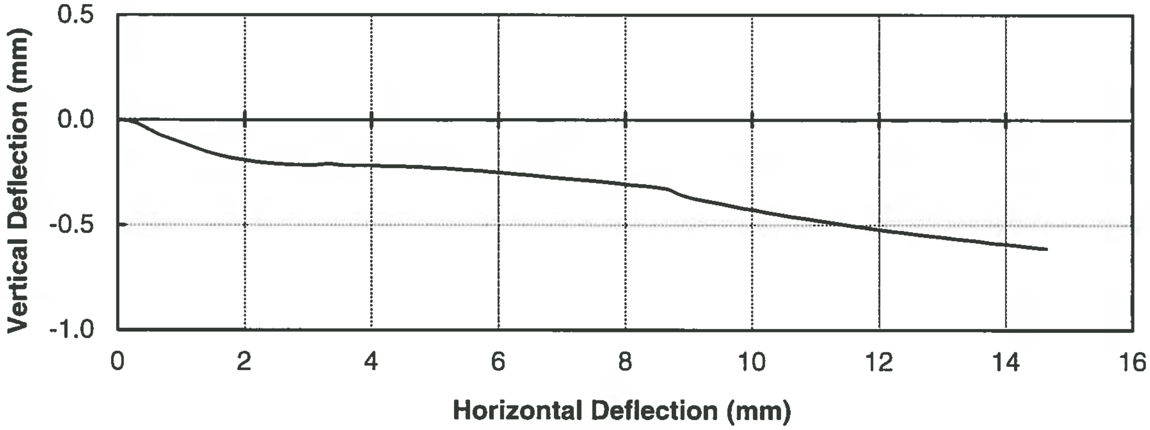
Peak Stress (kPa) = 1315

Moisture Content (%) = 11.4

Wet Density (Mg/m^3) = 2.222

Dry Density (Mg/m^3) = 1.994





Remarks:

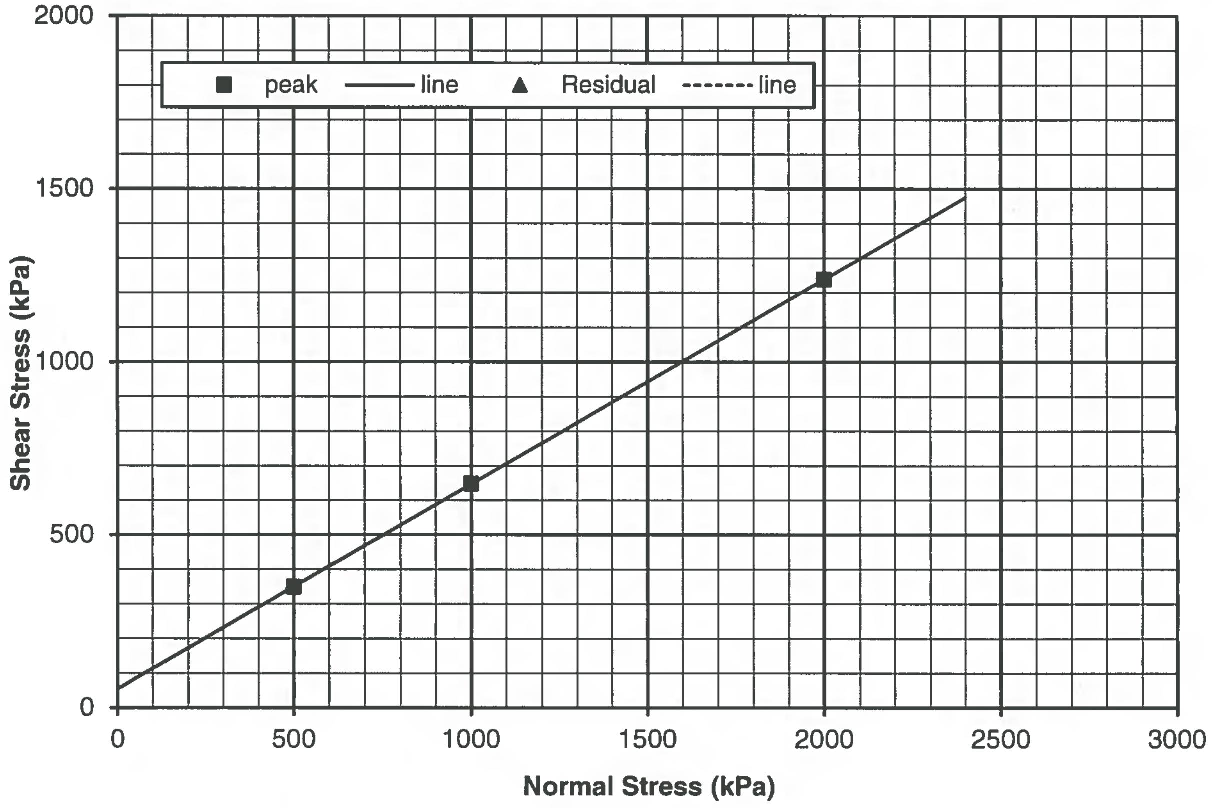
Reviewed By: ______________ P.Eng.

TETRA TECH

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project:	Eagle Gold	Test Hole:	GT18-02-S2, 06-S2 & 07-S2
Project No.:	**ENG.EARC03103-02**	Depth:	1.2-1.5, 2.5-3.1 & 2.2-2.6 m
Client:	**Victoria Gold**	Date:	May 30, 2018
Attention:	**Dr. Stephen Wilbur**	Tested By:	TD/SK
Email:	SWilbur@vitgoldcorp.com	Office:	Edmonton



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	**54.0**	**30.6**
Residual Strength:	**N/A**	**N/A**

Reviewed By: JR P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-02-S2/06-S2/07-S2
Project No.:	ENG.EARC03103-02	Depth:	1.2-1.5, 2.5-3.1, 2.2-2.6 m
Client:	Victoria Gold	Test No.:	DS-4
Date Tested:	May 18, 2018	Machine:	1
Descrition:	SAND	Preparation:	Remolded

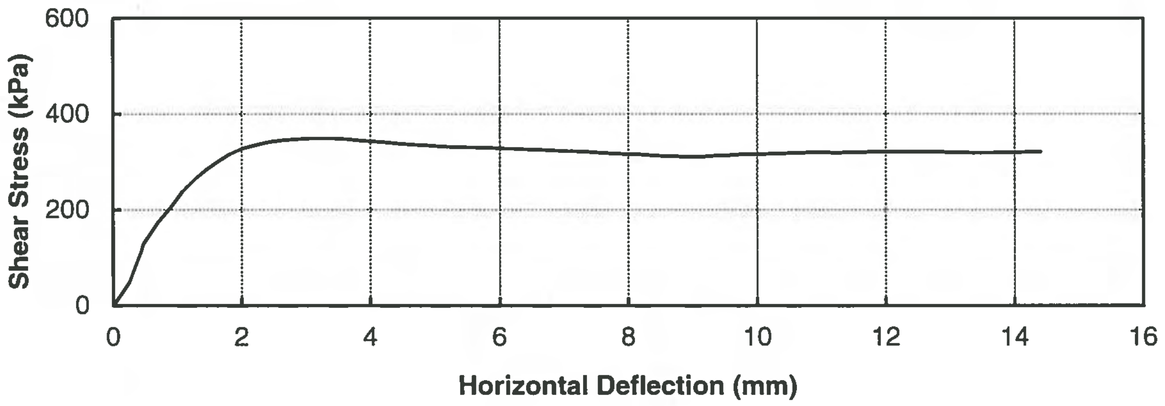
Normal Stress (kPa) = 500

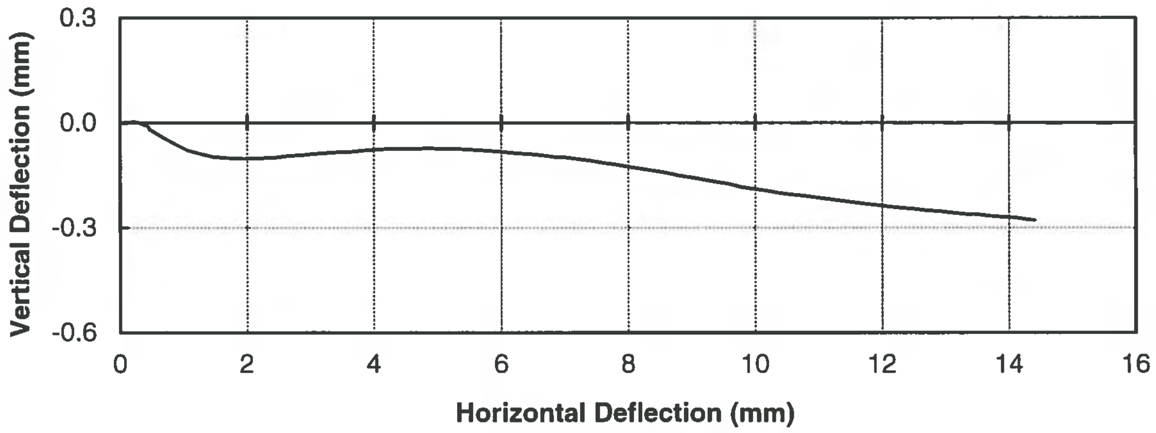
Peak Stress (kPa) = 349

Moisture Content (%) = 14.0

Wet Density (Mg/m^3) = 2.225

Dry Density (Mg/m^3) = 1.951





Remarks:

Reviewed By: _______________ P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-02-S2/06-S2/07-S2
Project No.:	ENG.EARC03103-02	Depth:	1.2-1.5, 2.5-3.1, 2.2-2.6 m
Client:	Victoria Gold	Test No.:	DS-5
Date Tested:	May 18, 2018	Machine:	3
Descrition:	SAND & GRAVEL, clayey, some silt, brown	Preparation:	Remolded

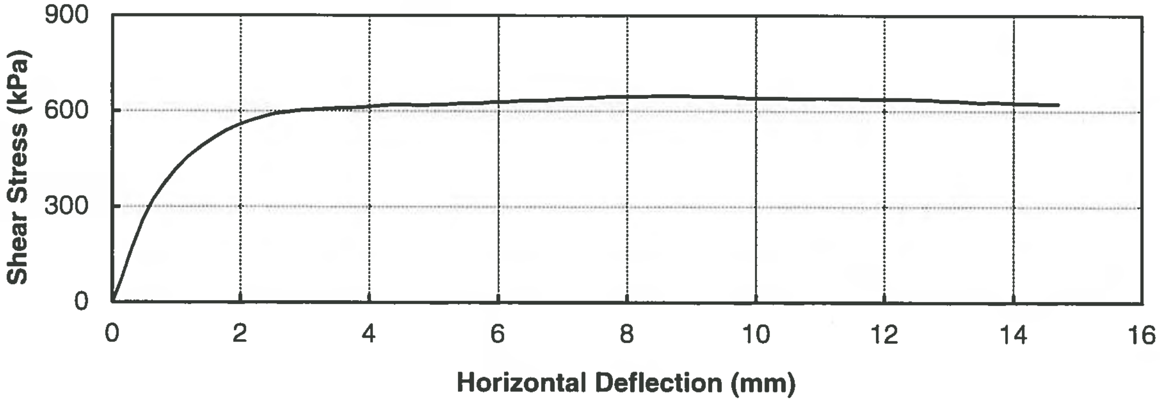
Normal Stress (kPa) = 1000

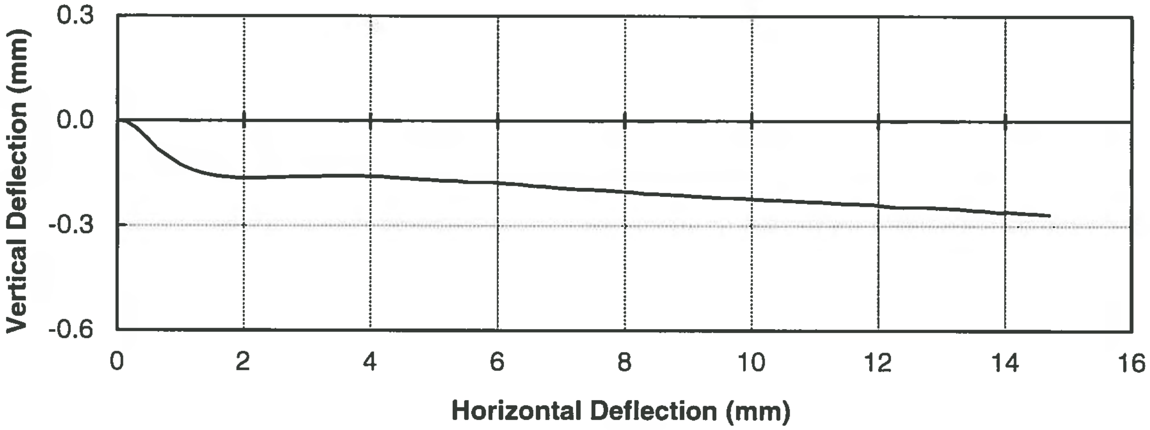
Peak Stress (kPa) = 648

Moisture Content (%) = 13.9

Wet Density (Mg/m^3) = 2.225

Dry Density (Mg/m^3) = 1.954





Remarks:

Reviewed By: JDR P.Eng.

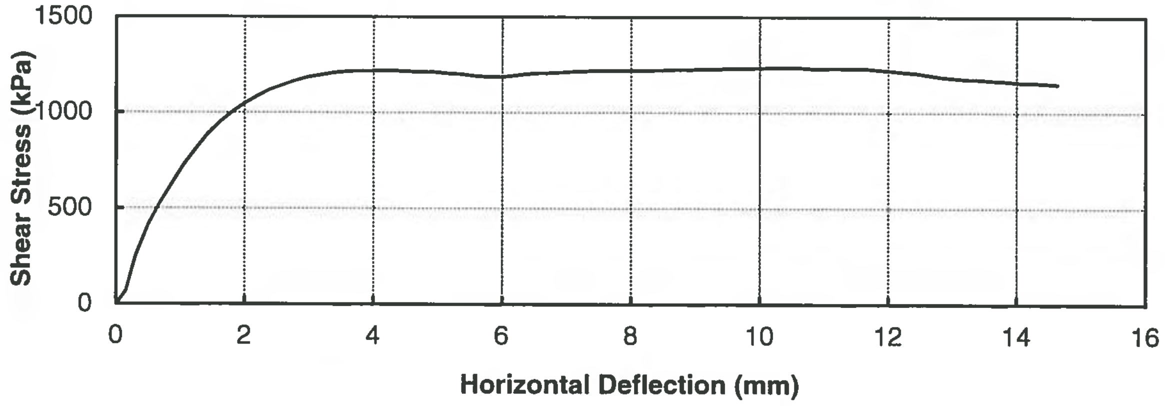
TETRA TECH

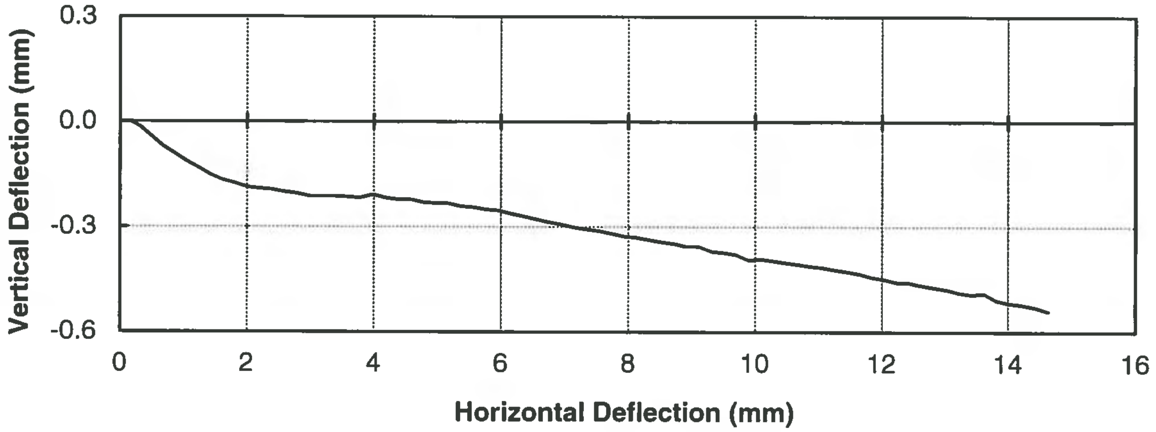
DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-02-S2/06-S2/07-S2
Project No.:	ENG.EARC03103-02	Depth:	1.2-1.5, 2.5-3.1, 2.2-2.6 m
Client:	Victoria Gold	Test No.:	DS-6
Date Tested:	May 18, 2018	Machine:	2
Descrition:	SAND & GRAVEL, clayey, some silt, brown	Preparation:	Remolded

Normal Stress (kPa) =	2000	Moisture Content (%) =	13.8
Peak Stress (kPa) =	1238	Wet Density (Mg/m^3) =	2.225
		Dry Density (Mg/m^3) =	1.956





Remarks:

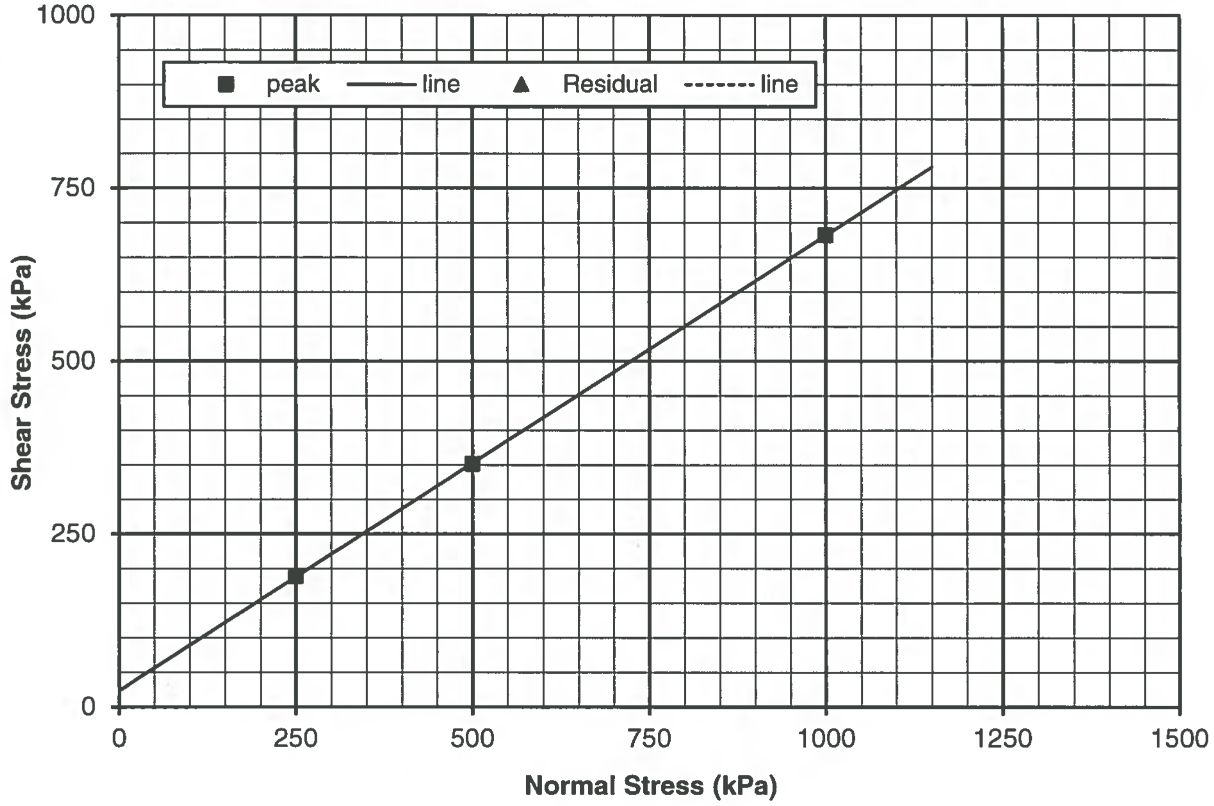
Reviewed By: P.Eng.

TETRA TECH

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project:	Eagle Gold	Test Hole:	GT18-08-S6
Project No.:	**ENG.EARC03103-02**	Depth:	3.5-3.7 m
Client:	**Victoria Gold**	Date:	May 31, 2018
Attention:	**Dr. Stephen Wilbur**	Tested By:	TD/SK
Email:	SWilbur@vitgoldcorp.com	Office:	Edmonton



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	**23.5**	**33.3**
Residual Strength:	**N/A**	**N/A**

Reviewed By: ______________________ P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-08-S6
Project No.:	ENG.EARC03103-02	Depth:	3.5-3.7 m
Client:	Victoria Gold	Test No.:	DS-7
Date Tested:	May 23, 2018	Machine:	1
Descrition:	SAND & SILT, trace clay, brown	Preparation:	Remolded

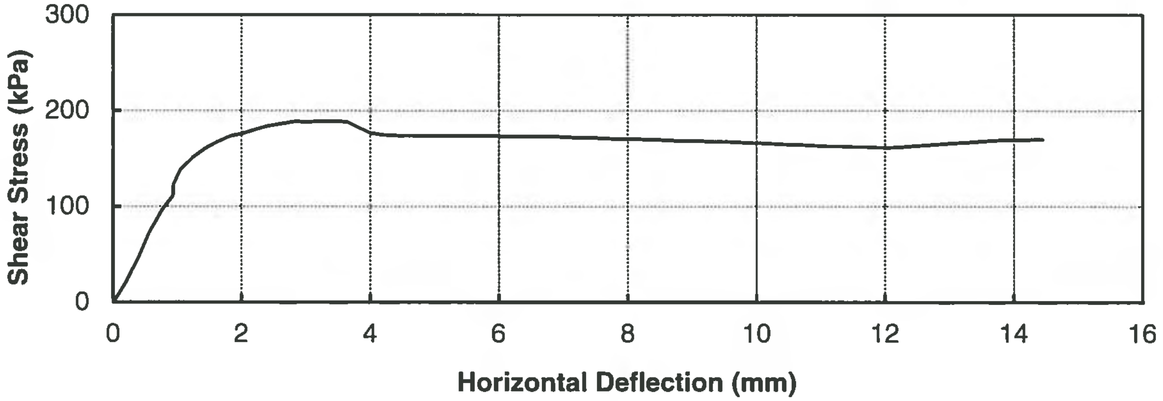
Normal Stress (kPa) = 250

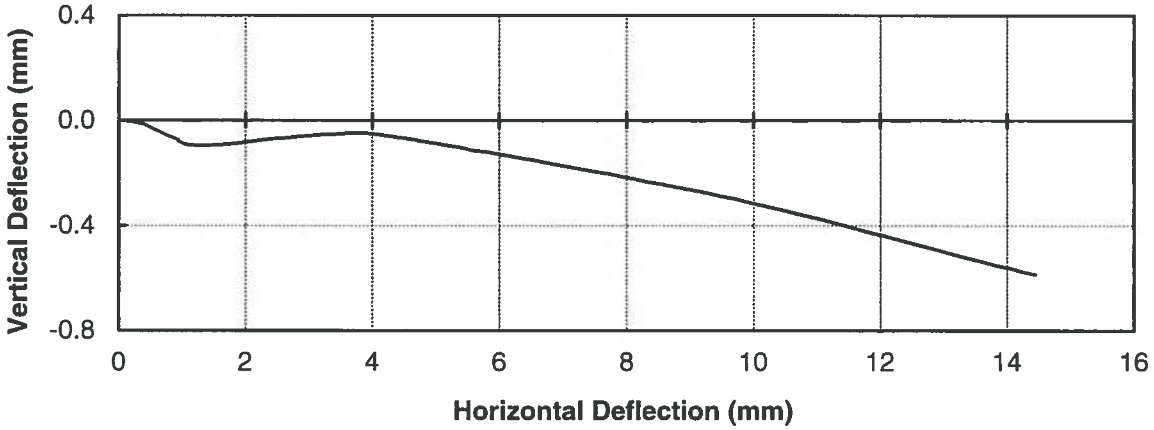
Peak Stress (kPa) = 189

Moisture Content (%) = 15.5

Wet Density (Mg/m^3) = 2.051

Dry Density (Mg/m^3) = 1.775





Remarks:

Reviewed By: JR P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-08-S6
Project No.:	ENG.EARC03103-02	Depth:	3.5-3.7 m
Client:	Victoria Gold	Test No.:	DS-8
Date Tested:	May 23, 2018	Machine:	3
Descrition:	SAND & SILT, trace clay, brown	Preparation:	Remolded

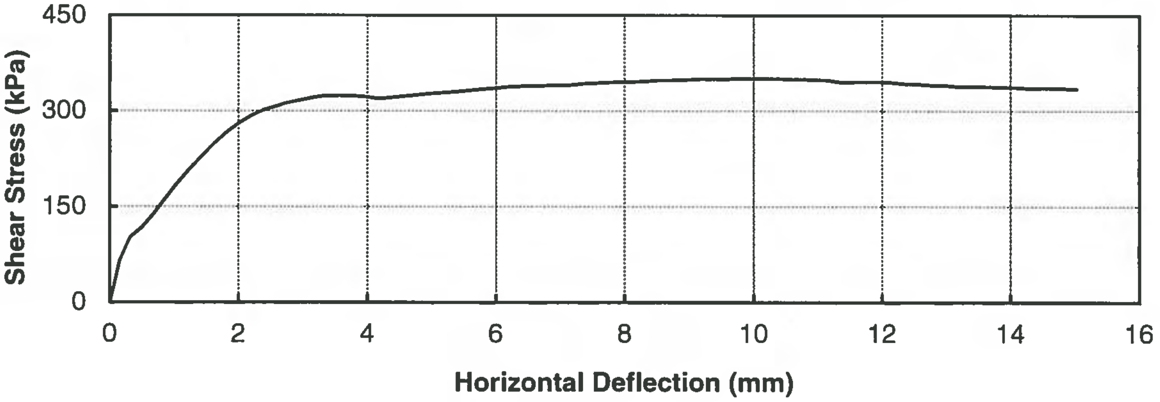
Normal Stress (kPa) = 500

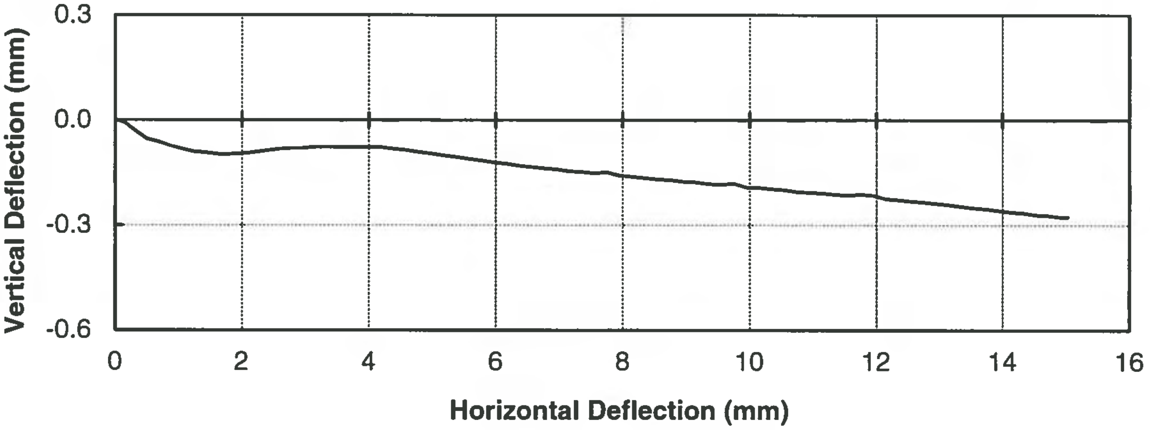
Peak Stress (kPa) = 351

Moisture Content (%) = 14.4

Wet Density (Mg/m^3) = 2.051

Dry Density (Mg/m^3) = 1.792





Remarks:

Reviewed By: JR P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-08-S6
Project No.:	ENG.EARC03103-02	Depth:	3.5-3.7 m
Client:	Victoria Gold	Test No.:	DS-9
Date Tested:	May 23, 2018	Machine:	1
Descrition:	SAND & SILT, trace clay, brown	Preparation:	Remolded

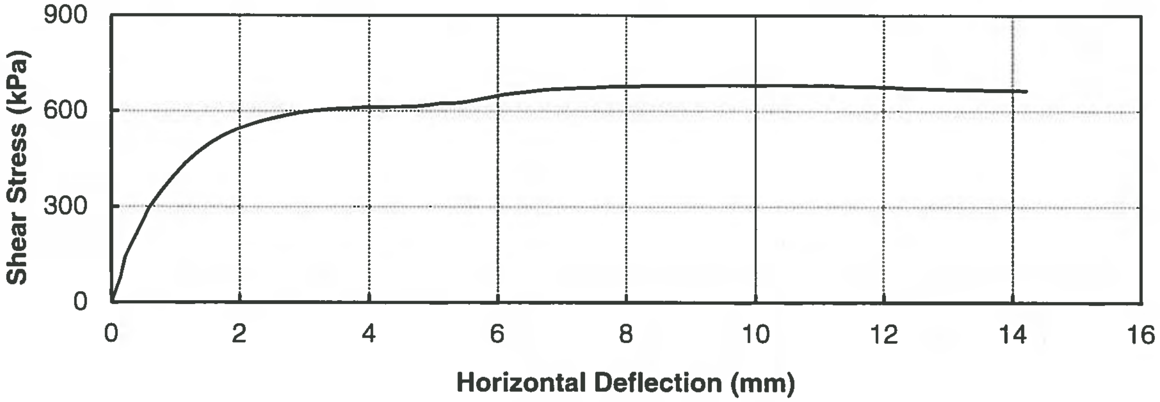
Normal Stress (kPa) = 1000

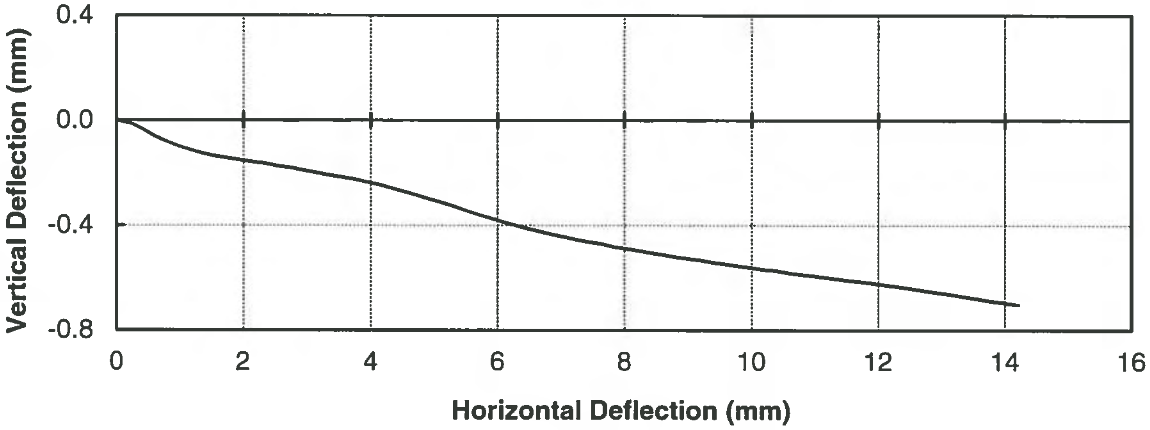
Peak Stress (kPa) = 682

Moisture Content (%) = 14.6

Wet Density (Mg/m^3) = 2.051

Dry Density (Mg/m^3) = 1.789





Remarks:

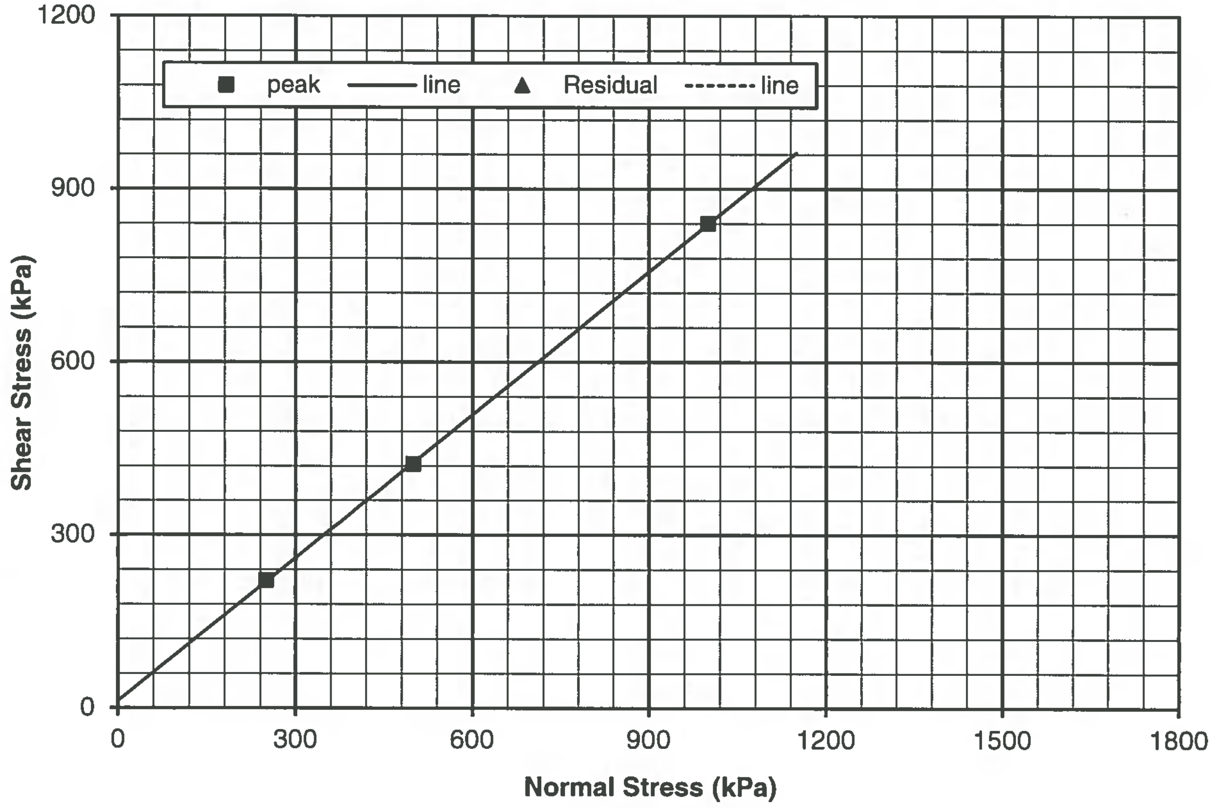
Reviewed By: ______________________ P.Eng.

TETRA TECH

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project:	Eagle Gold	Test Hole:	GT18-08-S4
Project No.:	**ENG.EARC03103-02**	Depth:	2.45-2.6 m
Client:	**Victoria Gold**	Date:	May 31, 2018
Attention:	**Dr. Stephen Wilbur**	Tested By:	TD/SK
Email:	SWilbur@vitgoldcorp.com	Office:	Edmonton



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	**12.5**	**39.6**
Residual Strength:	**N/A**	**N/A**

Reviewed By: JDR P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-08-S4
Project No.:	ENG.EARC03103-02	Depth:	2.45-2.6 m
Client:	Victoria Gold	Test No.:	DS-10
Date Tested:	May 25, 2018	Machine:	3
Descrition:	SAND & GRAVEL, clayey, some silt, brown	Preparation:	Remolded

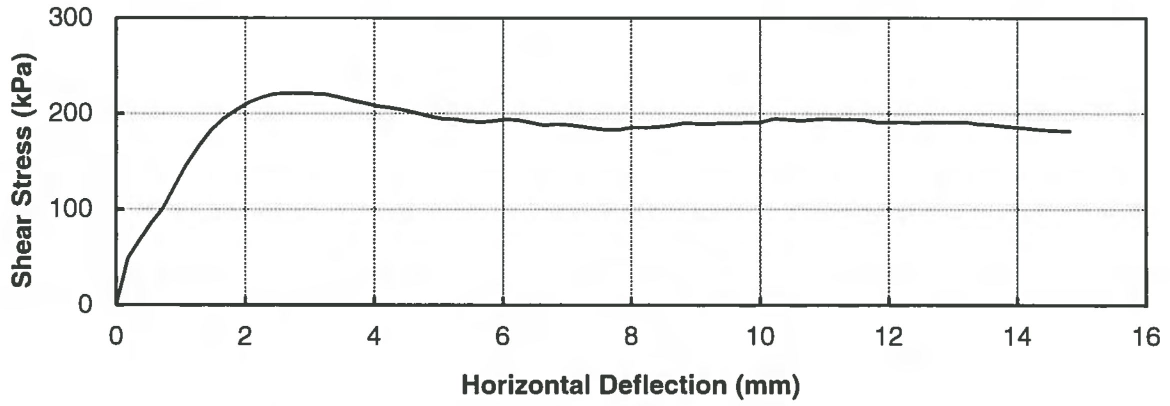
Normal Stress (kPa) = 250

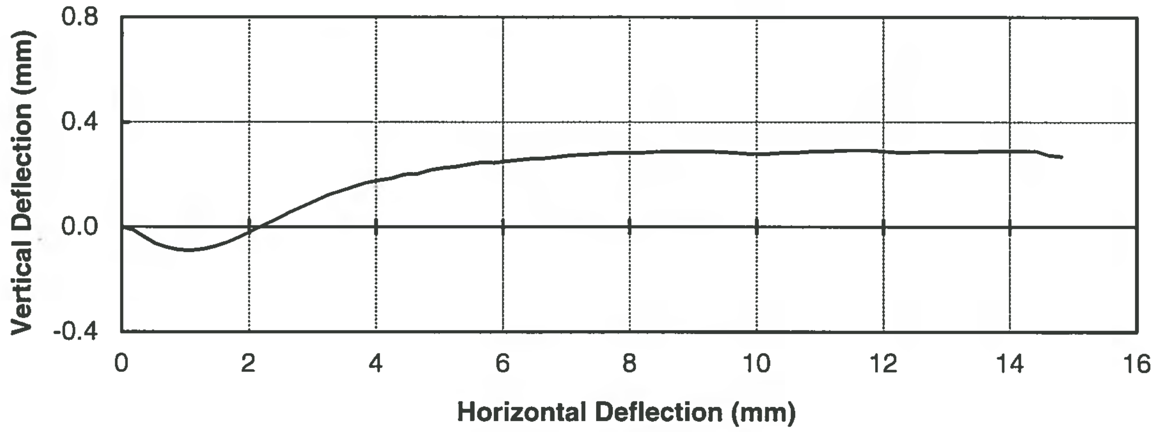
Peak Stress (kPa) = 221

Moisture Content (%) = 12.9

Wet Density (Mg/m^3) = 2.213

Dry Density (Mg/m^3) = 1.961





Remarks:

Reviewed By: JDR P.Eng.

TETRA TECH

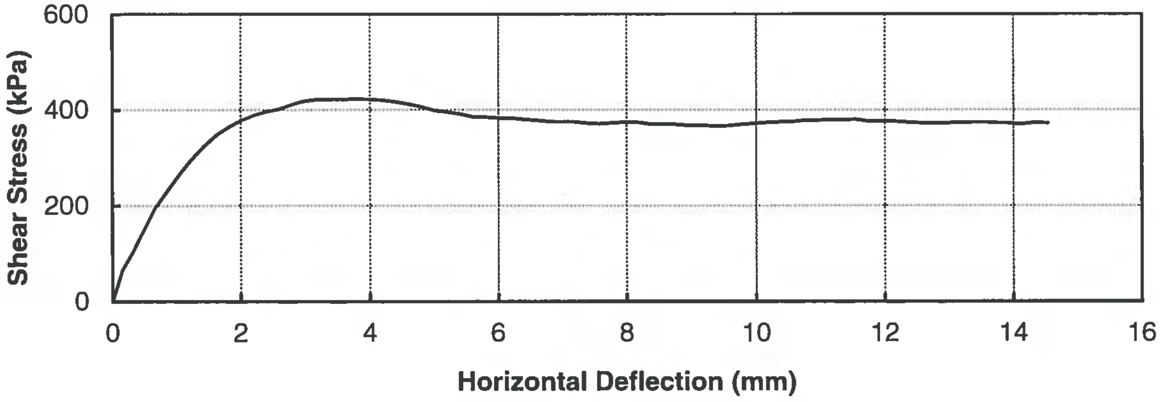
DIRECT SHEAR TEST

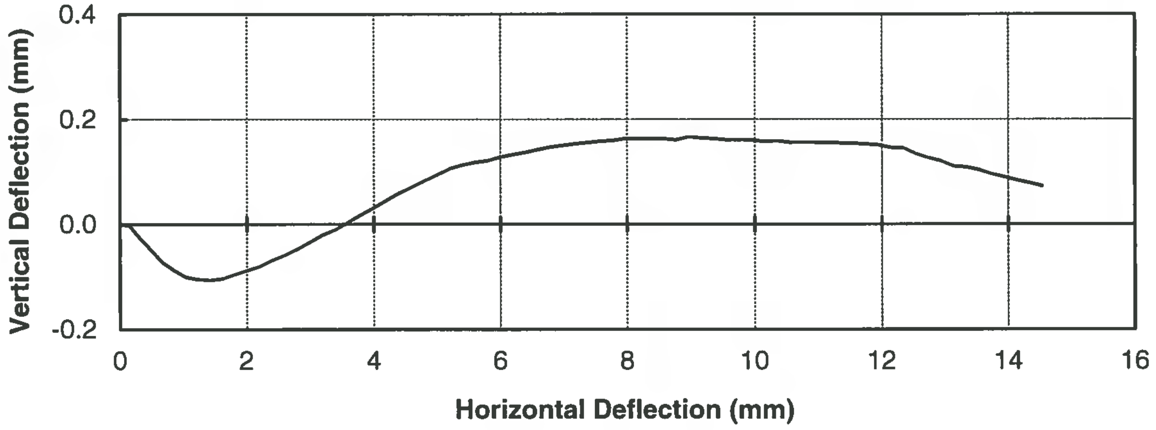
ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-08-S4
Project No.:	ENG.EARC03103-02	Depth:	2.45-2.6 m
Client:	Victoria Gold	Test No.:	DS-11
Date Tested:	May 29, 2018	Machine:	3
Descrition:	SAND & GRAVEL, clayey, some silt, brown	Preparation:	Remolded

Normal Stress (kPa) = 500
Peak Stress (kPa) = 423

Moisture Content (%) = 12.5
Wet Density (Mg/m^3) = 2.213
Dry Density (Mg/m^3) = 1.967





Remarks:

Reviewed By: P.Eng.

TETRA TECH

DIRECT SHEAR TEST

ASTM D3080

Project:	Eagle Gold	Test Hole No.:	GT18-08-S4
Project No.:	ENG.EARC03103-02	Depth:	2.45-2.6 m
Client:	Victoria Gold	Test No.:	DS-12
Date Tested:	May 29, 2018	Machine:	1
Descrition:	SAND & GRAVEL, clayey, some silt, brown	Preparation:	Remolded

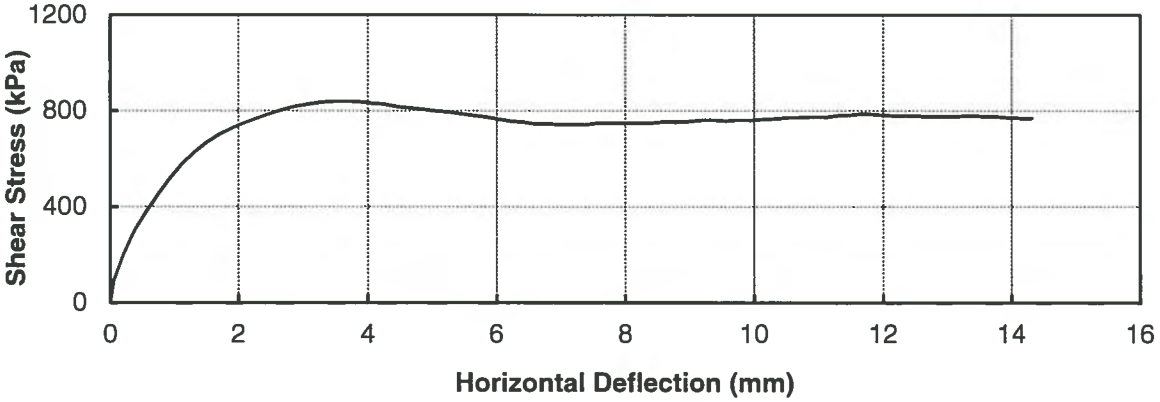
Normal Stress (kPa) = 1000

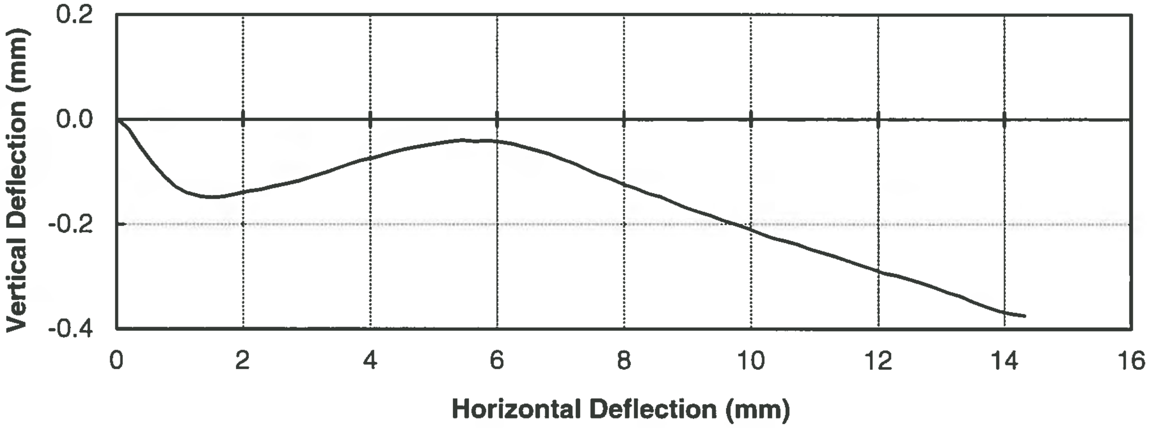
Peak Stress (kPa) = 840

Moisture Content (%) = 12.6

Wet Density (Mg/m^3) = 2.214

Dry Density (Mg/m^3) = 1.966





Remarks:

Reviewed By: P.Eng.

APPENDIX D

GTC INSTALLATION FORMS AND GROUND TEMPERATURE PROFILES

SITE: EAGLE GOLD MINE SITE, YT

LOCATION: GT18-01

COORDINATES: NORTHING: 7 100 952

EASTING: 459 831

GROUND ELEVATION: 913.0 m

1ST BEAD ELEVATION: 912.5 m

NUMBER OF BEADS: 16

CABLE INSTALLATION NO.: 1

CABLE SERIAL NO.: TT 2665

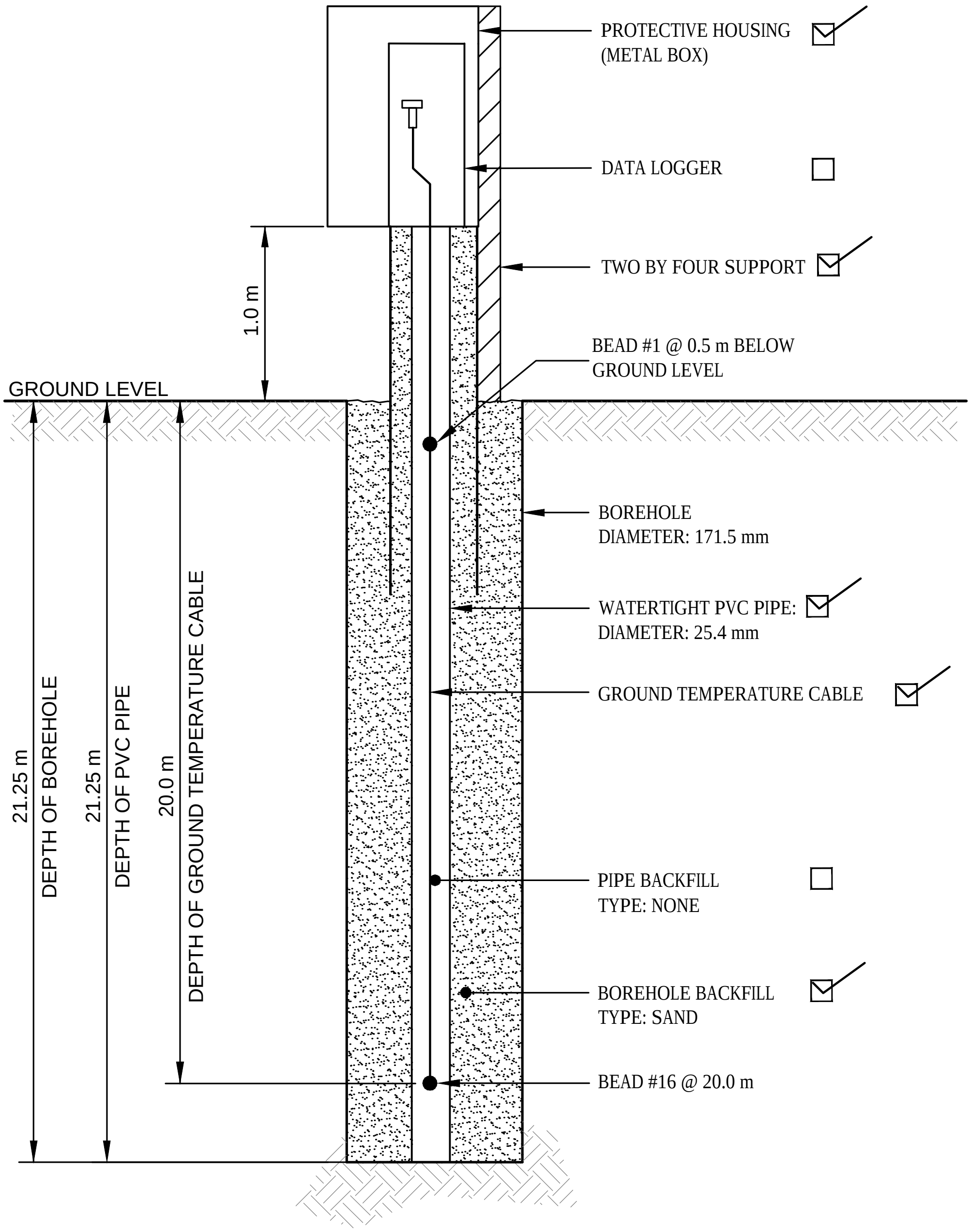
DRILLING DATE: April 7, 2018

INSTALLATION DATE: April 7, 2018

CABLE LENGTH: 21.5 m

LEAD LENGTH: 1.5 m

HOLE DEPTH: 21.25 m



BEAD NO.	DEPTH BELOW OG (m)
1	0.50
2	1.00
3	1.50
4	2.25
5	3.00
6	3.75
7	4.50
8	5.50
9	7.00
10	8.50
11	10.00
12	11.50
13	13.00
14	15.00
15	17.00
16	20.00

NOTES

1) INDICATE ORIGINAL GROUND ELEVATIONS
2) INDICATE ALL BEAD LOCATIONS
3) LEAD LENGTH IS THE LENGTH OF CABLE TO THE FIRST BEAD
4) ALL DIMENSIONS ARE IN METRES
5) DRAWING NOT TO SCALE

CLIENT

Victoria GOLD CORP

TETRA TECH

GROUND TEMPERATURE CABLE INSTALLATION REPORT
EAGLE GOLD MINE SITE, YT

GT18-01

PROJECT NO.	DWN	CKD	REV
ENG.EARC03103-02	RO	VER	0

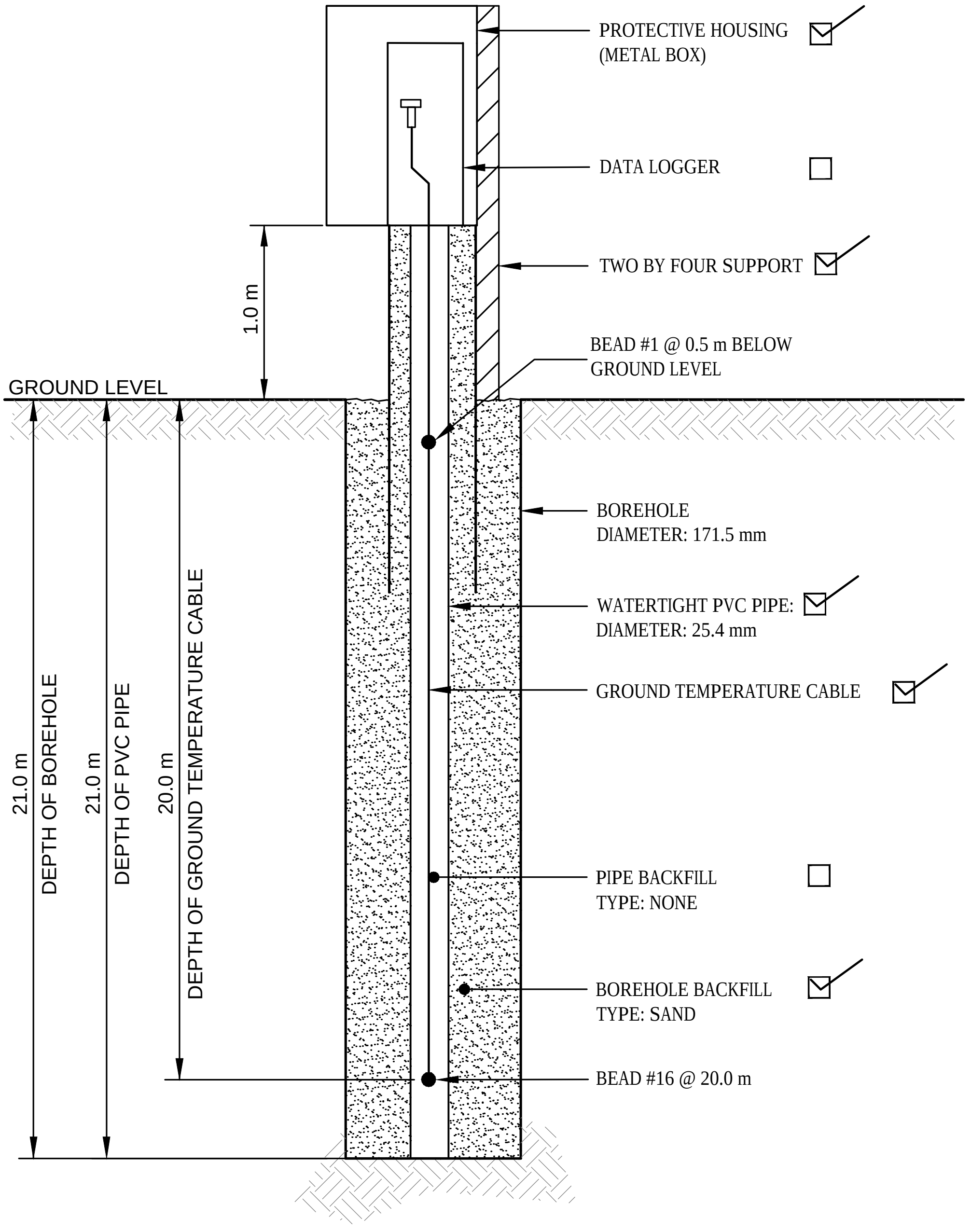
OFFICE	DATE
EDM	May 2018

GTC# TT 2665

Q:\Edmonton\Engineering\E141\Projects\ENG.EARC03103-02 Victoria-Eagle Gold\GTC Installation Reports\Eagle Spring 2018 GTC Installation Reports.dwg [GTC# TT 2665] September 19, 2018 - 10:39:52 am (BY: OKKEMA, RYAN)

SITE: EAGLE GOLD MINE SITE, YT
LOCATION: GT18-07
COORDINATES: NORTHING: 7 100 709
EASTING: 460 139
GROUND ELEVATION: 965.0 m
1ST BEAD ELEVATION: 964.5 m
NUMBER OF BEADS: 16

CABLE INSTALLATION NO.: 2
CABLE SERIAL NO.: TT 2663
DRILLING DATE: April 8, 2018
INSTALLATION DATE: April 8, 2018
CABLE LENGTH: 21.5 m
LEAD LENGTH: 1.5 m
HOLE DEPTH: 21.0 m



BEAD NO.	DEPTH BELOW OG (m)
1	0.50
2	1.00
3	1.50
4	2.25
5	3.00
6	3.75
7	4.50
8	5.50
9	7.00
10	8.50
11	10.00
12	11.50
13	13.00
14	15.00
15	17.00
16	20.00

NOTES

1) INDICATE ORIGINAL GROUND ELEVATIONS
2) INDICATE ALL BEAD LOCATIONS
3) LEAD LENGTH IS THE LENGTH OF CABLE TO THE FIRST BEAD
4) ALL DIMENSIONS ARE IN METRES
5) DRAWING NOT TO SCALE

CLIENT

Victoria GOLD CORP

TETRA TECH

GROUND TEMPERATURE CABLE INSTALLATION REPORT
EAGLE GOLD MINE SITE, YT

GT18-07

PROJECT NO.	DWN	CKD	REV
ENG.EARC03103-02	RO	VER	0

OFFICE: EDM
DATE: May 2018

GTC# TT 2663

Q:\Edmonton\Engineering\E141\Projects\ENG.EARC03103-02 Victoria-Eagle Gold\GTC Installation Reports\Eagle Spring 2018 GTC Installation Reports.dwg [GTC# TT 2663] September 19, 2018 - 10:42:23 am (BY: OKKEMA, RYAN)

SITE: EAGLE GOLD MINE SITE, YT

LOCATION: GT18-05

COORDINATES: NORTHING: 7 100 814

EASTING: 460 006

GROUND ELEVATION: 944.0 m

1ST BEAD ELEVATION: 943.5 m

NUMBER OF BEADS: 16

CABLE INSTALLATION NO.: 3

CABLE SERIAL NO.: TT 2666

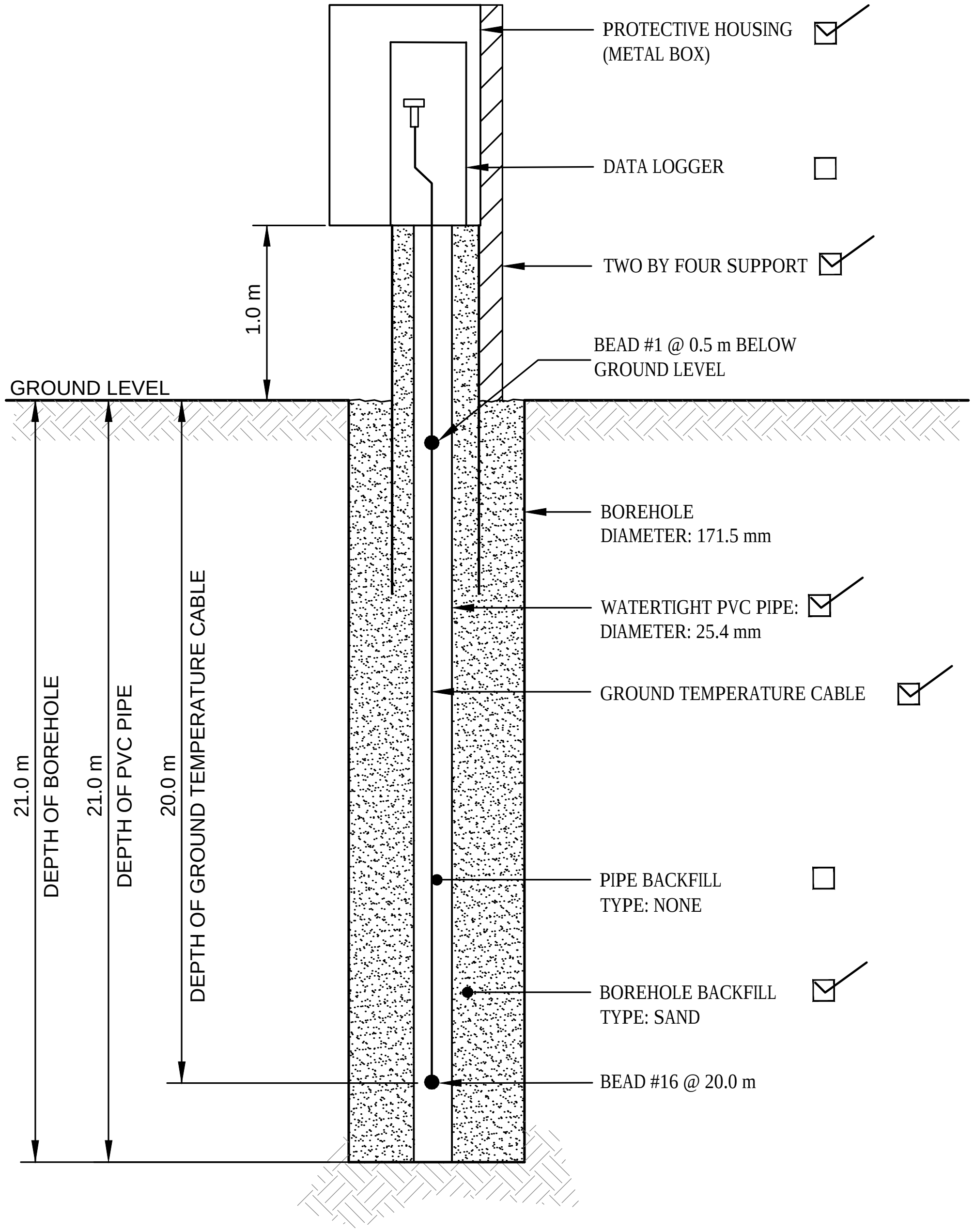
DRILLING DATE: April 9, 2018

INSTALLATION DATE: April 9, 2018

CABLE LENGTH: 21.5 m

LEAD LENGTH: 1.5 m

HOLE DEPTH: 21.0 m



BEAD NO.	DEPTH BELOW OG (m)
1	0.50
2	1.00
3	1.50
4	2.25
5	3.00
6	3.75
7	4.50
8	5.50
9	7.00
10	8.50
11	10.00
12	11.50
13	13.00
14	15.00
15	17.00
16	20.00

NOTES

1) INDICATE ORIGINAL GROUND ELEVATIONS
2) INDICATE ALL BEAD LOCATIONS
3) LEAD LENGTH IS THE LENGTH OF CABLE TO THE FIRST BEAD
4) ALL DIMENSIONS ARE IN METRES
5) DRAWING NOT TO SCALE

CLIENT

Victoria GOLD CORP

TETRA TECH

GROUND TEMPERATURE CABLE INSTALLATION REPORT
EAGLE GOLD MINE SITE, YT

GT18-05

PROJECT NO.	DWN	CKD	REV
ENG.EARC03103-02	RO	VER	0

OFFICE	DATE
EDM	May 2018

GTC# TT 2666

Q:\Edmonton\Engineering\E141\Projects\ENG.EARC03103-02 Victoria-Eagle Gold\GTC Installation Reports\Eagle Spring 2018 GTC Installation Reports.dwg [GTC# TT 2666] September 19, 2018 - 10:41:30 am (BY: OKKEMA, RYAN)

SITE: EAGLE GOLD MINE SITE, YT

LOCATION: GT18-15

COORDINATES: NORTHING: 7 100 583

EASTING: 459 597

GROUND ELEVATION: 961.0 m

1ST BEAD ELEVATION: 960.5 m

NUMBER OF BEADS: 16

CABLE INSTALLATION NO.: 4

CABLE SERIAL NO.: TT 2667

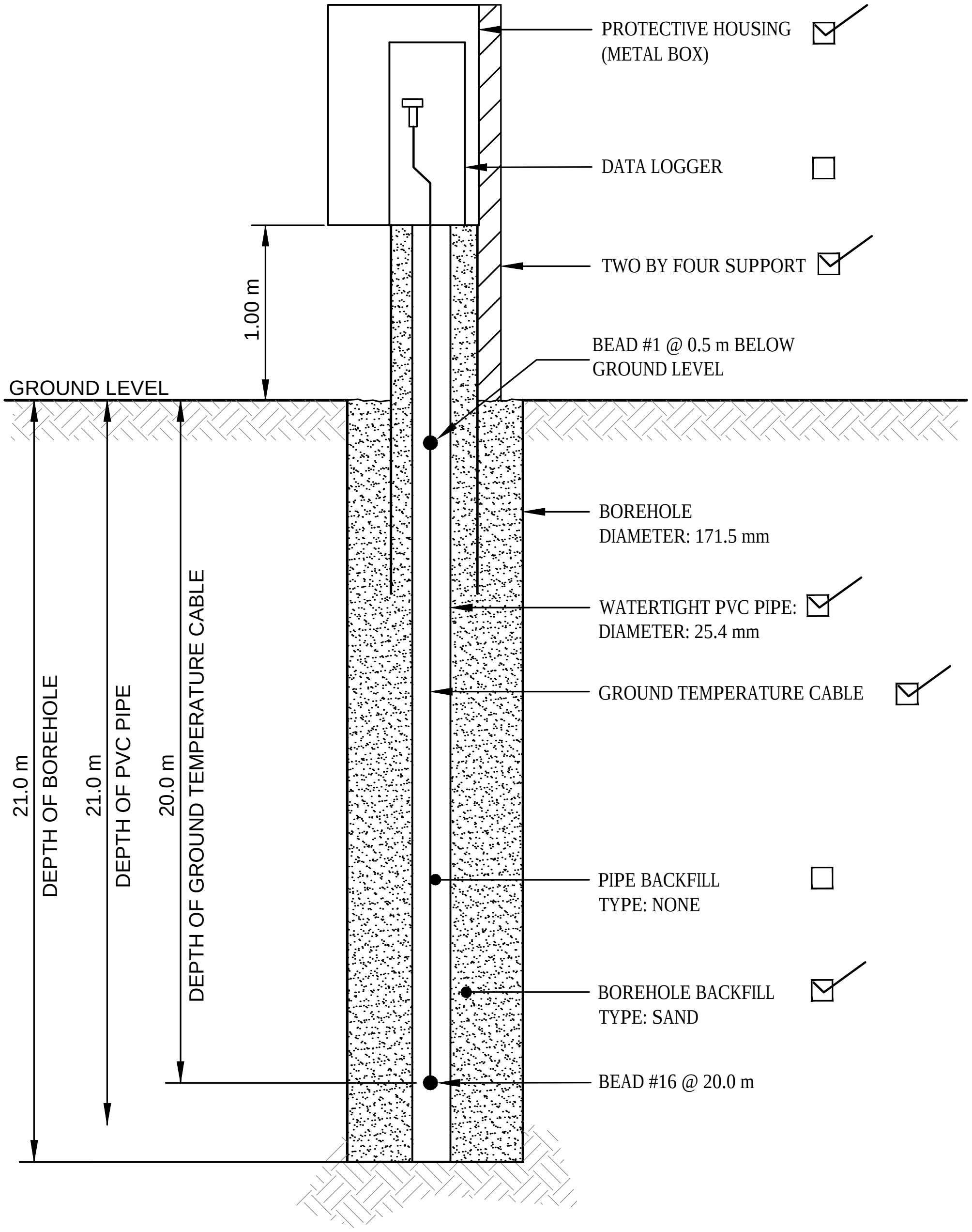
DRILLING DATE: April 10, 2018

INSTALLATION DATE: April 10, 2018

CABLE LENGTH: 21.5 m

LEAD LENGTH: 1.5 m

HOLE DEPTH: 21.0 m



BEAD NO.	DEPTH BELOW OG (m)
1	0.50
2	1.00
3	1.50
4	2.25
5	3.00
6	3.75
7	4.50
8	5.50
9	7.00
10	8.50
11	10.0
12	11.5
13	13.0
14	15.0
15	17.0
16	20.0

NOTES

1) INDICATE ORIGINAL GROUND ELEVATIONS
2) INDICATE ALL BEAD LOCATIONS
3) LEAD LENGTH IS THE LENGTH OF CABLE TO THE FIRST BEAD
4) ALL DIMENSIONS ARE IN METRES
5) DRAWING NOT TO SCALE

CLIENT

Victoria GOLD CORP

TETRA TECH

GROUND TEMPERATURE CABLE INSTALLATION REPORT
EAGLE GOLD MINE SITE, YT

GT18-15

PROJECT NO.	DWN	CKD	REV
ENG.EARC03103-02	RO	VER	0

OFFICE	DATE
EDM	May 2017

GTC# TT 2667

Q:\Edmonton\Engineering\E141\Projects\ENG.EARC03103-02 Victoria-Eagle Gold\GTC Installation Reports\Eagle Spring 2018 GTC Installation Reports.dwg [GTC# TT 2667] September 19, 2018 - 10:43:40 am (BY: OKKEMA, RYAN)

SITE: EAGLE GOLD MINE SITE, YT

LOCATION: GT18-08

COORDINATES: NORTHING: 7 099 141

EASTING: 459 517

GROUND ELEVATION: 990.0 m

8TH BEAD ELEVATION: 989.35 m

NUMBER OF BEADS: 16 (7 ABOVE GL)

CABLE INSTALLATION NO.: 5

CABLE SERIAL NO.: TT 2668

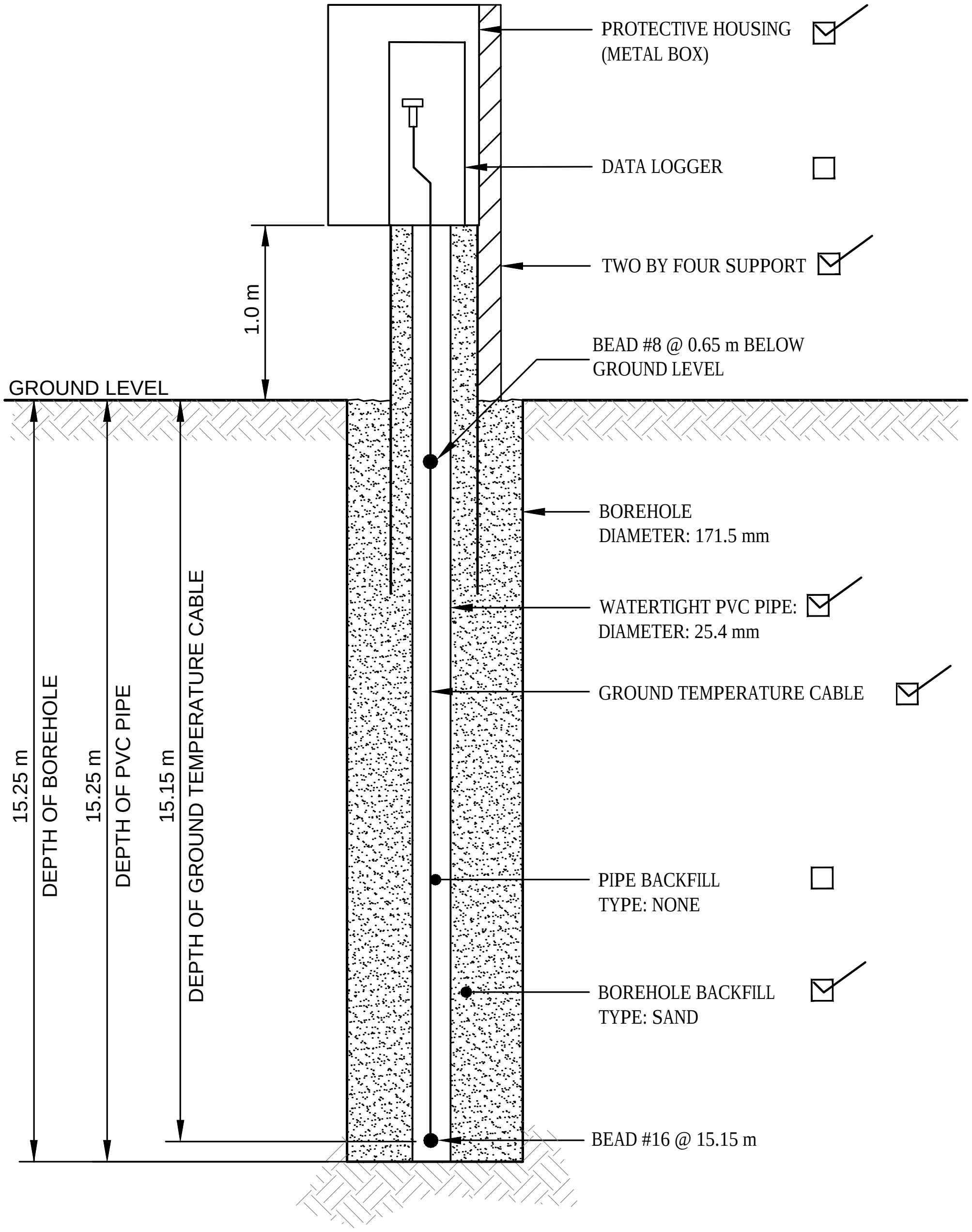
DRILLING DATE: April 11, 2018

INSTALLATION DATE: April 11, 2018

CABLE LENGTH: 21.5 m

LEAD LENGTH: 1.5 m

HOLE DEPTH: 15.25 m



PROTECTIVE HOUSING (METAL BOX) ☑

DATA LOGGER ☐

TWO BY FOUR SUPPORT ☑

BEAD #8 @ 0.65 m BELOW GROUND LEVEL

BOREHOLE DIAMETER: 171.5 mm

WATERTIGHT PVC PIPE: ☑ DIAMETER: 25.4 mm

GROUND TEMPERATURE CABLE ☑

PIPE BACKFILL TYPE: NONE ☐

BOREHOLE BACKFILL TYPE: SAND ☑

BEAD #16 @ 15.15 m

BEAD NO.	DEPTH BELOW OG (m)
1	-1.10
2	-1.10
3	-1.10
4	-1.10
5	-1.10
6	-1.10
7	-0.35
8	0.65
9	2.15
10	3.65
11	5.15
12	6.65
13	8.15
14	10.15
15	12.15
16	15.15

NOTES

1) INDICATE ORIGINAL GROUND ELEVATIONS
2) INDICATE ALL BEAD LOCATIONS
3) LEAD LENGTH IS THE LENGTH OF CABLE TO THE FIRST BEAD
4) ALL DIMENSIONS ARE IN METRES
5) DRAWING NOT TO SCALE

CLIENT

Victoria GOLD CORP

TETRA TECH

GROUND TEMPERATURE CABLE INSTALLATION REPORT
EAGLE GOLD MINE SITE, YT

GT18-08

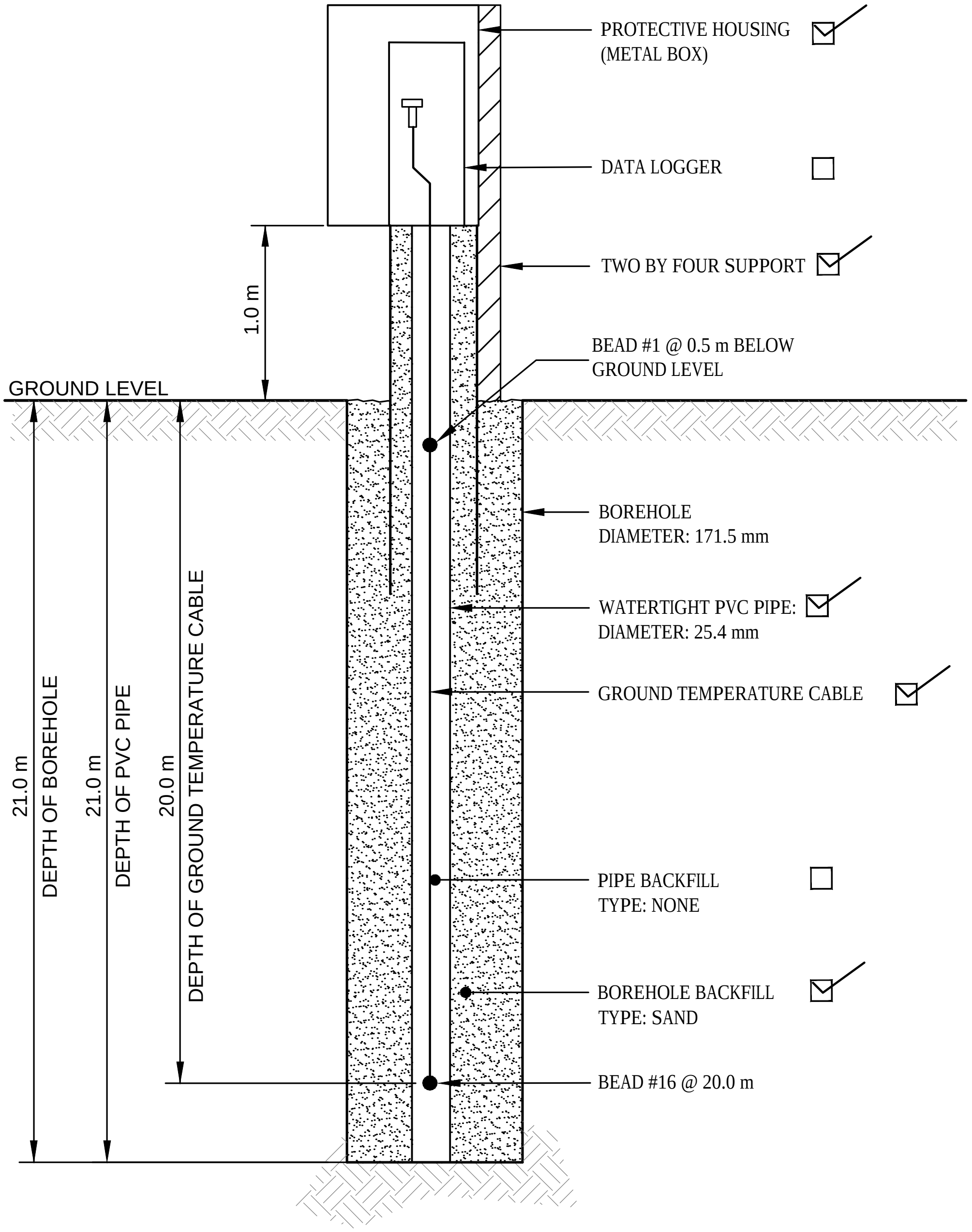
PROJECT NO.	DWN	CKD	REV
ENG.EARC03103-02	RO	VER	0

OFFICE	DATE
EDM	May 2018

GTC# TT 2668

SITE: EAGLE GOLD MINE SITE, YT
LOCATION: GT18-09
COORDINATES: NORTHING: 7 098 981
EASTING: 459 925
GROUND ELEVATION: 1117.0 m
1ST BEAD ELEVATION: 1116.5 m
NUMBER OF BEADS: 16

CABLE INSTALLATION NO.: 6
CABLE SERIAL NO.: TT 2669
DRILLING DATE: April 13, 2018
INSTALLATION DATE: April 13, 2018
CABLE LENGTH: 21.5 m
LEAD LENGTH: 1.5 m
HOLE DEPTH: 21.0 m



BEAD NO.	DEPTH BELOW OG (m)
1	0.50
2	1.00
3	1.50
4	2.25
5	3.00
6	3.75
7	4.50
8	5.50
9	7.00
10	8.50
11	10.00
12	11.50
13	13.00
14	15.00
15	17.00
16	20.00

Q:\Edmonton\Engineering\E141\Projects\ENG.EARC03103-02 Victoria-Eagle Gold\GTC Installation Reports\Eagle Spring 2018 GTC Installation Reports.dwg [GTC# TT 2669] September 19, 2018 - 10:43:20 am (BY: OKKEMA, RYAN)

NOTES

1) INDICATE ORIGINAL GROUND ELEVATIONS
2) INDICATE ALL BEAD LOCATIONS
3) LEAD LENGTH IS THE LENGTH OF CABLE TO THE FIRST BEAD
4) ALL DIMENSIONS ARE IN METRES
5) DRAWING NOT TO SCALE

CLIENT
Victoria GOLD CORP

TETRA TECH

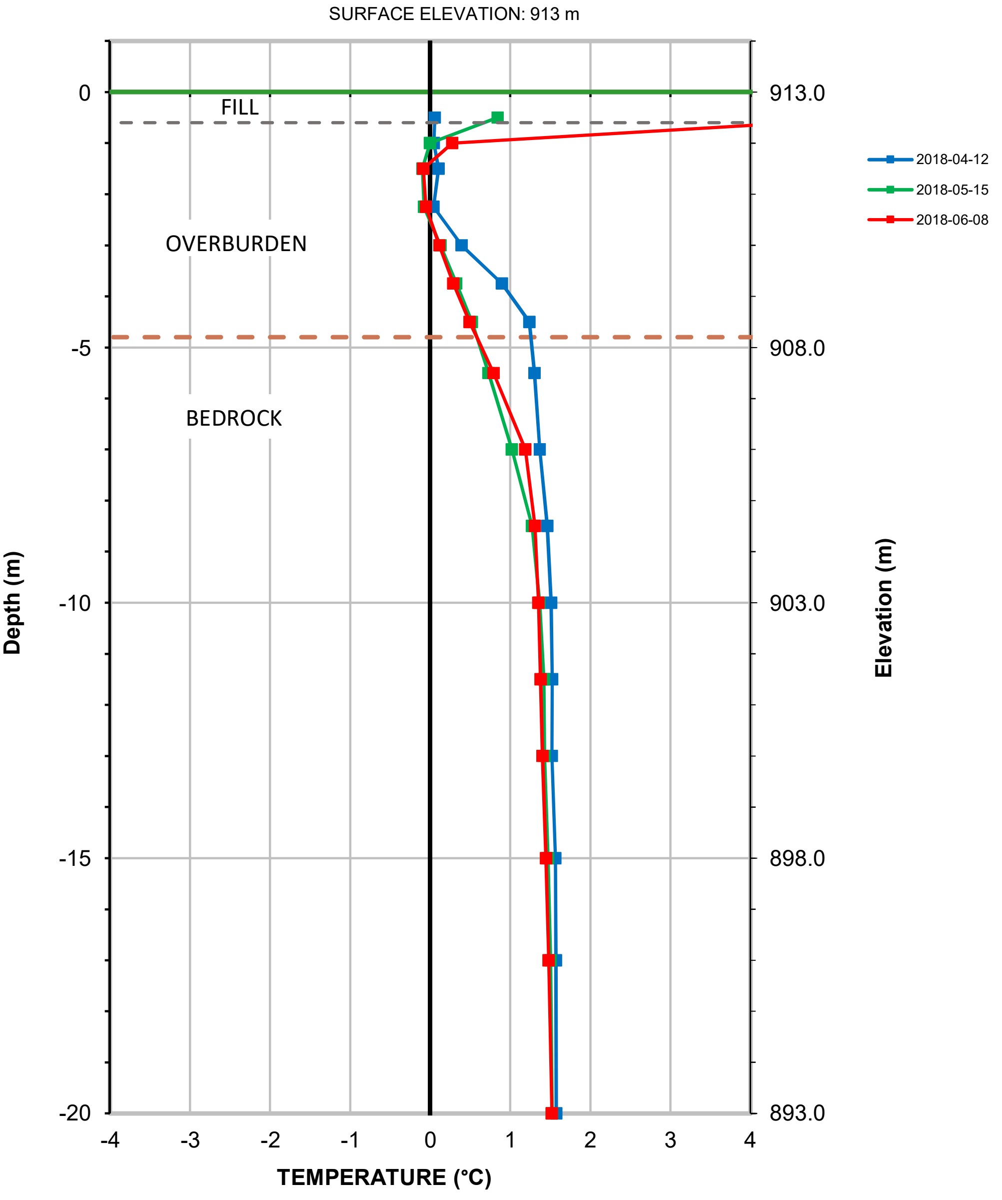
GROUND TEMPERATURE CABLE INSTALLATION REPORT
EAGLE GOLD MINE SITE, YT

GT18-09

PROJECT NO.	DWN	CKD	REV
ENG.EARC03103-02	RO	VER	0

OFFICE	DATE
EDM	May 2018

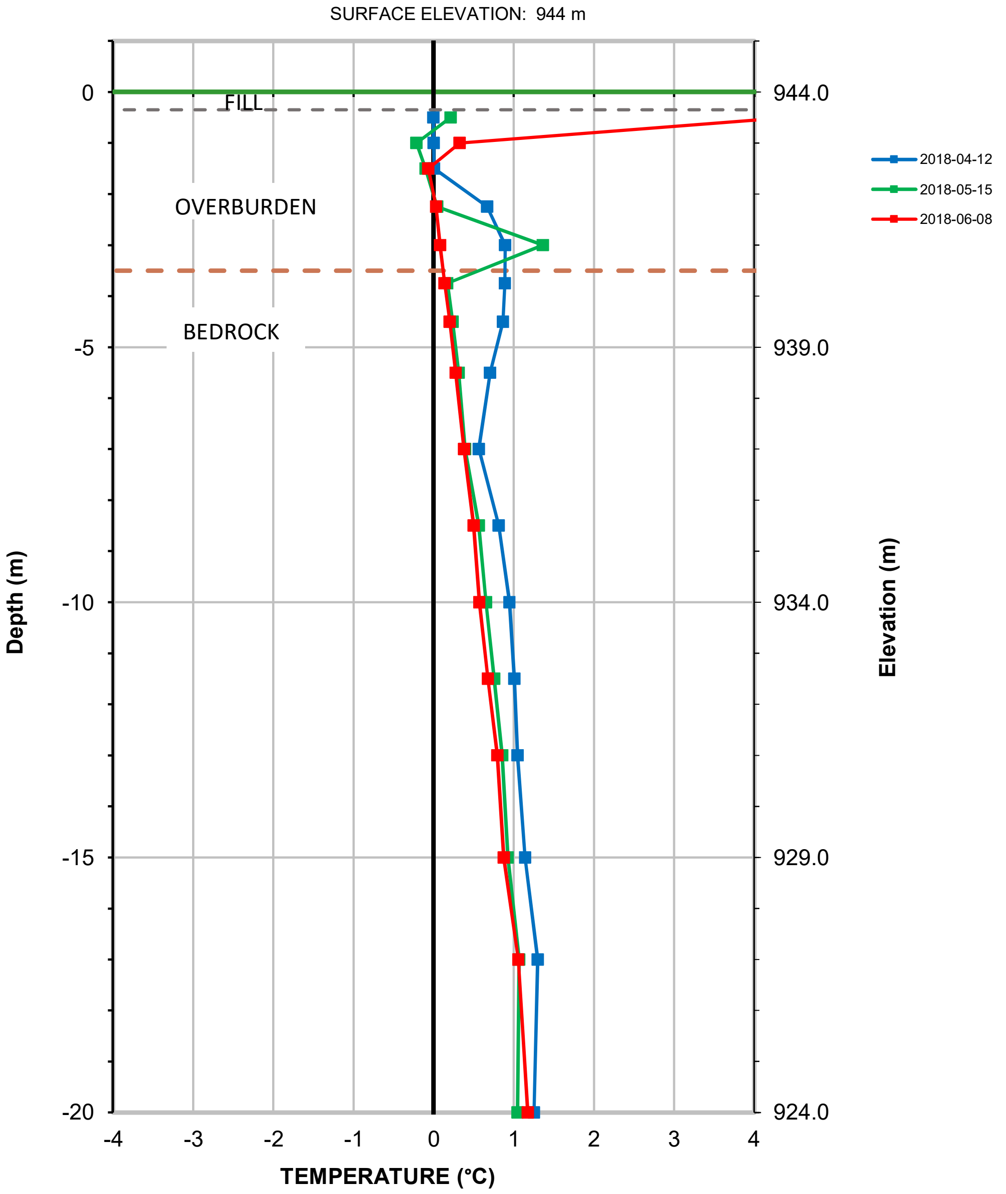
GTC# TT 2669



Serial No.: TT 2665
Date Installed: April 6, 2018
Coordinates (UTM Zone 7): E: 459 831
N: 7 100 952

Tetra Tech File No.: ENG.EARC03103-02

Eagle Pup WRSA
Ground Temperature Profile
Dublin Gulch, Borehole GT18-01
Elevation: 913 m

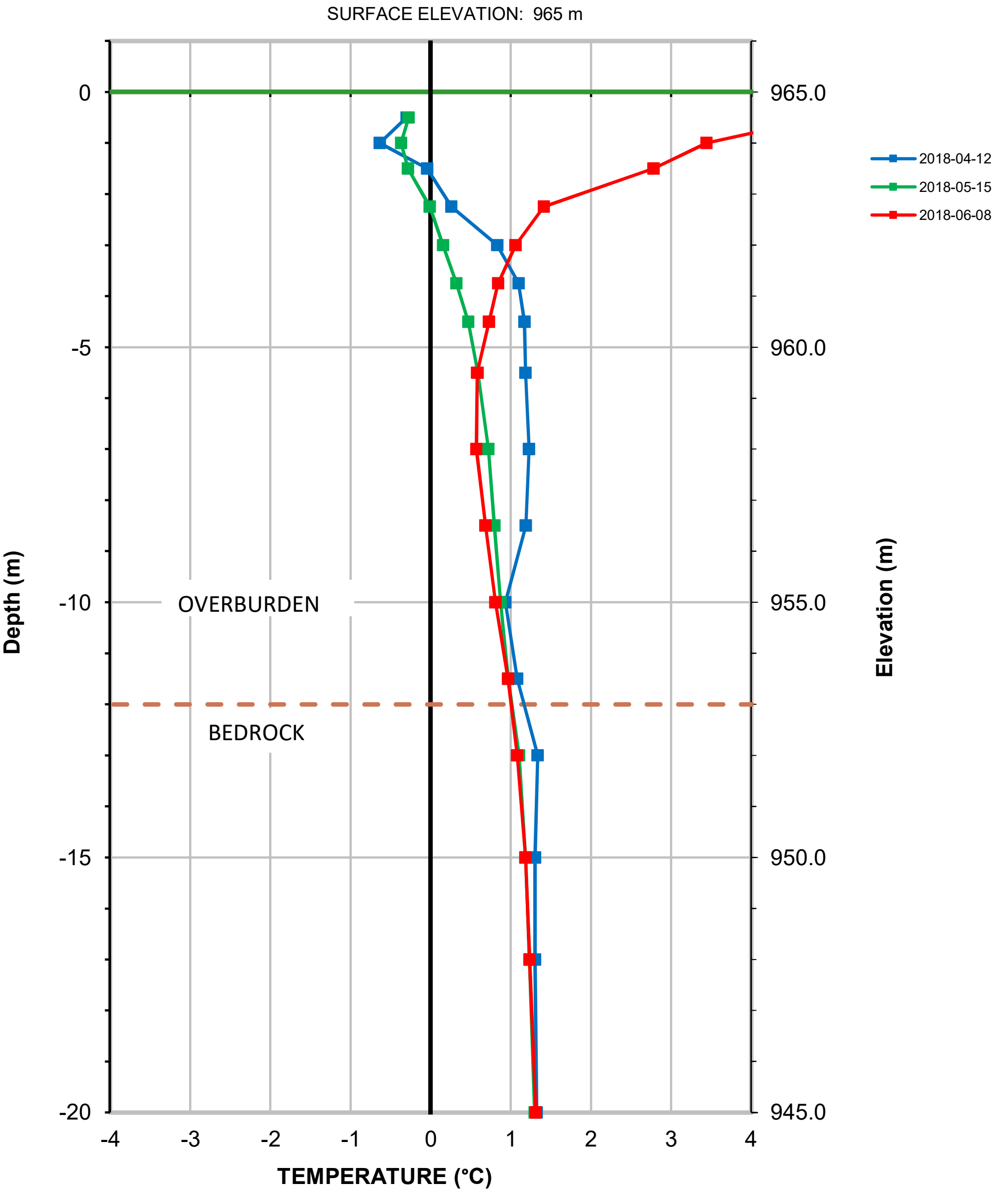


Serial No.: TT 2666
Date Installed: April 6, 2018
Coordinates (UTM Zone 7): E: 460 006
N: 7 100 814

Tetra Tech File No.: ENG.EARC03103-02

TETRA TECH

Eagle Pup WRSA
Ground Temperature Profile
Dublin Gulch, Borehole GT18-05
Elevation: 944 m

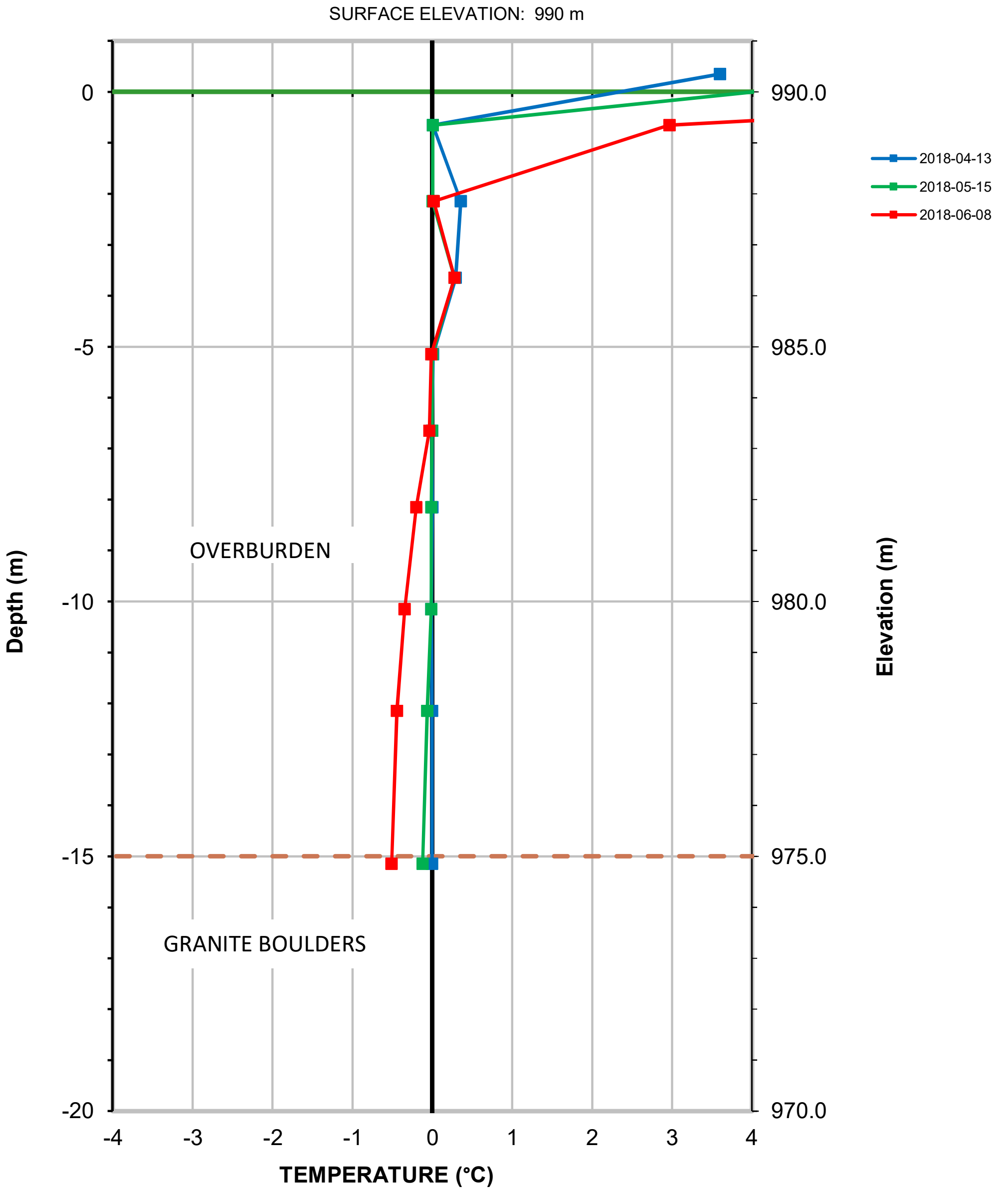


Serial No.: TT 2663
Date Installed: April 6, 2018
Coordinates (UTM Zone 7): E: 460 139
N: 7 100 709

Tetra Tech File No.: ENG.EARC03103-02

TETRA TECH

Eagle Pup WRSA
Ground Temperature Profile
Dublin Gulch, Borehole GT18-07
Elevation: 965 m

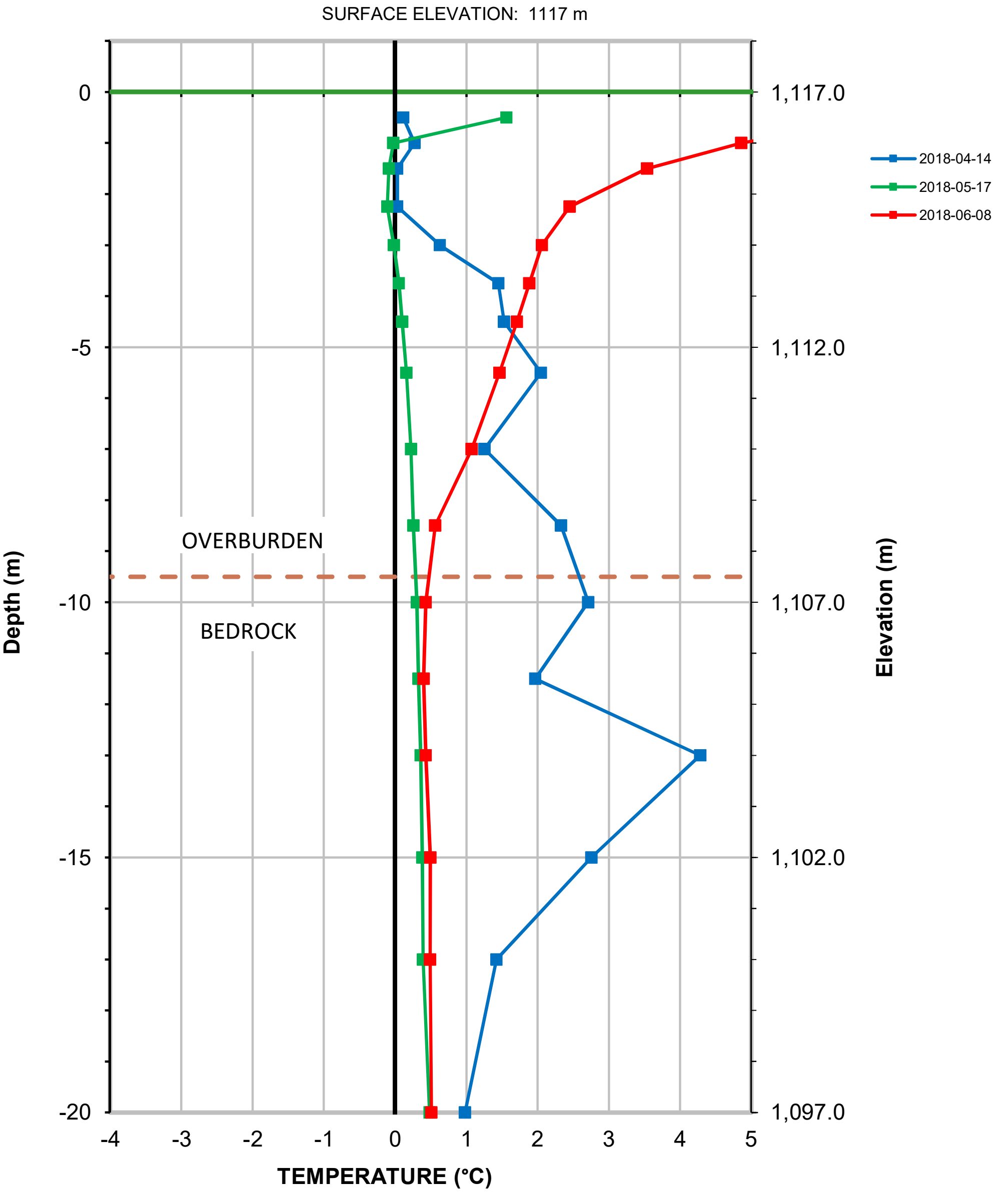


Serial No.: TT 2668
Date Installed: April 6, 2018
Coordinates (UTM Zone 7): E: 559 517
N: 7 099 141

Tetra Tech File No.: ENG.EARC03103-02

TETRA TECH

Platinum Gulch WRSA
Ground Temperature Profile
Borehole GT18-08
Elevation: 990 m

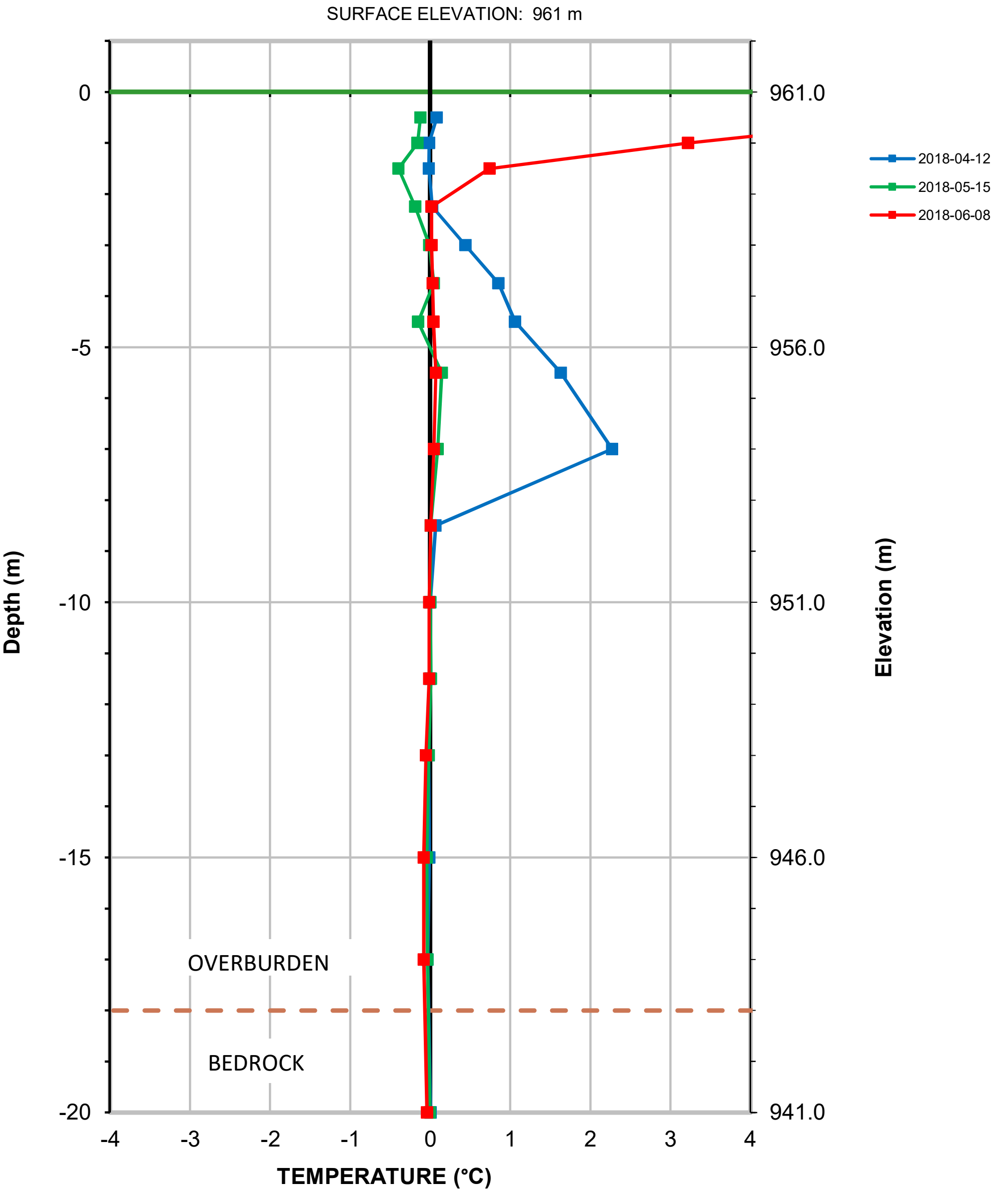


Serial No.: TT 2669
Date Installed: April 13, 2018
Coordinates (UTM Zone 7): E: 459 925
N: 7 098 981

Tetra Tech File No.: ENG.EARC03103-02

TETRA TECH

Platinum Gulch WRSA
Ground Temperature Profile
Borehole GT18-09
Elevation: 1117 m



Serial No.: TT 2667
Date Installed: April 6, 2018
Coordinates (UTM Zone 7): E: 459 597
N: 7 100 583

Tetra Tech File No.: ENG.EARC03103-02

TETRA TECH

Potential ROM Storage

Ground Temperature Profile
Borehole GT18-15
Elevation: 961 m

APPENDIX E

TETRA TECH WORK METHODS

WORK METHOD

FOR INTERNAL USE

WM4400 GEOTECHNICAL SOIL CLASSIFICATION

CATEGORY:	Field Testing/Sampling	**REVISION NO.:**	03	**PAGE:**	1 of 15
SUBCATEGORY:	Geotechnical	**REVISION DATE:**	July 2013	**APPROVED DATE:**	June 2009
				EXPIRY DATE:	July 2017

1.0 PURPOSE

1.1 To define the responsibilities and procedures to be used when classifying soils for geotechnical purposes. It is acknowledged that for some projects a variation from this method may be necessary. In these cases, authorization from the Manager (after consultation by the Manager with the Chief Engineer) should be obtained and documentation of the differences should be included in the report and project file.

2.0 SCOPE

2.1 This work method applies to classification of soils based on inspection of samples recovered from ground investigations and laboratory testing. Soils are typically logged in the field, (generally in accordance with ASTM D2488), and then laboratory classification tests are used to confirm the description (generally in accordance with ASTM D2487-93). This work method is intended as a supplement to those standards.

2.2 This work method is intended to provide Tetra Tech Canada (EBA OU)[1] employees with guidelines to carry out Geotechnical Soil Classification (WM4400). Significant deviation from this work method should be in collaboration with your Manager and/or a Quality Council (QC) Representative. Any variance should be documented and placed in the project file.

3.0 DEFINITIONS

3.1 **EBA OU** – EBA Operating Unit of Tetra Tech Canada Inc. (Tetra Tech).

3.2 **Boulders:** particles of rock (rounded or sub-rounded) that will not pass a 300 mm square sieve opening.

3.3 **Cobbles:** particles of rock (rounded or sub-rounded) that will pass a 300 mm square sieve opening and be retained on a 75 mm sieve.

3.4 **Gravel:** particles of rock that will pass a 75 mm sieve and be retained on a 4.75 mm sieve, with the following subsections:

- Coarse – passes a 75 mm sieve and is retained on a 19 mm sieve.
- Fine – passes a 19 mm sieve and is retained on a 4.75 mm sieve.

---

[1] Please note that as of January 1, 2017, our legal operating name changed from Tetra Tech EBA Inc. to Tetra Tech Canada Inc.

3.5 **Sand:** particles of rock that will pass a 4.75 mm sieve and be retained on a 0.0750 mm sieve with the following subsections:

- Coarse – passes a 4.75 mm sieve and is retained on a 2 mm sieve.
- Medium – passes a 2 mm sieve and is retained on a 0.425 mm sieve.
- Fine – passes a 0.425 mm sieve and is retained on a 0.075 mm sieve.

3.6 **Silt:** soil which passes a 0.075 mm sieve that is non-plastic or very slightly plastic (Plasticity Index <4 or plots below A line (Attachment 7.1)) and that exhibits little or no strength when air dry.

3.7 **Clay:** soil passing a 0.002 mm sieve that exhibits plasticity (Plasticity Index >4 and plots on or above A line (Attachment 7.1)) and has considerable strength when air dry.

4.0 RESPONSIBILITIES AND AUTHORITIES

4.1 Manager

- Ensure that the project team is qualified to classify soils according to these methods.
- Ensure that the safety procedures/methods are understood and followed by project team.
- Ensure that the project team has sufficient project budget and schedule, and is aware of and meets these requirements.

4.2 Project Engineer

- Ensure that the field personnel and testing laboratory staff are qualified to complete the tests and classify the soils according to these methods.
- Designate the testing laboratory.
- Ensure that the field personnel have all necessary resources for the soil characterization.
- Be available for timely consultation with the field personnel and the testing laboratory.
- Review the soil classification report (borehole logs and laboratory test results) and provide timely input.
- Develop the laboratory testing program in consultation with field personnel.

4.3 Field Personnel

- Be familiar with this work method.
- Classify soils based on the inspection of samples recovered from geotechnical investigations and the results of laboratory testing.
- Have the equipment and supplies available to carry out the appropriate tests.
- Assist the Project Engineer in developing the laboratory testing program.

5.0 WORK METHOD

The following method identifies the soil properties that shall be recorded for a complete geotechnical soil description. There are two phases to the classification of soils: the initial description prepared in the field; and the refinement of the description completed after laboratory testing.

5.1 Soil Classification in the Field

5.1.1 General

Soil can generally be divided into three main groups:

- Coarse-grained soils (e.g., fluvial deposits);
- Fine-grained soils (e.g., lacustrine deposits); and
- Organic soils (e.g., topsoil).

It is the intent of this work method to make sure that the classifications of soils correlate in a general way with the engineering behaviour of soils.

Coarse-grained: the description's behaviour is confirmed in the laboratory with a Gradation Analysis.

Fine-grained: the description's behaviour is confirmed in the laboratory with the Atterberg Limits Test.

Organic soils: the description's behaviour is confirmed in the laboratory with Organic Content Test and Gradation Analysis.

When presented with a soil sample, the first task is to assess which of these three categories it is likely to fall into:

- If the sample contains visible organics, is dark brown or black, and has an organic smell, it will likely fall into the organic soil category (refer to Section 5.1.1.3);
- If it displays cohesion, such as a sample of till, it is likely to be a fine-grained material (refer to Section 5.1.1.2); and
- If it is non-plastic, such as pit-run granular, it is a coarse-grained soil (refer to Section 5.1.1.1).

5.1.1.1 **Coarse-grained Soils:** The behaviour is influenced mainly by sand and gravel sized particles and shall be described in the following sequence.

5.1.1.1.1 **Coarse-grained Principal Soil Constituent** is the soil component with the highest percentage by mass. This soil constituent shall be capitalized in the soil description:

Example: 52% sand, 34% silt, 12% gravel, 2% clay.

In this example, SAND will be the principal soil constituent since it has the highest percentage.

SAND, silty, some gravel and trace clay.

The percentage of cobbles and boulders in the original sample should be estimated and included in the description (e.g., 5% cobbles). Provide the maximum size of the boulder(s) evident (e.g., up to ---mm in diameter).

5.1.1.1.2 **Coarse-grained Minor Soil Constituents** include all remaining soil components that are found in the soil mass. These constituents are described according to the amount, by mass, of each component. They are described in the following manner and are listed in decreasing order of significance:

- >35% "and" (soil constituent in capital letters, e.g., …and SAND) (Note that the use of the qualifier "and" is not to be applied to SILT/CLAY Principal constituents)

- 21 to 35% “y – adjective” (e.g., silty, clayey)
- 10 to 20% “some” (soil constituent, e.g.. some sand)
- >0 to 10% “trace” (soil constituent, e.g.. trace gravel)
- “occasional” use for noting presence of isolated occurrences

Example: 40% sand, 36% silt, 21% gravel, 3% clay shall be called SAND and SILT, gravelly, trace clay

5.1.1.1.3 **Coarse-grained Grading** shall describe the particle size distribution. In general, soils with predominantly one particle size are poorly graded, while soils with a range of particle sizes are well graded.

5.1.1.1.4 **Coarse-grained Particle Size** shall further describe the size of particles of the principal soil constituent in coarse-grained soils. The principal soil constituent shall be described as any, some, or all of the following:

- *fine* and *coarse* for gravel; and
- *fine*, *medium*, and *coarse* for sand.

Note: these descriptions can also be used if the granular soils are a minor constituent.

5.1.1.1.5 **Coarse-grained Angularity/Particle Shape** shall describe the angularity and shape of the principal soil constituent in coarse-grained soils.

The angularity of coarse-grained soils shall be described as one or more of the following: *angular*, *sub-angular*, *sub-rounded*, *rounded*.

Particle shape shall be described as one or more of the following: *flat*, *elongated* (see Attachment 7.2 for a more complete description).

Note: these descriptions can also be used if the granular soils are a minor constituent.

5.1.1.1.6 **Coarse-grained Moisture** shall describe the wetness of the soil mass. The following terms shall be used to describe moisture:

- *dry* – no moisture can be seen or felt
- *damp* – a slight dampness to the touch when handling the soil
- *moist* – soil is moist to the touch but there is no free water
- *wet* – a film of water is visible around the particles
- *very wet* – there is free water, the water is separated from the soil particles

5.1.1.1.7 **Coarse-grained Consistency** shall describe the in situ density of granular soils. It is determined during drilling with Standard Penetration Testing, Dynamic Cone Penetration Testing, Becker Penetration Testing, or Cone Penetration Testing. The consistency of the soil shall be described using the following terms: *very loose*, *loose*, *compact*, *dense*, *very dense* (see Attachment 7.3 for the relationship between SPT N - index and Consistency).

5.1.1.1.8 **Coarse-grained Colour** shall describe the overall colour of the moist soil mass as well as any staining or mottling that may be present. If the colour provided in the description is for the dry soil, this should be noted. The Munsell Soil Colour Chart will be used as a reference.

5.1.1.1.9 **Coarse-grained Odour** shall describe any odour that is emitted from the soil mass. This may include a decaying smell that would indicate the presence of organics or a petroleum or chemical smell that may signal an area of contamination.

5.1.1.1.10 **Coarse-grained Inclusions** shall describe any other material that is present within the soil mass. Examples of inclusions include, but are not limited to, roots, metal pieces, glass, concrete, and precipitates.

5.1.1.1.11 **Coarse-grained Origin** shall be the geologic or anthropologic source of the deposit. This descriptor should be capitalized and bracketed, e.g., (GLACIAL TILL) or (FILL), and shall be inserted after the Principal Component, e.g. SAND (TILL)…

5.1.1.1.12 **Coarse-grained Example** of a complete soil description is as follows:

- SAND (ALLUVIUM), silty, some gravel, trace clay, occasional boulders and shell fragments, well graded, damp, compact, grey; fine to medium sand; fine to coarse rounded gravel; boulders up to 2000 mm diameter

5.1.1.2 **Fine-grained** soil behaviour is influenced mainly by silt and clay sized particles. It must be stressed that the final (i.e., laboratory results based) description of fine-grained soil is based strictly on behaviour, not the grain size distribution. They shall be described in the following sequence:

5.1.1.2.1 **Fine-grained Principal Soil Constituent** shall be described as above for Coarse-grained Principal Soil Constituent. The principal soil constituent should describe the engineering behaviour of the soil mass.

The following field tests shall be performed to determine if the soil behaves as a SILT or as a CLAY in fine-grained soils:

- dilatancy, dry strength, toughness, thread roll test (see Attachment 7.4 for a complete description of these tests)

Example: 50% silt, 27% clay, 20% sand, and 3% gravel.

In this example, although silt is the principal soil constituent (by size/mechanical analysis), the soil will behave as a clay due to clay content. As a general rule, clay contents over about 20% dominate soil behaviour.

CLAY, silty, some sand, trace gravel.

Note: for fine-grained soils the description should be either Clay or Silt but not Clay and Silt.

5.1.1.2.2 **Fine-grained Minor soil constituents** include all remaining soil components that are found in the soil mass. These constituents are described according to the amount, by mass, of each component. They are described in the following manner and are listed in decreasing order of significance:

- >35% “and” (soil constituent in capital letters, e.g., …and SAND) (Note that the use of the qualifier “and” is not to be applied to SILT/CLAY Principal constituents, i.e., SILT and CLAY).
- 21 to 35% “y-adjective” (e.g., silty, clayey)
- 10 to 20% “some” (soil constituent, e.g., some sand)
- >0 to 10% “trace” (soil constituent, e.g., trace gravel)
- “occasional” use for noting presence of isolated inclusions

5.1.1.2.3 **Fine-grained Structure** describes the features that are found throughout the soil mass if any. Structure can be an indication of the process of deposition or geologic history. Examples of structures include stratification, layering, and lamination.

5.1.1.2.4 **Fine-grained Moisture** shall be described as above in Section 5.1.1.1.6 with the following changes:

- *wet* – the soil can be easily smeared or remolded between fingers
- *very wet* will not be used to describe fine-grained soils

5.1.1.2.5 **Fine-grained Consistency** shall describe the stiffness of the soil mass. The tests mentioned in Section 5.1.1.1.7 can be used to approximate the consistency of the soil. Since soil samples are usually disturbed, a lower bound estimate of the consistency can be made from the stiffness of the sample. Consistency of fine-grained soils shall be described using the following terms: *very soft*, *soft*, *firm*, *stiff*, *very stiff*, *hard*

Note: for silt, the consistency can be described as above if it displays plasticity, or as described in Section 5.1.1.1.7 if it is very low to non-plastic (see Attachment 7.5 for a more detailed description of these terms).

5.1.1.2.6 **Fine-grained Plasticity** shall describe the ability of a soil to undergo deformation without cracking or crumbling. Plasticity can be determined by performing a thread roll test in the field. The plasticity of fine grained soils shall be described using the following terms: *non-plastic*, *low plastic*, *medium plastic*, *high plastic* (see Attachment 7.6 for a more detailed description of these terms).

5.1.1.2.7 **Fine-grained Colour** shall be described as above in Section 5.1.1.1.8.

5.1.1.2.8 **Fine-grained Odour** shall be described as above in Section 5.1.1.1.9.

5.1.1.2.9 **Fine-grained Inclusions** shall be described as above in Section 5.1.1.1.10.

5.1.1.2.10 **Fine-grained Example** of a complete soil description is as follows:

- CLAY (LACUSTRINE), silty, some sand, trace gravel, occasional shell fragments, moist, firm, low plastic, brown fine sand; rounded, fine gravel.

5.1.1.3 **Organic Soils** These soils can generally be divided into three categories: transition soils, peat, and organic silt or clay.

Transition soils are topsoil and ‘B’ horizon soils that are typically the result of weathering of surficial soils and decay of vegetation.

Peat comprises negligible inorganic content and should be described by the method provided in P3401 – Classification of Peat.

Organic silt or clay is fine-grained soil where the organic content dominates the behaviour of the deposit. Due to the complexity of the composition of organic matter, there are no definitive guidelines as to the percentage of organics that will result in this behaviour. The organic content can influence plasticity, shrinkage, compressibility, permeability, and strength. When presented with a sample of fine-grained soil for a field description, if it is dark brown to black, lightweight, has an organic smell, and displays sponginess, it should be noted as such and the appropriate laboratory test completed to make a determination.

5.1.1.3.1 **Organic Principal Soil Constituent** shall be modified by adding the word ORGANIC in front of the Principal Component.

PEAT shall be used as the Principal Component if the soil contains negligible inorganic contents. Refer to P3401 - Classification of Peat.

5.1.1.3.2 **Organic Minor Soil Constituents** shall be described as above in Section 5.1.1.2.2.

5.1.1.3.3 **Organic Texture** shall describe the feel of the organic soil. The soil shall be described as either amorphous for fine-grained peat or fibrous for woody peat (refer to P3401).

5.1.1.3.4 **Organic Moisture** shall be described as above in Section 5.1.1.2.4.

5.1.1.3.5 **Organic Consistency** shall be described as above in Section 5.1.1.2.5.

5.1.1.3.6 **Organic Colour** shall be described as above in Section 5.1.1.1.8.

5.1.1.3.7 **Organic Odour** shall be described as above in Section 5.1.1.1.9.

5.1.1.3.8 **Organic Inclusions** shall be described as above in Section 5.1.1.1.10.

5.1.2 Soil Class

The Modified Unified Soil Classification System provides a number of classes of soil (e.g., SM, CH). These are very useful but often do not provide sufficient information for the project engineer/designer. For example, they do not convey any information regarding consistency, colour, etc. Therefore, although the soil class can be used, it must be supplemented by the description as discussed in Sections 5.1.1.1, 5.1.1.2, and 5.1.1.3.

5.2 Soil Sampling

5.2.1 Once the soil has been classified, a representative sample shall be bagged and labelled with the project number, location of the sample, and date of sampling. The bag shall be sufficiently sealed so that moisture and air cannot be transferred in or out of the sample. The sample may be sent to the laboratory for testing at the discretion of the Project Director and Project Engineer.

5.3 Laboratory Testing and Presentation of Laboratory Test Results

5.3.1 Laboratory testing shall be carried out following ASTM standards and shall be used to refine the soil classification. Grain Size and Hydrometer Analysis shall be carried out following ASTM Standard D422. Plasticity testing to determine Atterberg Limits shall be carried out following ASTM Standard D4318. Preparation of soil samples for the above laboratory testing shall be carried out following ASTM Standard D2217.

For Grain Size analysis testing, an estimate of the percentage of cobbles/boulders by mass shall be recorded before they are removed from the sample for the test. The description shall include the estimate of oversize materials if it is not evident on the grain size curve.

5.3.2 Presentation of Laboratory Data

5.3.2.1 Grain Size Analysis

5.3.2.1.1 Percentages of each soil constituent by mass shall be recorded on the laboratory sheet; this shall include the following:

- Cobbles, Gravel, Sand, Fines (Silt and Clay)

5.3.2.1.2 Grain size analysis graphs shall include the sieve sizes in millimetres as well as the corresponding soil constituent size boundaries on the top ‘x’ axis. Boundaries separating the different grain sizes of each coarse-grained constituent will also be included. The following soil boundaries shall be included on the grain size analysis graphs:

- Cobbles, Gravel (fine and coarse), Sand (fine, medium, coarse), Fines (Silt and Clay)

5.3.2.2 Hydrometer Analysis

5.3.2.2.1 Percentages of each fine-grained soil constituent (Silt and Clay) shall be provided on the laboratory report.

5.3.2.2.2 Hydrometer graphs shall include particle sizes in millimetres as well as the corresponding particle size boundaries (Silt and Clay).

5.3.3 Classification Using Laboratory Results

5.3.3.1 Soil Constituents

The grain size analysis can be used to confirm the percentages of the constituent materials. Care must be taken to include particles (cobbles and boulders) not represented by the sample.

The grain size analyses can also be used to provide the particle size within the constituents, i.e., fine, medium, and coarse sand or fine and coarse gravel.

5.3.3.2 Grading

A more accurate description of the grading can be undertaken by using the following relationships:

- Coefficient of Uniformity Cu = D_{60}/D_{10}
- Coefficient of Curvature Cc = $(D_{30})^2$ / $(D_{10}$ x $D_{60})$

Where D_{10}, D_{30}, and D_{60} are the particle sizes diameters corresponding to 10%, 30%, and 60% passivity on the cumulative particle size distribution curve.

5.3.3.3 Moisture Content

The results of the moisture content test will give an indication of the wetness of the soil and can be compared to the Atterberg Limits to estimate behaviour characteristics for fine-grained soils.

5.3.3.4 Plasticity

Fine-grained soils will be classified by how they plot on a plasticity chart; refer to Attachment 7.1.

6.0 REFERENCES

6.1 Internal References

None

6.2 External References

- ASTM (1998). Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Test Designation D2487 and D2488. *1998 Annual Book of ASTM Standards, American Society for Testing and Materials*, Philadelphia, vol. 04.08.
- Canadian Geotechnical Society (2006), *Canadian Foundation Engineering Manual 4th Edition*, Richmond, British Columbia.

7.0 ATTACHMENTS

- Attachment 7.1 – Modified Unified Soil Classification
- Attachment 7.2 – Angularity and Particle Shape of Coarse-grained Particles
- Attachment 7.3 – Consistency of Coarse-grained Soils
- Attachment 7.4 – Field Tests for Estimating Proportions of SILT and CLAY
- Attachment 7.5 – Consistency of Fine-grained Soils
- Attachment 7.6 – Plasticity of Fine-grained Soils

8.0 WORK METHOD CONTACT PERSON

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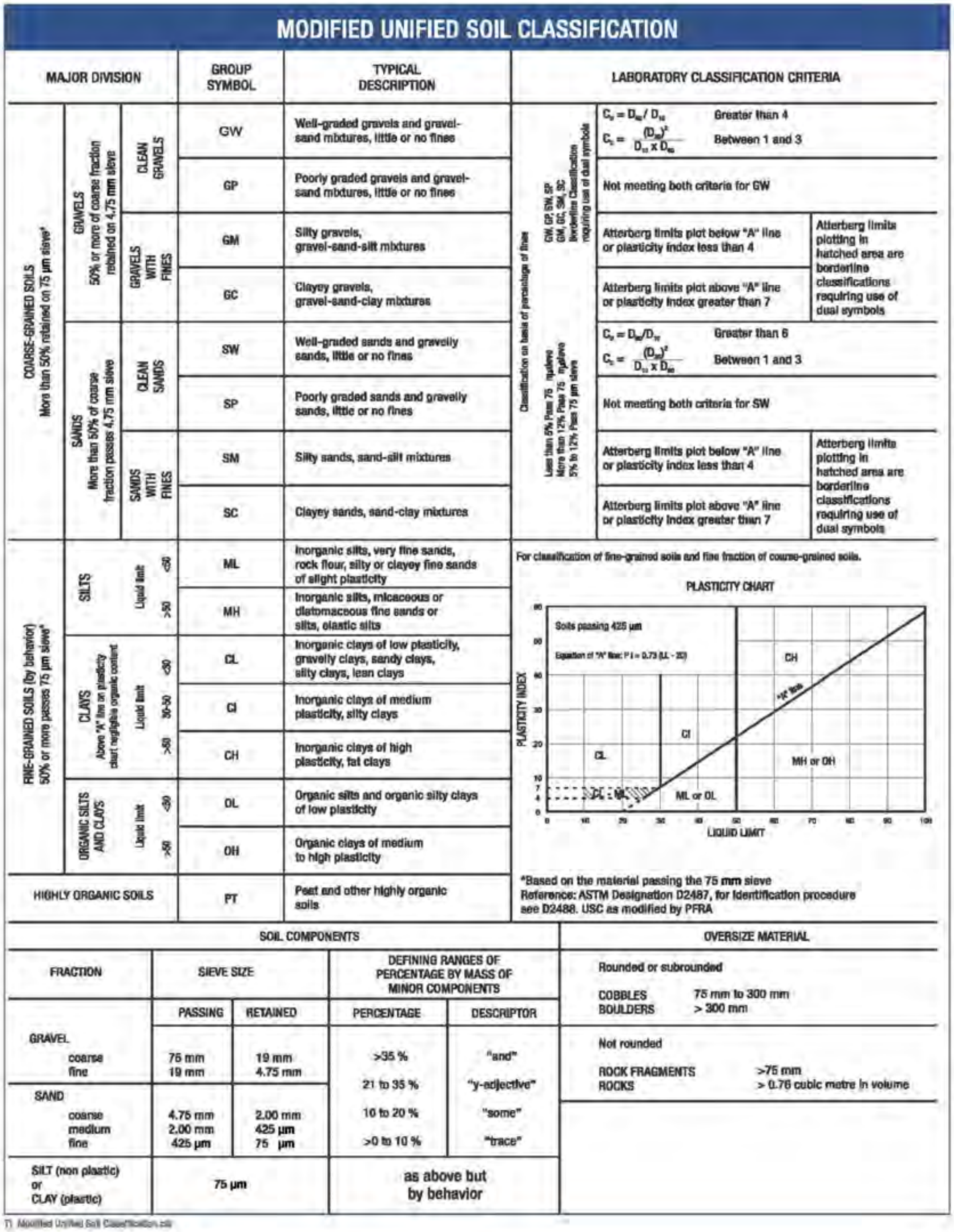
Attachment 7.1 – Modified Unified Soil Classification



MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines Less than 5% Pass 75 µm sieve GW, GP, SW, SP More than 12% Pass 75 µm sieve GM, GC, SM, SC 5% to 12% Pass 75 µm sieve Borderline Classification requiring use of dual symbols	$C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 4 Between 1 and 3
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 6 Between 1 and 3
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity	For classification of fine-grained soils and fine fraction of coarse-grained soils. PLASTICITY CHART		
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
	CLAYS Above "A" line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays			
		Liquid limit 30-50	CI	Inorganic clays of medium plasticity, silty clays			
		Liquid limit >50	CH	Inorganic clays of high plasticity, fat clays			
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity			
		Liquid limit >50	OH	Organic clays of medium to high plasticity			
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils	*Based on the material passing the 75 mm sieve Reference: ASTM Designation D2487, for identification procedure see D2488. USC as modified by PFRA		

SOIL COMPONENTS				
FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENTAGE	DESCRIPTOR
GRAVEL coarse fine	75 mm 19 mm	19 mm 4.75 mm	>35 % 21 to 35 %	"and" "y-adjective"
SAND coarse medium fine	4.75 mm 2.00 mm 425 µm	2.00 mm 425 µm 75 µm	10 to 20 % >0 to 10 %	"some" "trace"
SILT (non plastic) or CLAY (plastic)	75 µm		as above but by behavior	

OVERSIZE MATERIAL	
Rounded or subrounded	
COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm
Not rounded	
ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

TT: Modified Unified Soil Classification.cdr

TETRA TECH

Attachment 7.2 – Angularity and Particle Shape of Coarse-grained Particles

Angularity:

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Sub-angular	Particles are similar to angular description but have rounded edges.
Sub-rounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

Particle Shape:

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Description	Criteria
Flat	Particles with width/thickness >3
Elongated	Particles with length/width >3
Flat and Elongated	Particles meet criteria for both flat and elongated

Reference:

ASTM (1998). Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Test Designation D2487 and D2488. 1998 Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, Vol. 04.08.

Attachment 7.3 – Consistency of Coarse-grained Soils

Description	SPT N-Index (blows per 0.3 m)
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Over 50

Note:

To be of practical value, the split-spoon sampling method of indirectly determining the compactness of cohesionless soil must satisfy three conditions:

1. The SPT N-index must be independent of the operator and the boring method;
2. The correlation between the SPT N-index and the compactness condition must be accurate to within acceptable limits; and
3. The same correlation between the SPT N-index and the compactness condition must be used by all.

Reference:

Canadian Geotechnical Society (2006) *Canadian Foundation Engineering Manual 4th Edition*, Richmond, British Columbia.

Attachment 7.4 – Field Tests for Estimating Proportions of SILT and CLAY

Dilatancy (reaction to shaking):

After removing particles larger than sand sizes, prepare a pat of moist soil with a volume of about 10 cm^3. If necessary, add enough water to make the soil soft but not sticky. Then, place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat, which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil. Very fine, clean sands give the quickest and most distinct reaction, whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (crushing characteristics):

After removing particles larger than sand sizes, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by sun, or air drying, (when in the field) and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the clay fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for inorganic clays of high plasticity. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty, whereas a typical silt has the smooth feel of flour.

Toughness (consistency near plastic limit):

After removing particles larger than sand sizes, a specimen of soil about 10 cm^3 is moulded to the consistency of putty. If too dry, water must be added and, if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about 3 mm in diameter. The thread is then folded and rolled repeatedly. During the manipulation, the moisture content is gradually reduced and the specimen stiffens, until it is no longer malleable and crumbles. This indicates that the plastic limit has been reached. After the thread has crumbled, the pieces should be lumped together and a slight kneading action continued until the lump crumbles. The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more active is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays

Reference:

Canadian Geotechnical Society (2006) *Canadian Foundation Engineering Manual 4th Edition*, Richmond, British Columbia.

Attachment 7.5 – Consistency of Fine-grained Soils

Description	Field Identification	UCS kPa	SPT – Value (N)
Very soft	Easily penetrated several centimetres by the fist.	<25	0-2
Soft	Easily penetrated several centimetres by the thumb.	26-50	3-4
Firm	Can be penetrated several centimetres by the thumb with moderate effort.	51-100	5-8
Stiff	Readily indented by the thumb but penetrated only with great effort.	101-200	9-15
Very stiff	Readily indented by the thumbnail.	201-400	16-30
Hard	Indented with difficulty by the thumbnail.	>400	>30

Reference:

Canadian Geotechnical Society (2006) *Canadian Foundation Engineering Manual 4th Edition*, Richmond, British Columbia.

Attachment 7.6 – Plasticity of Fine-grained Soils

From observations made during the toughness test (Attachment 7.4), plasticity shall be defined as below:

Description	**Criteria**
Non-plastic	A 3 mm thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Reference:

ASTM (1998). Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Test Designation D2488. *1998 Annual Book of ASTM Standards, American Society for Testing and Materials*, Philadelphia, Vol. 04.08.

ISSUED FOR USE

WM4102 LOGGING OF PERENNIALLY FROZEN SOILS AND GROUND ICE FOR ENGINEERING PURPOSES

CATEGORY:	Field Testing/Sampling	**REVISION NO.:**	04	**PAGE:**	1 of 34
SUBCATEGORY:	Arctic	**REVISION DATE:**	July 2018	**APPROVED DATE:**	December 2009
				EXPIRY DATE:	July 2023

1.0 PURPOSE

1.1 This work method provides a suggested procedure for identifying and describing perennially frozen soils and ground ice (if present) for engineering purposes based on visual examination and simple physical testing.

2.0 SCOPE

2.1 This work method is intended to be used in conjunction with Tetra Tech Canada (EBA OU)1 work methods WM4400 Geotechnical Soil Classification and WM3403 Geotechnical Logging of Rock Core.

2.2 This work method is based on ASTM Standard D4083-89 (2007): Standard Practice for Description of Frozen Soils (Visual-Manual Procedure) and the Guide to Field Description of Permafrost for Engineering Purposes, National Research Council of Canada (NRCC, 1963) and Tetra Tech's in-house field manuals and procedures for logging frozen overburden.

2.3 This work method is intended primarily for use by geotechnical engineers, geologists, and technicians in the field, where the soil cross-section or samples from it may be observed in a relatively undisturbed frozen state.

2.4 It may also be used in the laboratory to describe the condition of relatively undisturbed soil samples that have been maintained in a frozen condition following their acquisition in the field.

2.5 This work method is intended to provide Tetra Tech employees with guidelines to carry out Logging of Perennially Frozen Soils and Ground Ice for Engineering Purposes (WM4102). Significant deviation from this work method should be in collaboration with your Manager and/or a Quality Council (QC) Representative. Any variance should be documented and placed in the project file.

3.0 DEFINITIONS

3.1 **EBA OU** – EBA Operating Unit of Tetra Tech Canada Inc. (Tetra Tech).

3.2 **Active Layer** – The top layer of ground that is subject to annual thawing and freezing in areas underlain by permafrost.

3.3 **Ataxitic (Suspended) Cryostructure –** Develops in fine-grained soils and is represented predominantly by ice (up to 90% by volume) with randomly oriented soil inclusions (Photo 1).

3.4 **Basal Cryostructure** – Develops in coarse-grained soils and in fractured rock. It is represented predominantly by ice (greater than 50% by volume) that fills in voids and open fractures.

3.5 **Buried Ice** – Ice formed or deposited on the ground surface and later covered by sediments.

3.6 **Candled Ice** – Ice that has rotted or otherwise formed into long columnar crystals, very loosely bonded together.

3.7 **Clear Ice** – Ice that is transparent and contains only a moderate number of air bubbles.

3.8 **Cloudy Ice** – Ice that is translucent or relatively opaque due to the content of air (or other reasons), but which is essentially sound and impervious.

3.9 **Cryogenic Structure (Cryostructure)** – The structural characteristics of frozen earth materials. The structure of frozen soil may be described as massive, lenticular, layered, reticulate or ataxitic (or their combinations) based on the type and distribution of ice in the soil (Photos 1 to 5).

3.10 **Cryopeg** – A layer of unfrozen ground that is perennially cryotic (forming part of the permafrost), in which freezing is prevented by freezing-point depression due to the dissolved-solids content of the pore water.

3.11 **Cryotic Ground** – Soil or rock at temperatures of 0ºC or lower.

3.12 **Cryoturbation** – Irregular structures formed in earth materials by deep frost penetration and frost action processes, and characterized by folded, broken, and dislocated beds and lenses of unconsolidated deposits, including organic horizons and even bedrock.

3.13 **Dry Permafrost** – Permafrost containing neither free water nor ice.

3.14 **Epigenetic permafrost** – permafrost that formed after the deposition of the soil material in which it occurs.

3.15 **Excess Ice** – The volume of ice in the ground, which exceeds the total pore volume that the ground would have under natural unfrozen conditions.

3.16 **Foliated Ice** – Ground ice (usually wedge ice) with parallel inclusions of soil particles and/or air bubbles.

3.17 **Friable** – A condition under which the material is easily broken up under light to moderate finger pressure.

3.18 **Friable Permafrost** – Ice-bearing permafrost in which the soil particles are not held together by ice.

3.19 **Frost Action** – The process of alternate freezing and thawing of moisture in soil, rock and other materials, and the resulting effects on materials and on structures placed on, or in, the ground.

3.20 **Frost Heave** – The upward or outward movement of the ground surface (or objects on, or in, the ground) caused by the formation of ice in the soil.

3.21 **Frost Jacking** – Cumulative upward displacement of objects embedded in the ground, caused by frost action.

3.22 **Frost Shattering** – The mechanical disintegration of rock by the pressure of the freezing of water in pores and along grain boundaries.

3.23 **Frost Table** – The frozen surface, usually irregular, that represents the level to which thawing of seasonally frozen ground has penetrated.

3.24 **Frost Weathering** – The disintegration and break up of soil or rock by the combined action of frost shattering, frost wedging, and hydration shattering.

3.25 **Frost Wedging** – The mechanical disintegration, splitting or break-up of rock by the pressure of the freezing of water in cracks, crevices, pores, joints, or bedding planes.

3.26 **Frozen Ground** – Soil or rock in which part or all of the porewater consists of ice.

3.27 **Granular Ice** – Ice composed of coarse, more or less equidimensional, crystals weakly bonded together.

3.28 **Ground Ice** – A general term referring to all types of ice formed in freezing and frozen ground.

3.29 **Ice-Bearing Permafrost** – Permafrost that contains ice.

3.30 **Ice-Bonded Permafrost** – Ice-bearing permafrost in which the soil particles are cemented together by ice.

3.31 **Ice Coatings on Particles** – Discernible layers of ice found on or below the larger soil particles in a frozen soil mass.

3.32 **Ice Content** – The amount of ice contained in frozen or partially frozen soil or rock.

Ice content is normally expressed in one of two ways:

1. On a dry-weight basis (gravimetric), as the ratio of the mass of the ice in a sample to the mass of the dry sample, expressed as a percentage.
2. On a volume basis (volumetric), as the ratio of the volume of ice in a sample to the volume of the whole sample, expressed as a percentage.

3.33 **Crystal** – A very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in combination with other ice formations.

3.34 **Ice Lens** – A dominantly horizontal, lens-shaped body of ice ranging in thickness from hairline to 0.3 m (Photos 1 to 5). Ice layers more than 0.3 m in the thickness are better termed massive ice beds (Photos 7 to 10). Ice lenses occur essentially parallel to each other, generally normal to the direction of heat loss, and commonly in repeated layers.

3.35 **Ice-Rich Permafrost** – Permafrost containing excess ice.

3.36 **Ice Segregation** – The formation of segregated ice as distinct lenses, layers, veins, and masses in mineral or organic soils (i.e., the growth of ice within soil in excess of the amount that may be produced by the in-place conversion of the original void moisture to ice). Segregated ice formations are commonly, but not always, oriented normal to the direction of heat flow.

3.37 **3.37 Ice Vein** – A permafrost feature caused by frost action; an ice-filled crack or fissure in the ground.

3.38 **Ice Wedge** – A permafrost feature caused by frost action; a massive, generally wedge-shaped body with its apex pointing downward, composed of foliated or vertically banded, commonly white, ice. It is usually associated with frost cracks in frozen ground.

3.39 **Icing** – A sheet-like mass of layered ice formed on the ground surface, or on river or lake ice, by freezing of successive flows of water.

3.40 **Intrusive Ice** – Ice formed from water injected into soils or rocks.

3.41 **Layered Cryostructure** – Represented by distinctly oriented horizontal or inclined layers of ice alternating with soil layers that have massive cryostructure (Photos 1 to 4).

3.42 **Lenticular Cryostructure** – Formed by discrete ice lenses that may (or may not) form continuous ice layers with soil inclusions (Photos 1 and 2).

3.43 **Massive Cryostructure** – Characterized by the predominant presence of non-visible pore ice and by a relatively low total ice content (Photo 1).

3.44 **Massive Ice** – A comprehensive term used to describe large masses of ground ice, including ice wedges, pingo ice, buried ice, and predominantly horizontal beds of segregated ice (Photos 6 to 9). Massive ice beds typically have an ice content of at least 250% (on an ice-to-dry-soil weight basis). If the ice content is less than 250%, the beds are better termed “massive icy beds”. Massive ice beds have a minimum thickness of 0.3 m. Ice layers less than 0.3 m in thickness are better termed ice lenses. Some massive ice beds are more than 40 m thick and extend several kilometres horizontally (Photos 7 and 8).

3.45 **Micro-Lenticular Cryostructure** – Formed by thin and short ice lenses in perennially frozen soil matrix characterized by massive cryostructure (Photo 1).

3.46 **Perennially Frozen Soils** – Soils, which include ground ice (visible and/or non-visible), that remain frozen for at least two years due to natural climatic conditions.

3.47 **Permafrost** – Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two years due to natural climatic conditions. Permafrost is defined exclusively on the basis of temperature. It is not necessarily frozen.

3.48 **Permafrost Aggradation** – A naturally or artificially caused increase in the thickness and/or areal extent of permafrost.

3.49 **Permafrost Table** – The upper boundary of permafrost.

3.50 **Pingo Ice** – Massive ice forming the core of a pingo.

3.51 **Poorly-Bonded** – A condition in which soil particles are weakly held together by ice so that the frozen soil has poor resistance to chipping and breaking (i.e., is characterized by low unconfined compressive strength).

3.52 **Pore Ice** – Ice occurring in the pores of soils and rocks.

3.53 **Porous Ice** – Ice that contains numerous voids, usually interconnected and usually resulting from melting of ice with air bubbles or along crystal interfaces from the presence of salt or other materials in the water, or from the freezing of saturated snow. Though porous, the mass retains its structural unity.

3.54 **Reticulate Cryostructure** – Represented by lenses and layers of ice that form a random net in perennially frozen soil matrix characterized by massive cryostructure (Photos 1, 2, and 5).

3.55 **Syngenetic Permafrost** – permafrost that formed more or less simultaneously with the deposition of the soil material in which it occurs.

3.56 **Talik** – A layer or body of unfrozen ground in permafrost.

3.57 **Thawed Ground** – Previously frozen ground in which all ice has melted.

3.58 **Total Moisture Content** – The total amount of water (unfrozen water plus ice) contained in soil or rock.

3.59 **Unfrozen Ground** – Soil or rock that does not contain any ice.

3.60 **Vein Ice** – A type of ground ice occupying cracks in permafrost.

3.61 **Wedge Ice** – A type of ground ice occurring in an ice wedge; comprises a series of ice veins formed at the same location over a period of time.

3.62 **Well-Bonded** – A condition in which soil particles are strongly held together by ice, so that the frozen soil possesses relatively high resistance to chipping or breaking (i.e., characterized by medium to high unconfined compressive strength).

3.63 **Work Method (WM)** – A document setting out the specific scope of work, method, and sequence of activities and organizational responsibilities relevant to a particular part of the practice.

4.0 RESPONSIBILITIES AND AUTHORITIES

4.1 Manager

- Establishes the terms of reference and project parameters with client, including contract terms;
- Confirms the project team has sufficient resources to carry out the site investigation;
- Confirms all safety procedures/methods are understood and followed by the project team;
- Confirms the project team is aware and meets the project objectives, budget and schedule requirements; and
- Reviews Issued for Use Report and authorizes it with his/her professional seal.

4.2 Project Engineer/Geologist

- Confirms the site investigation is appropriate for the site-specific conditions, available equipment, and proposed scope of work;
- Organizes and manages all logistical support, including subcontractors;
- Confirms field personnel have suitable qualifications and training for conducting fieldwork;
- Confirms the field personnel are aware of the objectives of the site investigation;

- Confirms field personnel are aware of their authority to adjust the site investigation;
- Is available for consultation with field personnel during the site investigation; and
- Confirms all safety procedures/methods are adhered to.

4.3 Technical Reviewer

- Provides timely technical input during the planning, conducting and reporting stages of the site investigation.

4.4 Field Engineer/Geologist

- Understands the site investigation goals and objectives;
- Is familiar with the drilling/excavating, coring, logging, and sampling methods to be used;
- Understands and accepts the authority to adapt the field program as needed;
- Informs a driller on borehole requirements or an excavator operator for test pitting or trenching requirements;
- Conducts the logging of permafrost and soil and collects the data in accordance with the procedures outlined in this work method;
- Keeps the Project Engineer/Geologist informed of any unusual conditions, such as occurrence of large bodies of massive ice, etc., or unusual performance of the equipment;
- Fosters on-site communication and team building between the Project Engineer/Geologist, the subcontractor, and the owner's representative;
- Supervises operation of field laboratory (if applicable);
- Carries out basic field testing of samples of perennially frozen soils;
- Keeps comprehensive records including quality photographs of frozen core and equipment; and
- Ensures all safety procedures/methods are followed.

5.0 WORK METHOD

Required Apparatus and Supplies for Core Logging

- Tetra Tech forms (borehole logs, sample inventory, bulk density)
- Butcher's knife, large pocket knife, or small spatula
- Hatchet
- 5 m measuring tape (steel)
- Low-power magnifying hand lens
- Graduated beakers (for excess ice content determination)
- Weigh scale with accuracy of 0.1 g (for measuring bulk density)
- Caliper (for measuring diameter of a core sample when doing bulk density calculations)
- Digital camera, memory cards, color scale chart and tripod if necessary
- A single-bead thermistor string or thermometer that can measure temperatures below 0°C
- Ohm-meter with a switch box for reading multi-bead ground temperature cables

- Permanent markers
- Pencils
- Clipboards
- White board and dry erase markers
- Field note books
- Pails
- Insulated core box
- Heavy duty coolers
- Freezer (ice) packs
- Industrial towels or rags
- Sample bags and sample tags
- Saran wrap (rolls)
- Foil (rolls)

Useful Auxiliary Apparatus and Supplies

- Small bottle of dilute hydrochloric acid
- Small test tube and stopper
- Munsell Soil Colour Chart or Rock Colour Chart
- Flashlight

5.1 Logging of Perennially Frozen Soils and Ground Ice

The system for describing and classifying perennially frozen soils and ground ice involves three steps: Parts I, II and III. Part I consists of a description of the soil composition (lithology), i.e., gravel, sand, silt, etc., and its classification independent of the frozen state. Part II describes the frozen state of the soil. Part III consists of a description of characteristic ice strata found in the soil.

5.1.1 Part I: Description of Soil Phase

The soil phase, whether thawed or frozen, is described independently of the frozen state according to the Modified Unified Soil Classification (MUSC) system (Appendix A) and Tetra Tech Work Method (WM4400).

5.1.2 Part II: Description of Frozen Soil

The perennially frozen soil is described according to the NRCC Ground Ice Classification system (1963) (Appendix A). This system is based on whether ice in the frozen soil is visible or not. Accordingly, frozen soils are divided into two major groups: soils in which ice is not visible to the unaided eye (N), and soils in which segregated ice is visible (V) (Photos 1 and 2).

5.1.2.1 Frozen Soils with Non-Visible Ice

Frozen soils in which ice is not visible to the unaided eye are divided into two main subgroups: poorly bonded or friable material (Nf), and well-bonded frozen soil (Nb). The Nf condition exists when the degree of saturation is low.

The Nb soils are further divided into two subtypes: Nbn (no excess ice) and Nbe (excess ice uniformly distributed throughout the frozen soil) (Photo 1).

The Nbe condition may occur in very fine sands, silty sands or coarse silts where excess ice is present but is so uniformly distributed that it is not easily identifiable by the unaided eye. However, on close examination, the presence of ice within the soil pores may be identified by crystalline reflections or by a sheen on trimmed surfaces. It can also be verified by placing some frozen soil in a graduated beaker, allowing it to melt, and observing the quantity of supernatant water as a percentage of the total volume.

5.1.2.2 Frozen Soils with Visible Ice (less than 50% by volume)

Frozen soils in which ice is visible to the unaided eye as discrete ice inclusions of measurable dimensions comprising less than 50% by volume are designated by the symbol V. These are divided into five subgroups: Vx (frozen soils, which contain individual ice crystals or inclusions); Vc (frozen soils with ice coatings on larger particles); Vr (frozen soils with random or irregularly oriented ice formations); Vs (frozen soils with stratified or distinctly oriented ice formations); and Vu (visible ice uniformly distributed throughout frozen soil) (Photos 1 to 5).

In addition to using the above symbols on the borehole logs, descriptions of cryostructures (massive, lenticular, layered, etc.) that are characteristic of perennially frozen soils should be described. Cryostructures are useful for determining the nature of the freezing process. Cryostructures are also helpful for determining the permafrost (i.e., syngenetic vs. epigenetic) and the conditions under which the sediments accumulated. The main types of cryogenic structures are defined in Section 3.0 and illustrated in Photos 1 to 5.

When logging an ice-rich frozen soil, multiple symbols may be used to indicate borderline or mixed classifications, e.g., Vr, Vc, Vx 30% (see BH 11580-TRD03, Appendix B); Vs, Vr 40% to 50% (see BH 11580.093-03, Appendix B). The percentage of volumetric ice content should be given only for visible ice symbols. It is important to include a more detailed description of the ice formations along with the ice classification. For example, Vs 10% - 2 mm thick ice lenses regularly spaced at 25 mm intervals.

Volumetric ice content of the ice-rich frozen soil should be estimated using Charts for Estimating Proportions (Appendix C) or measured if possible. A simple field test (suggested by Linell and Kaplar (1963) and Kokelj and Burn (2005)) should be conducted on frozen soil core samples to more accurately determine volumetric ice content of the ice-rich frozen soil. The test consists of placing an approximately 10 cm long frozen soil core sample into a graduated glass beaker and allowing it to thaw. The beaker should be covered with plastic wrap to prevent evaporation. The thawed saturated soil in the beaker should be thoroughly mixed and allowed to settle for 12 hours or more (Photo 6). Volumes of sediment and supernatant water are recorded to estimate excess ice content in percent (I_c) of the sample using the following formula:

$$I_c = [(W_v*1.09)/(S_v + (W_v*1.09))]*100$$

Where W_v is the volume of supernatant water (cm^3), multiplied by 1.09 to estimate the equivalent volume of ice, and S_v is the volume of saturated sediment (cm^3).

It is strongly recommended to test this same thawed sample for moisture content to compare volumetric ice content with total water content. Visual estimates of volumetric ice content as indicated on borehole logs should be within ± 5%.

Since proportions of ice and soil may vary widely, it may sometimes be difficult to decide without the excess ice beaker test whether a given material falls, for example, in the category of frozen soil or of ice with soil inclusions. Material containing as much as 80% ice by volume and 20% soil can sometimes give the appearance of being mostly soil (Linell and Kaplar 1963).

Soil and ice classifications and percentages may be altered on the field borehole logs after the laboratory testing results (moisture contents, grain size analyses, Atterberg Limits, and bulk densities) are complete.

5.1.2.3 Simplified Logging of Frozen Soils with Non-Visible or Visible Ice

In those cases, when recovered frozen soil samples are disturbed and it's difficult to divide main groups of frozen soils (N and V) into subgroups (Nbn vs. Nbe and Vx, Vc, Vs, Vr or Vu) it would be satisfactory to use Nb designation without breakdown into Nbn or Nbe categories, or it might even be sufficient to use only the N and V major group designations to indicate whether or not ground ice is visible, as suggested by Linell and Kaplar (1963). However, it is important to collect such disturbed frozen soil samples and conduct an excess ice beaker test to determine their volumetric ice content.

5.1.3 Part III: Description of Ice Formations

Discrete visible ice formations in frozen soils that are greater than 50% by volume are designated by the symbol ICE and are divided into two subgroups: ICE + Soil Type and ICE (see BH 11580-TRD03, Appendix B; (Photos 1, 9 and 10).

If the ice formation contains soil inclusions, it is designated as ICE + Soil Type. If the ice formation contains no soil inclusions, it is designated simply as ICE (Photo 1, 9 and 10).

Description of various forms of ground ice in permafrost should preferably be made using undisturbed core samples collected by coring with a CRREL dry auger, diamond drill or sonic drill. The description should include structure (clear, cloudy, porous, candled, granular, or stratified), colour (colourless, gray, blue), and the presence of air bubbles or any soil or organic inclusions.

When appreciable masses of ice are encountered in perennially frozen ground, they are termed massive ice (see Section 3.47 for definition of massive ice). It is recommended that these ice formations be designated as ICE or ICE + Soil Type and described as “massive ice bed” or “massive icy bed”, respectively, if the layer in question has a minimum thickness of 0.3 m (Photos 7, 8, 9, and 10).

5.2 Logging and Sampling of Frozen Core Obtained by Diamond Drilling

5.2.1 In the case of diamond drilling, which is often used for Tetra Tech's site investigations in permafrost regions, the recovered core is extruded into a core box. The core box should be kept at a temperature below 0°C during logging and sampling to prevent thawing of the frozen core. A measuring tape should be placed along the edge of the core and the amount of recovery noted (e.g., 1.2 m/1.5 m). A hatchet, a butcher's knife and a hammer can be used to break or split pieces of core for close examination. The ice formations in the frozen soil should be studied on the basis of observations from several directions. The Munsell Soil Colour Chart should be used to correctly describe colour of the soil phase. The core must be cleaned and wetted prior to describing the colour. When a core box is full, core photographs should be taken prior to covering the core box with a lid and removing it from the drill site.

5.2.2 After the core is logged and photographed, several representative core samples should be taken from the entire borehole, or run, wrapped in saran and foil, double-bagged, labelled (project number, borehole number, and depth) and ideally kept frozen (i.e., stored outside if weather permits or in an insulated core box if air temperature is above 0°C). Ultimately, the project will dictate how much of the recovered core is retained.

5.2.3 If both visible and non-visible ice is present in the frozen core, two samples of a representative frozen core interval should be acquired:

- The first sample should include both mineral layers and ice lenses. If layered or reticulate cryogenic structure is present, the sample should contain at least three ice lenses of each orientation. The weight of the sample may range from 1 kg to 3 kg. This sample will allow a total moisture content measurement to be made for frozen soil that includes visible ice formations, non-visible pore ice and unfrozen water.
- The second sample should comprise mineral soil between ice lenses that does not include visible ice. Its weight should range from 15 g to 50 g. This sample will allow moisture content of the mineral portion of the core interval to be determined.

5.2.4 Several representative sections of the core (at least 150 mm long) should be set aside for bulk density measurements. The sections must remain frozen prior to testing. These sections should be undisturbed, perfectly cylindrical, and well preserved. It is recommended that bulk density measurements be carried out in the field since the condition of the frozen core may deteriorate when shipped to a geotechnical laboratory.

5.2.5 Each sample should be recorded on a Sample Inventory Form (Appendix D). The sample interval and sample type should be recorded on the borehole log.

6.0 REFERENCES

6.1 Internal References

- WM3100 Site Investigation by Coring with a Diamond Drill Rig
- WM3403 Geotechnical Logging of Rock Core
- WM4400 Geotechnical Soil Classification

6.2 External References

- ASTM (2007). Standard D4083-89: Standard Practice for Description of Frozen Soils (Visual-Manual Procedure).
- Glossary of Permafrost and Related Ground-Ice Terms, 1988. NRCC, Technical Memorandum No. 142, 156 pp.

- Guide to a Field Description of Permafrost for Engineering Purposes, 1963. NRCC, Technical Memorandum 79, 24 pp.
- Kokelj, S.V. and Burn, C.R. 2005. Near-Surface Ground Ice in Sediments of the Mackenzie Delta, Northwest Territories, Canada. In: Permafrost and Periglacial Processes 16, pp. 291-303.
- Linell, K.A. and Kaplar, C.W. 1963. Description and Classification of Frozen Soils. In: Proceedings of International Conference on Permafrost, 11-15 November 1963, Lafayette, Indiana, pp. 481-487.

7.0 ATTACHMENTS

- Photographs
- Appendix A Modified Unified Soil Classification and Ground Ice Description
- Appendix B Select Borehole Logs and Sample Photographs
- Appendix C Charts for Estimating Proportions (Soil/Rock/Ice)
- Appendix D Tetra Tech Forms: Borehole Log, Sample Inventory, Bulk Density

8.0 WORK METHOD CONTACT PERSON

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PHOTOGRAPHS

Massive (N_{bn} or N_{be})

Individual Ice Crystals (Vx, Vu)
(in Organic-Matrix)

Micro-Lenticular (Vu)

Layered (V_s)

Reticulate (trapezoidal)
(V_r)

Reticulate (lattice)
(V_r)

Wavy Layered
(V_s)

Ataxitic (Suspended)
(ICE + Soil)

Massive Ice Bed
(ICE)

Photo 1: Photographs of simple cryostructures found in perennially frozen soils in the Colville River Delta, Alaska.

Lenticular-Layered (V_s)

Layered-Lenticular (V_s)

Reticulate-Layered
(V_r, V_s)

Vein-Layered
(includes lenticular)
(V_s, V_r)

Vein-Lenticular
(V_r, V_s)

Reticulate-Layered (V_r)

Photo 2: Photographs of common composite cryostructures found in perennially frozen soils in the Colville River Delta, Alaska.

Photo 3: Layered cryostructure (Vs 30-40%) in perennially frozen till (at depths of 1.5 m and 3.0 m). Note distinctly oriented ice lenses.

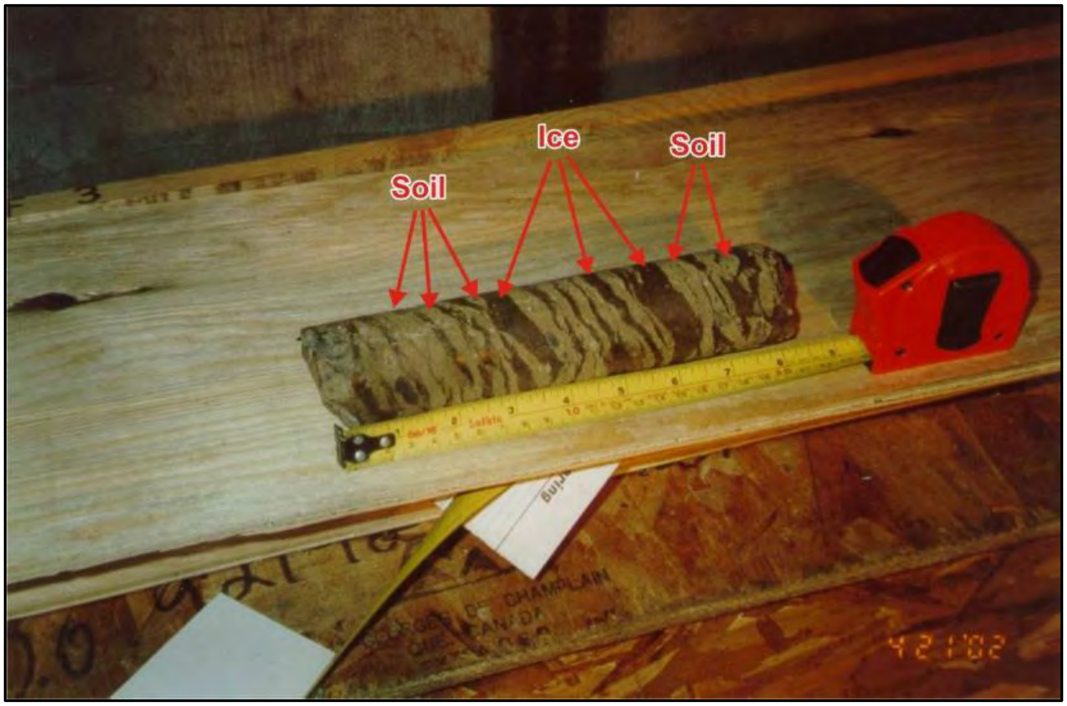


Photo 4: Layered cryostructure (Vs 40-50%) in perennially frozen till. Note distinctly oriented ice lenses.

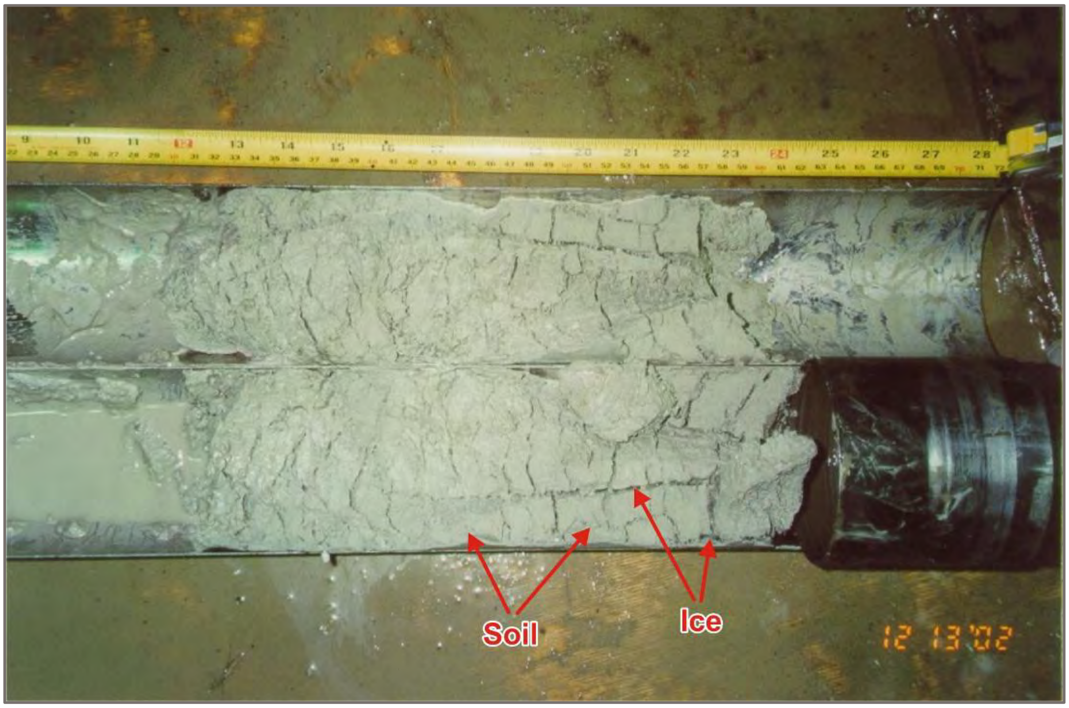


Photo 5: Reticulate cryostructure (Vr) in perennially frozen tailings from a gold mine in Northeastern Siberia.

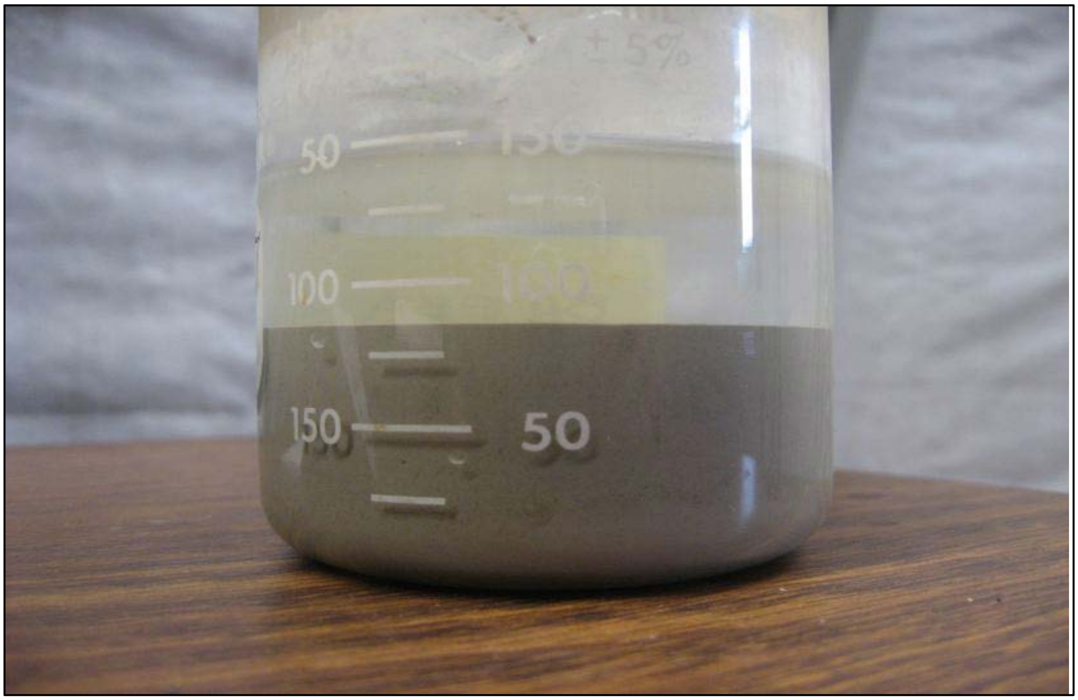


Photo 6: Determining excess ice content in overburden core sample

Photo 7: Massive ice exposed in steep bank along the Yerkota-Yakha River, Yamal Peninsula, West Siberia. Notice borrow pit development on top of the terrace.

Photo 8: Exposure of massive ice bed. East Yamal Peninsula, West Siberia.

Photo 9: Massive ice bed in perennially frozen till underlain by pegmatite (bedrock). (See Borehole Log: BH 11580-TRD03, Appendix B).

- From 4.5 m to 6.4 m: Ice and Gravel and Silt;
- From 6.4 m to 7.8 m: Ice
- From 7.8 m to 8.0 m: Sand and Gravel
- From 8.0 m to 9.0 m: Pegmatite (Bedrock).

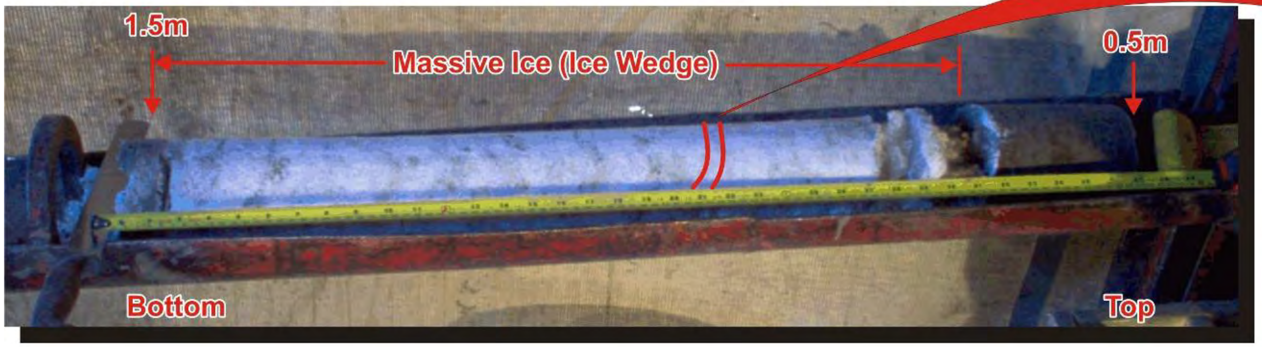


Photo 10a: Core of frozen overburden with ice wedge recovered with a CRREL core barrel.
Depth: 0.5 m - 1.5 m.

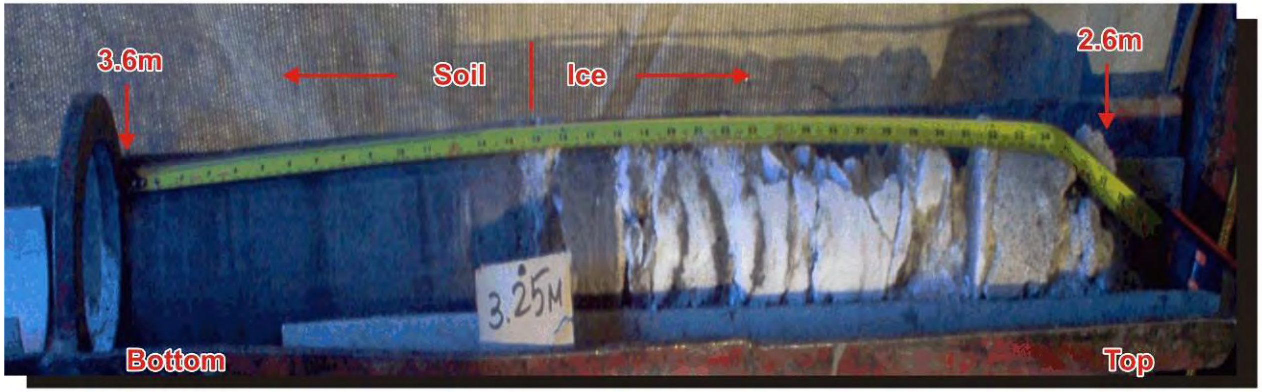
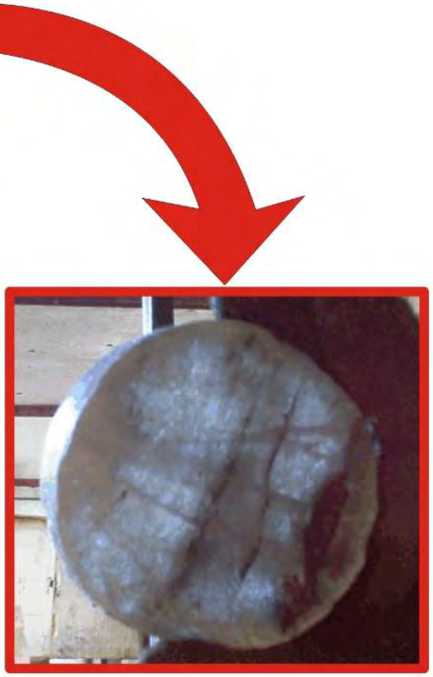


Photo 10b: Core of frozen overburden with ice wedge recovered with a CRREL core barrel.
Depth: 2.6 m - 3.6 m.



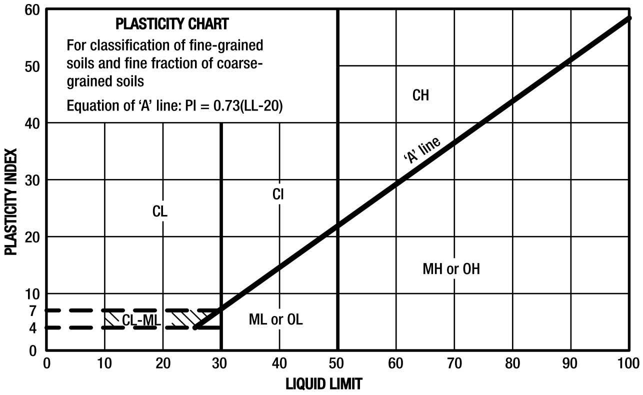
Close Up
Slice of an ice core. Note soil (silt) inclusions oriented vertically along vertical cracks in the ice.

APPENDIX A

MODIFIED UNIFIED SOIL CLASSIFICATION AND GROUND ICE DESCRIPTION

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	**GRAVELS** 50% or more of coarse fraction retained on 4.75 mm sieve	**CLEAN GRAVELS**	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	**Classification on basis of percentage of fines** Less than 5% Pass 75 µm sieve: GW, GP, SW, SP More than 12% Pass 75 µm sieve: GM, GC, SM, SC 5% to 12% Pass 75 µm sieve: Borderline Classification requiring use of dual symbols	$C_U = D_{60} / D_{10}$ Greater than 4 $C_C = \frac{(D_{30})2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	**CLEAN SANDS**	SW	Well-graded sands and gravelly sands, little or no fines		$C_U = D_{60}/D_{10}$ Greater than 6 $C_C = \frac{(D_{30})2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	**SILTS**	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity			
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
	CLAYS Above "A" line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays			
		Liquid limit 30-50	CI	Inorganic clays of medium plasticity, silty clays			
		Liquid limit >50	CH	Inorganic clays of high plasticity, fat clays			
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity			
		Liquid limit >50	OH	Organic clays of medium to high plasticity			
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils			



* Based on the material passing the 75 mm sieve

† ASTM Designation D 2487, for identification procedure see D 2488 USC as modified by PFRA

SOIL COMPONENTS				
FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENTAGE	DESCRIPTOR
GRAVEL coarse fine	 75 mm 19 mm	 19 mm 4.75 mm	>35 % 21 to 35 % 11 to 20 % >0 to 10 %	"and" "y-adjective" "some" "trace"
SAND coarse medium fine	 4.75 mm 2.00 mm 425 µm	 2.00 mm 425 µm 75 µm		
SILT (non plastic) or CLAY (plastic)	75 µm		as above but by behavior	

OVERSIZE MATERIAL

Rounded or subrounded

COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm

Not rounded

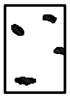
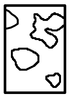
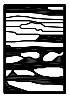
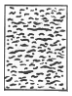
ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

TETRA TECH

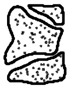
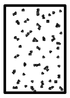
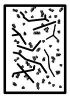
Tt_Modified Unified Soil Classification_Ice Description.cdr

GROUND ICE DESCRIPTION

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	SKETCH	PHOTOGRAPH
V	Vx	Individual ice crystals or inclusions		
	Vc	Ice coatings on particles		
	Vr	Random or irregularly oriented ice formations		
	Vs	Stratified or distinctly oriented ice formations		
	Vu	Ice formations uniformly distributed throughout frozen soil		

ICE NOT VISIBLE

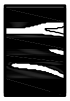
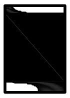
GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	SKETCH	PHOTOGRAPH
N	Nf	Poorly-bonded or friable		
	Nbn	No excess ice, well-bonded		
	Nbe	Excess ice, well-bonded		

LEGEND: Soil ☐ Ice ■

NOTES:

1. Dual symbols are used to indicate borderline or mixed ice classifications.
2. Visual estimates of ice contents indicated on borehole logs ± 5%
3. This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes.

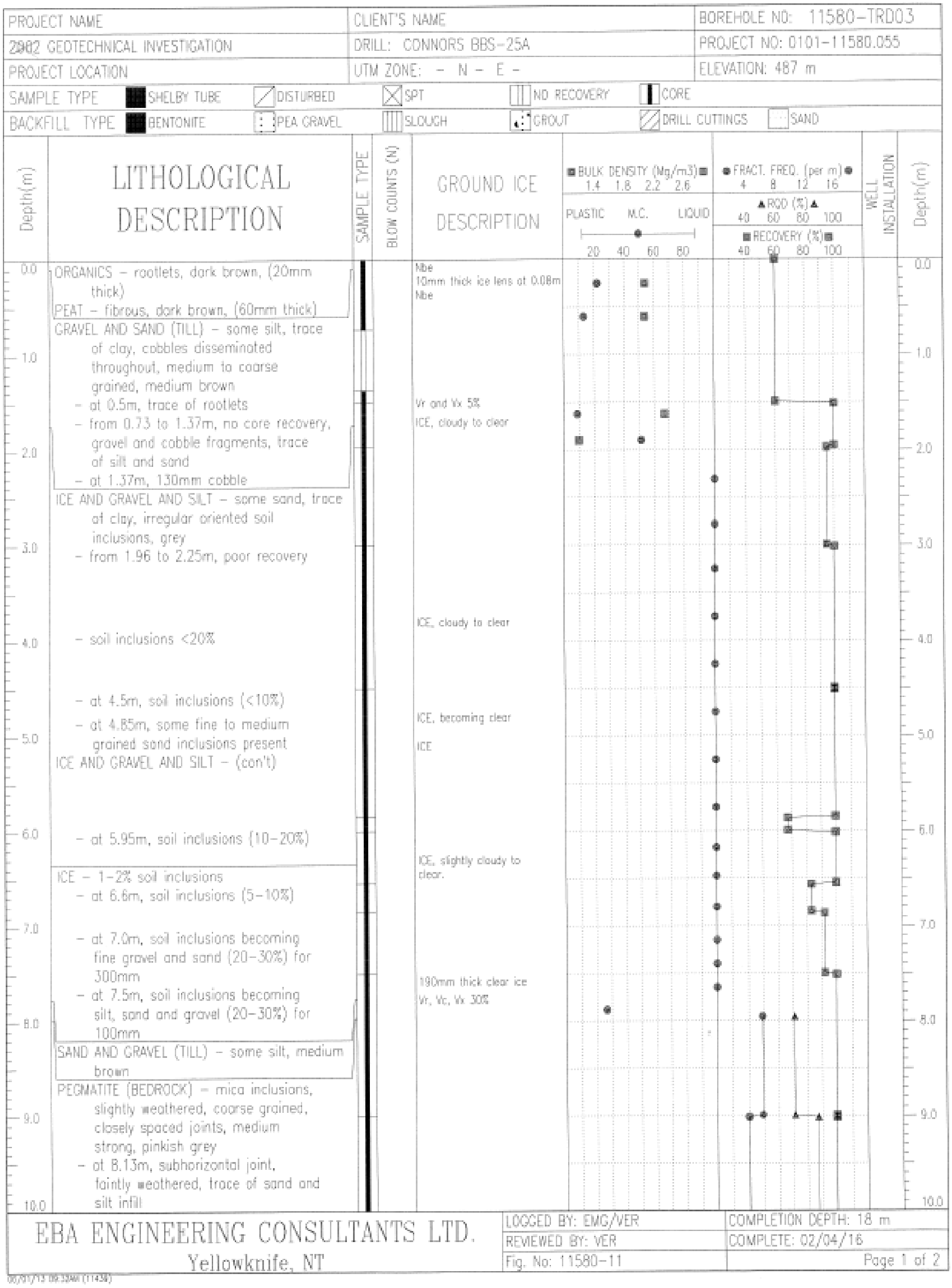
VISIBLE ICE GREATER THAN 50% BY VOLUME

GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	SKETCH	PHOTOGRAPH
ICE	ICE + Soil Type	Ice with soil inclusions (greater than 25 mm thick)		
	ICE	Ice without soil inclusions (greater than 25 mm thick)		

TETRA TECH

APPENDIX B

SELECT BOREHOLE LOGS AND SAMPLE PHOTOGRAPHS



PROJECT NAME	CLIENT'S NAME	BOREHOLE NO: 11580-TRD03
2002 GEOTECHNICAL INVESTIGATION	DRILL: CONNORS BBS-25A	PROJECT NO: 0101-11580.055
PROJECT LOCATION	UTM ZONE: - N - E -	ELEVATION: 487 m

SAMPLE TYPE ▪ SHELBY TUBE ⧄ DISTURBED ☒ SPT ▯ NO RECOVERY ▮ CORE

BACKFILL TYPE ▪ BENTONITE ⁝ PEA GRAVEL ▥ SLOUGH ⁖ GROUT ▨ DRILL CUTTINGS ⬚ SAND

ORGANICS – rootlets, dark brown, (20mm thick)

PEAT – fibrous, dark brown, (60mm thick)

GRAVEL AND SAND (TILL) – some silt, trace of clay, cobbles disseminated throughout, medium to coarse grained, medium brown
- at 0.5m, trace of rootlets
- from 0.73 to 1.37m, no core recovery, gravel and cobble fragments, trace of silt and sand
- at 1.37m, 130mm cobble

ICE AND GRAVEL AND SILT – some sand, trace of clay, irregular oriented soil inclusions, grey
- from 1.96 to 2.25m, poor recovery
- soil inclusions <20%
- at 4.5m, soil inclusions (<10%)
- at 4.85m, some fine to medium grained sand inclusions present

ICE AND GRAVEL AND SILT – (con't)
- at 5.95m, soil inclusions (10–20%)

ICE – 1–2% soil inclusions
- at 6.6m, soil inclusions (5–10%)
- at 7.0m, soil inclusions becoming fine gravel and sand (20–30%) for 300mm
- at 7.5m, soil inclusions becoming silt, sand and gravel (20–30%) for 100mm

SAND AND GRAVEL (TILL) – some silt, medium brown

PEGMATITE (BEDROCK) – mica inclusions, slightly weathered, coarse grained, closely spaced joints, medium strong, pinkish grey
- at 8.13m, subhorizontal joint, faintly weathered, trace of sand and silt infill

Nbe
10mm thick ice lens at 0.08m
Nbe

Vr and Vx 5%
ICE, cloudy to clear

ICE, cloudy to clear

ICE, becoming clear

ICE

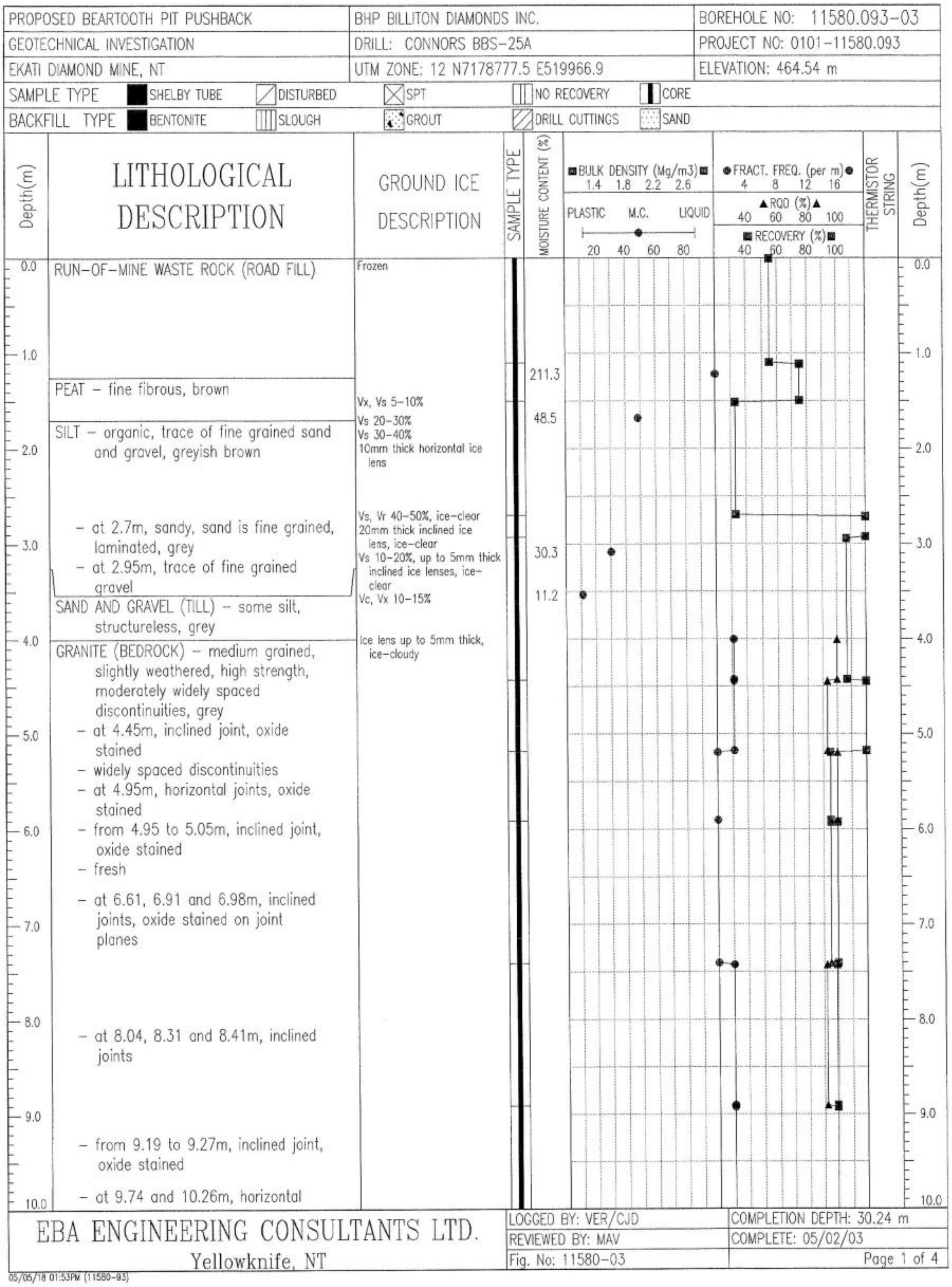
ICE, slightly cloudy to clear.

190mm thick clear ice
Vr, Vc, Vx 30%

EBA ENGINEERING CONSULTANTS LTD. Yellowknife, NT	LOGGED BY: EMG/VER	COMPLETION DEPTH: 18 m
	REVIEWED BY: VER	COMPLETE: 02/04/16
	Fig. No: 11580-11	Page 1 of 2

Figure 1a
BH 11580-TRD03
Core of Frozen Overburden. Depth: 0.0m - 4.5m.

Figure 1b
BH 11580-TRD03
Core of Frozen Overburden Underlain by Frozen Bedrock (Pegmatite). Depth: 4.5m - 9.0m.



PROPOSED BEARTOOTH PIT PUSHBACK	BHP BILLITON DIAMONDS INC.	BOREHOLE NO: 11580.093-03
GEOTECHNICAL INVESTIGATION	DRILL: CONNORS BBS-25A	PROJECT NO: 0101-11580.093
EKATI DIAMOND MINE, NT	UTM ZONE: 12 N7178777.5 E519966.9	ELEVATION: 464.54 m

SAMPLE TYPE ■ SHELBY TUBE ▨ DISTURBED ☒ SPT ▥ NO RECOVERY ▮ CORE

BACKFILL TYPE ■ BENTONITE ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ░ SAND

LITHOLOGICAL DESCRIPTION

RUN-OF-MINE WASTE ROCK (ROAD FILL)

PEAT – fine fibrous, brown

SILT – organic, trace of fine grained sand and gravel, greyish brown
- at 2.7m, sandy, sand is fine grained, laminated, grey
- at 2.95m, trace of fine grained gravel

SAND AND GRAVEL (TILL) – some silt, structureless, grey

GRANITE (BEDROCK) – medium grained, slightly weathered, high strength, moderately widely spaced discontinuities, grey
- at 4.45m, inclined joint, oxide stained
- widely spaced discontinuities
- at 4.95m, horizontal joints, oxide stained
- from 4.95 to 5.05m, inclined joint, oxide stained
- fresh
- at 6.61, 6.91 and 6.98m, inclined joints, oxide stained on joint planes
- at 8.04, 8.31 and 8.41m, inclined joints
- from 9.19 to 9.27m, inclined joint, oxide stained
- at 9.74 and 10.26m, horizontal

GROUND ICE DESCRIPTION

Frozen

Vx, Vs 5–10%

Vs 20–30%

Vs 30–40%

10mm thick horizontal ice lens

Vs, Vr 40–50%, ice-clear

20mm thick inclined ice lens, ice-clear

Vs 10–20%, up to 5mm thick inclined ice lenses, ice-clear

Vc, Vx 10–15%

Ice lens up to 5mm thick, ice-cloudy

MOISTURE CONTENT (%)

211.3

48.5

30.3

11.2

EBA ENGINEERING CONSULTANTS LTD. Yellowknife, NT	LOGGED BY: VER/CJD	COMPLETION DEPTH: 30.24 m
	REVIEWED BY: MAV	COMPLETE: 05/02/03
	Fig. No: 11580-03	Page 1 of 4

05/05/18 01:53PM (11580-93)

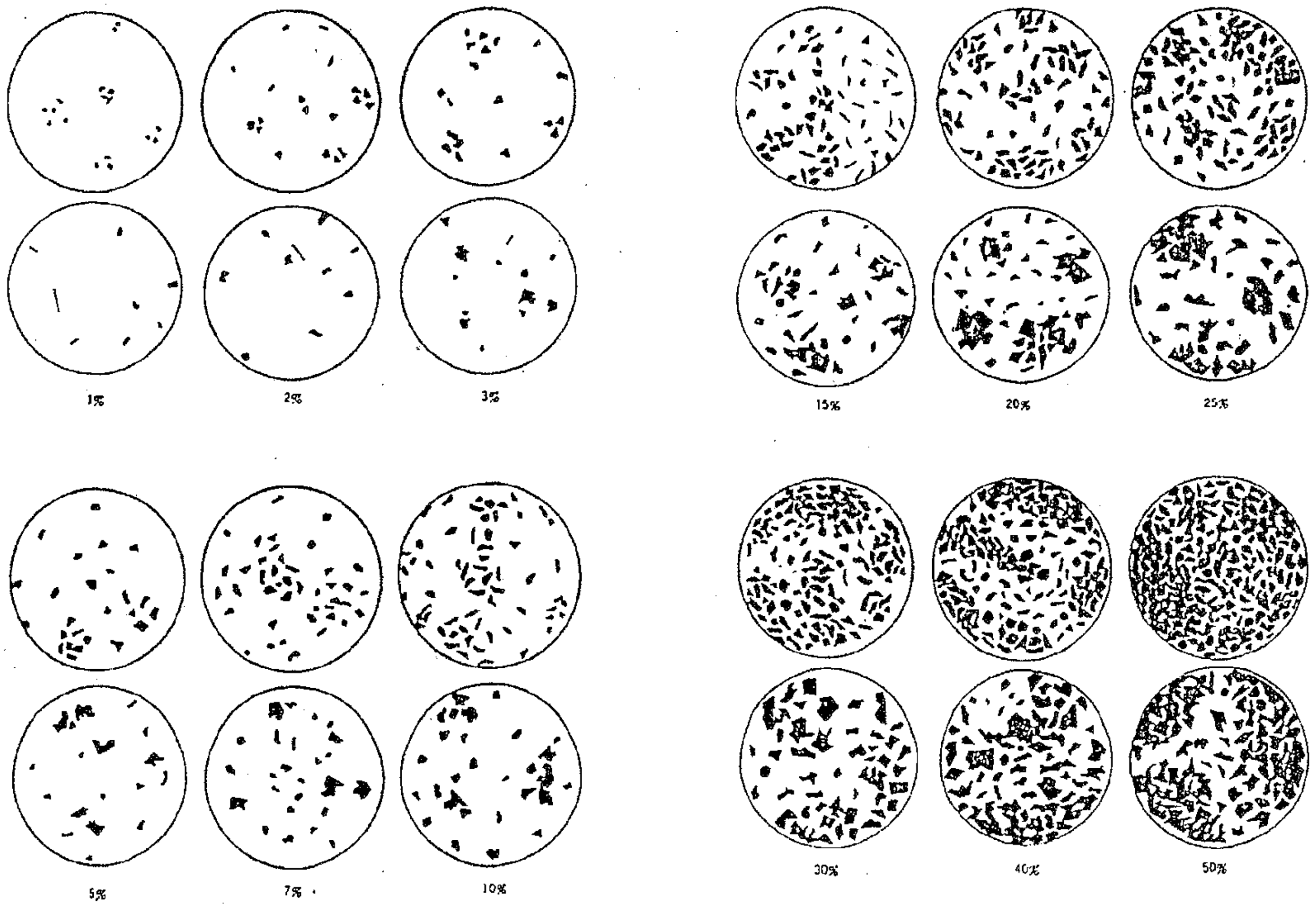
Figure 2a
BH 11580.093-03
Core of Frozen Overburden Underlain by Frozen Granite Bedrock (left portion of the core box). Depth: 0.0m - 5.2m

Photo 2b
BH 11580.093-03
Core of Frozen Overburden Underlain by Frozen Granite Bedrock (right portion of the core box). Depth: 0.0m - 5.2m.

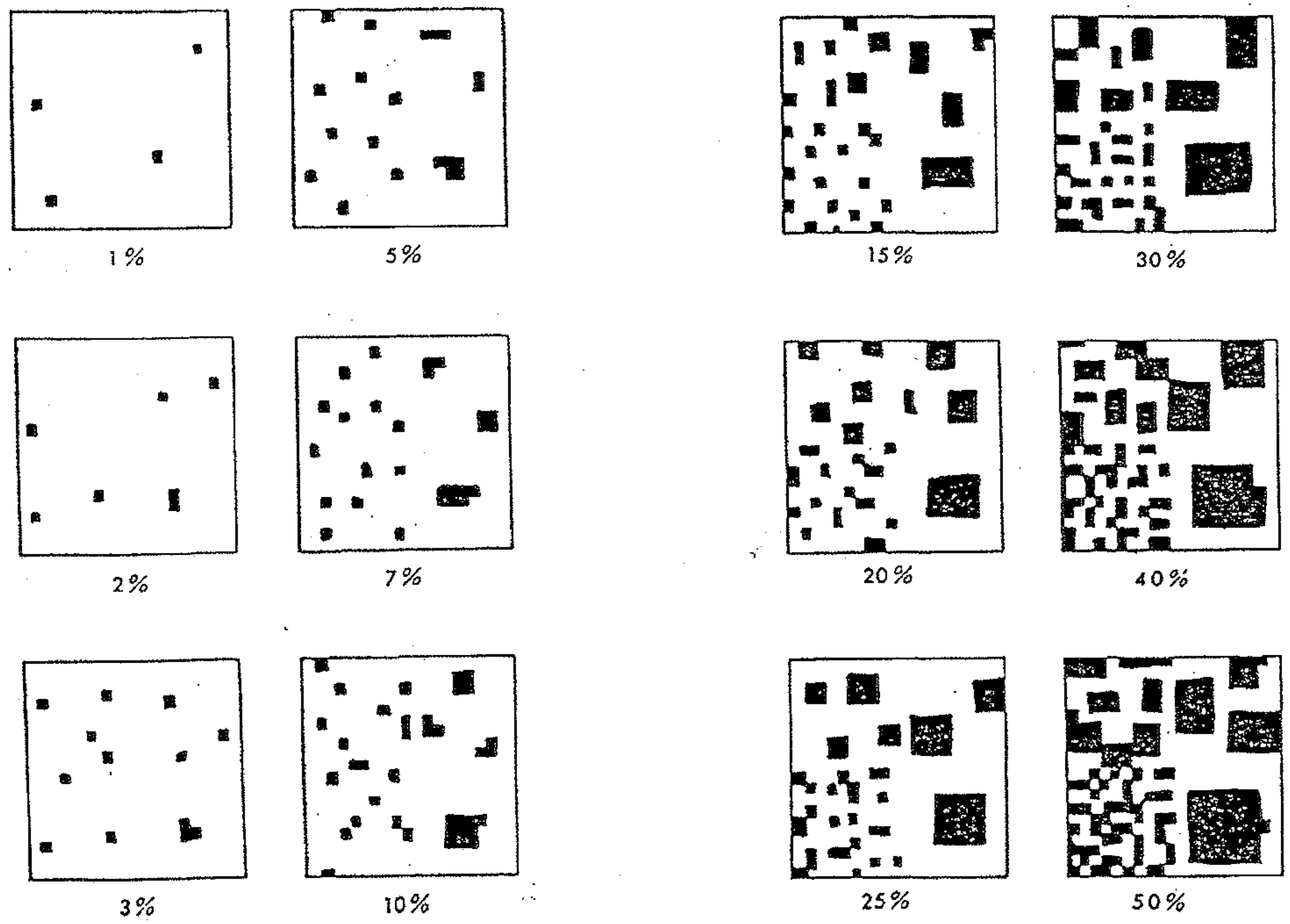
APPENDIX C

CHARTS FOR ESTIMATING PROPORTIONS (SOIL/ROCK/ICE

CHARTS FOR ESTIMATING PROPORTIONS
(SOILS/ROCKS/ICE)



CHARTS FOR ESTIMATING PROPORTIONS
(SOILS/ROCKS/ICE)



1 %

5 %

15 %

30 %

2 %

7 %

20 %

40 %

3 %

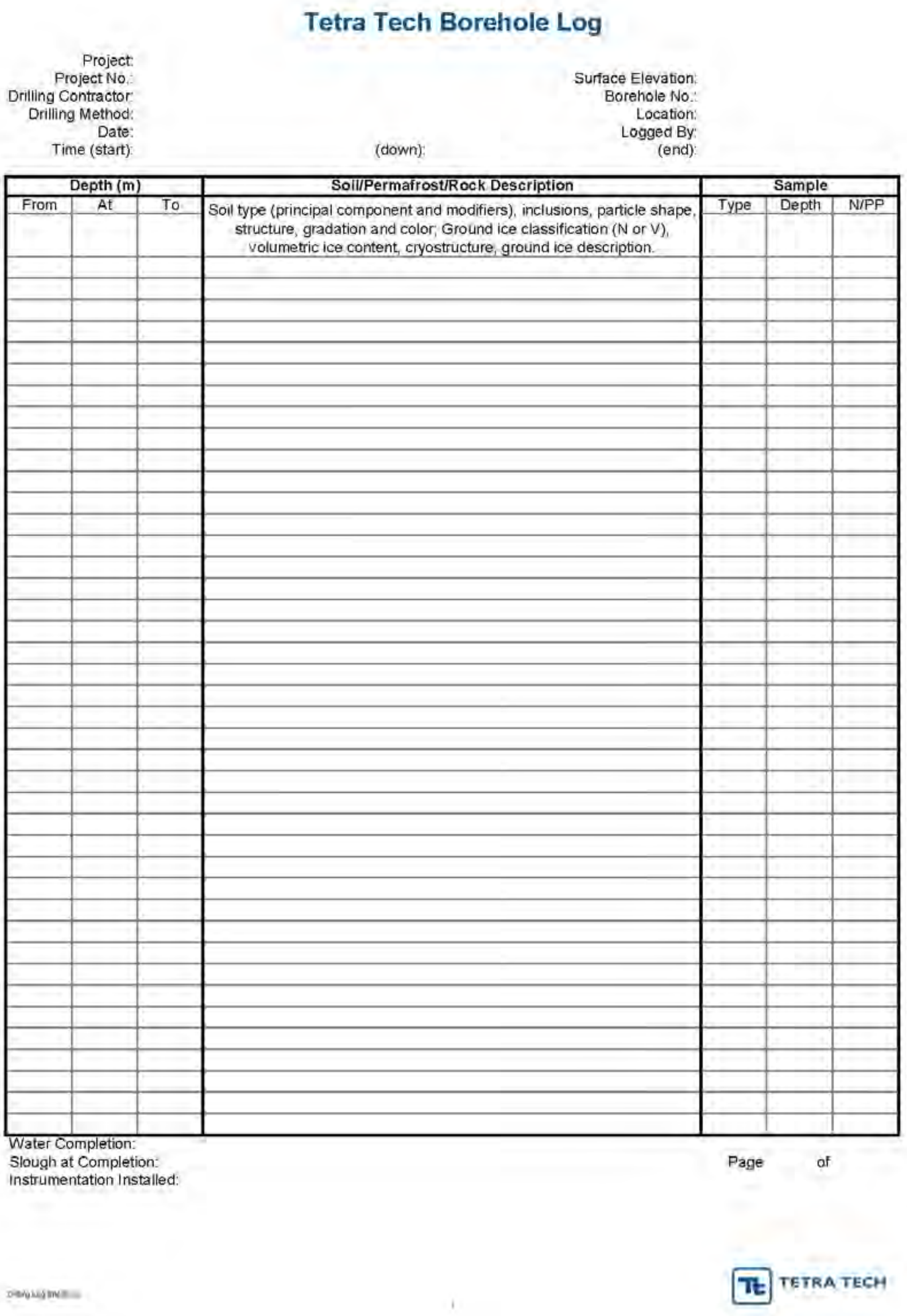
10 %

25 %

50 %

APPENDIX D

TETRA TECH FORMS: BOREHOLE LOG, SAMPLE INVENTORY, BULK DENSITY



Tetra Tech Borehole Log

Project:
Project No.:
Drilling Contractor:
Drilling Method:
Date:
Time (start): (down): (end):

Surface Elevation:
Borehole No.:
Location:
Logged By:

Depth (m)			Soil/Permafrost/Rock Description	Sample		
From	At	To	Soil type (principal component and modifiers), inclusions, particle shape, structure, gradation and color; Ground ice classification (N or V), volumetric ice content, cryostructure, ground ice description.	Type	Depth	N/PP

Water Completion:
Slough at Completion:
Instrumentation Installed:

Page of

SAMPLE INVENTORY

Project: ______________________ **Borehole No.:** ______________________

Project No.: ______________________ **Completion Date:** ______________________

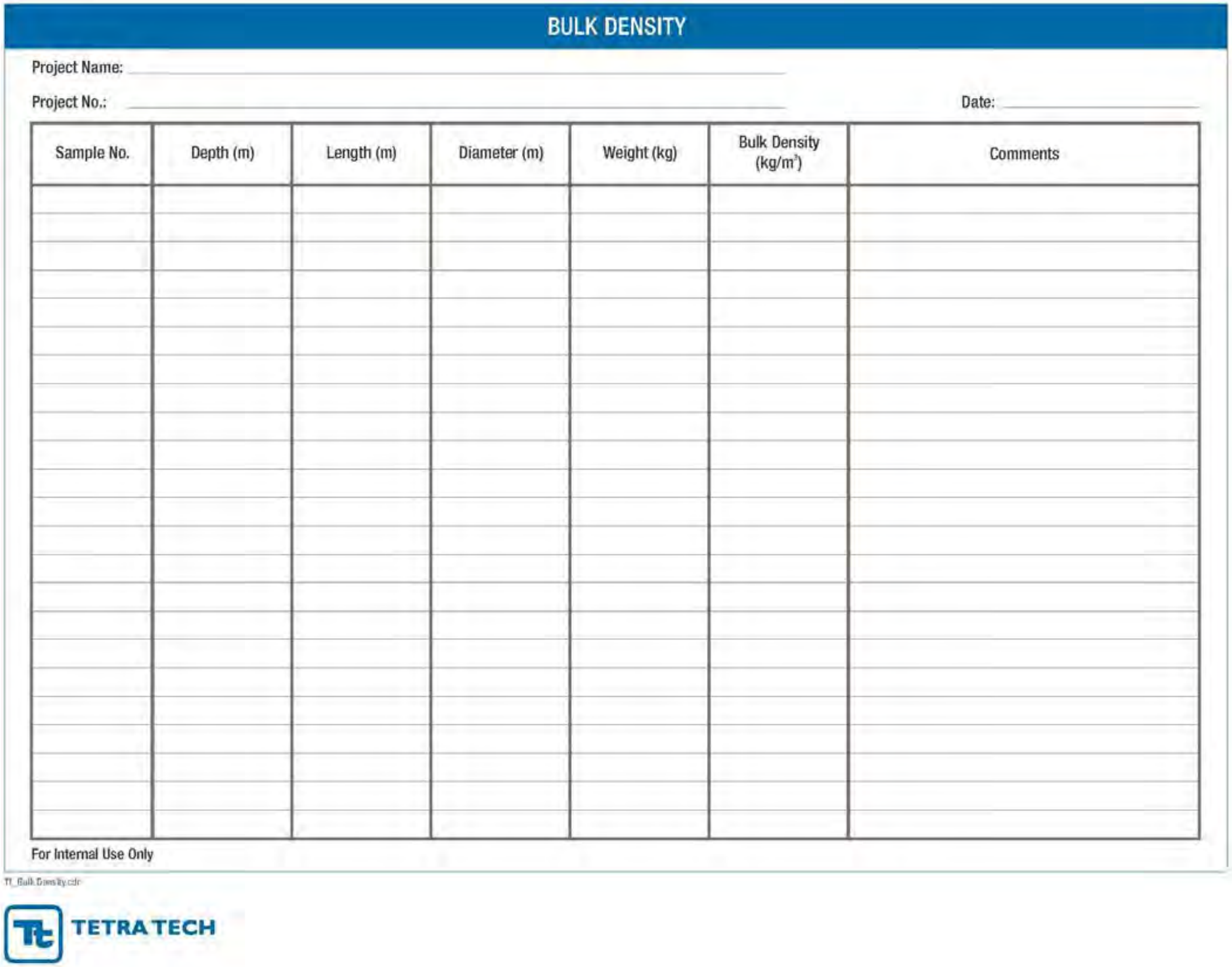
Sample No.	Depth (m)		Dimensions (mm)		Sample Type	USC	Remarks
	From	To	Diameter	Length			

Tt_Sample Inventory.cdr

TETRA TECH

For Internal Use Only

Sheet ____ of ____



BULK DENSITY

Project Name: ______________________________

Project No.: ______________________________ **Date:** ______________

Sample No.	Depth (m)	Length (m)	Diameter (m)	Weight (kg)	Bulk Density (kg/m^3)	Comments

For Internal Use Only

TT_Bulk Density.cdr

TETRA TECH

APPENDIX 3

Rock Drain Design Update for Eagle Pup and Platinum Gulch Waste Rock Storage Areas

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TETRA TECH

November 14, 2018

ISSUED FOR USE
FILE: ENG.EARC03103-02.003
Via Email: stang@vitgoldcorp.com
c: SWilbur@vitgoldcorp.com

Victoria Gold Corp.
Suite 1000 – 1050 West Pender Street
Vancouver, BC V6E 3S7

Attention: Mr. Steve Tang, P.Eng., Manager of Mining Engineering

Subject: Rock Drain Design Update for Eagle Pup and Platinum Gulch Waste Rock Storage Areas
Eagle Gold Project

1.0 INTRODUCTION

NND EBA Land Protection Corp. operating as NELPCo Limited Partnership (NELPCo) was retained by Victoria Gold Corp. (Victoria Gold) to provide engineering services for a rock drain design update for the Eagle Pup and Platinum Gulch waste rock storage areas (WRSA) at the Eagle Gold Project (Project). The Project is located in the Dublin Gulch area of central Yukon Territory, approximately 45 km (85 km by road) north-northeast of Mayo and 370 km north of Whitehorse (485 km by road) (Figure 1).

This report has been prepared by Tetra Tech Canada Inc. (Tetra Tech), NELPCo's engineering service provider.

BGC (2012a) developed a feasibility-level design of the underdrains (or rock drains) for the Eagle Pup and Platinum Gulch WRSAs. Victoria Gold and JDS Energy & Mining, Inc. (JDS) are finalizing the design of the Eagle Pup and Platinum Gulch WRSAs. As a part of their design, a design update of the rock drains is required to incorporate recent site-specific information and the latest design of the WRSAs.

This report presents the basis, methodology, and drawings of the rock drain design update. Discussions on construction and material requirements are also provided.

2.0 GENERAL SITE CONDITIONS AND BACKGROUND INFORMATION

The topography of the Project area is characterized by rolling hills and plateaus ranging in elevation from approximately 750 m (metres above mean sea level or masl) to a local maximum of 1,525 masl at the summit of Potato Hills and is drained by deeply-incised creeks and canyons (JDS 2016). The ground surface is covered by residual soil and felsenmeer. Outcrops are rare, comprising generally less than 2% of the surface area and are limited to ridge tops and creek walls. Lower elevations are vegetated with black spruce, willow, alder, and moss, and higher elevations by subalpine vegetation. Patchy permafrost occurs on north-facing slopes (JDS 2016).

Central Yukon has a northern continental climate. The mean annual temperature at site is -3.0°C at the Camp climate station (782 masl) and -3.8°C at the Potato Hills Climate Station (1,420 masl). January is the coldest month, July the warmest. Mean annual precipitation for the site at 1,125 masl is 472 mm, about half of which falls as snow (Lorax 2018). The most recent hydro-meteorological characterization for the project area was completed in March 2017 (Lorax 2017). The report presents the expected long-term climatic and hydrologic conditions at the site, and in particular, provides the basis for assembly of hydro-meteorological inputs to be used in the design of water management structures such as the rock drains for the waste rock storage areas.

BGC (2012a) developed geotechnical assessment and design of the WRSAs for the Eagle Gold Project feasibility study. As a part of their study, a preliminary design of the rock drains was developed for the WRSAs. BGC (2012b) developed a feasibility study open pit design for the Project and documented the geotechnical conditions in the open pit area, including the source of the waste rock that could be used to construct the drain. SRK (2016) prepared an updated pit slope geotechnical report, which focused on pit stability, but also summarized the geomechanical properties of what will become waste rock. As input to the Eagle Gold Reclamation and Closure Plan, OKane (2014) summarized an assessment of closure cover system designs for the WRSAs.

Several geotechnical site investigations had been conducted in various areas at the Project site. The findings are documented in BGC (2012c), BGC (2012d), and Tetra Tech (2018). The April 2018 site investigation (Tetra Tech 2018) focused on characterizing the WRSA foundation materials, with ten boreholes drilled in the WRSAs.

The digital topographic contour data for the original ground in the WRSA area was provided by JDS on September 27, 2018. The design footprint of the Open Pit and the surface geometry of the Platinum Gulch WRSA were provided by JDS on September 27, 2018. The latest surface geometry for the Eagle Pup WRSA was provided by Victoria Gold on October 9, 2018. This information and data were used for the rock drain design update.

3.0 REQUIREMENT FOR WRSA UNDERDRAIN

To minimize the potential for hydrostatic pressures to build up at the bottom of the WRSA's, BGC (2012a) recommended rock drains to be constructed in the bottoms of the natural valleys within the footprints of both the proposed Eagle Pup and Platinum Gulch WRSAs. BGC (2012a) reported that multiple seeps were observed along road cuts in both Eagle Pup and Platinum Gulch and within the valley bottom areas in Eagle Pup. BGC (2012a) assumed that the groundwater table forms a subdued replica of the surface topography, with the water table relatively close to the original ground surface in the valley bottom areas. Based on groundwater well and piezometric data collected since 2010 in both valleys, it is clear that while seeps do exist along the valley bottoms, in general, there are losing reaches in both streams, and the depth to groundwater increases up the valley walls (Stantec 2012, BGC 2013, personal communication, S. Wilbur 2018). In their stability analyses for the WRSAs, BGC (2012a) conservatively assumed that the groundwater table coincided with the original ground surface. It is understood that similar assumptions were adopted in the current design of the WRSAs.

Site investigations indicated that the existing ground in Eagle Pup and Platinum Gulch consists of a thin layer of organics overlying colluvium over completely weathered bedrock and bedrock. The colluvium encountered in the test pits and boreholes ranged in thickness from 0 m to 16.4 m throughout the proposed WRSA footprints with an average thickness of 2.4 m (BGC 2012). The gradation of the colluvium was observed to be highly variable, predominantly ranging from sand and gravel with some silt and cobbles to silt and sand with gravel and some cobbles. The April 2018 site investigation had similar findings. The hydraulic conductivity of the overburden soils is expected to be relatively low due to the presence of fines (silt). Therefore, in combination with the available groundwater data, it is reasonable and conservative to assume that the groundwater table in the proposed WRSAs is close to the original ground surface in the valley bottom areas.

The waste rock to be stored in the WRSAs will primarily comprise phylittic metasediments and bedded quartzites. The metasediments are known to be susceptible to weathering and mechanical breakdown during and after placement, especially when interacting with drainage water. In addition, some waste rock may be highly weathered and fractured with some fines and may have a low hydraulic conductivity. Fine-grained waste rock with low hydraulic conductivity should not be placed in the channel bottoms to minimize the potential for hydrostatic pressure build-up, which could have an adverse effect on the physical stability of the structure. Further, the rock drains, which will be placed in the valley bottoms, should be constructed with coarser, durable waste rock to minimize the potential degradation of rock over time and to encourage more rapid subsurface flow.

4.0 DESIGN FLOW RATES FOR ROCK DRAIN

4.1 Review of BGC (2012a) Design Flow Rates

BGC (2012a) stated that "The peak instantaneous flows discharging from the Eagle Pup and Platinum Gulch drainages due to the 200-year precipitation event are estimated to be 2.1 m^3/s and be 2.3 m^3/s, respectively" (C. Aurala, 2011, pers. comm.). However, no details were provided on how these values were derived. It appears that BGC (2012a) used a peak flow of 2.1 m^3/s for the Eagle Pup WRSA rock drain and a peak flow of 0.92 m^3/s (40% of contributing percentage) for the Platinum Gulch WRSA rock drain in their feasibility level design. Based on these values, instantaneous peak yield rates for the Eagle Pup and Platinum Gulch WRSAs were calculated to be 2,234 $L/s/km^2$ and 2,421 $L/s/km^2$, respectively. These values are very high for this region when compared to those reported in Lorax (2017).

Lorax (2017) presented instantaneous peak yield recurrence internal estimates for the Project basins derived from regional surface hydrology analysis. For Station W26, which was in Stewart Gulch and is the adjacent basin east of Eagle Pup, the estimated instantaneous peak yield rate for a 1 in 200-year return event is 316 $L/s/km^2$ for a drainage area of 1.3 km^2 (the smallest catchment area studied, similar to the WRSA catchments). Note that this value was derived from regional WSC (Water Survey of Canada) peak flow records and scaled to the drainage basin areas at site. The regional peak flow records are generally representative of freshet peaks (rather than the peaks during an extreme rainfall event), given the larger catchment areas (relative to site catchment), as noted in an email from Lorax on September 28, 2018. Therefore, while peak yield rates from the regional surface hydrology analysis are not typically relied upon for engineering design of water management infrastructure, they provide reasonable comparable values to what should be expected for natural drainages in the area.

The reason for the higher design flow rates adopted by BGC (2012a) is not clear as no supporting details were provided. However, based on the peak yield rates calculated by Lorax (2017), it is clear that they are very conservative if not unrealistic. In recognizing the time lag and attenuation for the infiltrated water flowing through the waste rock to the drain exit point during a rainfall event, adopting the design flow rate based on the short-term rainfall event would be very conservative and is not realistic.

The design flow rate should more appropriately be based on basic surface water and subsurface (primarily vadose zone) flow processes that occur on and within a waste rock storage facility. Under a typical rainfall event, only some of the rain water will infiltrate waste rock materials while the remaining portion will become surface runoff. The infiltrated water will first wet the surfaces of waste rock materials in an unsaturated zone before any remaining portion of the infiltrated water can flow downward and intersect the rock drain. For a facility with a thick waste rock zone above the foundation, such as the Eagle Pup and Platinum Gulch WRSAs, the infiltrated water from a rainfall event will take time to pass through the thick unsaturated zone and gradually lose its volume before contributing to flow in the rock drains. Therefore, the flow rates adopted for the rock drains should consider this attenuating mechanism and site-specific conditions at the Project site.

4.2 Estimate of Peak Flow Rates for Rock Drain Design

4.2.1 Model Description

A hydrological model was built for each of the Eagle Pup and Platinum Gulch WRSAs to estimate the peak flow rates for rock drain design. The hydrological model was developed using PCSWMM, an advanced tool that allows simulation of both distributed hydrological processes and system hydraulics.

The model was set up to integrate surface runoff and subsurface (referred to in the model as groundwater) processes. Conceptually, the model represents both surface and groundwater as a series of interconnected buckets. Each WRSA drainage area is divided into sub-catchments, which are represented by two buckets, an upper one for surface runoff (surface bucket) and a lower one for groundwater flows (groundwater bucket). The model accounts every time step for precipitation, depression storage, infiltration, and surface runoff. Surface hydrology is modelled using a non-linear reservoir routing method which combines the continuity and Manning's equations. Water that infiltrates into the WRSA feeds the groundwater model component (or groundwater bucket). The groundwater model represents the vertical movement of water infiltrating through the vadose zone from the sub-catchments that lie above them. Groundwater in the model is represented using two zones – an un-saturated (vadose) zone and a saturated zone. Their behavior is characterized using such parameters as soil porosity, hydraulic conductivity, evapotranspiration depth, bottom elevation, and loss rate to deeper groundwater. Surface flows are routed to the next downstream sub-catchment (or surface bucket). Similarly, groundwater flows are routed to the next downstream groundwater bucket until reaching the rock drain outlet. The peak outflow at the rock drain outlet from the groundwater bucket is the peak flow for the rock drain design for each WRSA.

4.2.2 Input Parameters and Results

The design criteria adopted the 1 in 200-year 24-hour storm event (58 mm) as per Table 2-12 of Lorax (2017). Two scenarios were modelled for each WRSA: A) before open pit development (no waste rock placed in WRSA) and B) closure (completed open pit and WRSA with a topsoil and colluvium closure cover). Table 1 presents the watershed (catchment) areas for the two scenarios. The catchment area for scenario B is reduced because the open pit takes a portion of the area that originally drains down the hill as estimated for Scenario A.

Table 1: Catchment Areas for WRSA

WRSA	Catchment Area for Scenario A (ha)	Catchment Area for Scenario B (ha)
Eagle Pup	111.3	97.6
Platinum Gulch	56.8	53.2

The curve numbers (CN) used in the model were selected to be consistent with those that have been used for the Project in the past. The CN value was 60 for Scenario A and 82 for Scenario B. These two CN values encompass the expected runoff from construction though operations. Hyetograph shape was selected to be SCS Type II. Based on site rainfall data (Lorax 2018), Type II distributions have not been observed to date, thus, this selection is likely conservative for the project area.

Select results from the hydrological model are presented in Appendix A. Table 2 presents the estimated peak flow rates at the rock drain outlet locations. These values were used in the rock drain design. For comparison, Lorax (2017) computed lower peak units rates for the 24-hour 200-year storm for streams in the area (i.e. 0.26 $m^3/s/km^2$ to 0.32 $m^3/s/km^2$) based on regional hydrological data, which suggests that the estimated peak flow rates included here are higher and conservative.

Table 2: Estimated Peak Flow Rates at Rock Drain Outlet Locations

WRSA	Estimated Peak Flow Rate for Scenario A (m^3/s)	Scenario A Peak Unit Rates ($m^3/s/km^2$)	Estimated Peak Flow Rate for Scenario B (m^3/s)	Scenario B Peak Unit Rates ($m^3/s/km^2$)
Eagle Pup	1.18	1.06	0.73	0.75
Platinum Gulch	0.60	1.06	0.34	0.64

5.0 ESTIMATE OF ROCK DRAIN CROSS-SECTION AREAS

5.1 Review of BGC (2012a) Approach

BGC (2012a) calculated the cross-section areas of the rock drains required to convey the flows at key locations using the Wilkins equation, as follows:

$$Q = nAWm^{0.5}i^{0.54} \qquad [1]$$

Where:

Q = flow rate (m^3/s)

n = porosity

A = cross-section area through which the water flows (m^2)

W = Wilkins empirical constant (5.243)

m = hydraulic mean radius (m)

i = hydraulic gradient

BGC (2012a) used the approximate hydraulic gradient along the lower portion of the drainage where the slope is less steep (8°) in the design for Eagle Pup. For Platinum Gulch the slope of 21° of the valley bottom within the footprint of the WRSA was used.

The hydraulic mean radius of the rock drain materials was calculated from the following equation:

$$m = ed/6r_e \qquad [2]$$

Where:

e = void ratio

d = “dominant” (or representative) particle diameter (m)

r_e = particle surface-area efficiency

The particle surface-area efficiency is typically about 1.3 for coarse angular rock. The porosity of the rock drains is estimated to range from between 30% and 50%. A relatively low porosity of 30% was assumed for the rock drain design by BGC (2012a). The "dominant" particle diameter was assumed to be represented by the mean particle size (D_{50}, i.e. grain size of 50% passing by weight) of the waste rock. Geotechnical drilling conducted within the open pit area (BGC 2012b) indicated that the average in situ block size could range from 0.1 m to 0.2 m for the metasedimentary and igneous rocks, respectively. Based on these estimates, BGC (2012a) assumed a D_{50} of 0.1 m for the rock drain design.

The Wilkins equation was developed to represent flow in both laminar and non-laminar flow regimes in porous media (Banerjee et al. 2018). Banerjee et al. (2018) stated that the Wilkins equation can be satisfactorily used to represent post-laminar flow through porous media. Hawley and Cunning (2017) also stated that the Wilkins equation can be used for turbulent flow through a rock drain. Therefore, the method used by BGC (2012a) is reasonable and can be used for the design in this study.

The estimated rock drain cross-section areas vary with the assumed hydraulic mean radius of the rock drain material, which is associated with the particle size distribution and particle shape of the rock drain material. BGC (2012a) adopted the "dominant" particle diameter of D_{50}. Based on Hawley and Cunning (2017), using D_{50} would represent the approximate average particle size for a relatively uniformly graded drain rock, but the particle size associated with D_{10} (grain size of 10% passing by weight) is recommended as a representative particle size in the Wilkins equation to design coarse, uniformly graded drain rock that is sourced from waste rock and quarried rockfill.

5.2 Update on Estimates of Rock Drain Cross-section Areas

5.2.1 Methodology, Parameters, and Assumptions

Similar methodology, as described in Section 5.1, was adopted to estimate the rock drain cross-section areas, which vary with locations along the rock drain longitudinal profiles. Drawing C02 in Appendix C shows the locations of the longitudinal profiles (with stations) along the proposed rock drains for the Eagle Pup and Platinum Gulch WRSAs. The design flow rates at various stations (typically every 100 m along the rock drain longitudinal profile) were proportioned to the corresponding catchment area at each of the stations using the estimated peak design flow rates (see Table 2) and the overall catchment areas (see Table 1) at each of the rock drain outlet locations. The hydraulic gradient at each of the stations was estimated by assuming that the water surface in the rock drain conveying the design flows would be parallel to the existing ground surface. The existing ground surface slope gradient at each of the stations was estimated from the existing ground contour base drawing.

The porosity of rock drain materials was assumed to be 0.3, which is the same as used by BGC (2012a). The representative particle size for the rock drain materials was assumed to be 0.1 m during construction and mine operation before mine closure. The value was adopted after discussion with Victoria Gold to consider possible gradations of the materials after finer particles are removed by processing. A representative particle size of 0.05 m was adopted to consider the lower bound of the rock drain particle size gradation and potential particle break-down in the long term after mine closure.

Using the equations in Section 5.1, the rock drain cross-section area that is required to convey the pro-rated design flow at each of the selected stations has been estimated, as presented in Appendix B. To provide additional contingency against potential rock drain performance reduction due to various uncertainties and risks, a multiplier (factor of safety) is applied to the calculated area to estimate the design cross-section area at each of the selected stations. JDS's stability analyses of the WRSAs indicated that the toe area of the lowermost bench of the WRSAs is considered as a critical zone and is relatively sensitive to the groundwater levels assumed. Therefore, a higher factor of safety is adopted for the toe area. In addition, a set of higher factors of safety are selected for the long-term closure case. Table 3 summarizes the factors of safety adopted.

Table 3: Factors of Safety Adopted for Rock Drain Design Update

Case		Eagle Pup WRSA	Platinum Gulch WRSA
Construction and operation before mine closure	Critical zone (from rock drain outlet at the toe area to approximately 100 m inwards)	3	3
	The remaining area beyond the critical zone	2	2
Long term after mine closure	Critical zone (from rock drain outlet at the toe area to approximately 100 m inwards)	4	4
	The remaining area beyond the critical zone	3	3

The factors of safety are used to consider the following uncertainties and risks:

- Potential migration of fine grained materials into the voids of rock drains;
- Potential degradation of the rock drain materials over time;
- Temporarily freezing of a portion of the drains; and
- Minor deficiencies during construction.

Measures to reduce these risks are further discussed in Section 6.

5.2.2 Recommended Rock Drain Cross-section Areas

The calculation results, as summarized in Appendix B, indicate that the rock drain cross-section areas for the closure case are greater than those for the case during construction and operation. Therefore, the values for the closure case are adopted as the recommended rock drain cross-section areas for design, as presented in Tables 4 and 5 for the Eagle Pup and Platinum Gulch WRSAs, respectively.

Table 4: Design Rock Drain Areas and Dimensions for Eagle Pup WRSA

Rock Drain Location (Station)	Required Rock Drain Cross-Section Area (m^2)	Recommended Rock Drain Cross-section Area for Design (m^2)	Design Top Crest Width of Rock Drain (m)	Design Crest Elevation of Rock Drain (m)	Design Height at Centerline (m)
0+044 (lowermost toe of WRSA)	27.8	111.0	32	922.9	3.7
0+100	28.6	114.3	32	930.1	3.1
0+150	27.0	107.8	32	936.1	3.9
0+200	25.4	76.2	24	941.7	4.7
0+300	21.0	63.0	16	955.8	3.5
0+400	19.7	59.2	14	969.6	3.2
0+500	15.7	47.0	12	984.1	3.3
0+600	12.6	37.9	10	1,000.9	3.6
0+700	9.2	27.7	8	1,018.9	3.5
0+800	7.6	22.8	6	1,040.7	2.7
0+900	4.7	14.1	4	1,067.1	2.4
0+1000	4.2	12.6	4	1,100.3	2.2

Table 5: Design Rock Drain Areas and Dimensions for Platinum Gulch WRSA

Rock Drain Location (Station)	Required Rock Drain Cross-Section Area (m^2)	Recommended Minimum Rock Drain Cross-section Area for Design (m^2)	Design Top Crest Width of Rock Drain (m)	Design Crest Elevation of Rock Drain (m)	Design Height at Centerline (m)
0+062 (lowermost toe of WRSA)	10.6	42.5	11	954.5	3.1
0+100	9.4	37.8	10	963.1	3.0
0+150	8.4	33.7	10	974.5	3.1
0+200	7.6	22.7	7	989.5	2.9
0+300	7.1	21.4	6	1,023.4	2.8
0+400	6.0	18.1	6	1,055.4	3.3
0+500	5.7	17.0	5	1,091.3	2.4

6.0 DESIGN CONSIDERATIONS AND RECOMMENDATIONS

6.1 Foundation Preparation

It is understood that Victoria Gold and JDS plan to excavate the overburden layer to weathered bedrock (Type 3) in the toe area (50 m to 100 m from the toe) of the lowest bench for each of the WRSAs to increase overall slope stability. It is not planned to excavate the existing organic layer and underlying overburden soils in the remaining footprints of the WRSAs.

The April 2018 site investigation indicates that the organic layer in the WRSAs consists of fibrous peat up to 0.3 m thick (Tetra Tech 2018). Beneath the organic layer, poorly to well graded, silt, sand, and gravel mixtures with cobbles disseminated throughout make up the bulk of the colluvial overburden (Tetra Tech 2018). Any of these may be the dominant soil component.

In BGC's 2012 feasibility design, it was recommended to strip the 0.3 m organic layer from the footprints of the rock drains. Stripping the organic layer along the valley bottoms, outside of the noted 50 m to 100 m area from the toe would expose alluvium (gravels, cobbles, and boulders) mixed with colluvial overburden that may be susceptible to surface erosion when drainage water flows through the rock drain materials. It is believed that the existing surface materials, including the surficial organic material would provide better resistance to potential surface erosion since they have been subjected to natural surface water flow for a long time. Therefore, it is recommended that the rock drain materials be placed directly over the existing ground surface without stripping the organic layer. Settlement of the rock drain materials into the organic layer and underlying overburden soils upon loading from waste rock is expected, especially when the rock drain materials are placed in winter over seasonally frozen overburden soils. It is recommended that the as-built top elevation of the rock drain should be at least 0.3 m higher than the design elevation to compensate for the expected settlement after construction.

6.2 Rock Drain Materials

The rock drains shall be constructed of non-metal leaching, non-acid generating, clean, hard, durable rock, resistant to weathering; free from organic matter, frozen soil, snow, ice, and overburden soil materials; and shall meet the gradation requirements as specified in Table 6.

Table 6: Rock Drain – Particle Size Distribution Limits

Particle Size (mm)	**% Passing**
1,000	100
500	50 - 100
200	10 - 100
100	0 - 20
50	0 - 10

Victoria Gold is identifying potential sources for the rock drain materials. Based on available information, the candidate rock sources may include fresh or slightly weathered granodiorite, quartzite, or even hornfels. It is understood that most of the rock drain materials will be sourced from waste rock during open pit development. Processing such as running select waste rock materials through a screening system (or a grizzly) with an opening of 100 mm or larger may be required to remove finer particles. It is understood that Victoria Gold expects to use a grizzly to carry out the rock drain material screening in order to achieve the required gradation.

The risk of degradation of the rock drain materials can be limited by using durable materials for construction under adequate quality control. Particle gradation assessments and durability tests for the materials to be used for rock drain construction will be conducted to evaluate the suitability of the materials. This is outlined in the Rock Drain Durability Testing Plan (SGC 2018). Many laboratory tests have been used to evaluate rock durability. More recently developed tests (Micro-Deval Abrasion and Resistance to Unconfined Freezing and Thawing) are recommended to differentiate between marginal and durable aggregates than the traditional tests (Magnesium Sulphate Soundness and Los Angeles Abrasion) for rock (aggregate) durability. Highly absorptive rock is rarely durable. The following criteria are preliminarily adopted at this stage for the rock drain evaluation/confirmation:

- Non-metal leaching, non-acid generating, clean, hard, durable rock, resistant to weathering, free from organic matter, frozen soil, snow, ice, and overburden soil materials;
- Particle size distribution as specified in Table 6;
- Strong rock with a rock grade R4 or higher, an uniaxial compressive strength (UCS) of greater than 50 MPa, point load index of greater than 2.0 MPa, or equivalent;
- Absorption (ASTM D6473) of no greater than 2%; and
- Micro-Deval abrasion (CSA A23.2-29A) loss of no greater than 21%.

Resistance to unconfined freeze-thaw test (CSA A23.2-24A) of no greater than 10%.A construction quality control/quality assurance (QA/QC) and monitoring program is required during construction of the rock drains to ensure that design and construction requirements for the rock drains are met. It is understood that Victoria Gold is developing a plan for rock drain material durability tests and a QA/QC program during construction. The plan will be presented in a separate document.

6.3 Mine Waste Placement

Fine-grained overburden soils or completely weathered waste rock should not be placed within 20 m of the rock drain's outside surface.

Select good quality waste rock with minimal fines should be placed within 10 m distance of the rock drain outside surface to reduce the risk of potential fines migrating into the rock drain. Alternatively, the select waste rock zone over each rock drain can be replaced with a coarse rock fill zone above the rock drain. This coarse rock fill zone can be placed by end-dumping good quality waste rock material over a minimum 20 m high repose angle face to yield a well-graded filter zone above the drain that should prevent the migration of fines (Hawley and Cunning 2017).

6.4 Permafrost and Freezing

The April 2018 site investigation and the recent measured ground temperature data indicated that very warm permafrost (with measured temperatures equal to or warmer than -0.5°C at depths of about 8 m from the ground surface) was observed in the proposed Platinum Gulch WRSA; however, six boreholes drilled and three thermistors installed in the proposed Eagle Pup WRSA in 2018 showed permafrost-free conditions. Frozen ground with excess ice was observed in the proposed Eagle Pup WRSA area, as reported in BGC (2012a). However, it is expected that permafrost in the area is discontinuous and very warm (similar to Platinum Gulch WRSA or warmer). This suggests that the risk of freezing the drains due to permafrost development into the rock drains is low, especially in the Eagle Pup WRSA.

Without mitigation, seasonal freezing of a small portion of the rock drain close to the downstream slope toe of the lowest bench for each WRSA may occur. Therefore, the design includes an extension of the rock drain outlet to at least 5 m beyond the slope toe for each WRSA, and a select waste rock thermal cover of 4 m over the extended portion of the rock drain. This will limit seasonal freezing to the extended portion beyond the slope toe.

It is understood that a portion of the rock drains may be constructed in winter. Therefore, the rock drain materials may temporarily be in a frozen condition after construction. The temperature of the rock drain after construction will gradually come to equilibrium with the surrounding ground. The voids of the materials would be generally ice-free since the materials will be placed in relatively dry conditions. In the following thawing season, drainage water will flow through the voids and raise the rock drain temperature. Freezing water requires removing a significant amount of the latent heat from the water that is flowing through the voids of rocks. The rocks are not expected to be cold enough and therefore will not have the cooling capacity to freeze the flowing water.

7.0 ROCK DRAIN DESIGN DRAWINGS AND MATERIAL VOLUMES

The following design drawings for the rock drains are attached in Appendix C.

- C01: Plan view showing overall site layout of proposed WRSAs;
- C02: Plan view showing catchment boundaries for the WRSAs and proposed locations for rock drains;
- C03: Design profile along the proposed Eagle Pup WRSA rock drain;
- C04: Design profile along the proposed Platinum Gulch WRSA rock drain;
- C05: Eagle Pup WRSA rock drain design cross-sections Sta. 0+044 to 1+1000; and
- C06: Platinum Gulch WRSA rock drain design cross-sections Sta. 0+062 to 1+500.

A typical design section of the rock drains is presented in Drawing C06 in Appendix C. To compensate for the expected settlement of the foundation materials, the as-built elevations of the rock drains should be at least 0.3 m higher than the design values shown on the cross-section drawings. Table 7 summarizes the estimated rock drain in-place volumes.

Table 7: Estimated Rock Drain Material In-place Volumes

WRSA	Estimated Rock Drain In-place Volume for Design (without considering foundation settlement) (m^3)	Estimated Rock Drain In-place Volume for Construction (considering foundation settlement of 0.3 m) (m^3)
Eagle Pup	49,950	55,316
Platinum Gulch	11,352	12,880

Tables 8 and 9 summarize the required construction (as-built) areas and dimensions at selected locations for each rock drain for the Eagle Pup and Platinum Gulch WRSAs, respectively.

Table 8: Required As-built Rock Drain Areas and Dimensions for Eagle Pup WRSA

Rock Drain Location (Station)	Required Minimum As-built Rock Drain Cross-Section Area (m^2)	Required Minimum Top Crest Width of Rock Drain (m)	Estimated Bottom Width of As-built Rock Drain (m)	Minimum As-built Crest Elevation of Rock Drain (m)	Minimum As-built Height at Centerline (m)
0+044 (lowermost toe of WRSA)	123.2	32	36.0	923.2	4.0
0+100	127.1	32	37.6	930.4	3.4
0+150	119.0	32	36.2	936.4	4.2
0+200	85.8	24	26.6	942.0	5.0
0+250	76.4	18	22.2	948.4	4.0
0+300	70.0	16	21.2	956.1	3.8
0+350	68.5	16	22.0	962.8	3.7
0+400	66.3	14	22.1	969.9	3.5
0+450	59.1	14	18.7	975.8	4.0
0+500	52.6	12	18.1	984.4	3.6
0+550	48.4	10	16.5	992.9	3.8
0+600	44.0	10	15.7	1,001.2	3.9
0+650	37.7	9	14.4	1,009.7	3.4
0+700	32.1	8	12.6	1,019.2	3.8
0+750	30.6	7	12.7	1,029.6	3.1
0+800	27.2	6	12.0	1,041.0	3.0
0+850	21.9	4	10.2	1,053.8	3.1
0+900	17.2	4	9.0	1,067.4	2.7
0+950	16.7	4	9.3	1,087.0	2.5
0+1000	16.3	4	8.8	1,100.6	2.5

Table 9: Required As-built Rock Drain Areas and Dimensions for Platinum Gulch WRSA

Rock Drain Location (Station)	Required Minimum As-built Rock Drain Cross-Section Area (m^2)	Required Minimum Top Crest Width of Rock Drain (m)	Estimated Bottom Width of As-built Rock Drain (m)	Minimum As-built Crest Elevation of Rock Drain (m)	Minimum As-built Height at Centerline (m)
0+062 (lowermost toe of WRSA)	47.8	11	17.3	954.8	3.4
0+100	43.4	10	16.3	963.4	3.3
0+150	38.5	10	14.4	974.8	3.4
0+200	26.5	7	11.0	989.8	3.2
0+250	25.7	7	10.8	1,006.5	3.6
0+300	24.7	6	10.5	1,023.7	3.1
0+350	22.8	6	9.7	1,038.9	3.3
0+400	20.6	6	9.0	1,055.7	3.6
0+450	20.5	5	10.4	1,073.7	2.7
0+500	20.3	5	10.3	1,091.6	2.7

The design geometries in Tables 8 and 9 are based on the original ground contours in the base map drawing provided. It is recommended to survey the original ground within the footprints of the rock drains to confirm the original ground surface elevations. If the differences in elevations are more than 0.1 m, the newly surveyed data should be reviewed by the design engineer to evaluate whether the rock drain design geometries should be updated accordingly.

8.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Victoria Gold Corp. and their agents. Tetra Tech Canada Inc. (operating as Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Victoria Gold Corp., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on Use of this Document attached in Appendix D or Contractual Terms and Conditions executed by both parties.

9.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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Nov. 14, 2018

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REFERENCES

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FIGURES

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NOTES:
IMAGERY REFERENCE FROM
GOOGLE EARTH PRO, 2016.

0 25 km

Scale: 1:500,000 @ 8.5"x11"

CLIENT

Victoria
GOLD CORP

TETRA TECH

EAGLE GOLD PROJECT
ROCK DRAIN DESIGN

SITE LOCATION

PROJECT NO.	DWN	CKD	REV
ENG.EARC03103-02	EL	GZ	A

OFFICE	DATE
EDMONTON	OCTOBER 16, 2018

FIGURE 1

APPENDIX A

SUMMARY OF HYDROLOGICAL MODEL RESULTS

Estimated Peak Flows at Rock Drain Outlets for Eagle Pup and Platinum Gulch Waste Rock Storage Areas

by Mauricio Herrera, Ph.D., P.Eng.

Senior Hydrotechnical Engineer

Tetra Tech Canada Inc.

October 10, 2018

Hydrological Model

- A hydrological model was built using PCSWMM for each waste rock storage area(WRSA) , one for Platinum Gulch and one for Eagle Pup.
- Each WRSA was modeled as a separate watershed
- Two scenarios were modeled:
  - a) No waste rock in watershed (prior to pit development)
  - b) Closure (waste rock in watershed)
- CN values were selected consistently with those have been used in the project
  - CN for Scenario a) = 60
  - CN for Scenario b) = 82
- The model was run with the 200-year storm (58 mm) as per LORAX (2017)
- Hyetograph shape selected: SCS Type II (This selection is likely conservative for the project area, but it was selected to introduce a safety factor)
- Watershed areas:

WRSA	Scenario a): Area prior to pit development (ha)	Scenario b): Area after pit development (ha)
Eagle Pup	111.33	97.55
Platinum Gulch	56.8	53.2

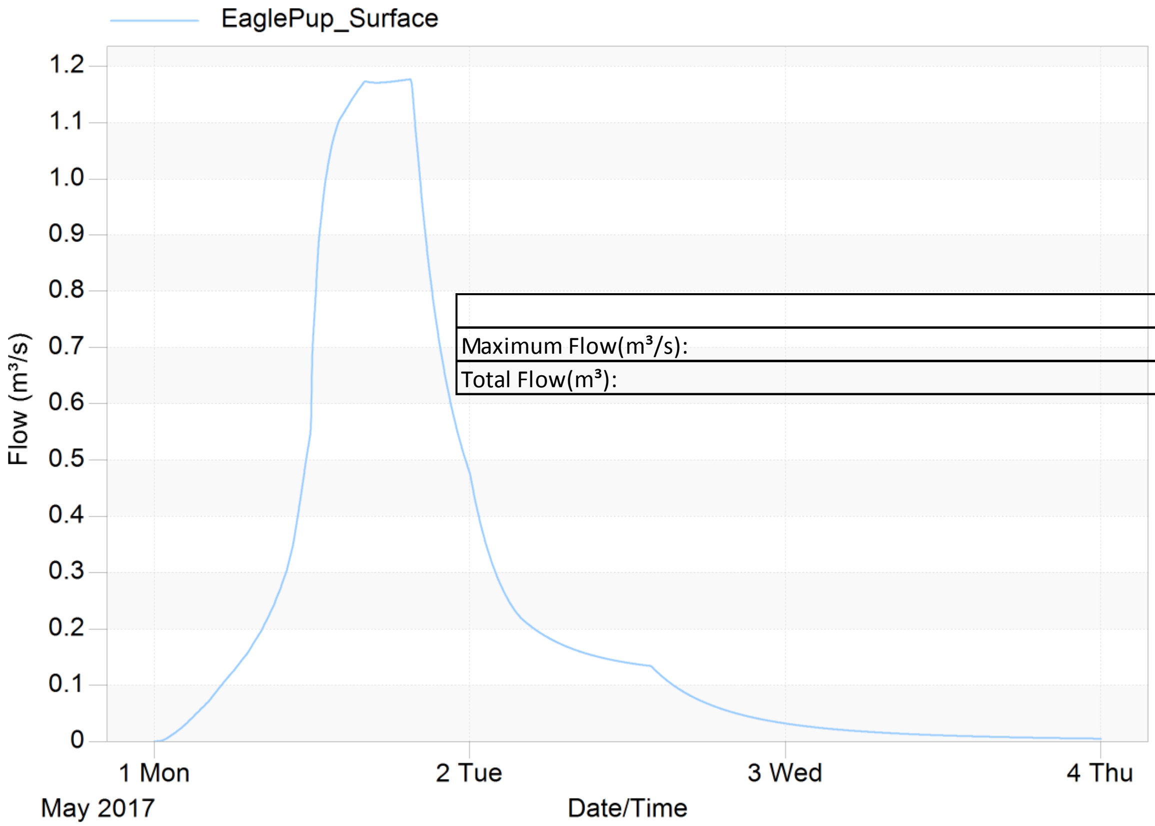
Hydrological modeling

- For Scenario b) the watersheds were divided in sub-catchments to better represent the WRSAs
- Each sub-catchment includes both surface and sub-surface hydrology
- The model accounts for precipitation, depression storage, infiltration, surface runoff and groundwater flow
- Surface runoff from one sub-catchment drains as sheet flow to the downstream sub-catchment
- Surface runoff can infiltrate or keep moving to the next sub-catchment
- Infiltrated water goes into the groundwater module
- Groundwater flow is routed via a conduit network that links the groundwater flows from all sub-catchments, from upstream to downstream

Hydrological Modeling Results

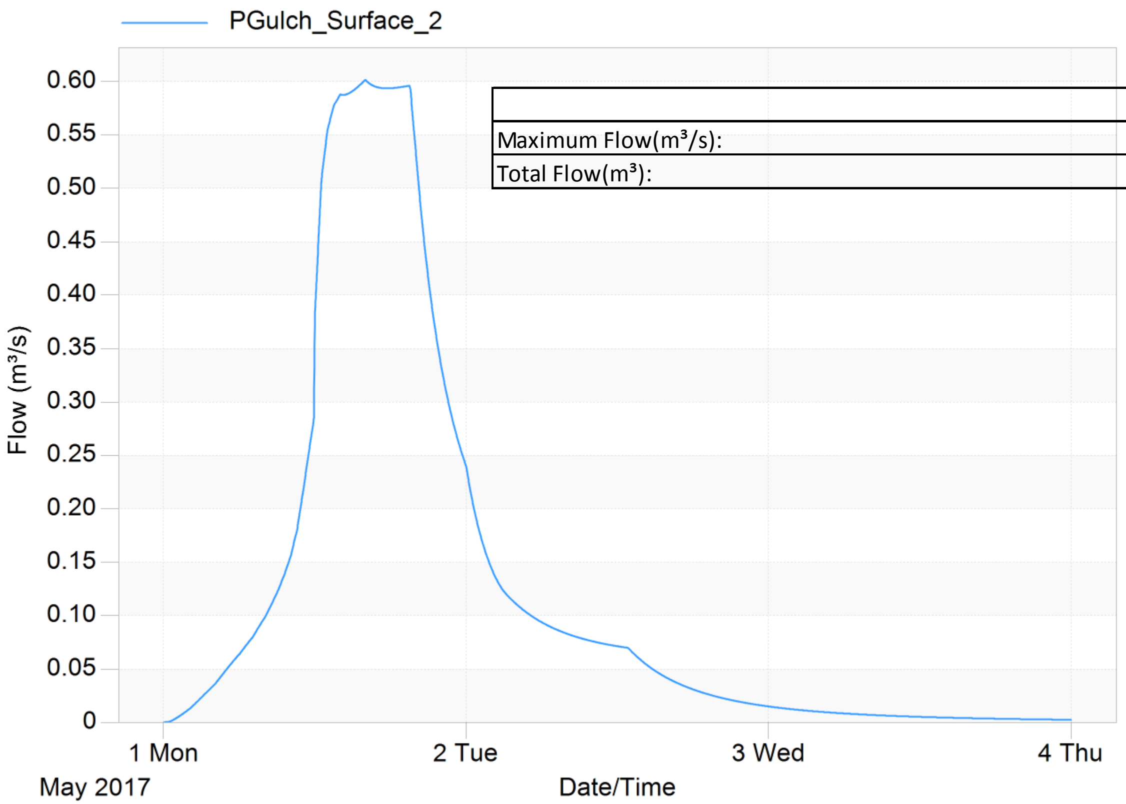
- For scenario a), one hydrograph is produced for surface flows from each watershed
- For scenario b) three hydrographs are presented for each watershed:
  1. Subsurface flow: flow through the waste rock into the rock drain, which is the estimated peak flow at the rock drain outlet. The value can be used for the rock drain design for the WRSA
  2. Surface flow: sheet surface runoff flow that will reach the toe of the WRSA but not flow into the rock drain
  3. Upstream flow: surface runoff from the watershed area upstream of the WRSA, which will not flow into the rock drain

Results: Scenario a) for Eagle Pup WRSA



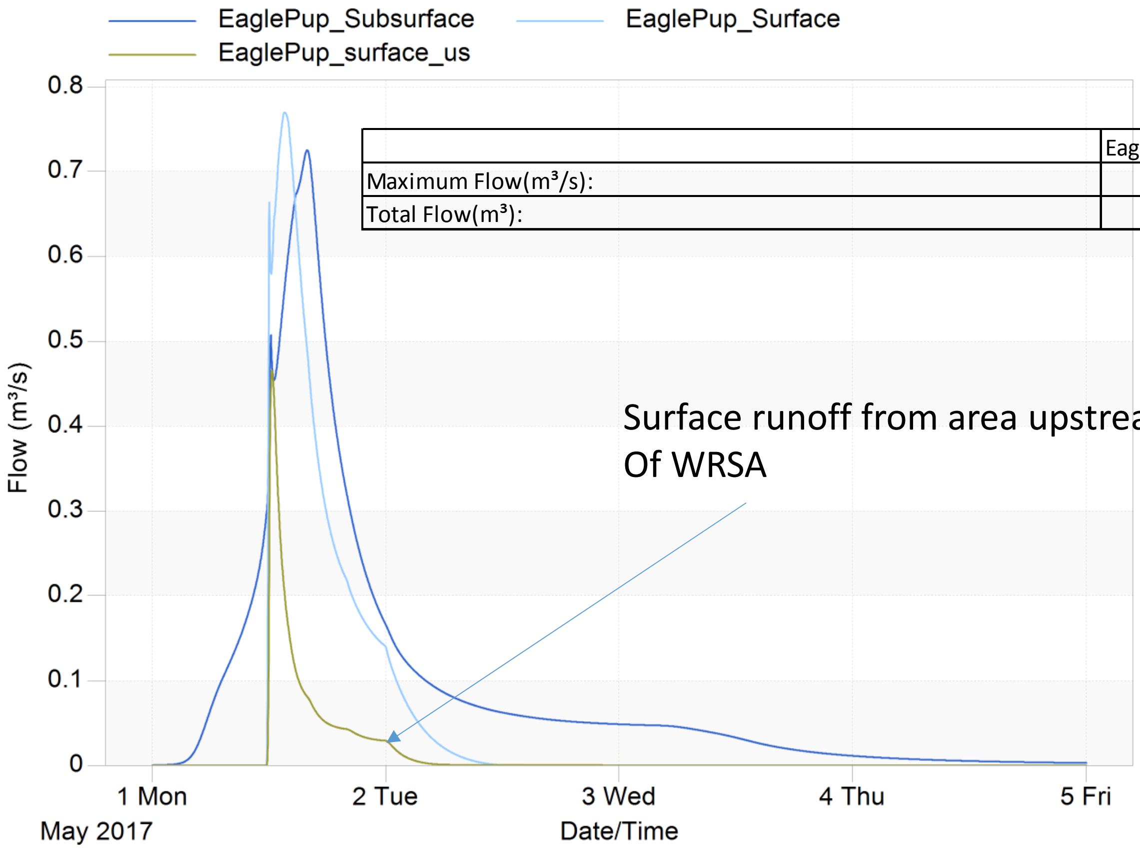
	Eagle Pup (prior to pit development)
Maximum Flow(m³/s):	1.176
Total Flow(m³):	62750

Results: Scenario a) for Platinum Gulch WRSA



	Platinum Gulch (prior to pit development)
Maximum Flow(m^3/s):	0.6015
Total Flow(m^3):	32030

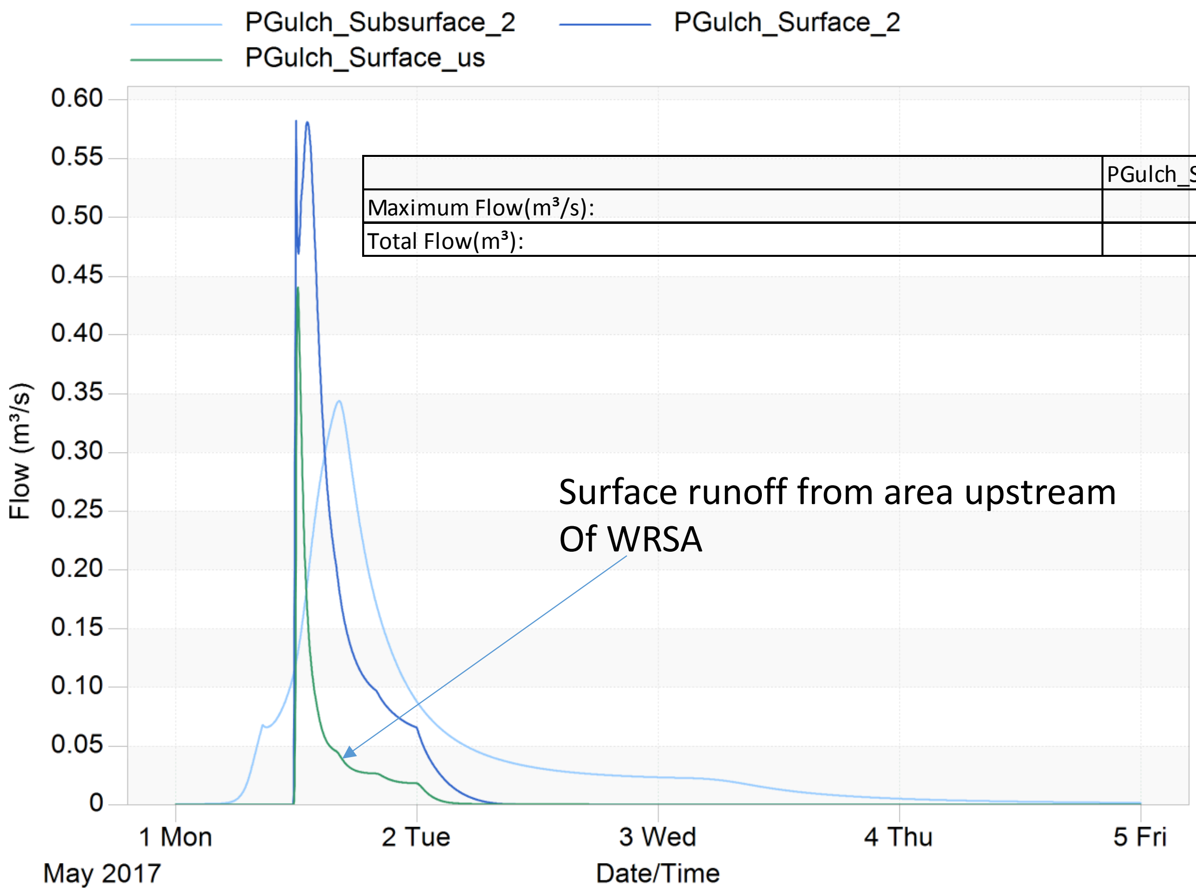
Results: Scenario b) for Eagle Pup WRSA



	EaglePup_Subsurface	EaglePup_Surface	EaglePup_surface_us
Maximum Flow(m³/s):	0.7254	0.7696	0.4658
Total Flow(m³):	32470	18150	4497

Surface runoff from area upstream
Of WRSA

Results: Scenario b) for Platinum Gulch WRSA



	PGulch_Subsurface_2	PGulch_Surface_2	PGulch_Surface_us
Maximum Flow(m³/s):	0.3437	0.5822	0.4404
Total Flow(m³):	15000	9712	2927

Surface runoff from area upstream
Of WRSA

APPENDIX B

SUMMARY OF ROCK DRAIN CROSS-AREA ESTIMATES

Total Catchment Area of Eagle Pup Rock Drain (m^2): 1,113,316 (before pit development)
Design Peak Flow Rate at Outlet of Eagle Pup Rock Drain (m^3/sec): 1.176 (Scenario A for construction and operation)

Station Number	Unit	1+000	0+900	0+800	0+700	0+600	0+500	0+400	0+300	0+200	0+150	0+100	0+044 (Outlet)
Total upstream catchment area	m^2	225,493	257,046	537,202	584,718	688,205	800,528	861,876	938,684	1,031,056	1,064,025	1,096,993	1,113,316
Estimated flow rate	m^3/sec	0.238	0.272	0.567	0.618	0.727	0.846	0.910	0.992	1.089	1.124	1.159	1.176
Natural ground surface slope		0.27	0.28	0.26	0.22	0.18	0.17	0.13	0.14	0.12	0.12	0.11	0.12
Porosity of rock drain material		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Hydraulic gradient		0.26	0.27	0.25	0.21	0.18	0.17	0.13	0.14	0.12	0.11	0.11	0.12
Dominant particle size	m	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Required rock drain area	m^2	4.2	4.7	10.3	12.2	15.9	19.0	23.6	24.7	29.5	31.1	32.8	31.8
Factor of safety adopted		2	2	2	2	2	2	2	2	2	3	3	3
Minimum design rock drain cross-section area	m^2	**8.4**	**9.5**	**20.5**	**24.3**	**31.8**	**38.1**	**47.2**	**49.4**	**58.9**	**93.3**	**98.5**	**95.5**

Total Catchment Area of Eagle Pup Rock Drain (m^2): 975,539 (after pit development)
Design Peak Flow Rate at Outlet of Eagle Pup Rock Drain (m^3/sec): 0.7254 (Scenario B for closure)

Station Number	Unit	1+000	0+900	0+800	0+700	0+600	0+500	0+400	0+300	0+200	1+150	0+100	0+044 (Outlet)
Total upstream catchment area	m^2	225,493	257,046	399,425	446,941	550,428	662,751	724,099	800,907	893,279	926,248	959,216	975,539
Estimated flow rate	m^3/sec	0.168	0.191	0.297	0.332	0.409	0.493	0.538	0.596	0.664	0.689	0.713	0.725
Natural ground surface slope		0.27	0.28	0.26	0.22	0.18	0.17	0.13	0.14	0.12	0.12	0.11	0.12
Porosity of rock drain material		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Hydraulic gradient		0.26	0.27	0.25	0.21	0.18	0.17	0.13	0.14	0.12	0.11	0.11	0.12
Dominant particle size	m	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Required rock drain area	m^2	4.2	4.7	7.6	9.2	12.6	15.7	19.7	21.0	25.4	27.0	28.6	27.8
Factor of safety adopted		3	3	3	3	3	3	3	3	3	4	4	4
Minimum design rock drain cross-section area	m^2	**12.6**	**14.1**	**22.8**	**27.7**	**37.9**	**47.0**	**59.2**	**63.0**	**76.2**	**107.8**	**114.3**	**111.0**

Total Catchment Area of Platinum Gulch Rock Drain (m^2): 568,048 (before pit development)

Design Peak Flow Rate at Outlet of Platinum Gulch Rock Drain (m^3/sec): 0.6015 (Scenario A for construction and operation)

Station Number	Unit	0+500	0+400	0+300	0+200	0+150	0+100	0+062 (outlet)
Total upstream catchment area	m^2	411,361	441,444	485,209	528,991	545,325	561,658	568,048
Estimated flow rate	m^3/sec	0.436	0.467	0.514	0.560	0.577	0.595	0.602
Natural ground surface slope		0.31	0.32	0.28	0.3	0.26	0.22	0.18
Porosity of rock drain material		0.3	0.3	0.3	0.3	0.3	0.3	0.3
Hydraulic gradient		0.30	0.30	0.27	0.29	0.25	0.21	0.18
Dominant particle size	m	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Required rock drain area	m^2	7.2	7.6	8.9	9.4	10.6	11.7	13.1
Factor of safety adopted		2	2	2	2	3	3	3
Minimum design rock drain cross-section area	m^2	**14.4**	**15.2**	**17.9**	**18.8**	**31.7**	**35.1**	**39.4**

Total Catchment Area of Platinum Gulch Rock Drain (m^2): 531,954 (after pit development)

Design Peak Flow Rate at Outlet of Platinum Gulch Rock Drain (m^3/sec): 0.3437 (Scenario B for closure)

Station Number	Unit	0+500	0+400	0+300	0+200	0+150	0+100	0+062 (outlet)
Total upstream catchment area	m^2	375,267	405,350	449,115	492,897	509,231	525,564	531,954
Estimated flow rate	m^3/sec	0.242	0.262	0.290	0.318	0.329	0.340	0.344
Natural ground surface slope		0.31	0.32	0.28	0.3	0.26	0.22	0.18
Porosity of rock drain material		0.3	0.3	0.3	0.3	0.3	0.3	0.3
Hydraulic gradient		0.30	0.30	0.27	0.29	0.25	0.21	0.18
Dominant particle size	m	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Required rock drain area	m^2	5.7	6.0	7.1	7.6	8.4	9.4	10.6
Factor of safety adopted		3	3	3	3	4	4	4
Minimum design rock drain cross-section area	m^2	**17.0**	**18.1**	**21.4**	**22.7**	**33.7**	**37.8**	**42.5**

APPENDIX C

ROCK DRAIN DESIGN DRAWINGS

NOTES:

1. HORIZONTAL DATUM/PROJECTION: UTM ZONE 8, NAD83 - METERS
2. EXISTING GROUND CONTOUR DATA AND PLATINUM GULCH WRSA GEOMETRY PROVIDED BY JDS ON SEPTEMBER 27, 2018.
3. EAGLE PUP WRSA GEOMETRY PROVIDED BY VICTORIA GOLD ON OCTOBER 9, 2018.

0 250m
Scale: 1:5,000 @ 22"x34"

LEGEND:

∼	25 m MAJOR CONTOUR INTERVAL
∼	5 m INTERMEDIATE CONTOUR INTERVAL
━	WASTE ROCK STORAGE AREA FOOTPRINT
– –	OPEN PIT FOOTPRINT

NUM	DATE	DWN	CKD	APR	DESCRIPTION
0	18-NOV-14	EL	GZ	KJ	ISSUED FOR CONSTRUCTION

REVISIONS

NUM	DATE	APR	DESCRIPTION

DRAWING STATUS

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE Kevin Jones
Date Nov. 14, 2018
PERMIT NUMBER PP003
Association of Professional
Engineers of Yukon

PERMIT

KEVIN W. JONES
Nov. 14, 2018

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Victoria GOLD CORP

TETRA TECH

EAGLE GOLD PROJECT
ROCK DRAIN DESIGN

PLAN VIEW SHOWING
OVERALL SITE LAYOUT

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
ENG.EARC03103-02	EDMONTON	GZ	GZ	0	C01
DATE:	SHEET No.	DWN	APP	STATUS	
NOVEMBER 14, 2018	01 of 06	EL	KJ	-	

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EAGLE PUP ROCK DRAIN LAYOUT POINTS

STATION	NORTHING	EASTING
0+044	7 100 909.54	459 877.17
0+100	7 100 880.73	459 925.27
0+150	7 100 857.94	459 969.76
0+200	7 100 829.28	460 010.72
0+250	7 100 795.96	460 047.99
0+300	7 100 758.89	460 081.55
0+350	7 100 722.31	460 115.57
0+400	7 100 677.74	460 138.14
0+450	7 100 629.13	460 149.83
0+500	7 100 580.46	460 161.22
0+550	7 100 530.48	460 162.18
0+600	7 100 480.91	460 168.72
0+650	7 100 431.09	460 172.99
0+700	7 100 381.25	460 176.81
0+750	7 100 331.63	460 177.28
0+800	7 100 293.42	460 209.46
0+850	7 100 260.33	460 246.95
0+900	7 100 226.87	460 284.10
0+950	7 100 194.45	460 322.03
1+000	7 100 158.46	460 349.78

PLATINUM GULCH ROCK DRAIN LAYOUT POINTS

STATION	NORTHING	EASTING
0+062	7 099 195.21	459 460.76
0+100	7 099 165.04	459 483.87
0+150	7 099 128.06	459 517.48
0+200	7 099 103.69	459 561.13
0+250	7 099 080.89	459 605.62
0+300	7 099 066.70	459 653.56
0+350	7 099 052.91	459 701.62
0+400	7 099 037.24	459 749.10
0+450	7 099 024.63	459 797.48
0+500	7 099 007.54	459 844.43

NOTES:

1. HORIZONTAL DATUM/PROJECTION: UTM ZONE 8, NAD83 - METERS
2. EXISTING GROUND CONTOUR DATA PROVIDED BY JDS ON SEPTEMBER 27, 2018

0 250m

Scale: 1:5,000 @ 22"x34"

LEGEND:

- 25 m MAJOR CONTOUR INTERVAL
- 5 m INTERMEDIATE CONTOUR INTERVAL
- WASTE ROCK STORAGE AREA FOOTPRINT
- OPEN PIT FOOTPRINT
- CATCHMENT BOUNDARY
- PROPOSED ROCK DRAIN

REVISIONS

NUM	DATE	DWN	CKD	APR	DESCRIPTION
0	18-NOV-14	EL	GZ	KJ	ISSUED FOR CONSTRUCTION

DRAWING STATUS

NUM	DATE	APR	DESCRIPTION

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE
Date Nov. 14, 2018
PERMIT NUMBER PP003
Association of Professional
Engineers of Yukon

PERMIT

KEVIN W. JONES
Nov. 14, 2018

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Victoria
GOLD CORP

TETRA TECH

EAGLE GOLD PROJECT
ROCK DRAIN DESIGN

PLAN VIEW SHOWING
CATCHMENT BOUNDARY AND
ROCK DRAIN LOCATIONS

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
ENG.EARC03103-02	EDMONTON	GZ	GZ	0	C02
DATE:	SHEET No.	DWN	APP	STATUS	
NOVEMBER 14, 2018	02 of 06	EL	KJ	-	

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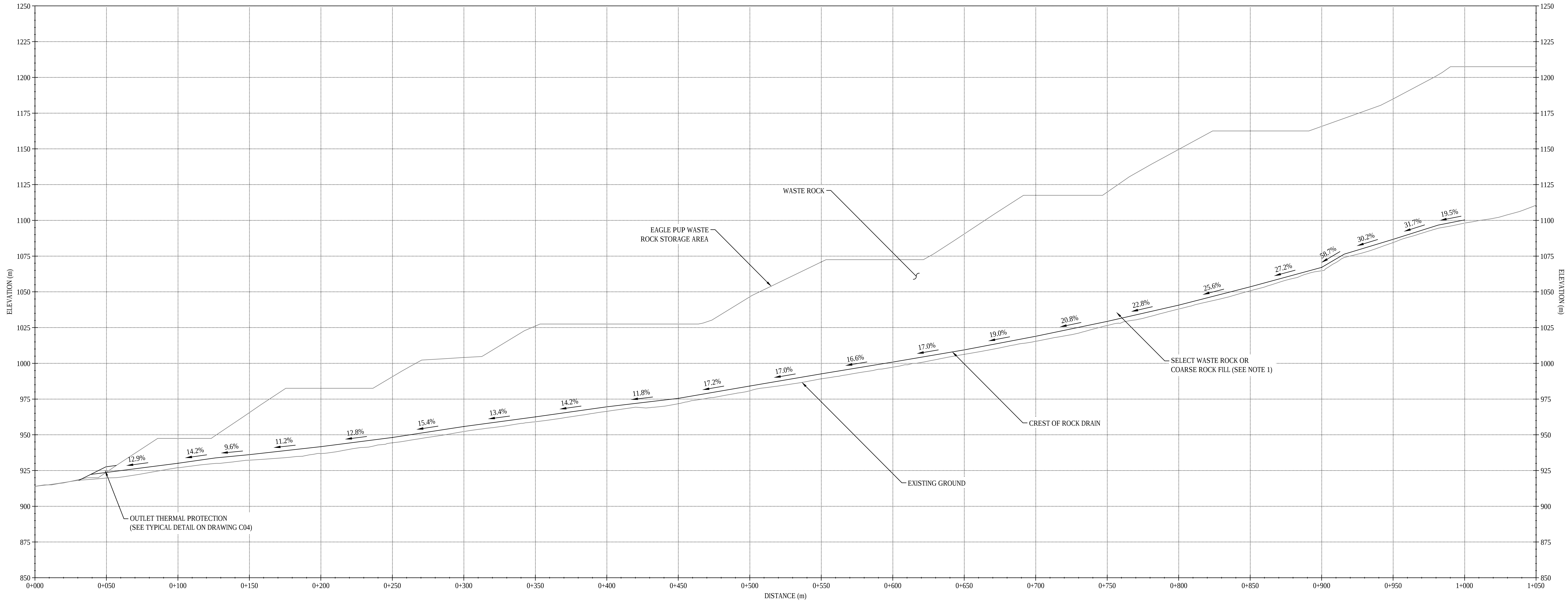

A / C02 DESIGN PROFILE - EAGLE PUP WRSA ROCK DRAIN

SCALE: 1:1 500

NOTES:

1. SELECT GOOD QUALITY WASTE ROCK WITH NO OR MINIMAL FINES SHOULD BE PLACED WITHIN 10 m DISTANCE OF ROCK DRAIN FILL. ALTERNATIVELY A COARSE ROCK FILL ZONE ABOVE THE ROCK DRAIN CAN BE PLACED USING END-DUMPING OFF A LIFT AT LEAST 20 m HIGH. THE COARSE ROCK FILL ZONE CAN REPLACE THE SELECT WASTE ROCK.
2. OVERBURDEN SOILS OR COMPLETELY WEATHERED WASTE ROCK SHOULD NOT BE PLACED WITHIN 20 m DISTANCE OF ROCK DRAIN FILL.

NUM	DATE	DWN	CKD	APR	DESCRIPTION
0	18-NOV-14	EL	GZ	KJ	ISSUED FOR CONSTRUCTION

REVISIONS

NUM	DATE	APR	DESCRIPTION

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Nov. 14, 2018

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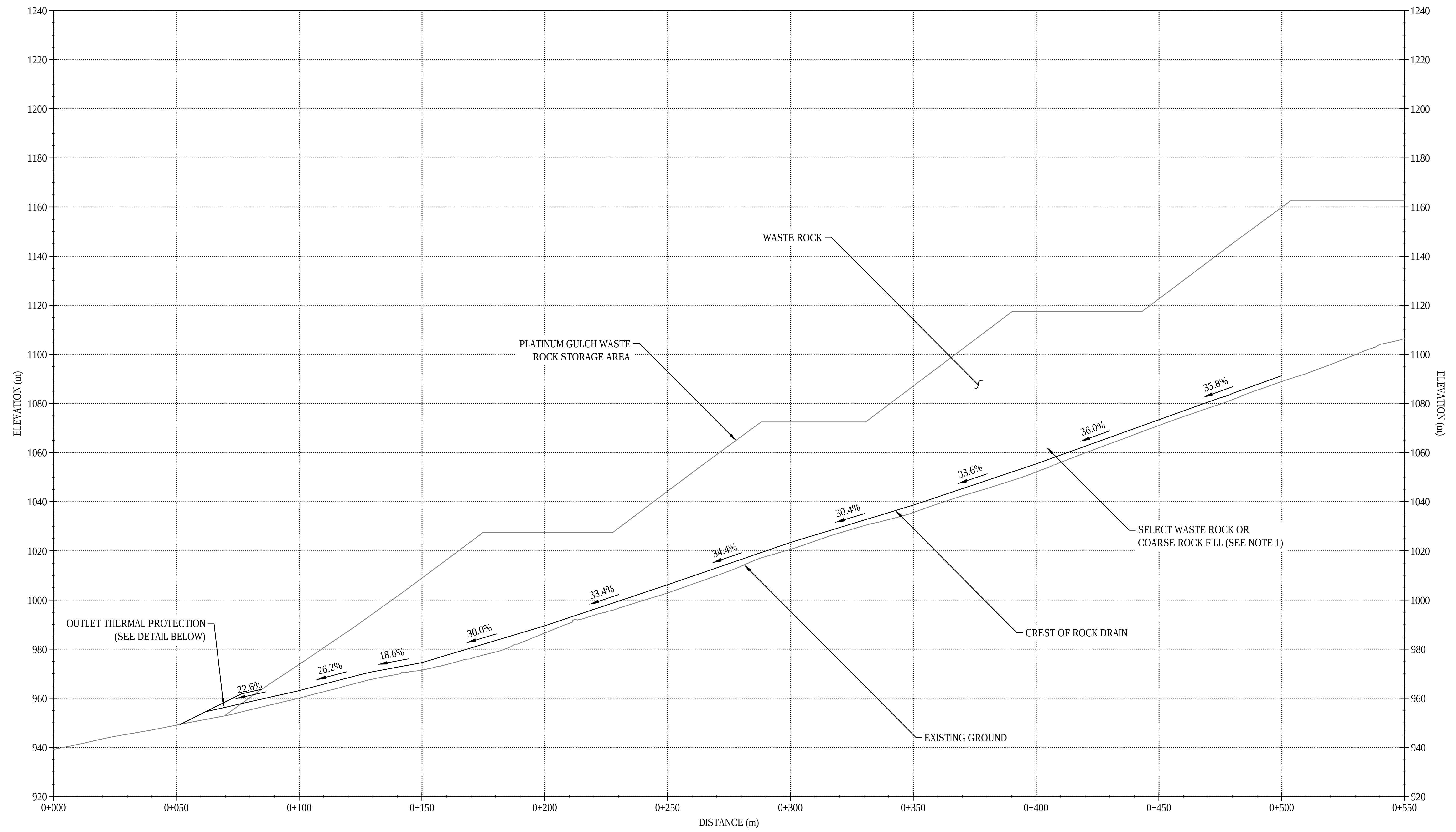
TETRA TECH

EAGLE GOLD PROJECT
ROCK DRAIN DESIGN

DESIGN PROFILE ALONG EAGLE PUP WRSA ROCK DRAIN

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
ENG.EARC03103-02	EDMONTON	GZ	GZ	0	C03
DATE:	SHEET No.	DWN	APP	STATUS	
NOVEMBER 14, 2018	03 of 06	EL	KJ	-	



B / C02 DESIGN PROFILE - PLATINUM GULCH WRSA ROCK DRAIN

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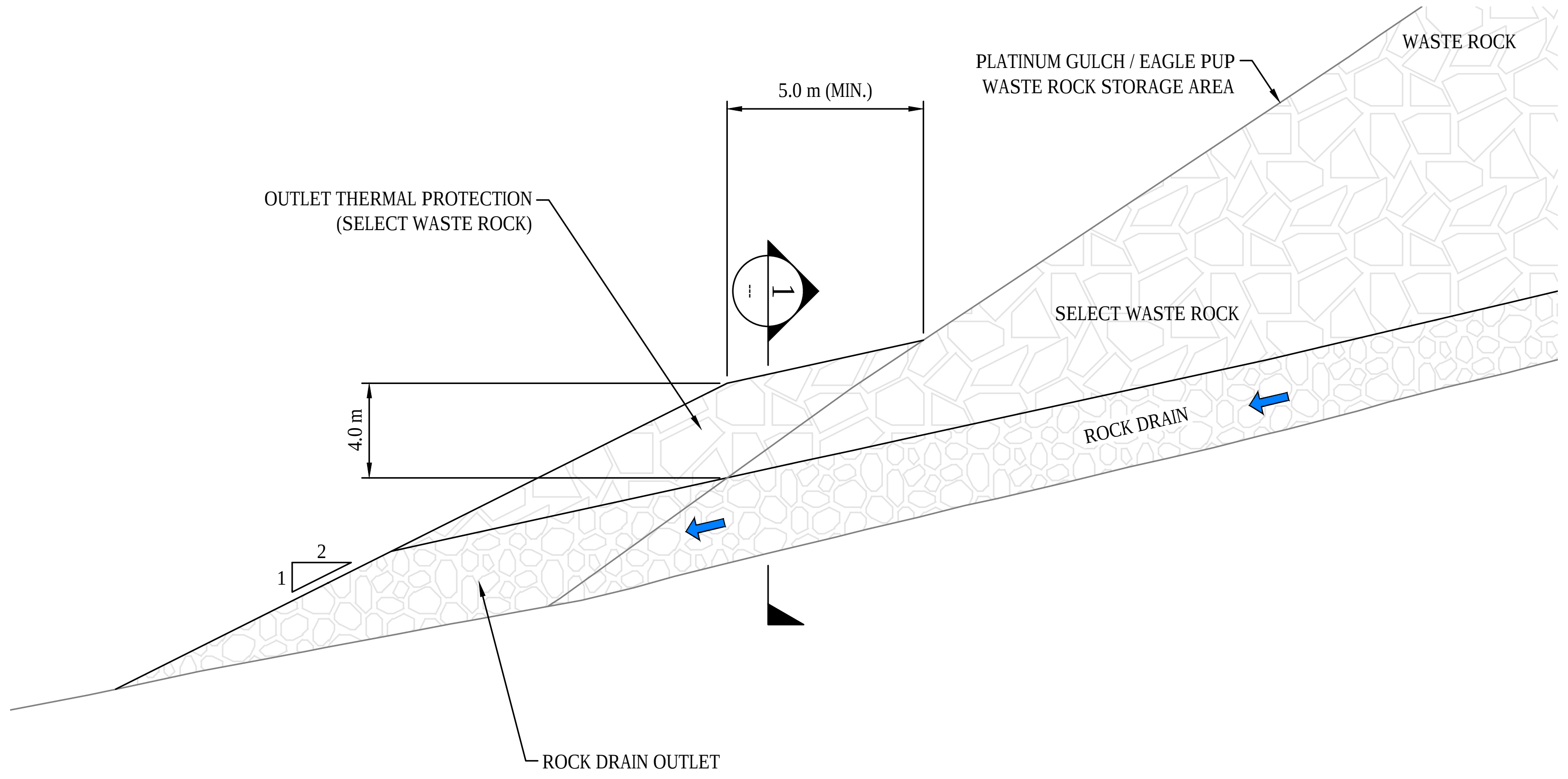
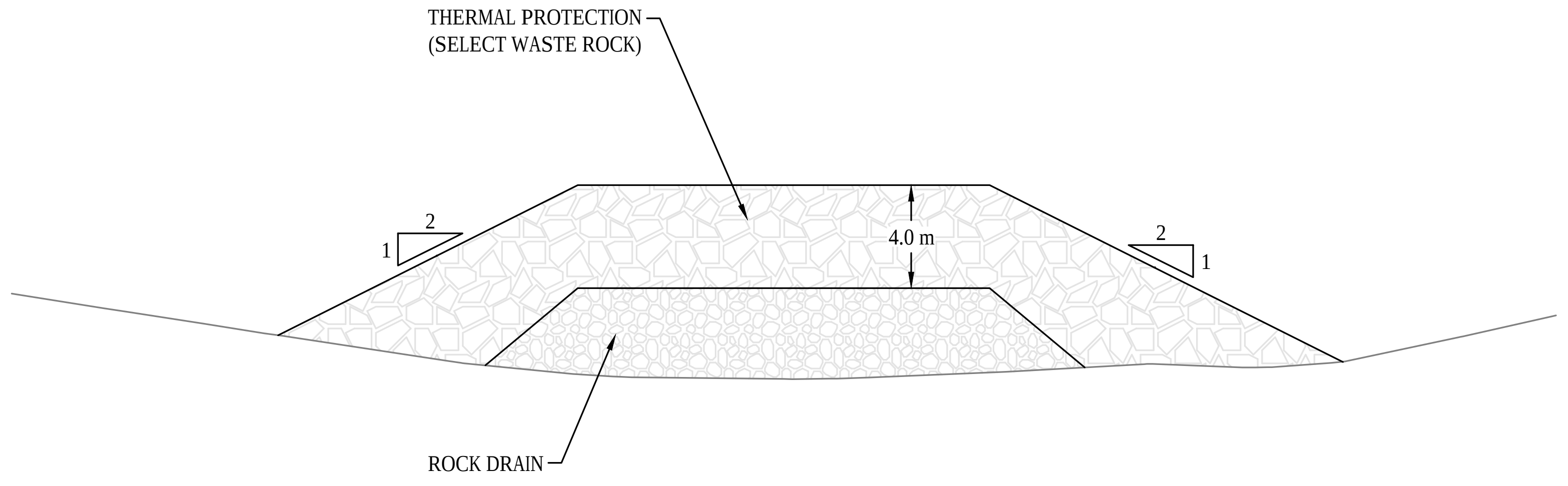


TYPICAL THERMAL PROTECTION AT OUTLET

SCALE = N.T.S.



1 / — TYPICAL DETAIL - THERMAL PROTECTION AT OUTLET

SCALE: N.T.S.

NOTES:

1. SELECT GOOD QUALITY WASTE ROCK WITH NO OR MINIMAL FINES SHOULD BE PLACED WITHIN 10 m DISTANCE OF ROCK DRAIN FILL. ALTERNATIVELY A COARSE ROCK FILL ZONE ABOVE THE ROCK DRAIN CAN BE PLACED USING END-DUMPING OFF A LIFT AT LEAST 20 m HIGH. THE COARSE ROCK FILL ZONE CAN REPLACE THE SELECT WASTE ROCK.
2. OVERBURDEN SOILS OR COMPLETELY WEATHERED WASTE ROCK SHOULD NOT BE PLACED WITHIN 20 m DISTANCE OF ROCK DRAIN FILL.

NUM	DATE	DWN	CKD	APR	DESCRIPTION
0	18-NOV-14	EL	GZ	KJ	ISSUED FOR CONSTRUCTION

REVISIONS

NUM	DATE	APR	DESCRIPTION

DRAWING STATUS

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Date Nov. 14, 2018
PERMIT NUMBER PP003
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KEVIN W. JONES
Nov. 14, 2018

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EAGLE GOLD PROJECT
ROCK DRAIN DESIGN

DESIGN PROFILE ALONG PLATINUM GULCH WRSA ROCK DRAIN

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
ENG.EARC03103-02	EDMONTON	GZ	GZ	0	C04
DATE:	SHEET No.	DWN	APP	STATUS	
NOVEMBER 14, 2018	04 of 06	EL	KJ	-	

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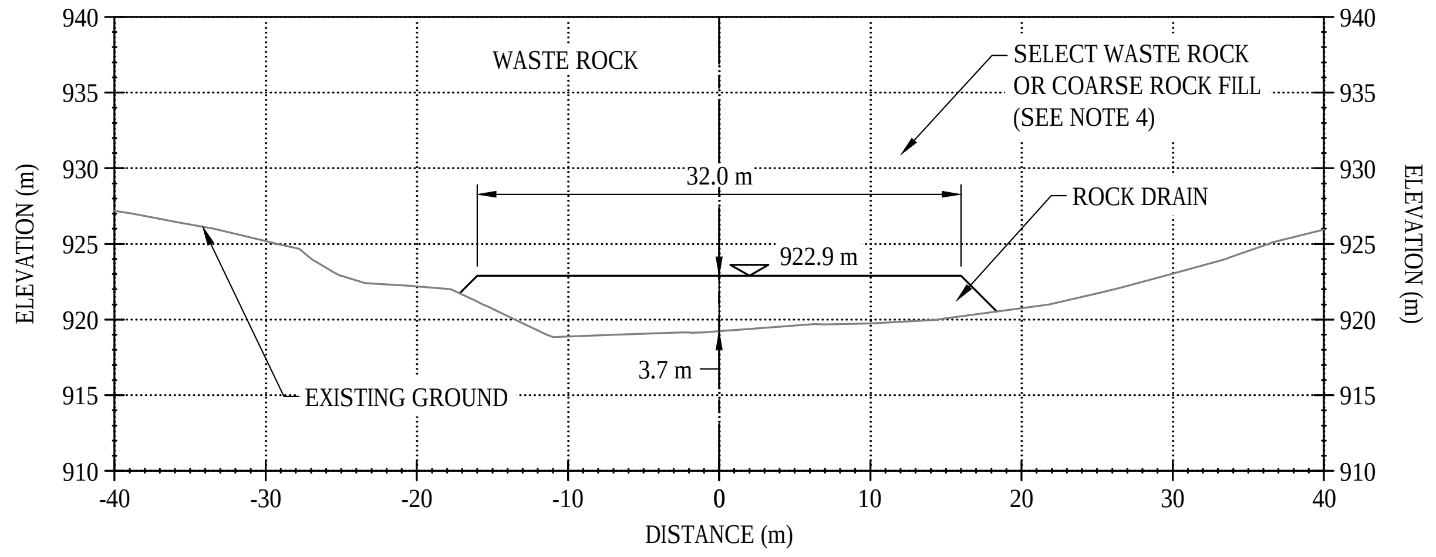

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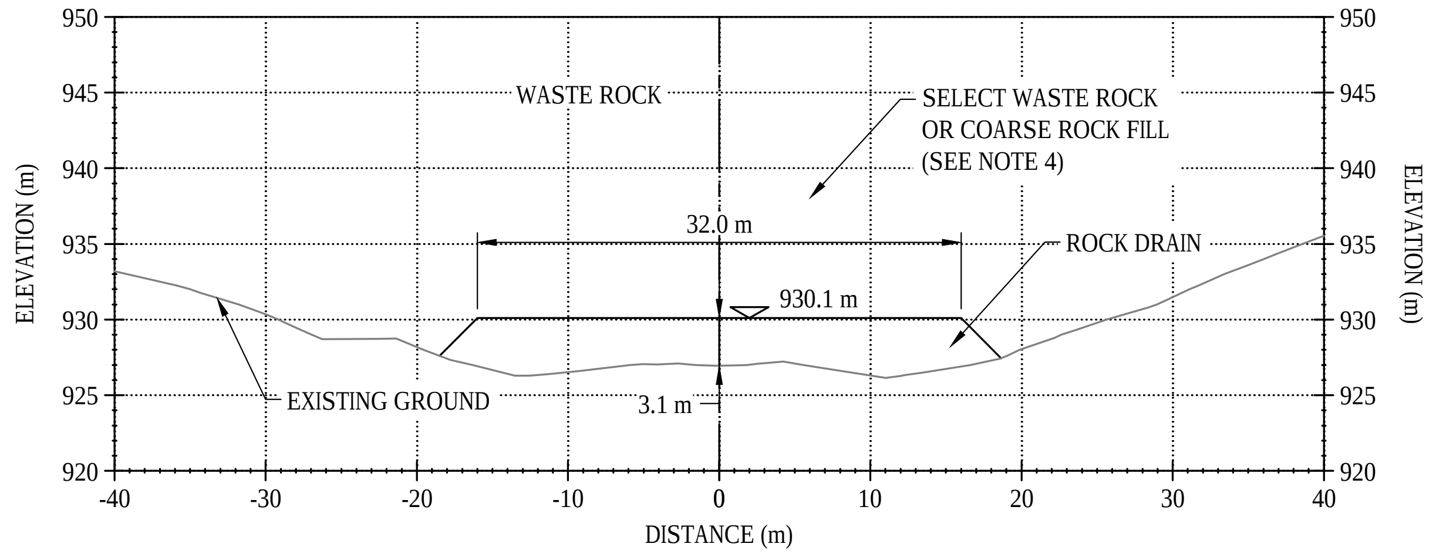

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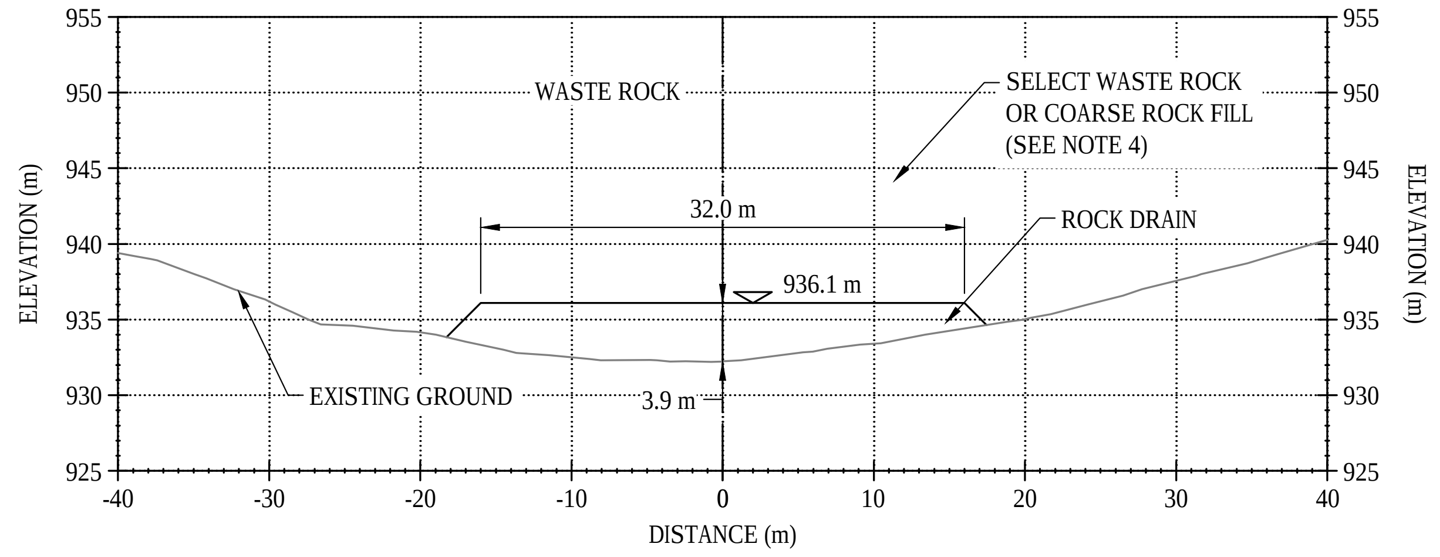

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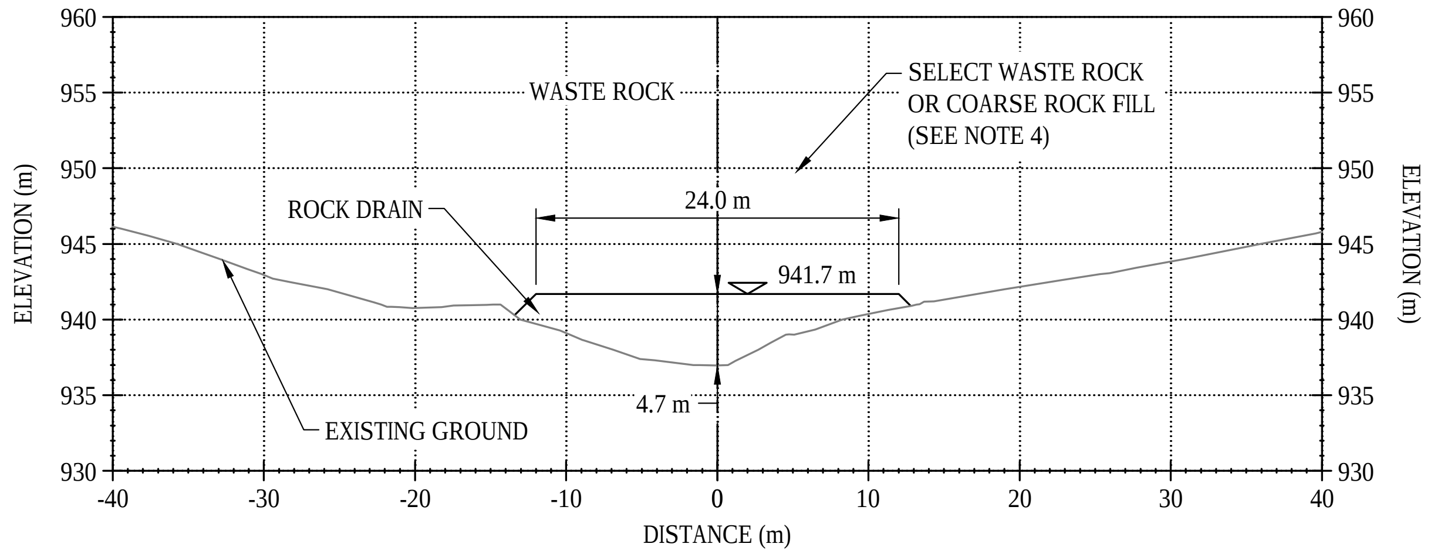

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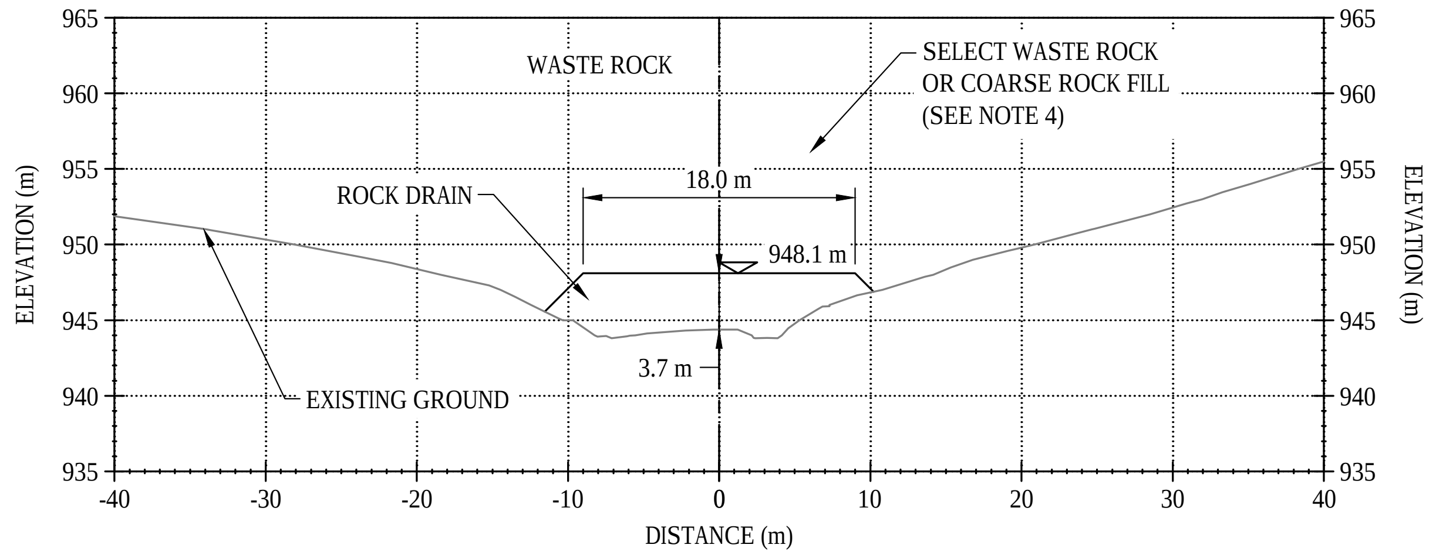

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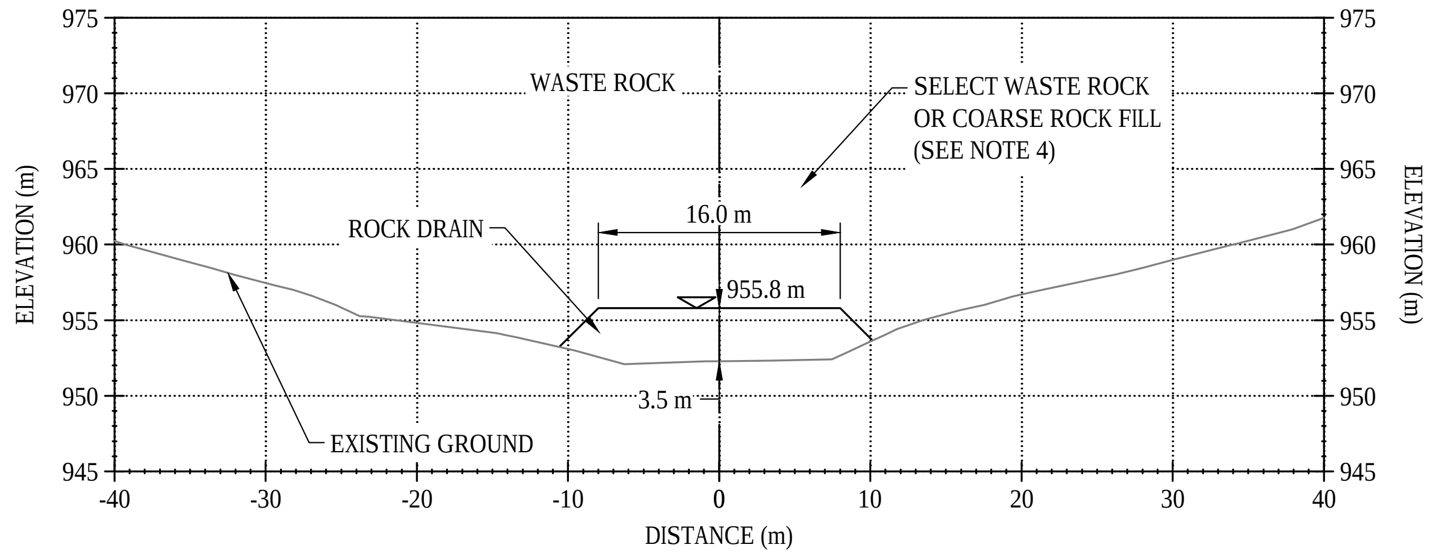

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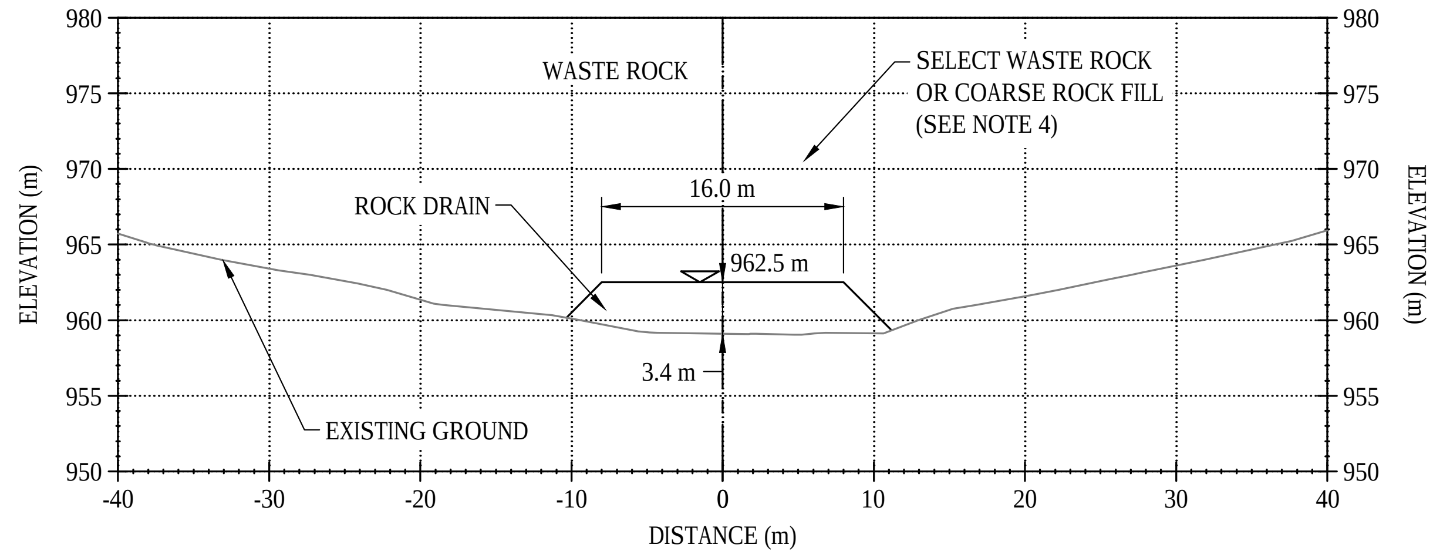

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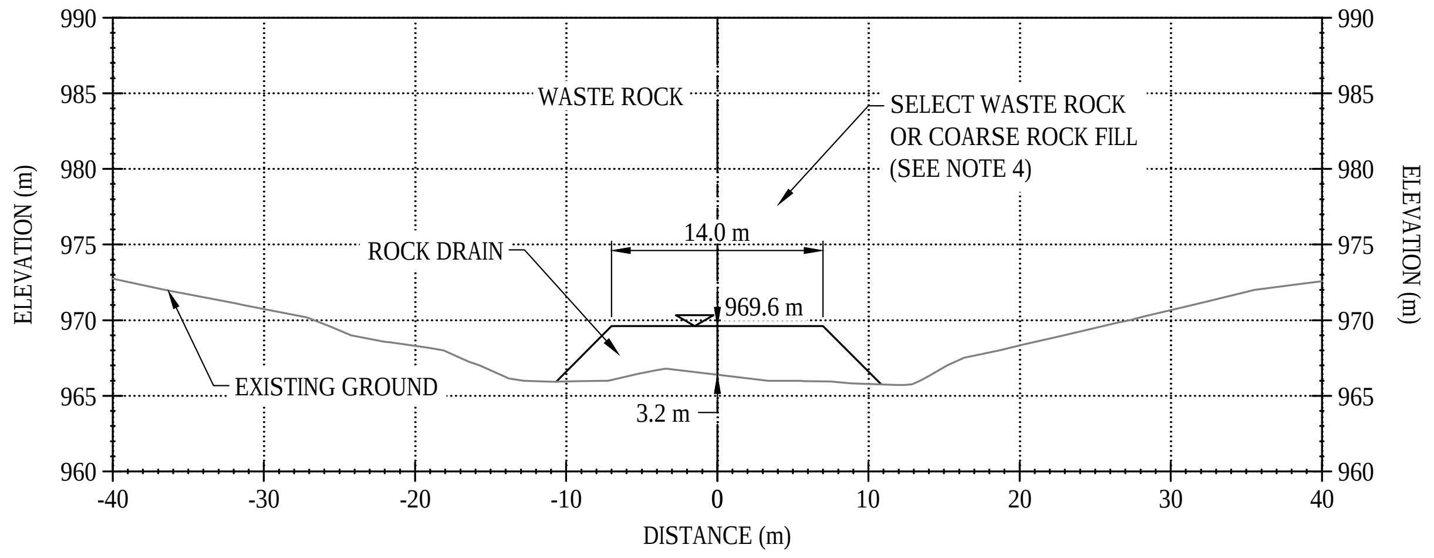

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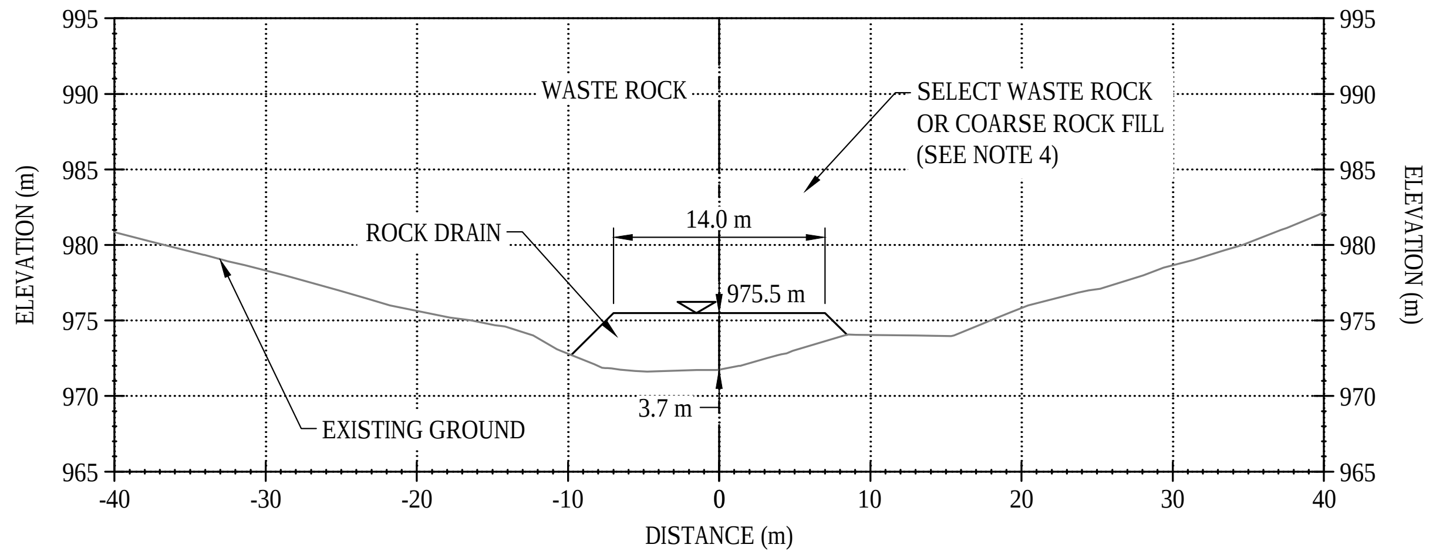

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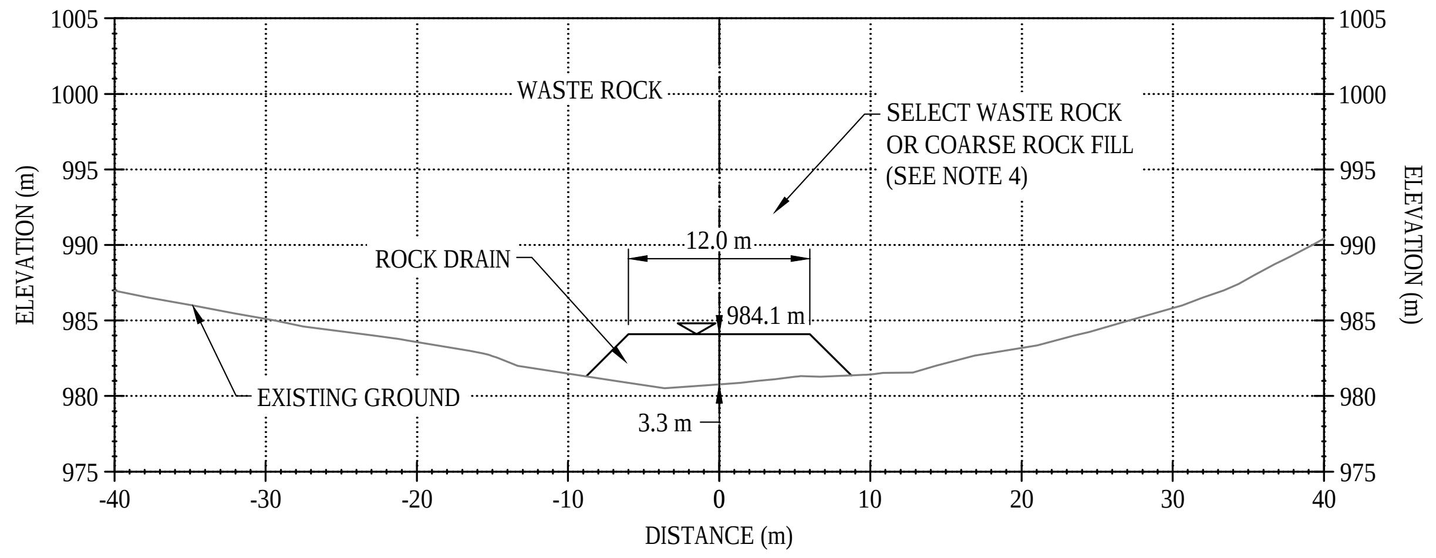

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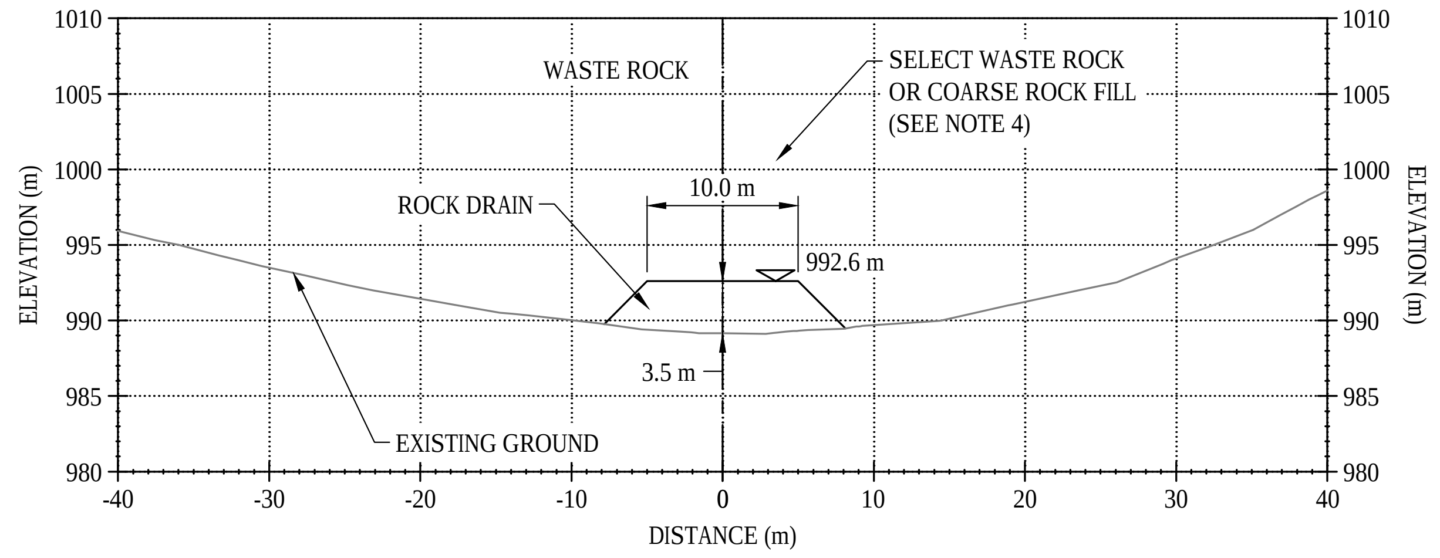

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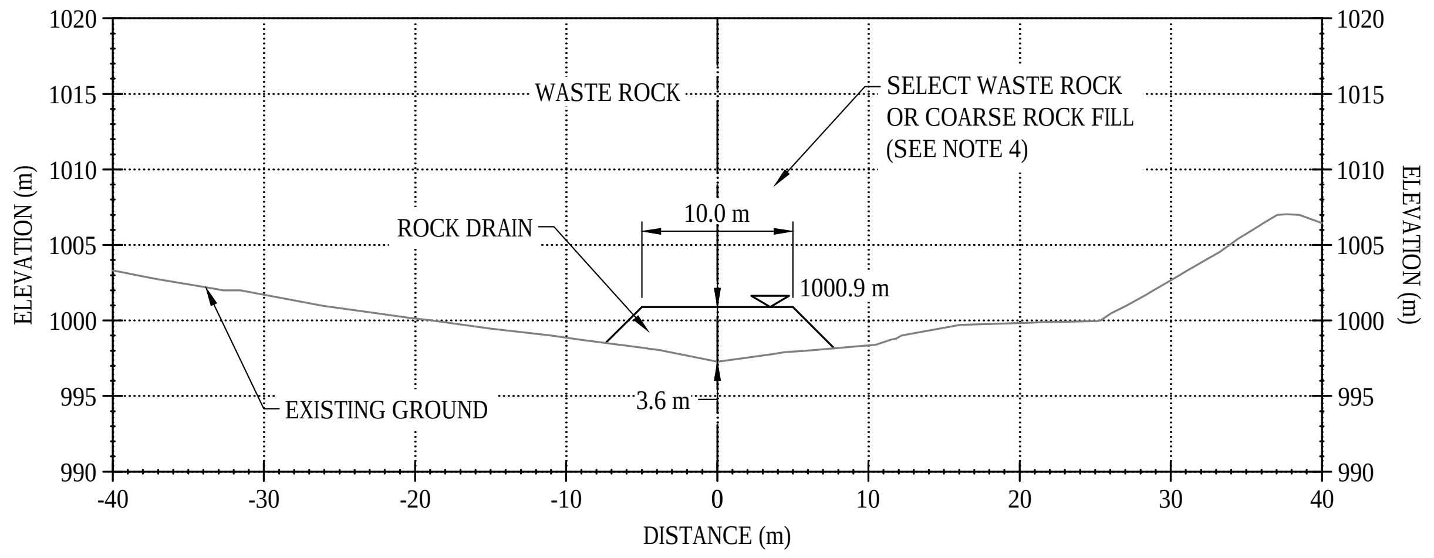

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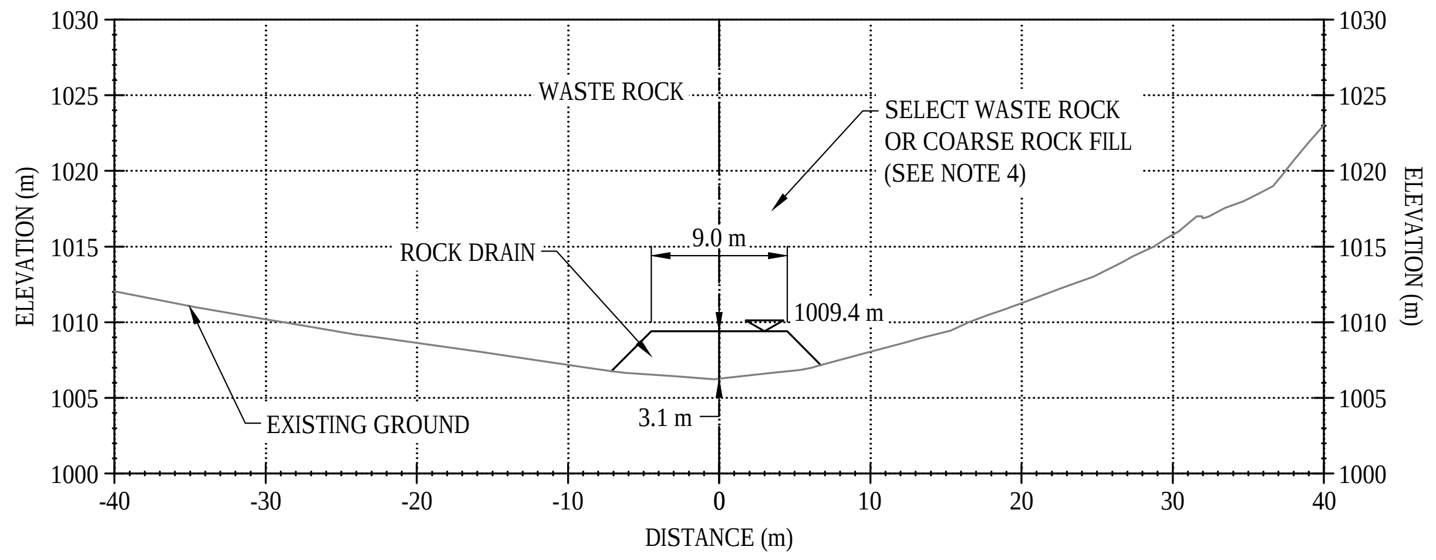

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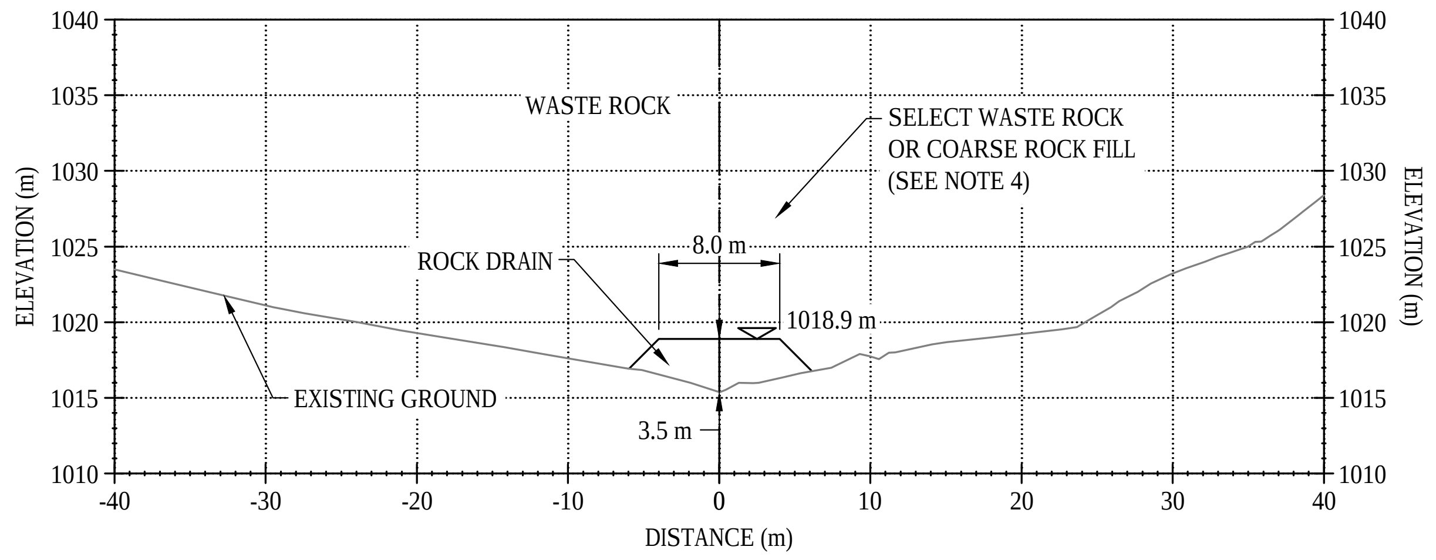

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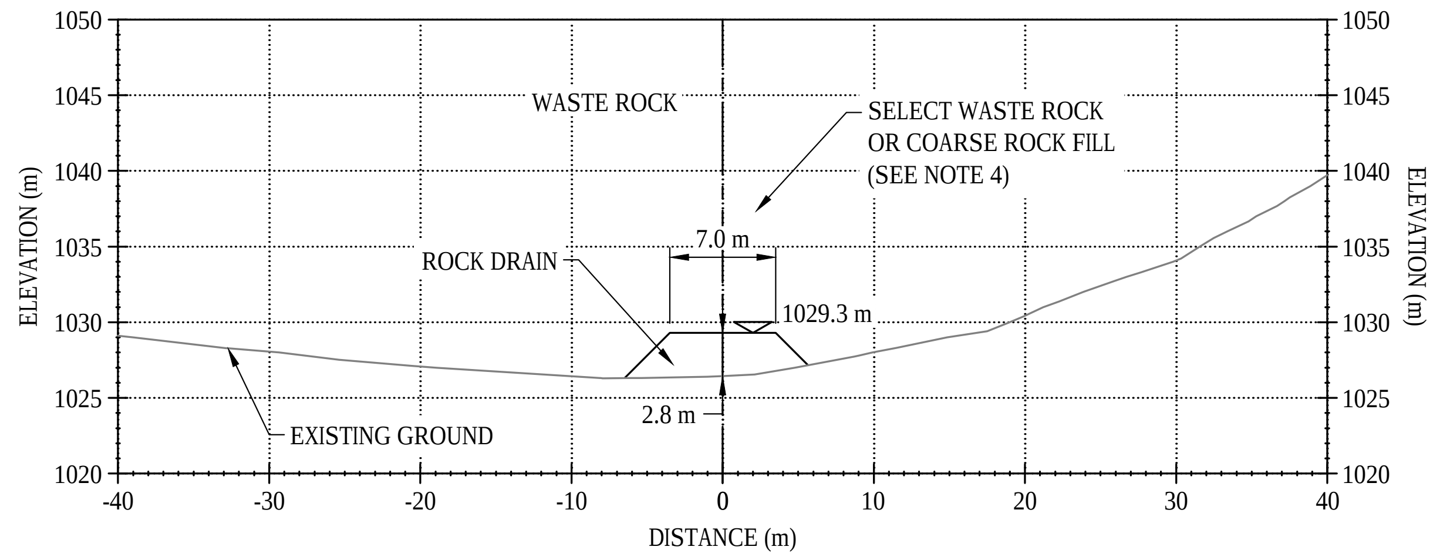

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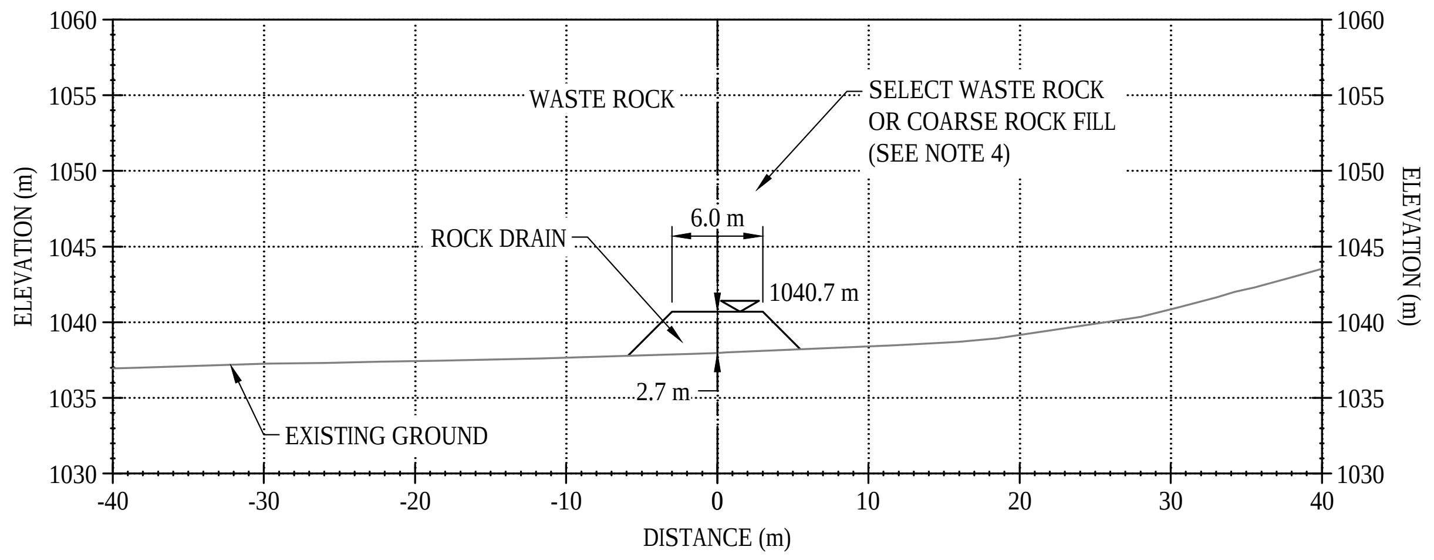

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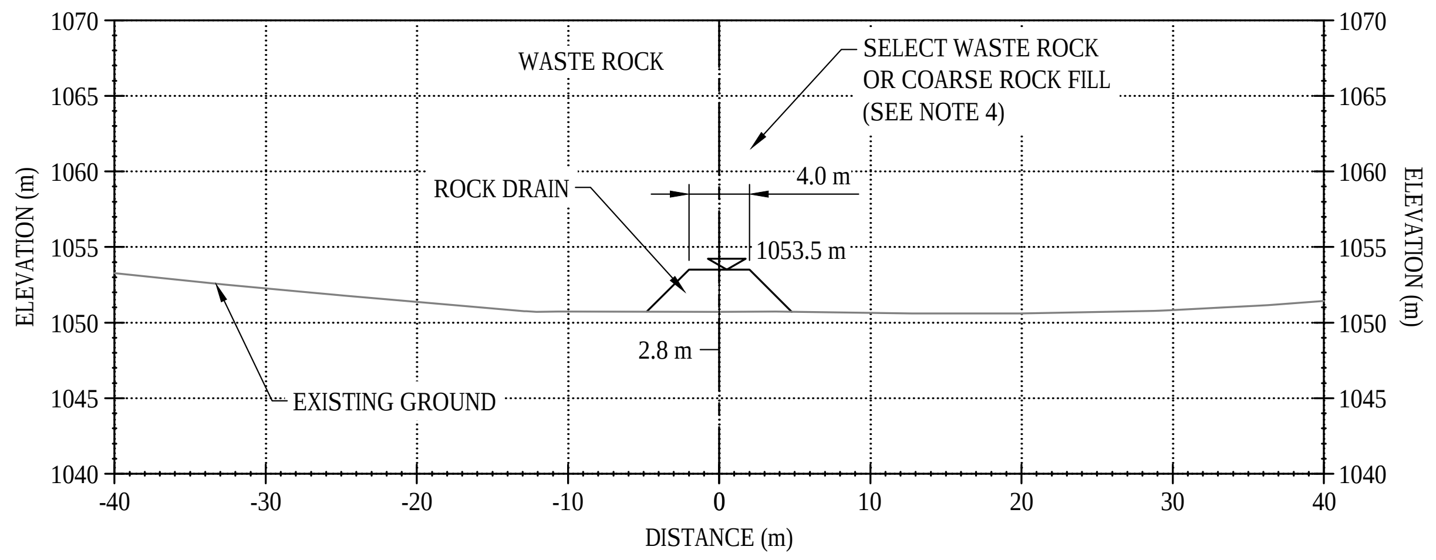

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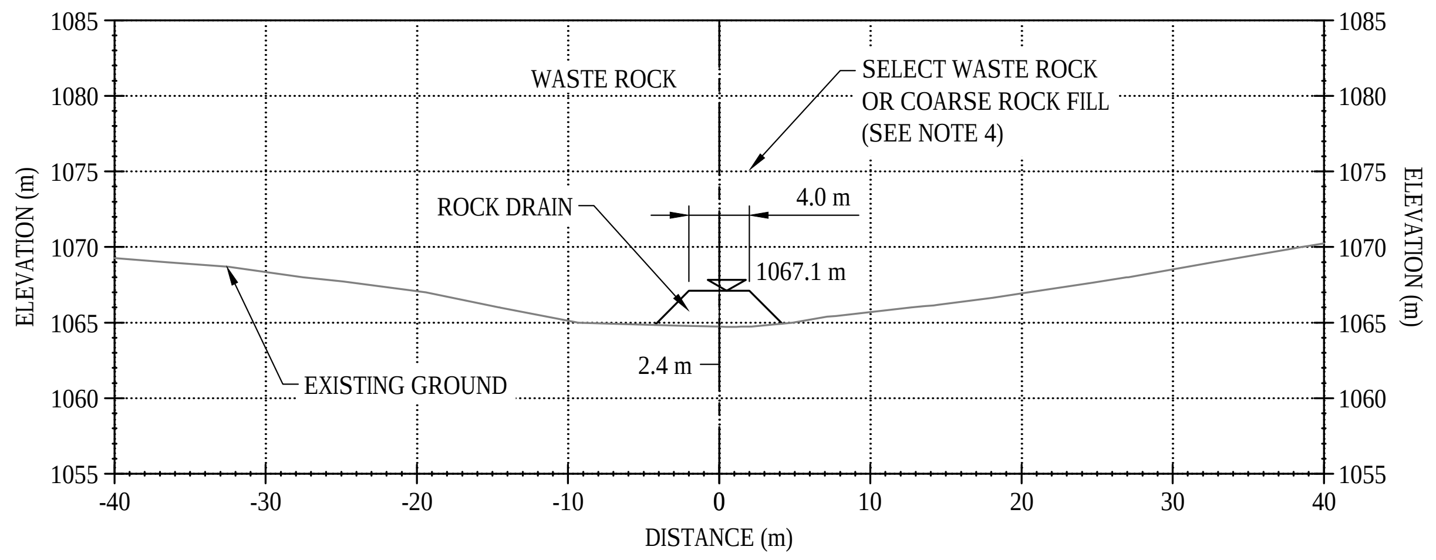

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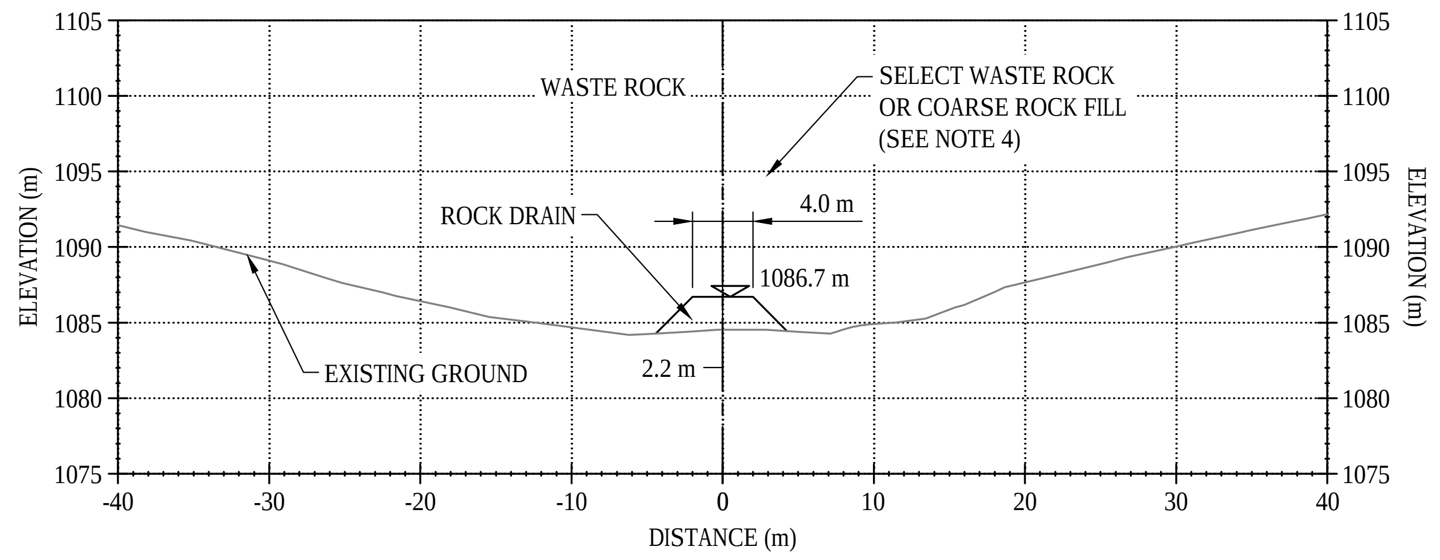

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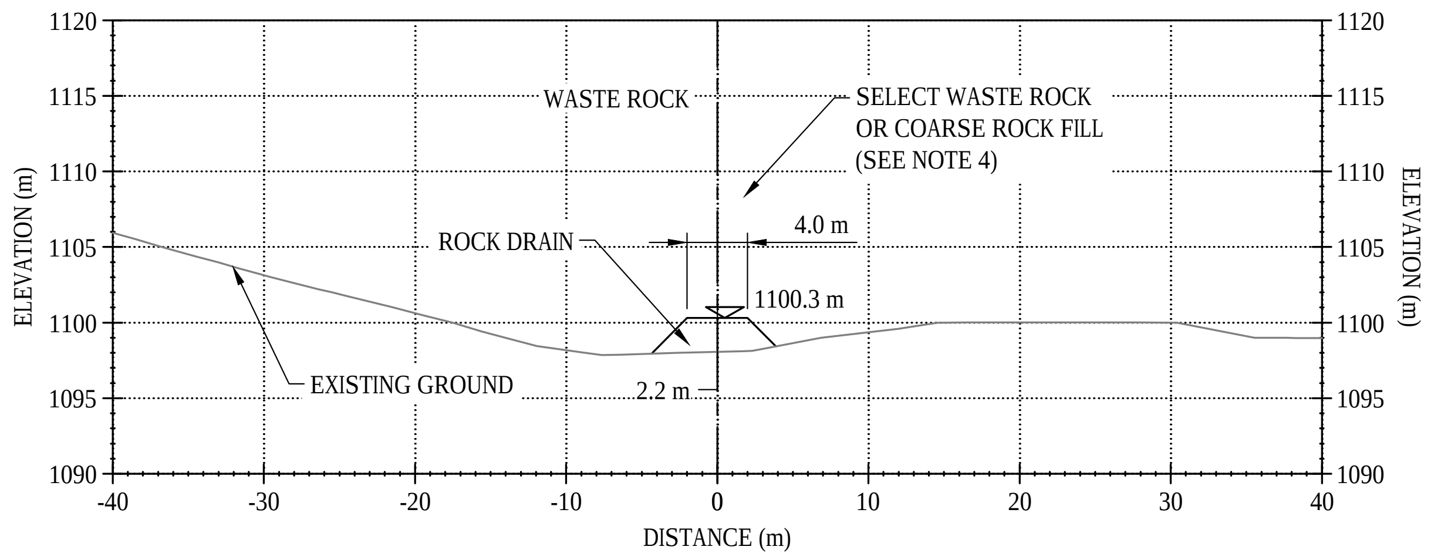

STATION 1+000

NOTES:

1. THE DESIGN ELEVATION SHOWN ON EACH SECTION IS THE FINAL ELEVATION AFTER EXPECTED SETTLEMENT OF ROCK DRAIN MATERIAL INTO FOUNDATION SOILS UPON LOADING FROM WASTE ROCK. THE AS-BUILT ELEVATIONS SHOULD BE AT LEAST 0.3 m HIGHER THAN THOSE SHOWN TO COMPENSATE FOR THE SETTLEMENT.
2. ROCK DRAIN SIDE SLOPES ARE ASSUMED TO BE ANGLE OF REPOSE (1H : 1V)
3. ROCK DRAIN FILL SHOULD MEET ROCK DURABILITY AND GRADATION CRITERIA AS SPECIFIED IN THE DESIGN REPORT.
4. SELECT GOOD QUALITY WASTE ROCK WITH NO OR MINIMAL FINES SHOULD BE PLACED WITHIN 10 m DISTANCE OF ROCK DRAIN FILL. ALTERNATIVELY A COARSE ROCK FILL ZONE ABOVE THE ROCK DRAIN CAN BE PLACED USING END-DUMPING OFF A LIFT AT LEAST 20 m HIGH. THE COARSE ROCK FILL ZONE CAN REPLACE THE SELECT WASTE ROCK.
5. OVERBURDEN SOILS OR COMPLETELY WEATHERED WASTE ROCK SHOULD NOT BE PLACED WITHIN 20 m DISTANCE OF ROCK DRAIN FILL.

0	18-NOV-14	EL	GZ	KJ	ISSUED FOR CONSTRUCTION
NUM	DATE	DWN	CKD	APR	DESCRIPTION

REVISIONS

NUM	DATE	APR	DESCRIPTION

DRAWING STATUS

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE Kevin Jones
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PERMIT

KEVIN W. JONES
Nov. 14, 2018

PROFESSIONAL SEAL

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Victoria
GOLD CORP

TETRA TECH

EAGLE GOLD PROJECT
ROCK DRAIN DESIGN

EAGLE PUP WRSA ROCK DRAIN
DESIGN CROSS-SECTIONS
STA. 0+044 TO 1+000

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
ENG.EARC03103-02	EDMONTON	GZ	GZ	0	C05
DATE:	SHEET No.	DWN	APP	STATUS	
NOVEMBER 14, 2018	05 of 06	EL	KJ	-	

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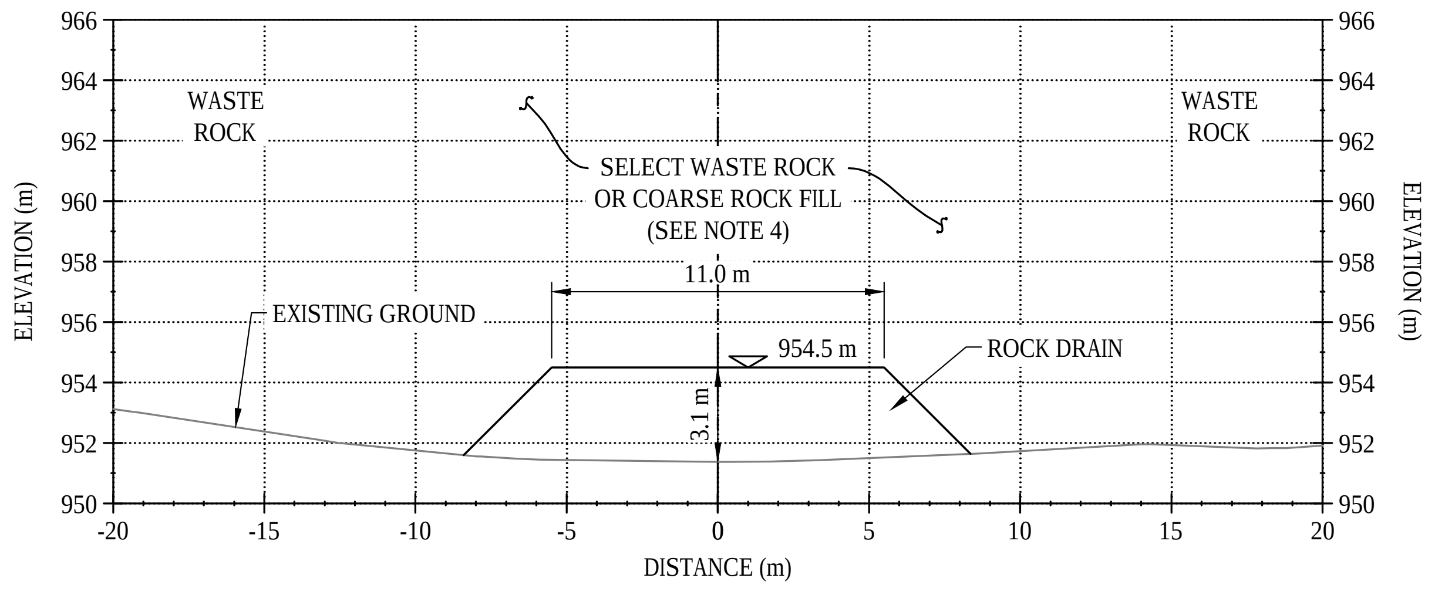

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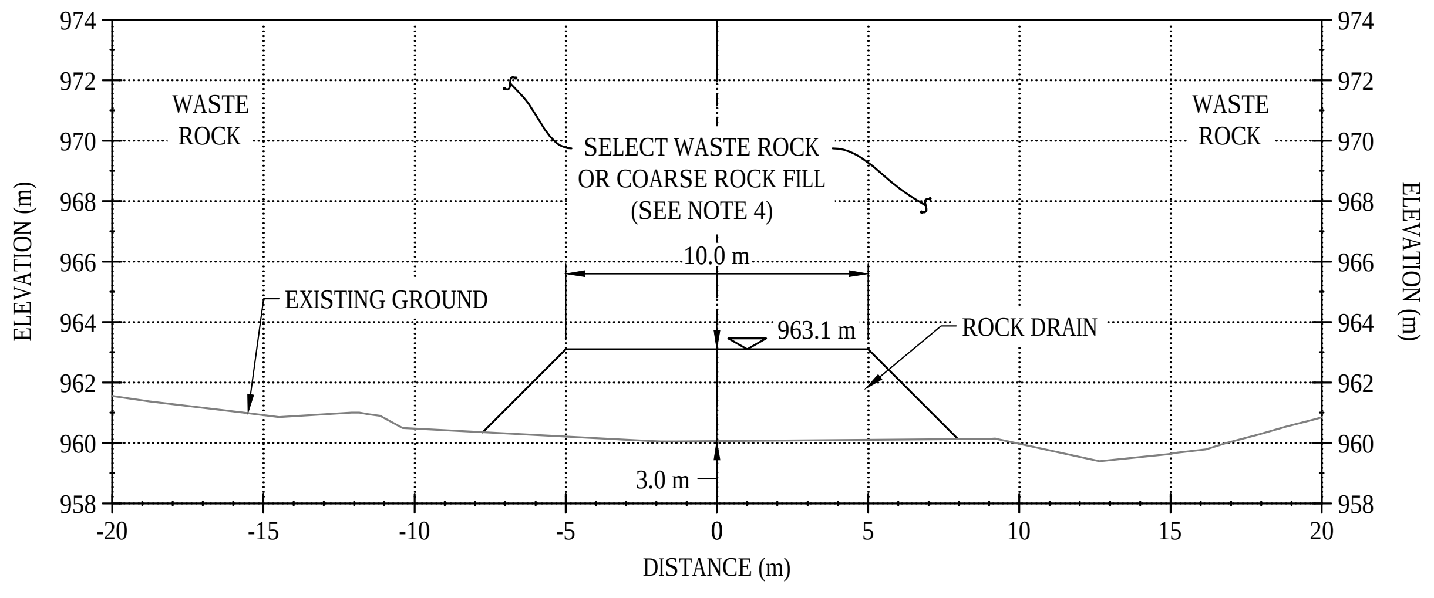

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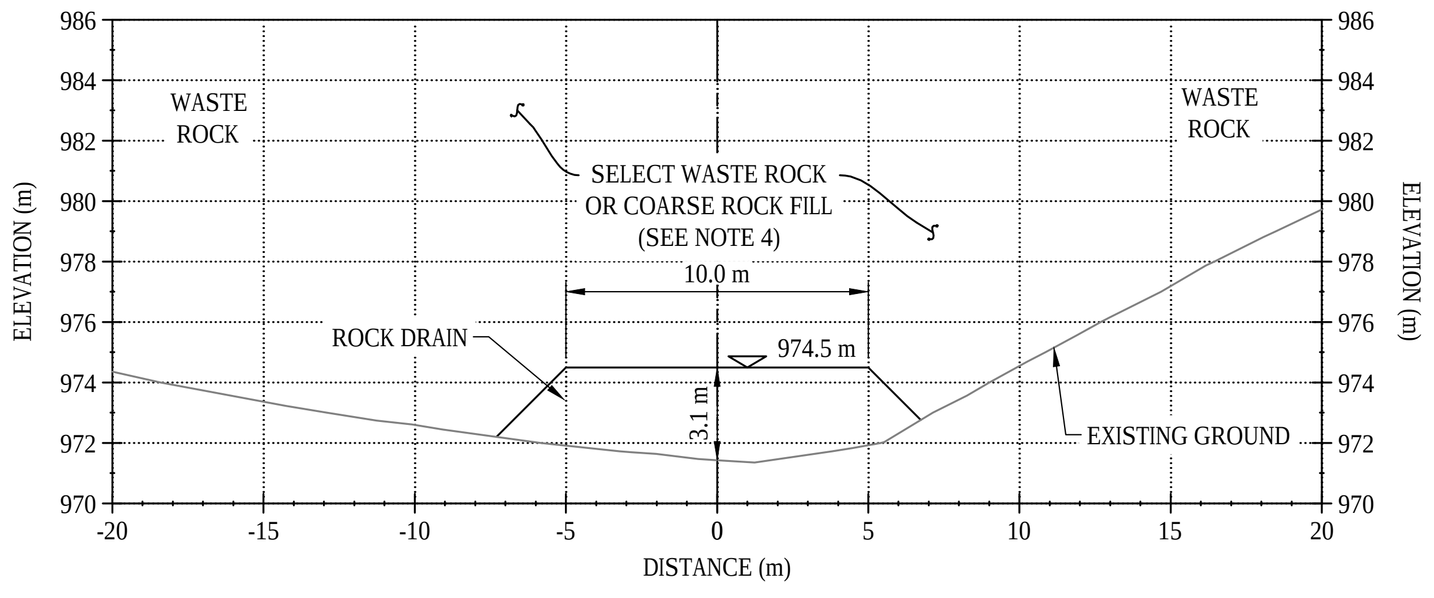

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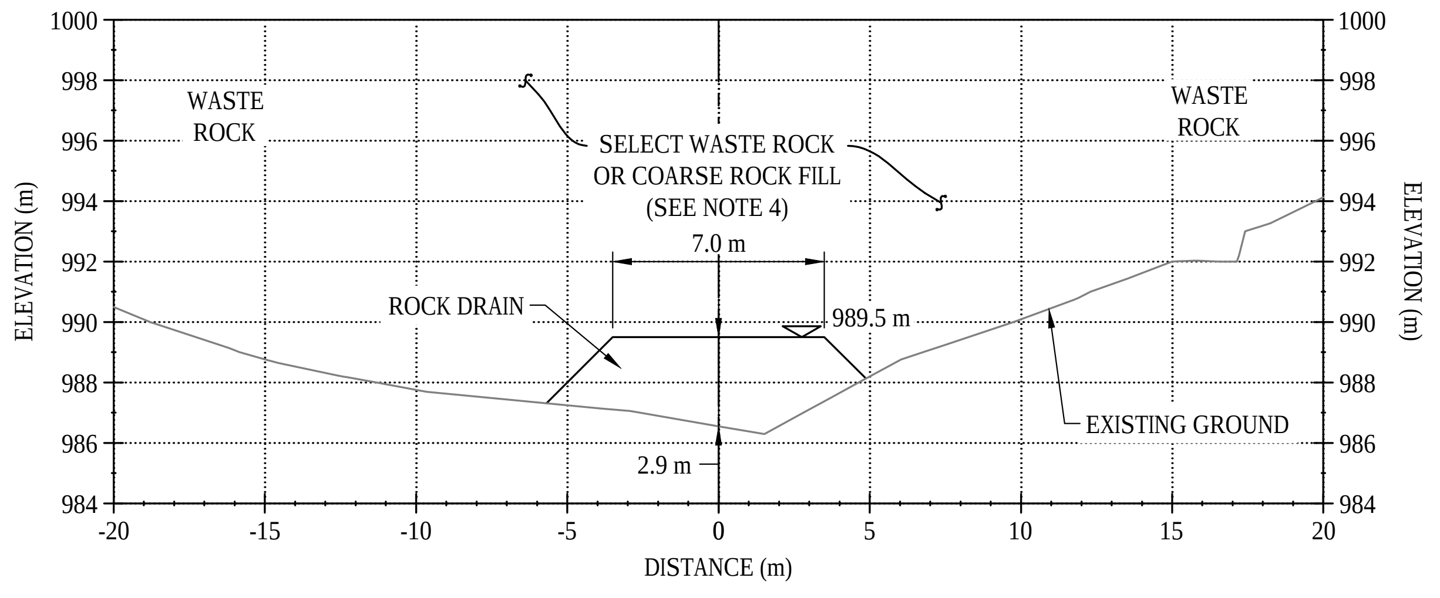

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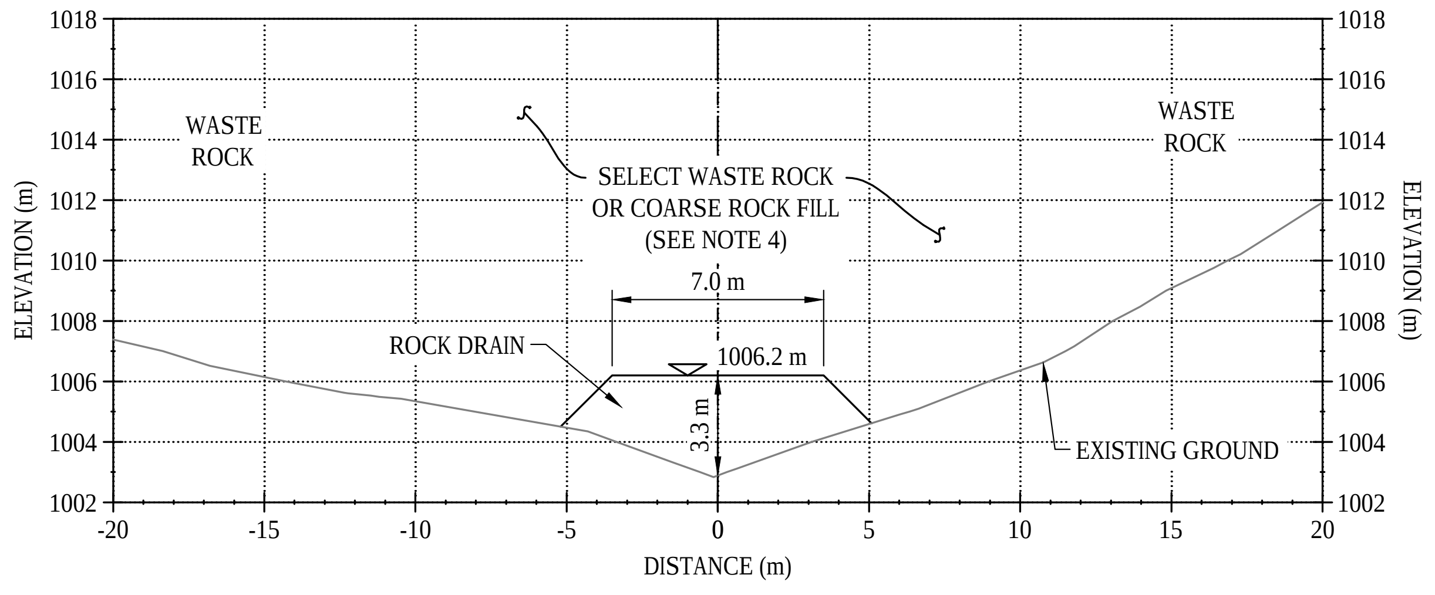

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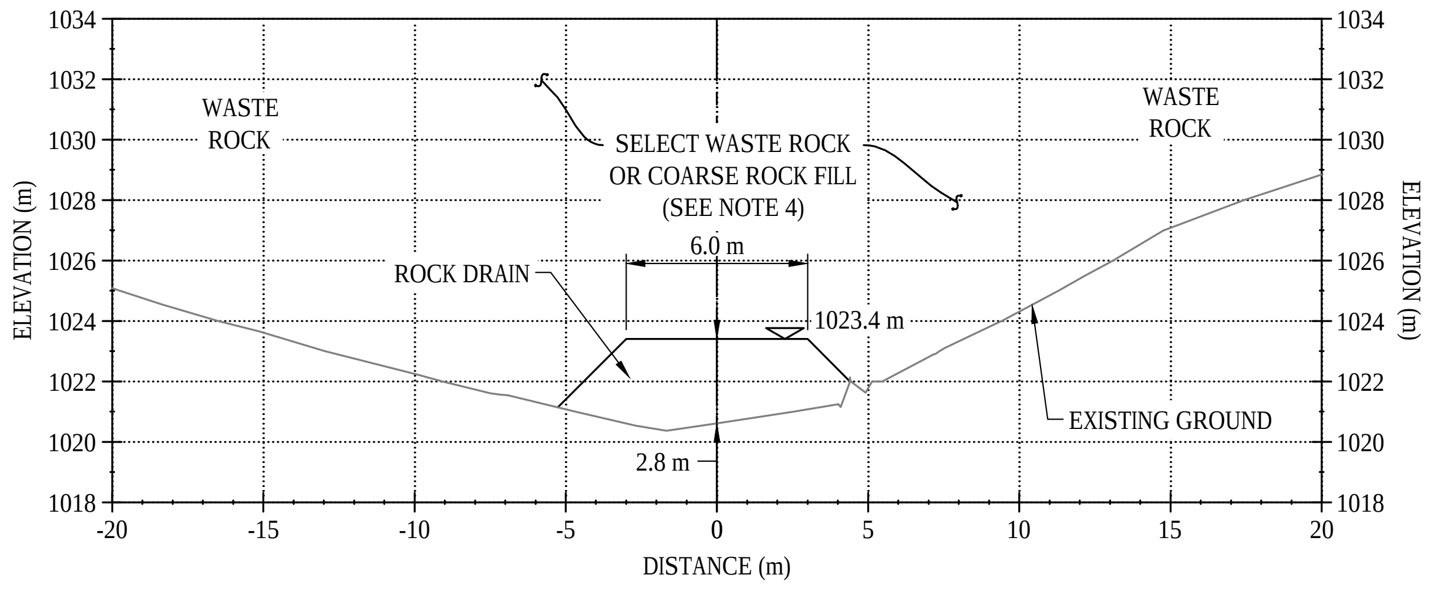

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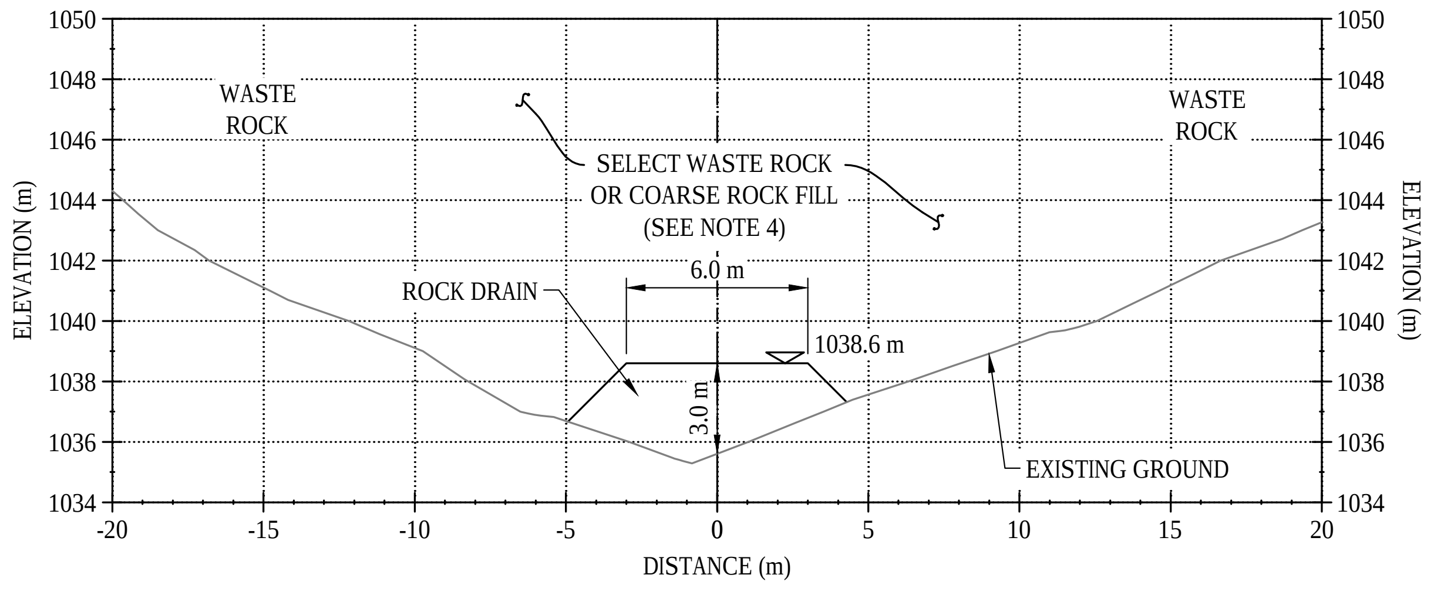

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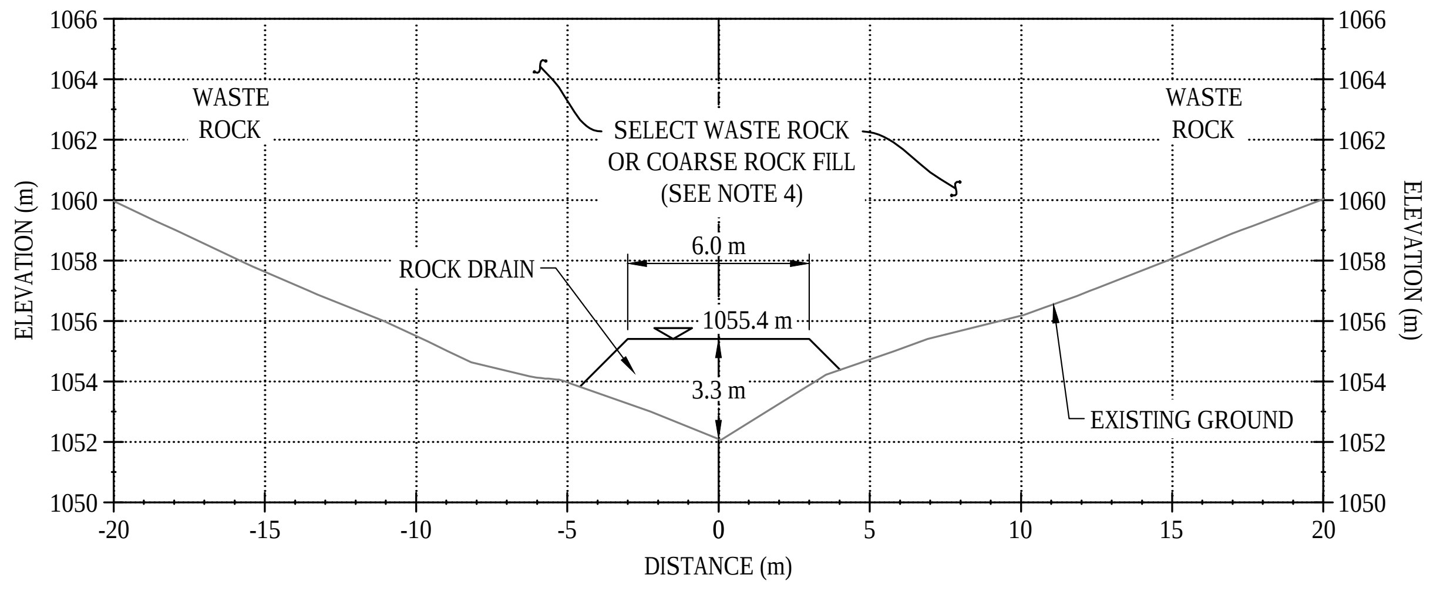

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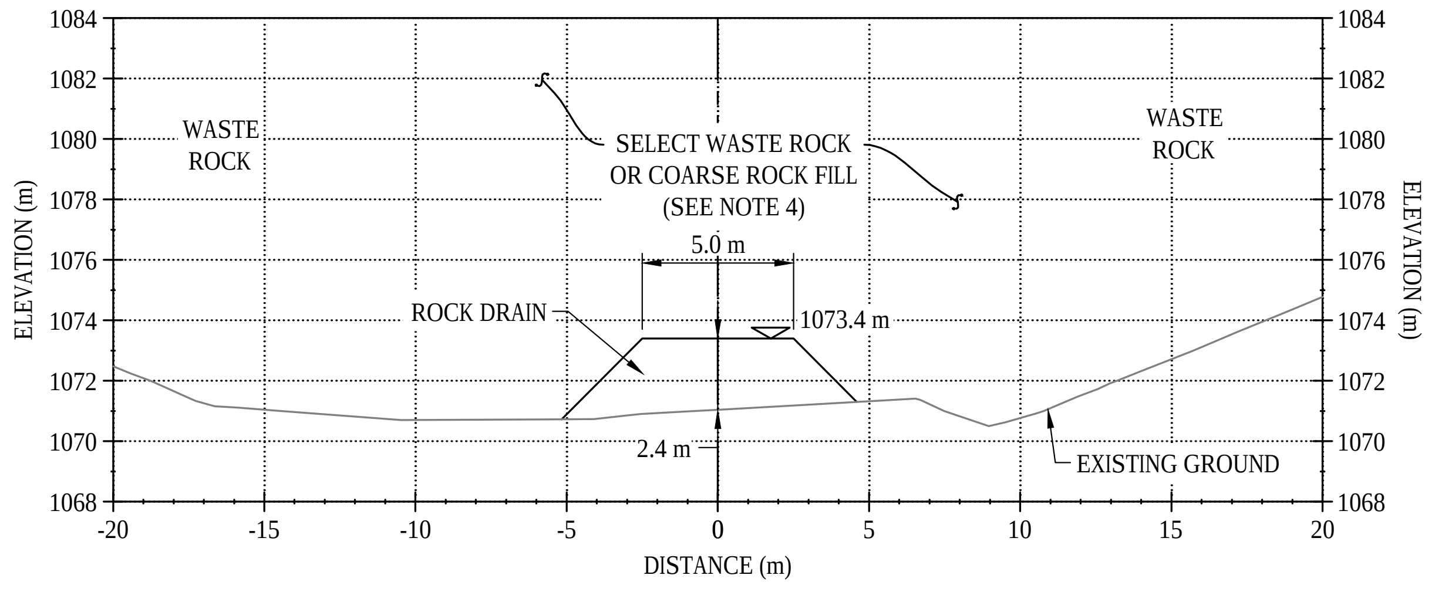

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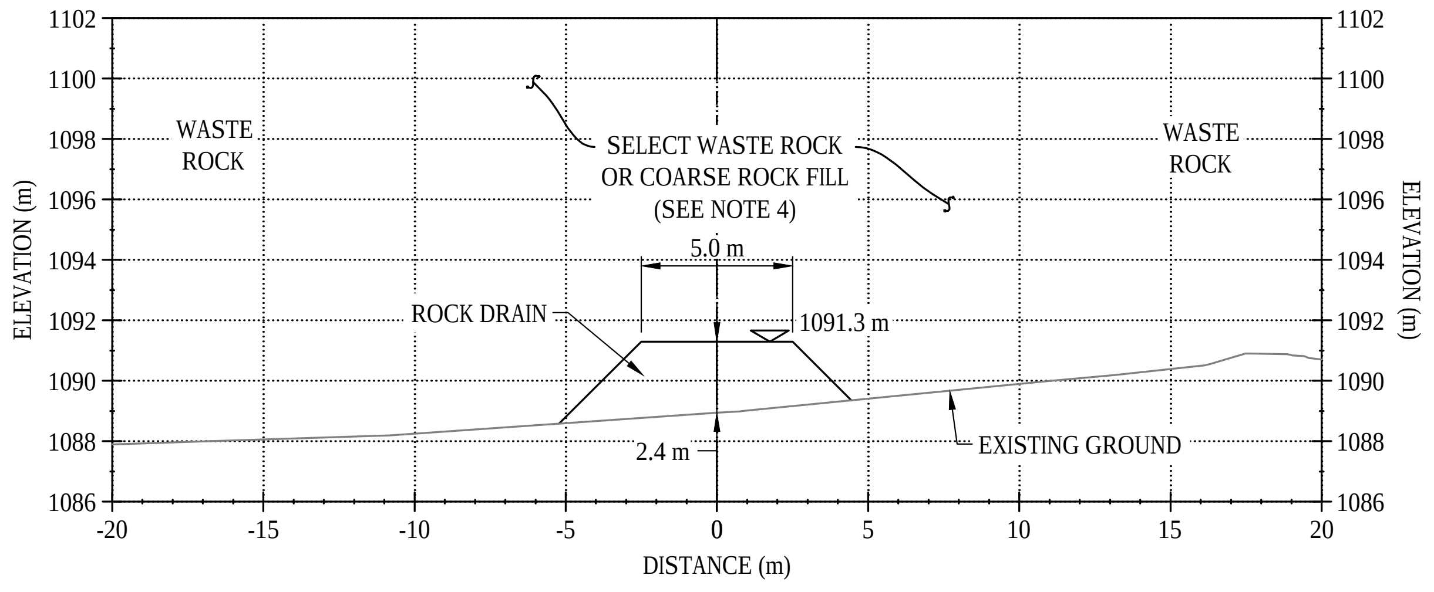

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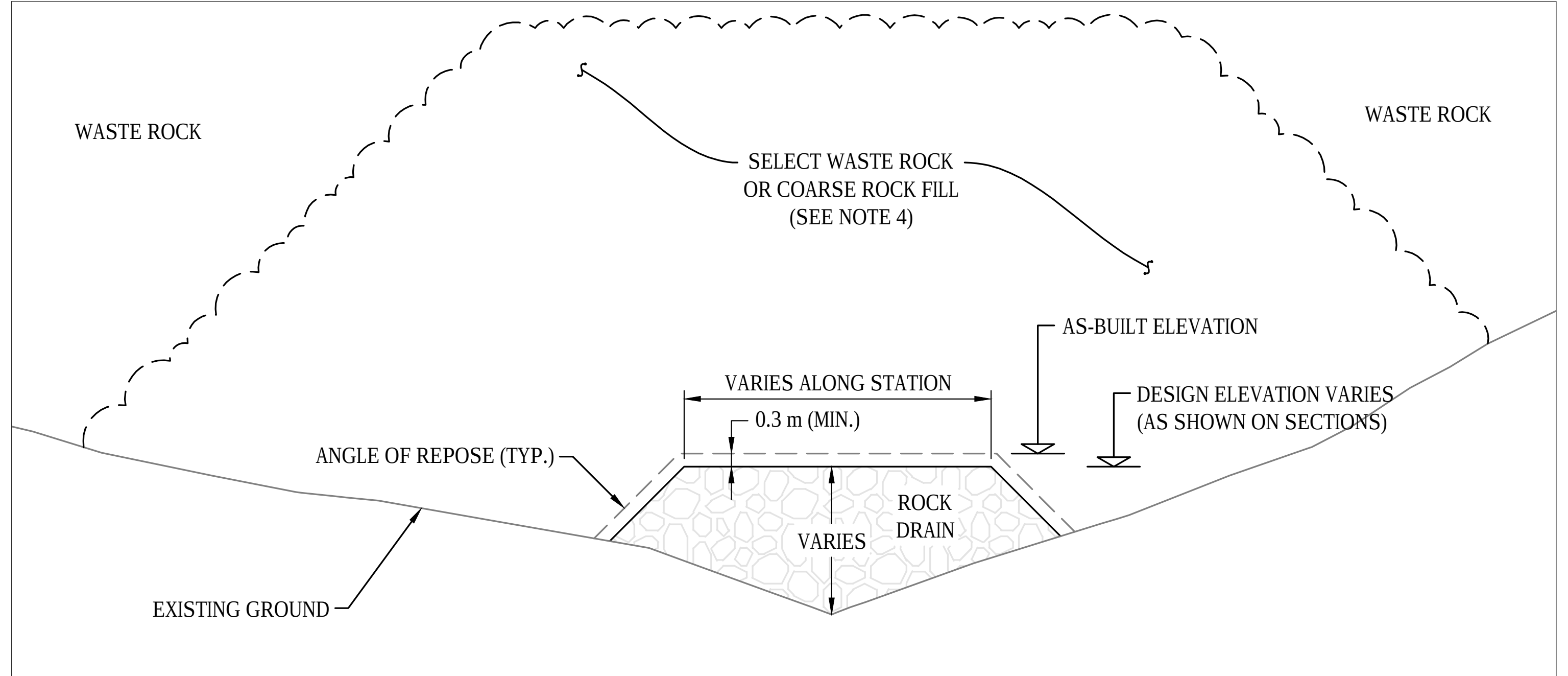

TYPICAL DESIGN SECTION - ROCK DRAIN

SCALE = N.T.S

NOTES:

1. THE DESIGN ELEVATION SHOWN ON EACH SECTION IS THE FINAL ELEVATION AFTER EXPECTED SETTLEMENT OF ROCK DRAIN MATERIAL INTO FOUNDATION SOILS UPON LOADING FROM WASTE ROCK. THE AS-BUILT ELEVATIONS SHOULD BE AT LEAST 0.3 m HIGHER THAN THOSE SHOWN TO COMPENSATE FOR THE SETTLEMENT.
2. ROCK DRAIN SIDE SLOPES ARE ASSUMED TO BE ANGLE OF REPOSE (1H : 1V)
3. ROCK DRAIN FILL SHOULD MEET ROCK DURABILITY AND GRADATION CRITERIA AS SPECIFIED IN THE DESIGN REPORT.
4. SELECT GOOD QUALITY WASTE ROCK WITH NO OR MINIMAL FINES SHOULD BE PLACED WITHIN 10 m DISTANCE OF ROCK DRAIN FILL. ALTERNATIVELY A COARSE ROCK FILL ZONE ABOVE THE ROCK DRAIN CAN BE PLACED USING END-DUMPING OFF A LIFT AT LEAST 20 m HIGH. THE COARSE ROCK FILL ZONE CAN REPLACE THE SELECT WASTE ROCK.
5. OVERBURDEN SOILS OR COMPLETELY WEATHERED WASTE ROCK SHOULD NOT BE PLACED WITHIN 20 m DISTANCE OF ROCK DRAIN FILL.

NUM	DATE	DWN	CKD	APR	DESCRIPTION
0	18-NOV-14	EL	GZ	KJ	ISSUED FOR CONSTRUCTION

REVISIONS

NUM	DATE	APR	DESCRIPTION

DRAWING STATUS

PERMIT TO PRACTICE
TETRA TECH CANADA INC.
SIGNATURE
Date Nov. 14, 2018
PERMIT NUMBER PP003
Association of Professional
Engineers of Yukon

PERMIT

KEVIN W. JONES
Nov. 14, 2018

PROFESSIONAL SEAL

CLIENT

Victoria GOLD CORP

TETRA TECH

EAGLE GOLD PROJECT
ROCK DRAIN DESIGN

PLATINUM GULCH WRSA ROCK DRAIN
DESIGN CROSS-SECTIONS
STA. 0+062 TO 0+700

PROJECT No.	OFFICE	DES	CKD	REV	DRAWING
ENG.EARC03103-02	EDMONTON	GZ	GZ	0	C06
DATE:	SHEET No.	DWN	APP	STATUS	
NOVEMBER 14, 2018	06 of 06	EL	KJ	-	

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APPENDIX D

TETRA TECH'S LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

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Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

APPENDIX 4

End of Period Surface for Eagle Pup and Platinum Gulch WRSAs

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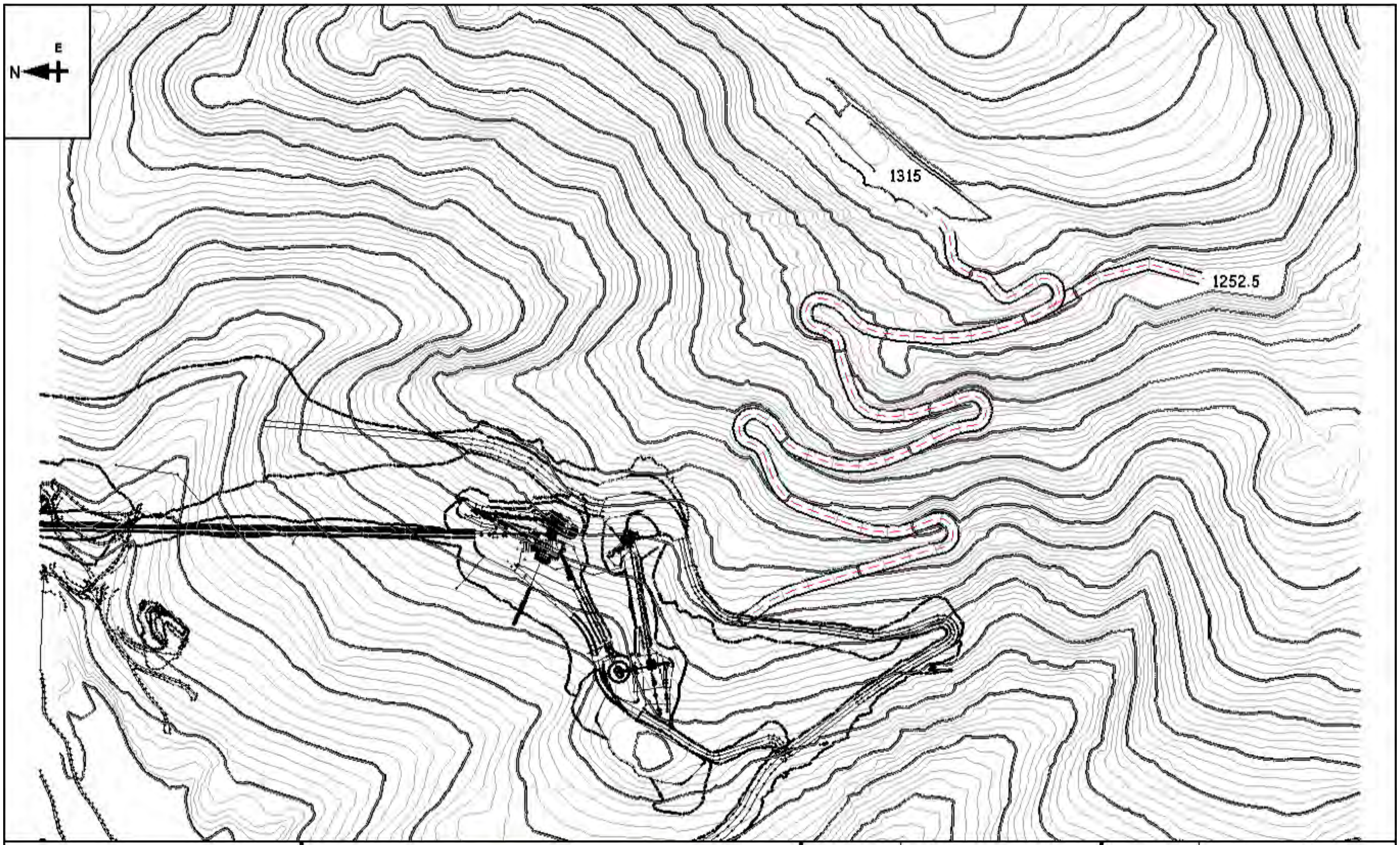

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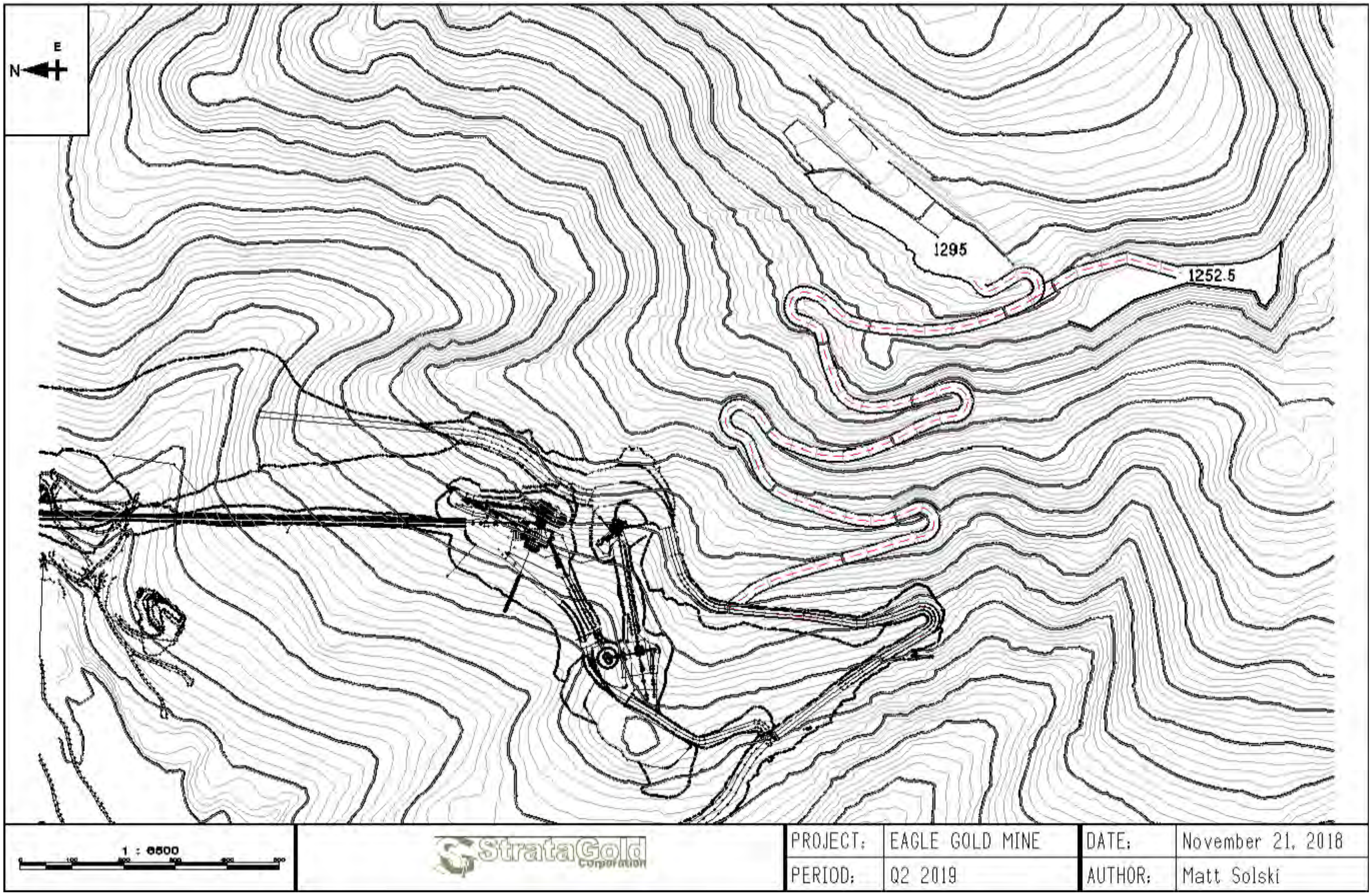
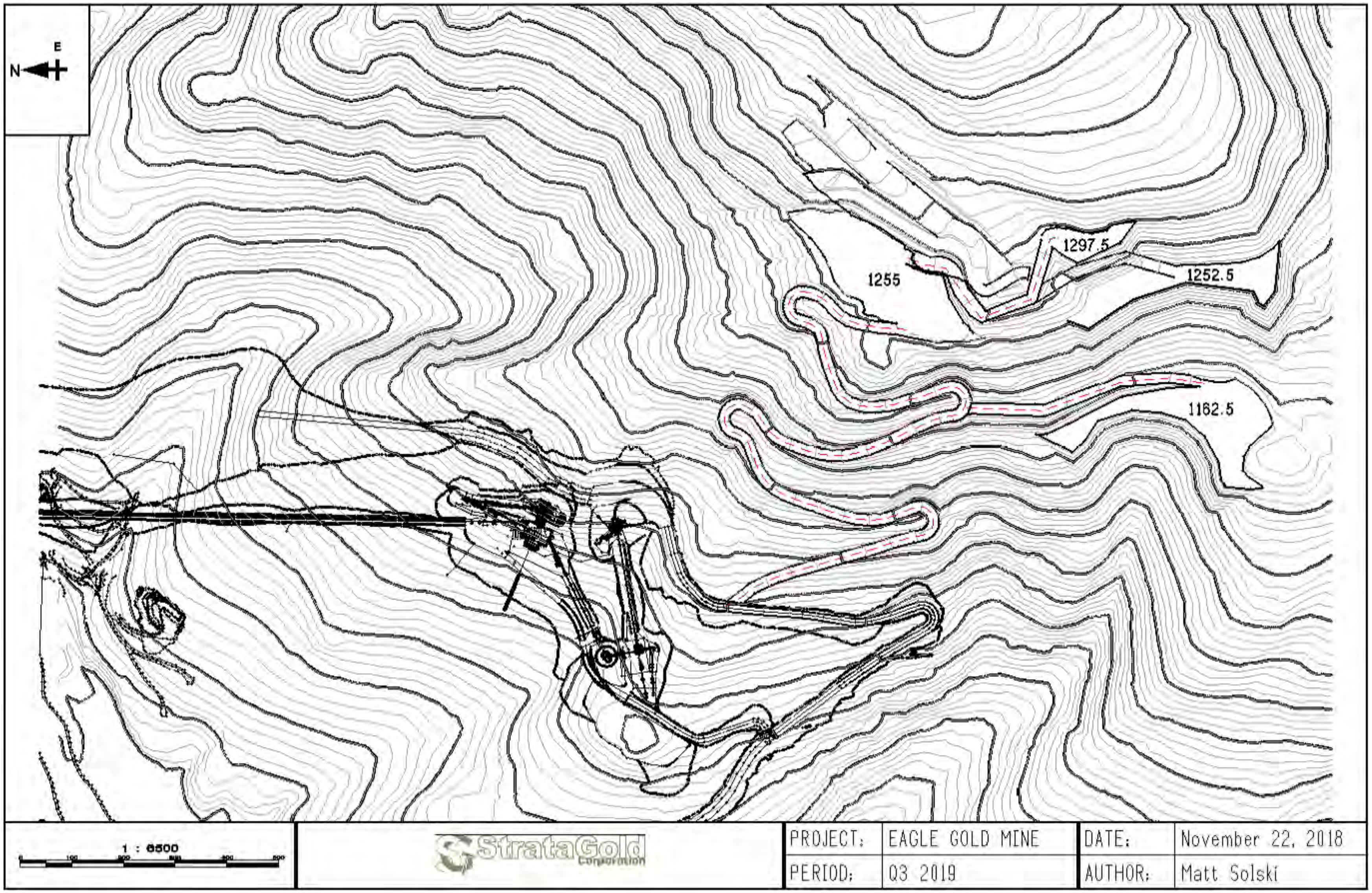
StrataGold Corporation

PROJECT:	EAGLE GOLD MINE	DATE:	November 21, 2018
PERIOD:	Q1 2019	AUTHOR:	Matt Solski

Appendix 4: End of Period Surface for Eagle Pup and Platinum Gulch WRSAs End of Period Surface for Eagle Pup and Platinum Gulch WRSAs





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PERIOD:	Q3 2019	AUTHOR:	Matt Solski

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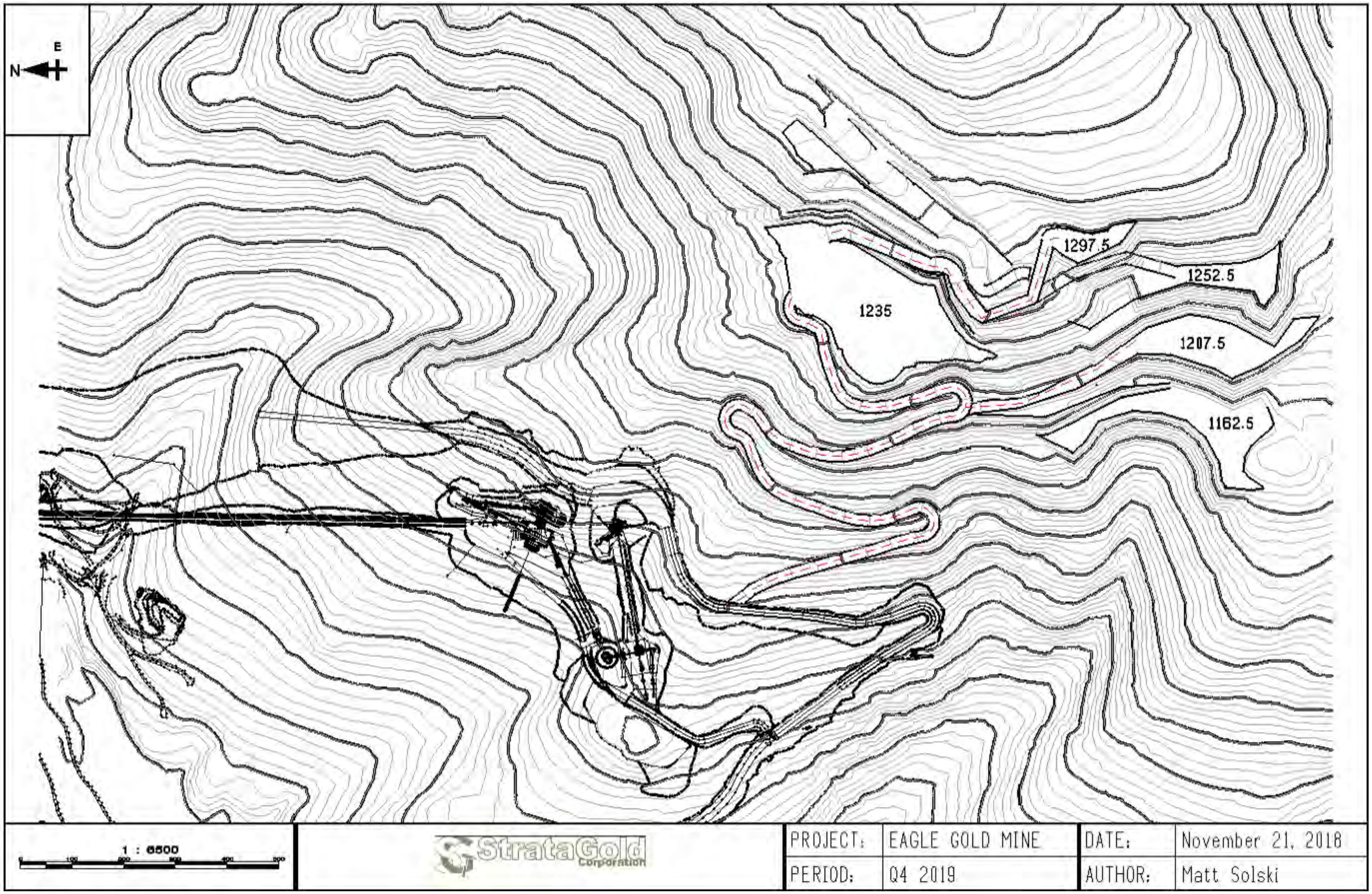

StrataGold Corporation

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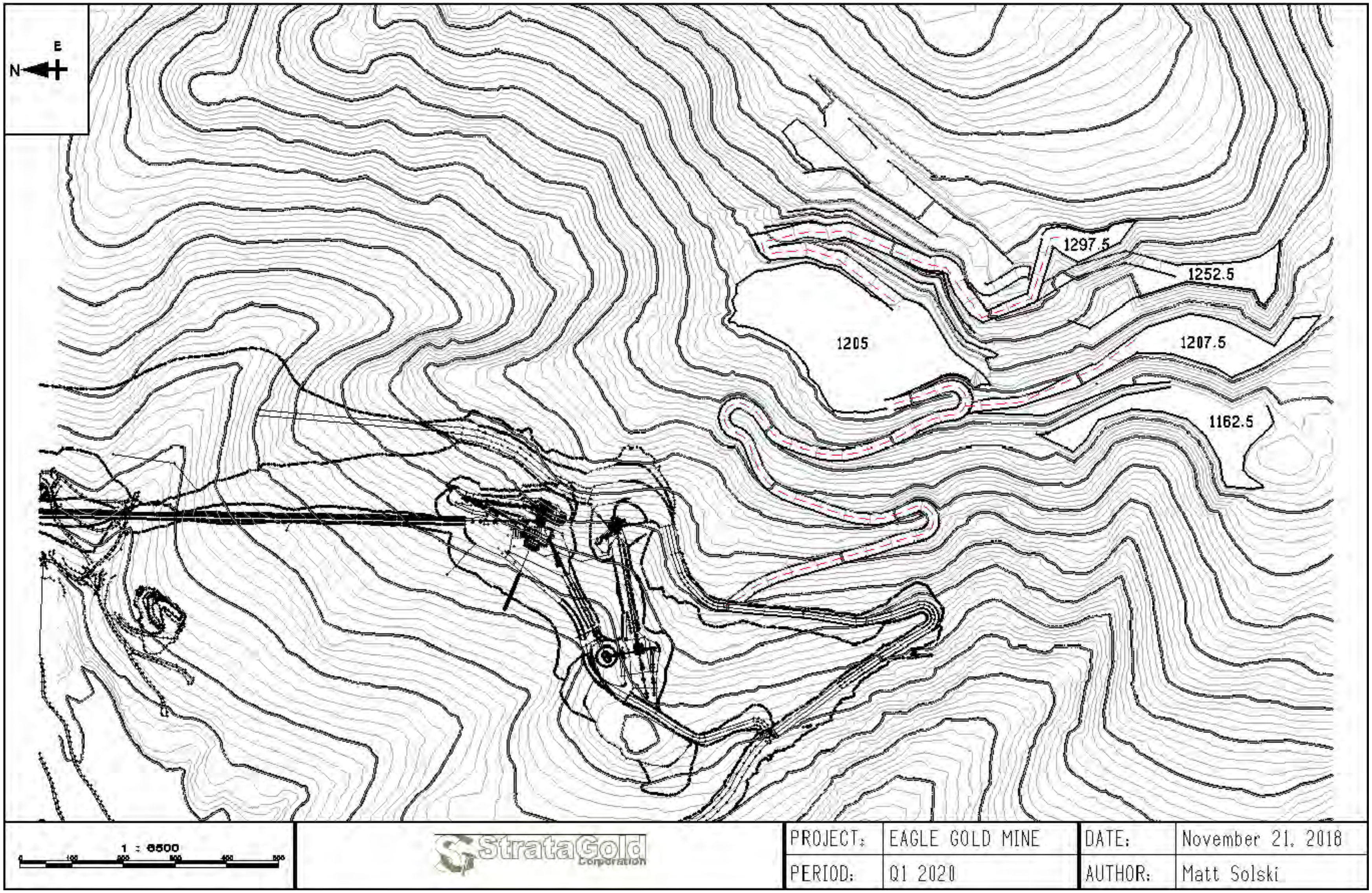
PERIOD:	Q4 2019	AUTHOR:	Matt Solski



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PERIOD:	Q1 2020	AUTHOR:	Matt Solski

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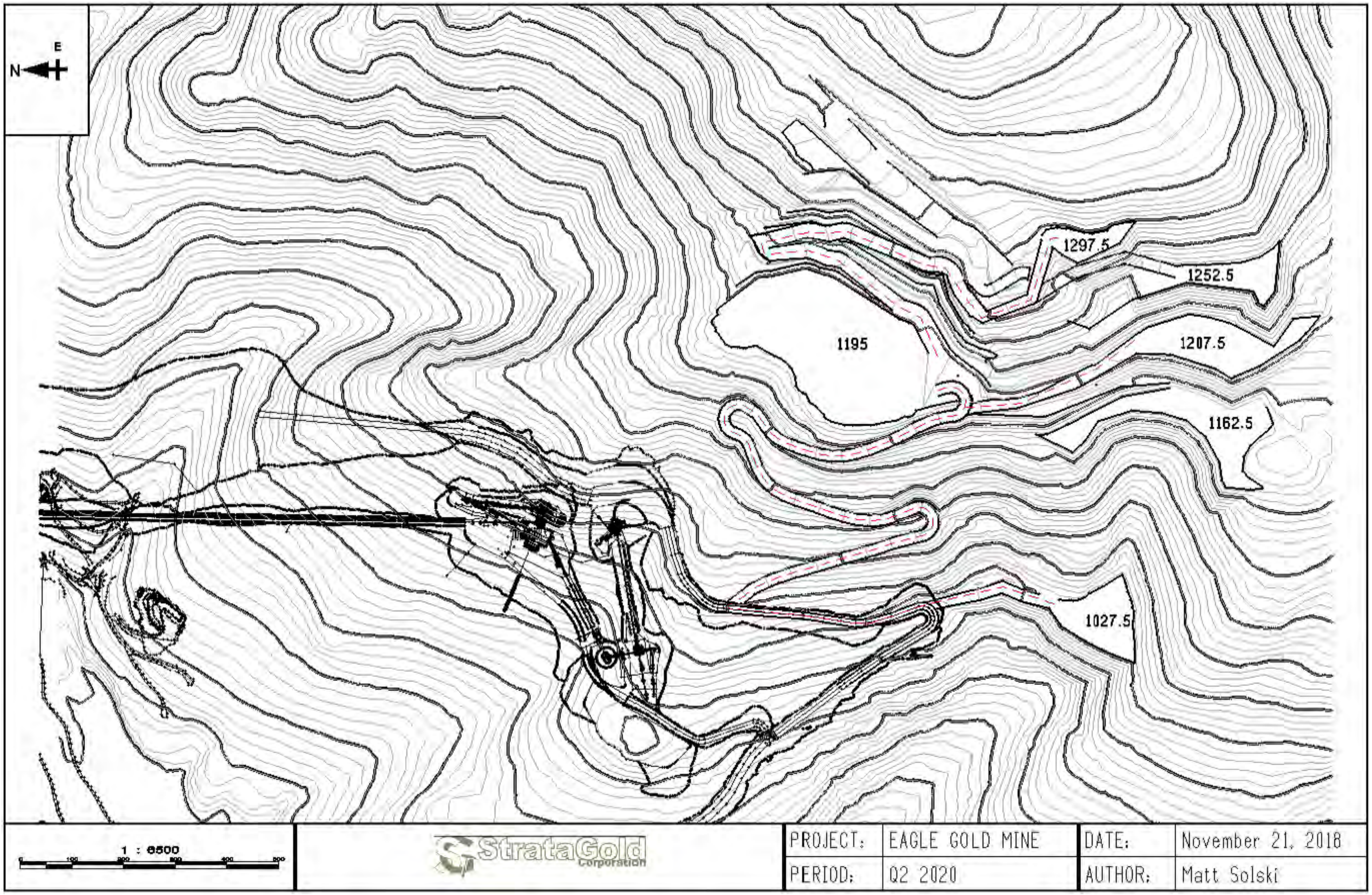

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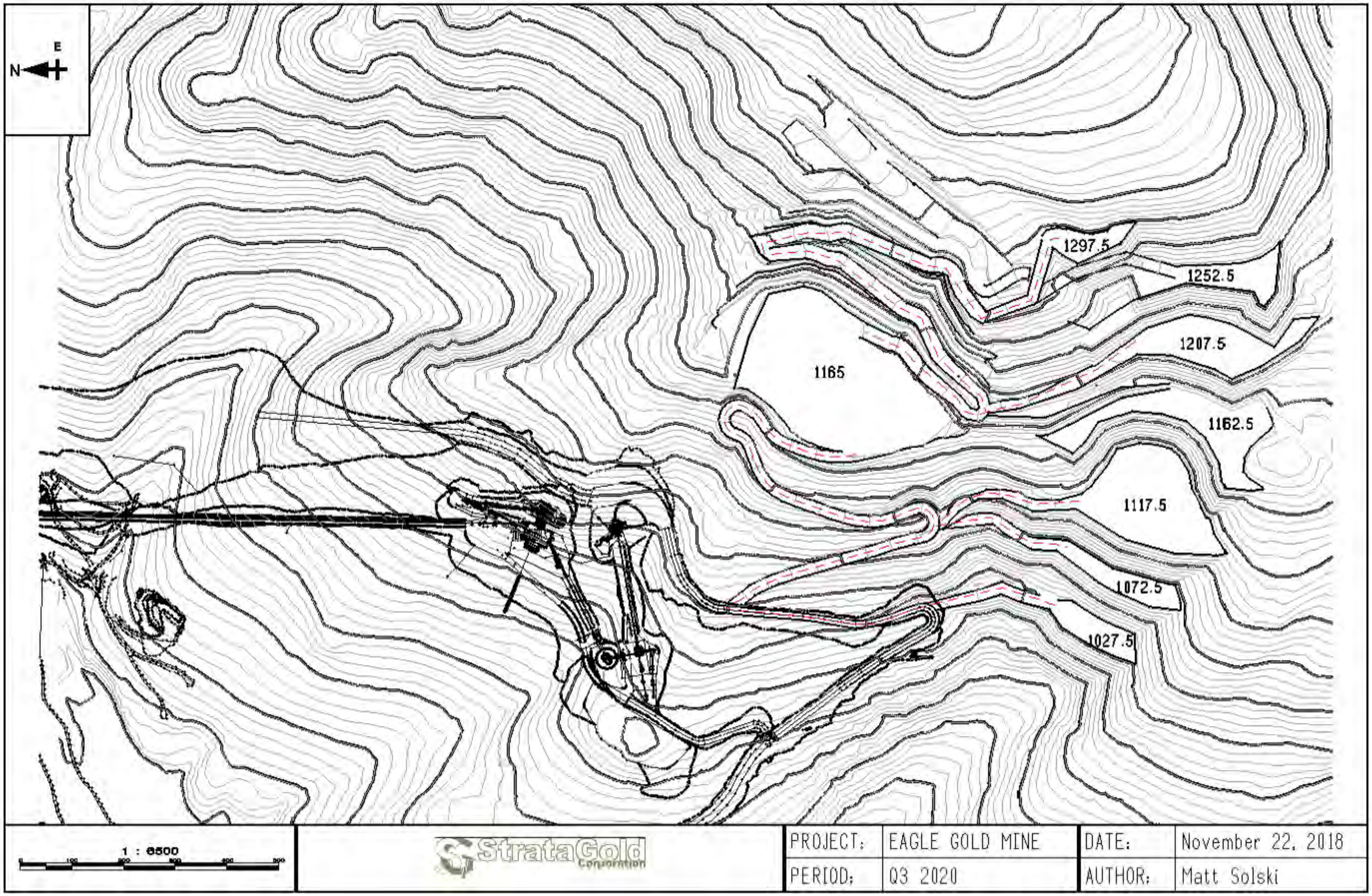

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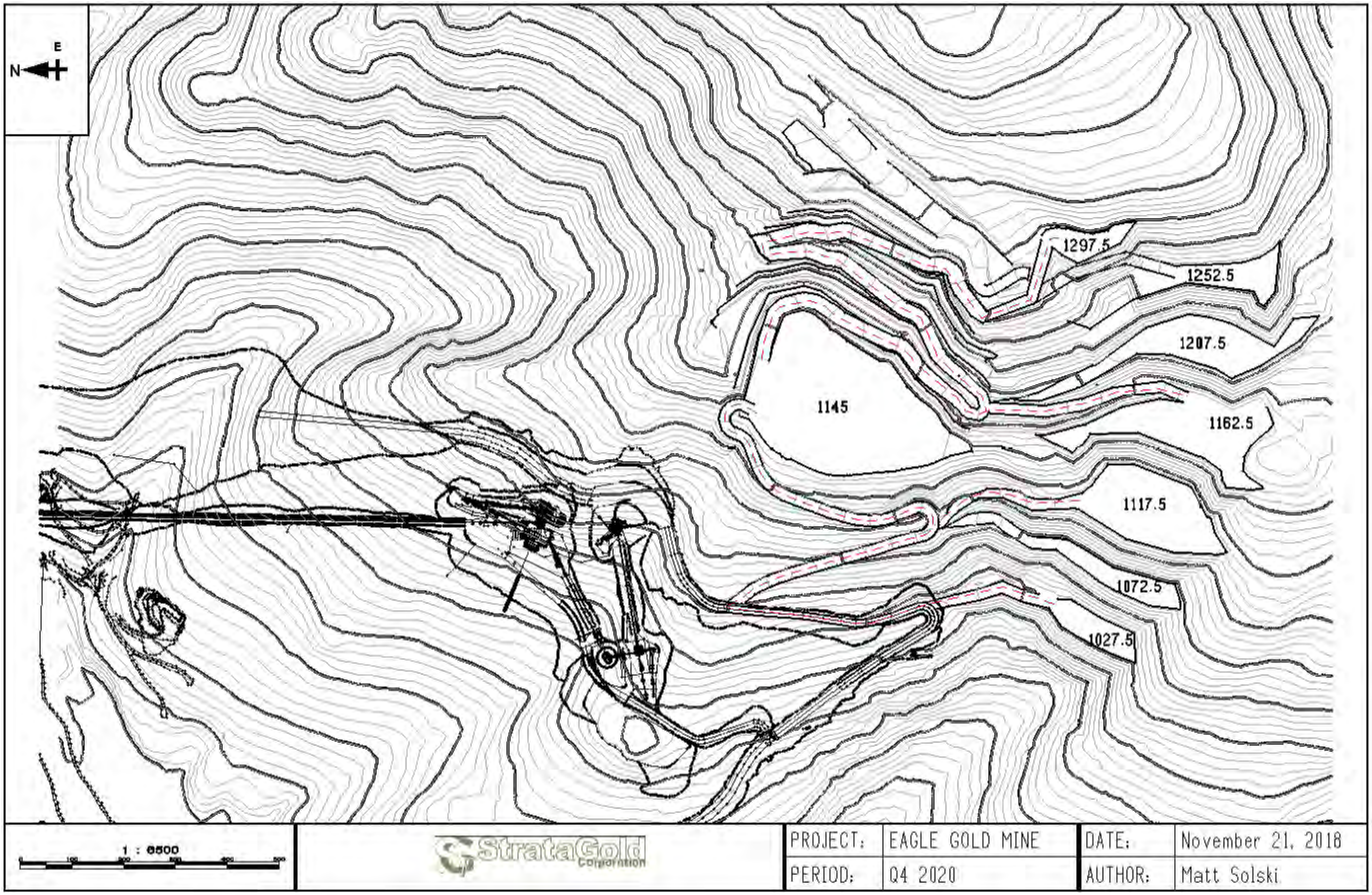

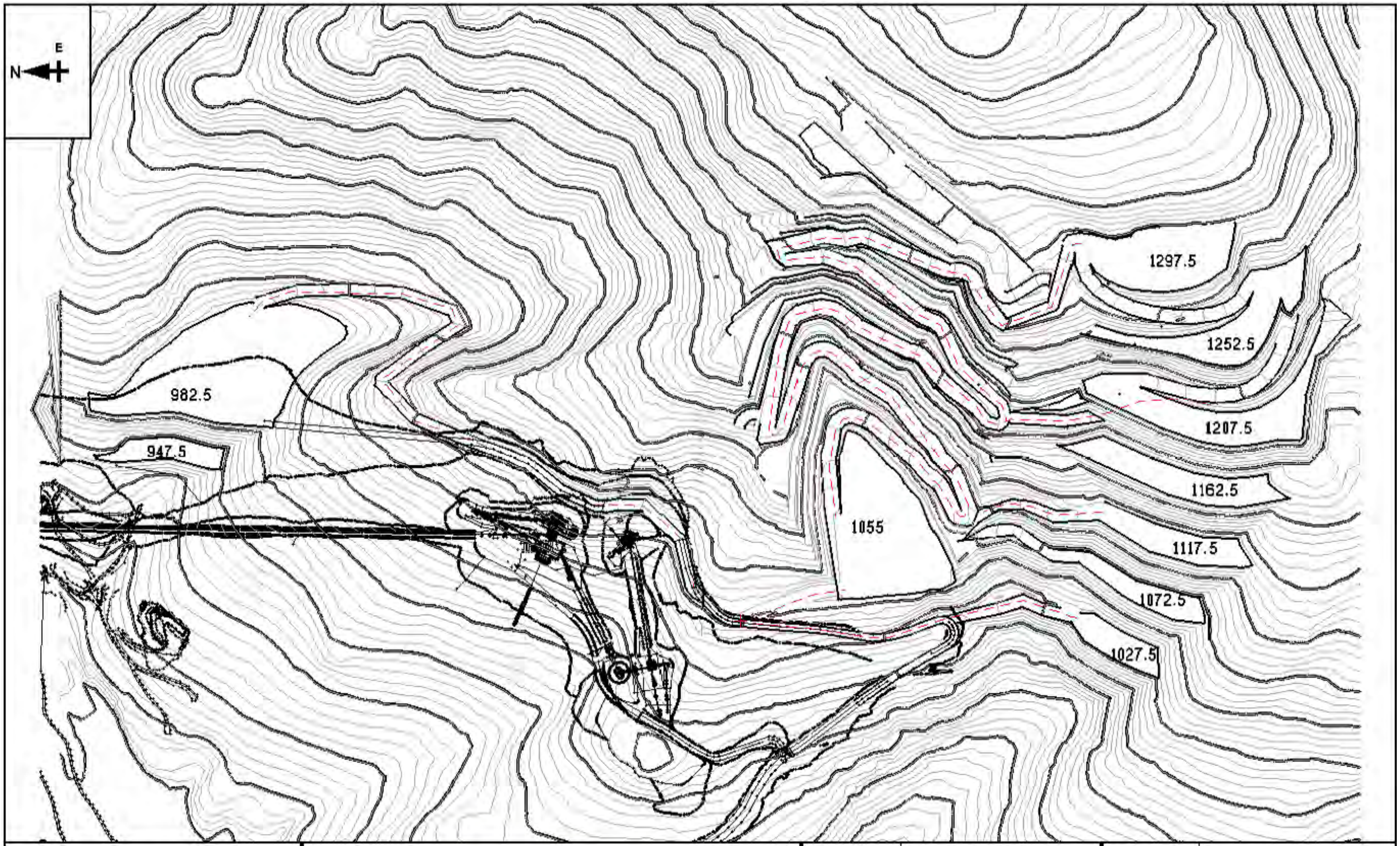

StrataGold Corporation

PROJECT:	EAGLE GOLD MINE	DATE:	November 22, 2018
PERIOD:	Q4 2021	AUTHOR:	Matt Solski

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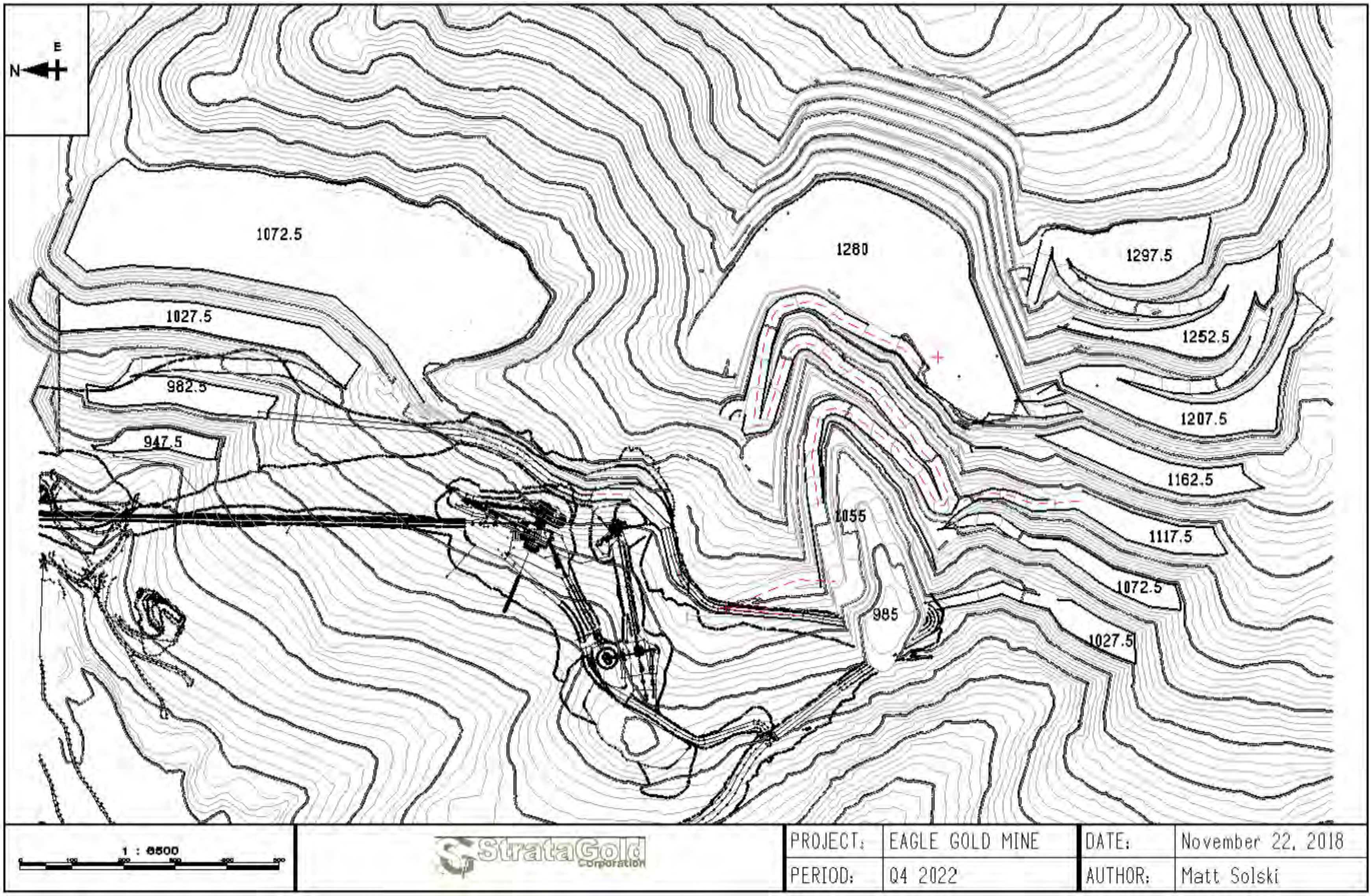

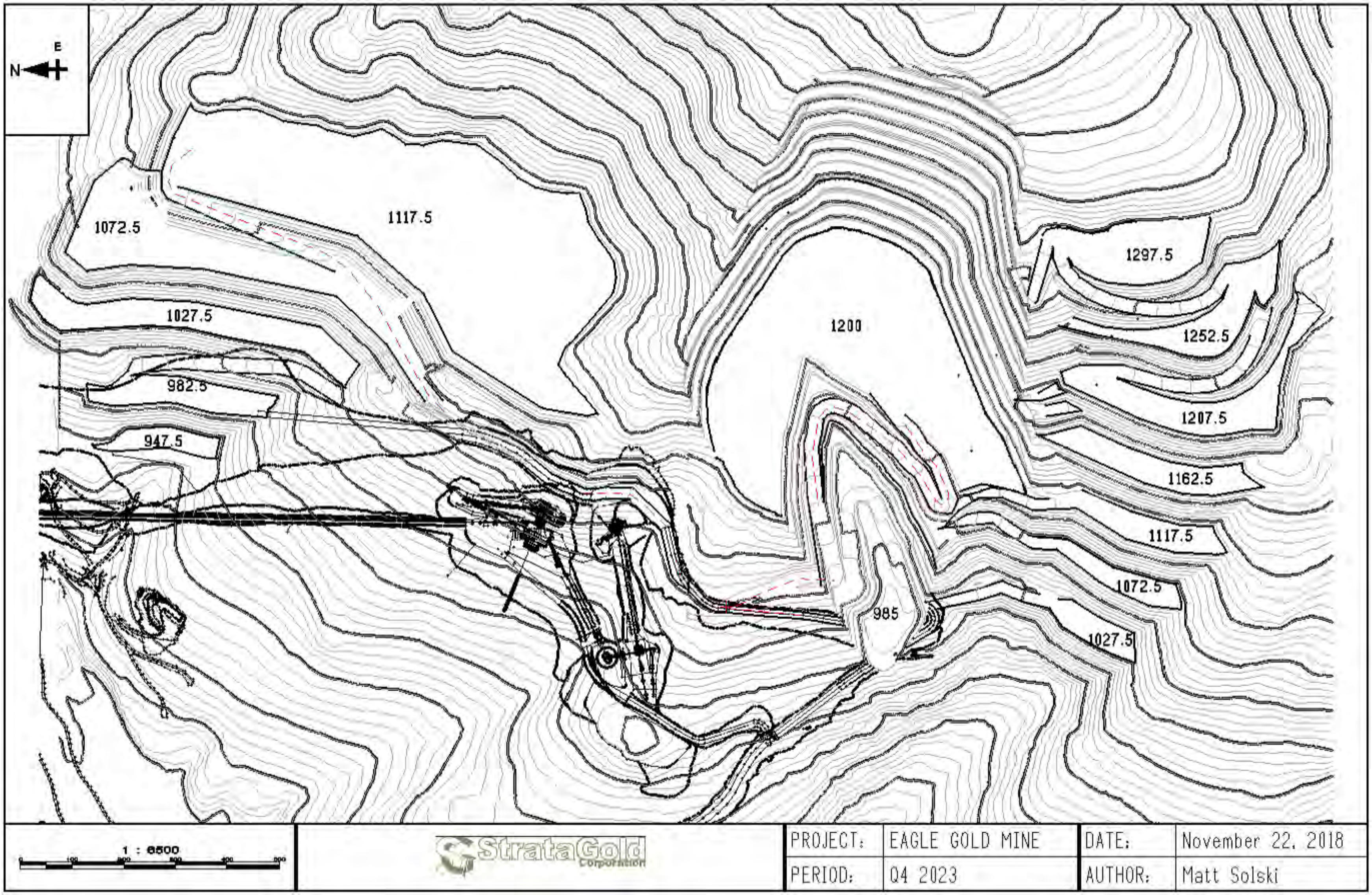
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StrataGold Corporation
PROJECT:
EAGLE GOLD MINE
PERIOD:
Q4 2023
DATE:
November 22, 2018
AUTHOR:
Matt Solski

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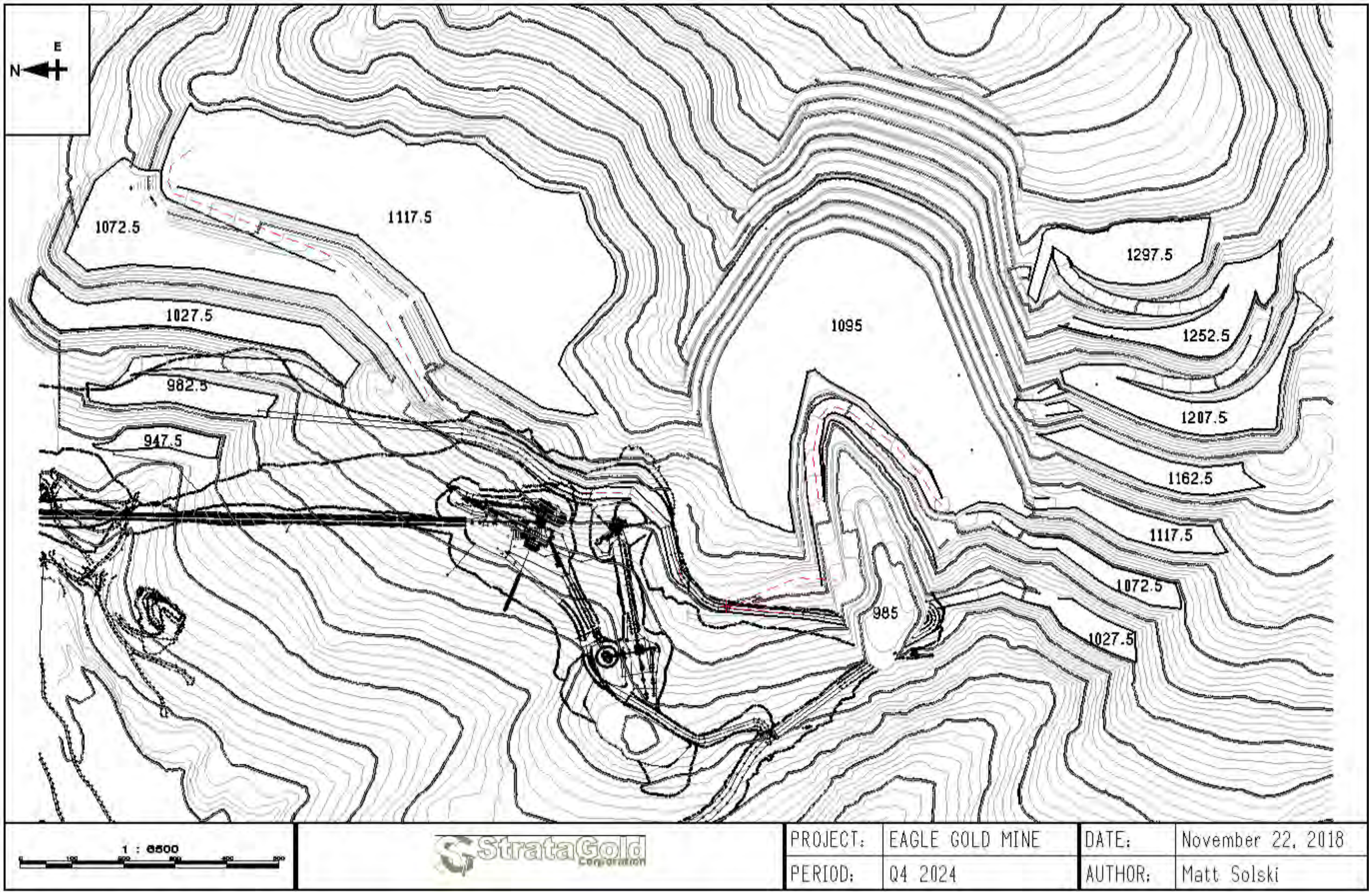

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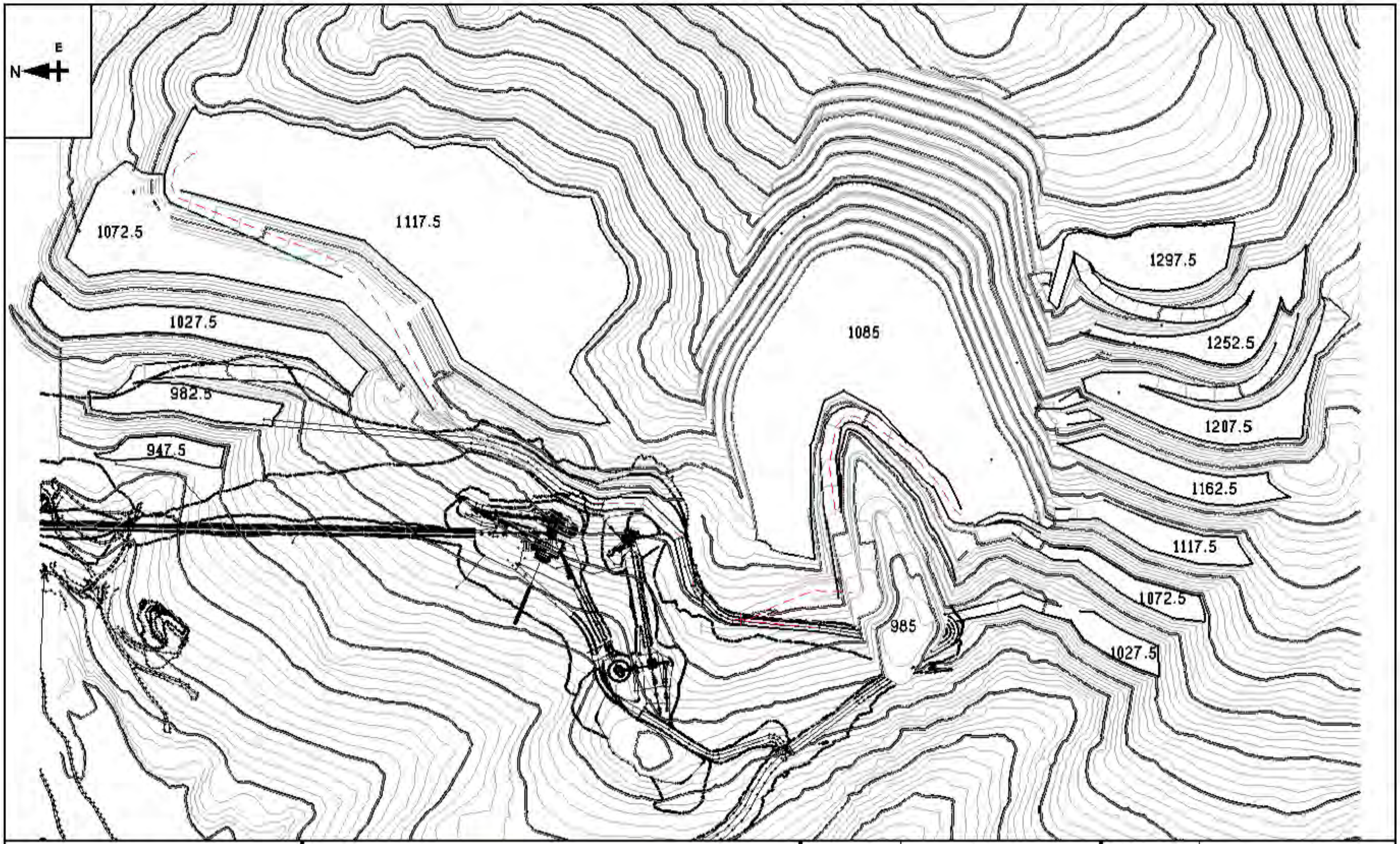

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PERIOD:	Q4 2025	AUTHOR:	Matt Solski

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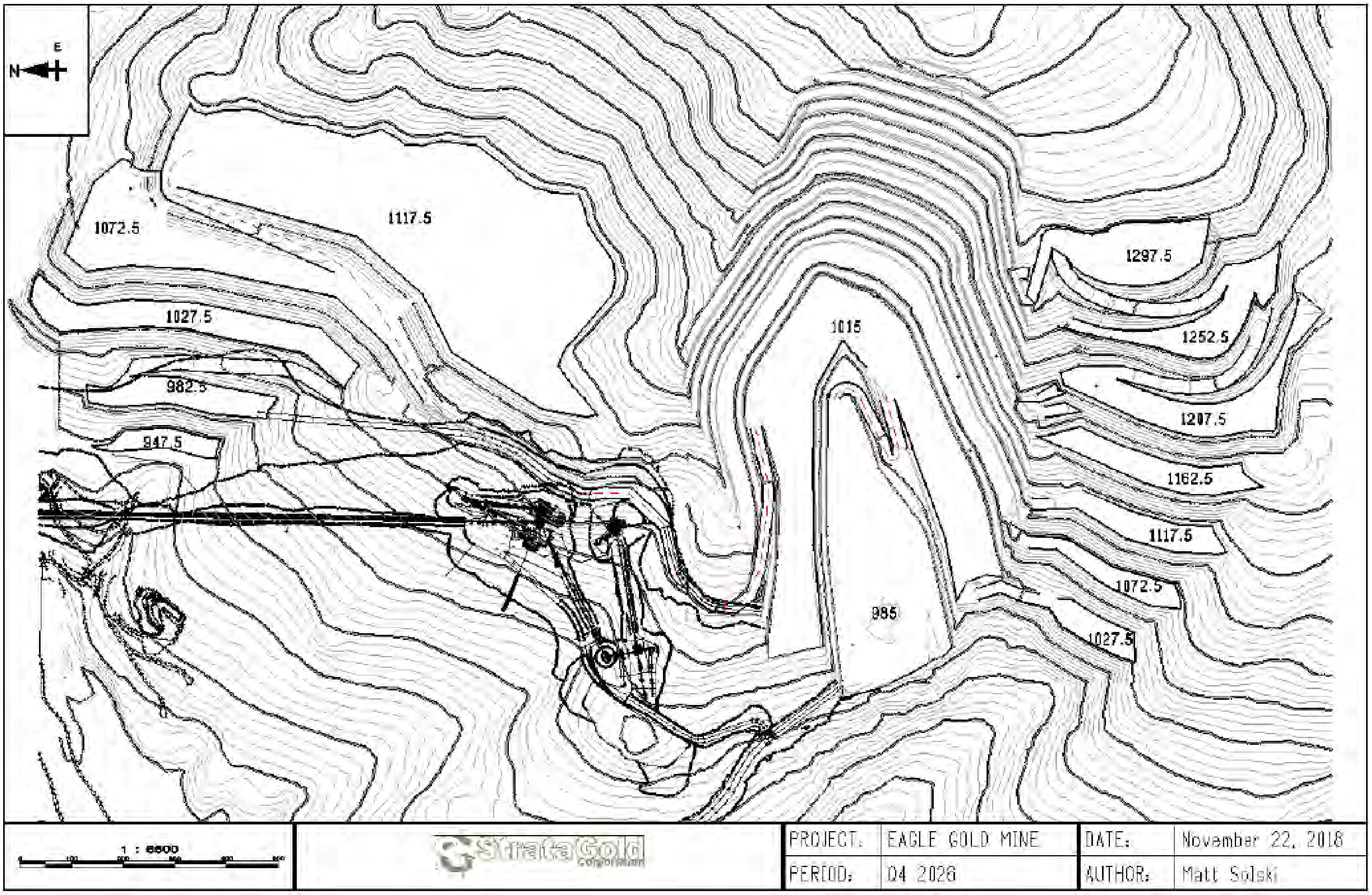

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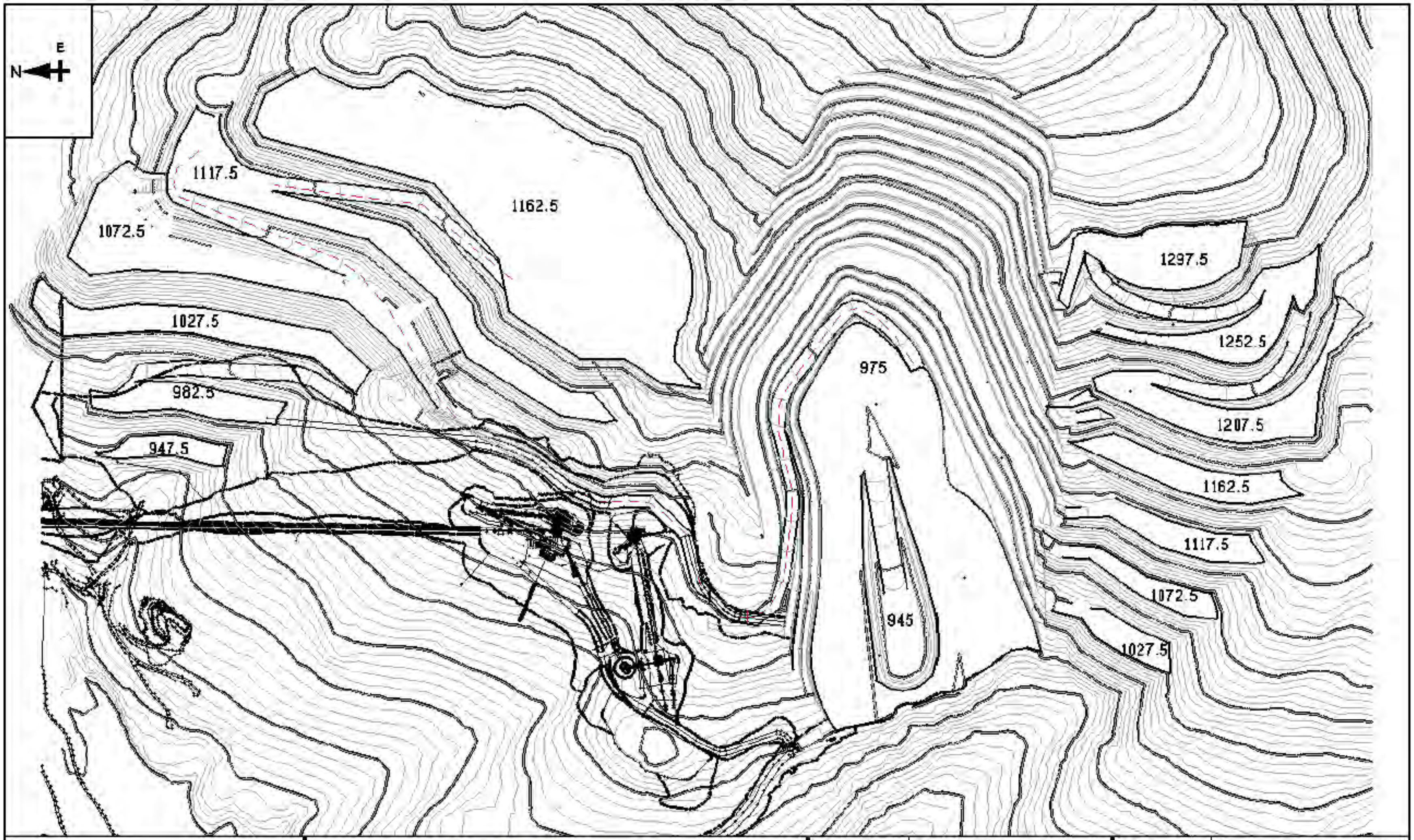

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StrataGold Corporation

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PERIOD:	Q4 2027	AUTHOR:	Matt Solski

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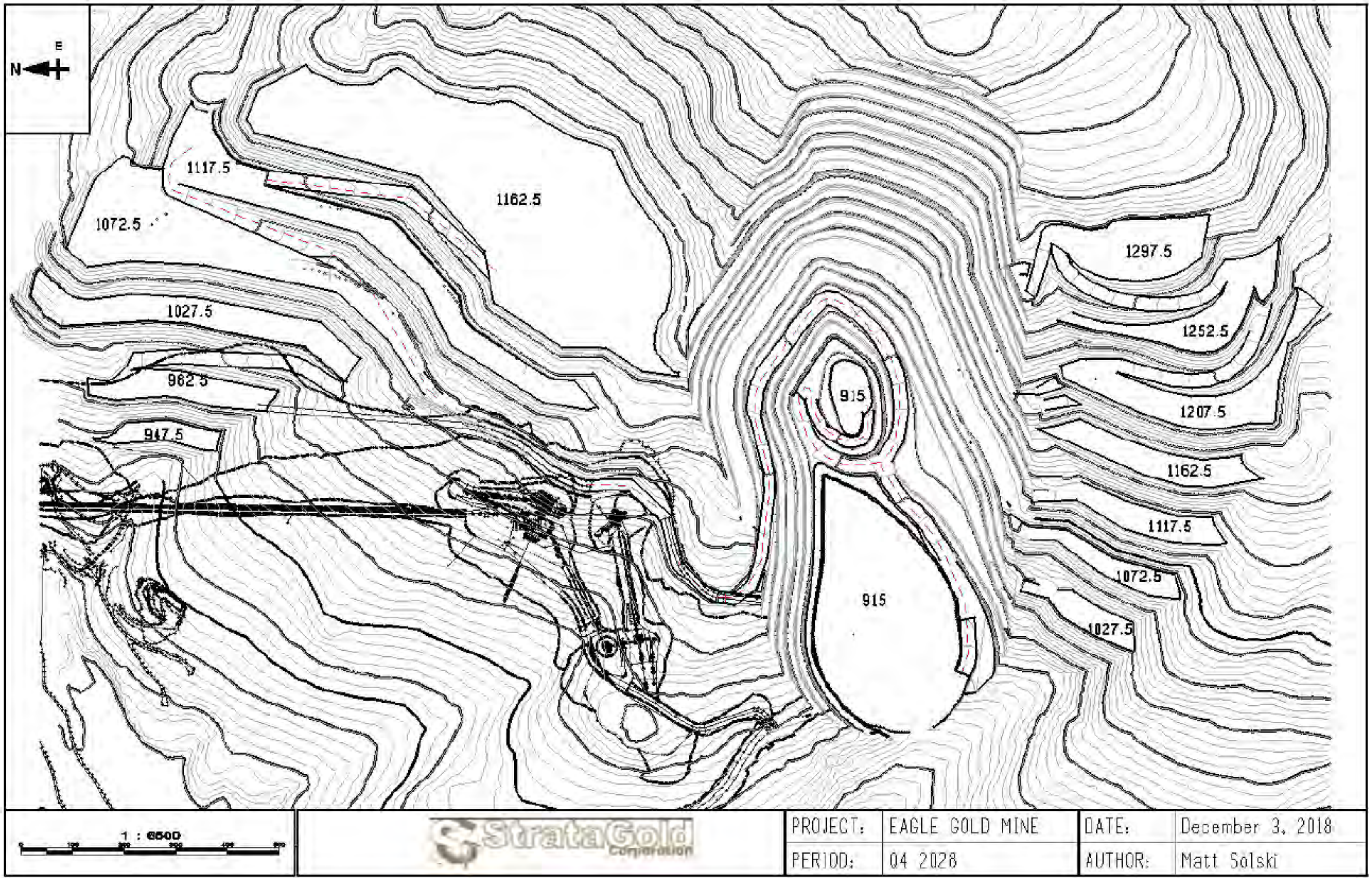

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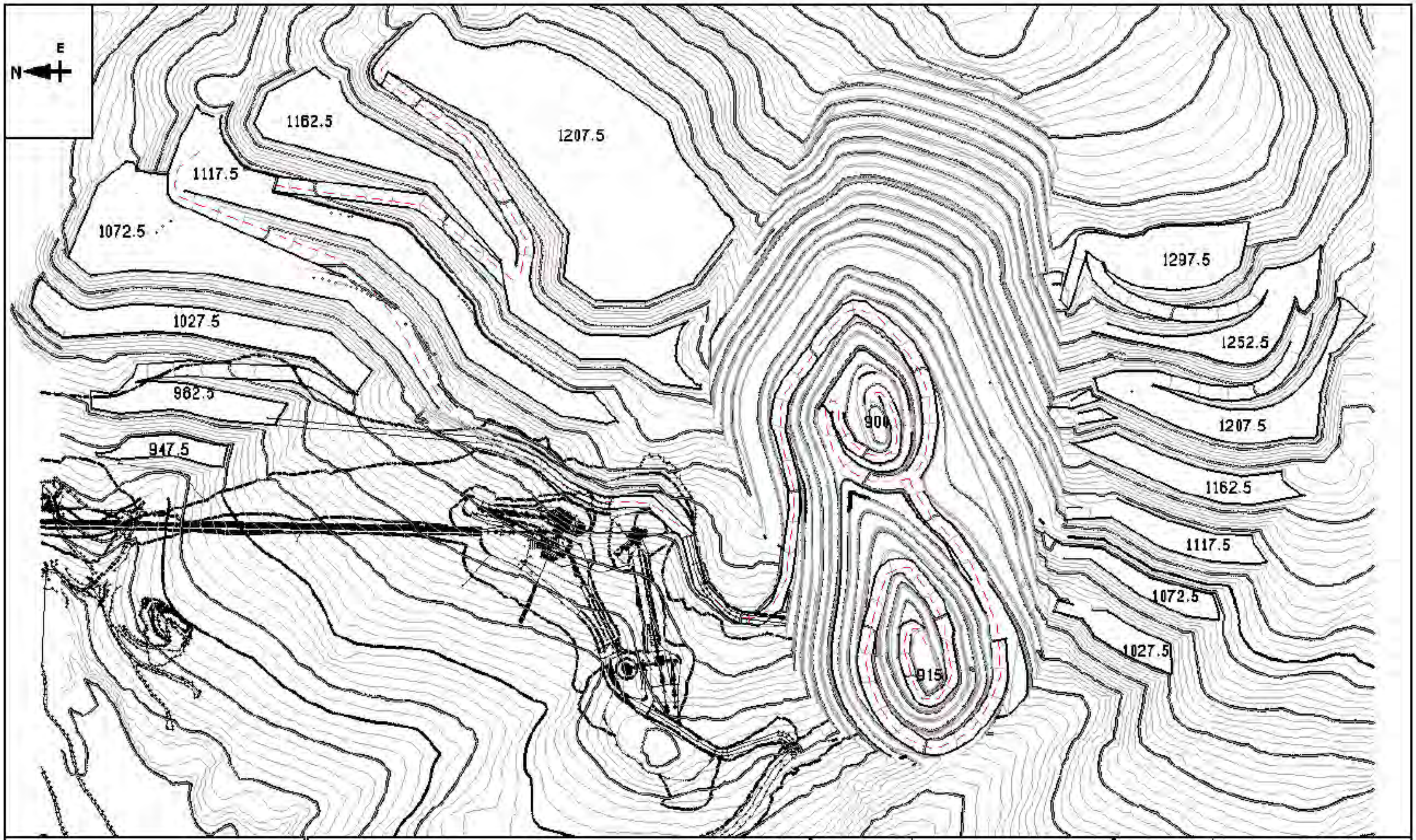
PERIOD:	Q4 2028	AUTHOR:	Matt Solski



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StrataGold Corporation

PROJECT:	EAGLE GOLD MINE	DATE:	December 3, 2018
PERIOD:	Q4 2029	AUTHOR:	Matt Solski

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APPENDIX 5

Eagle Project WRSA and 90-day Storage Area Slope Stability Analysis

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WRSA AND 90-DAY STORAGE AREA SLOPE STABILITY ANALYSIS

EAGLE GOLD PROJECT

YUKON, CANADA

January 22, 2019

Prepared by:
JDS ENERGY & MINING INC.
Suite 900, 999 W Hastings St.
Vancouver, BC V6C 2W2

Prepared for:
VICTORIA GOLD CORP.
Vancouver, BC
V6E 3S7, Canada

Table of Contents

List of Tables and Figures

1 Introduction

At the request or Victoria Gold Corp. (Victoria Gold), JDS Energy & Mining Inc. (JDS) completed slope stability analyses for the Eagle Pup and Platinum Gulch Waste Rock Storage Areas (WRSA) as well as the 90-day Storage Area.

A detailed geotechnical design report is currently being prepared that contains a summary of information regarding geotechnical data collection, testing and characterization, including recent permafrost mapping and additional field investigations of the WRSAs and 90-day Storage Area footprints, that were used to support the stability analyses described herein. This memo summarizes the results of the slope stability analyses in support of design details for the WRSAs and the 90-day Storage Area.

The analyses were carried out according to industry best practices as described in the recently published "*Guidelines for Mine Waste Dump and Stockpile Design*" (Hawley & Cunning, 2017). The 2017 guidelines are an update to the British Columbia Mine Waste Rock Pile Research Committee (BCMWRPRC) "*Mined Rock and Overburden Piles Investigation and Design Manual, Interim Guidelines*" published in 1991. The 2017 guidelines are a result of an industry funded initiative to incorporate the important contributions from the BCMWRPRC (1991) guidelines with industry experience gained since their publishing.

2 Overview of Facilities

2.1 Platinum Gulch WRSA

The Platinum Gulch (PG) WRSA will be located to the south of the proposed Eagle pit, within the Platinum Gulch watershed which has an overall northerly and westerly aspect. The PG WRSA has been designed using 45 m bench heights with 35°, angle of repose bench slopes. The toe of each bench will be set back a minimum of 50 m from the crest of the underlying bench, resulting in a final overall angle of approximately 2.5H:1V.

The lowest elevation will be 953 m above sea level (masl) and the highest point will be 1,293 masl. The total maximum vertical stack of waste rock above the natural ground surface will be approximately 70 m. The PG WRSA has been sequenced to initially place a few small waste rock benches near the head of the valley, near pit exit points, after which the remainder of the PG WRSA will be bottom-up construction. These small benches will be buttressed by the bottom-up construction within approximately 1 year from their placement.

Foundation soils consist of an up to 0.3 m thick organic layer over mostly permafrost free or ice-poor colluvium soils. Colluvium soils typically consist of 2 to 10 m of poorly to well graded silt, sand and gravel mixtures with cobbles disseminated throughout. Within the PG footprint, ice-rich soils are only believed to exist along the invert of the Platinum Gulch drainage, primarily on north to northeast facing slopes. Additional details regarding permafrost and ice-rich soils are contained below in the Ice-rich Colluvium section.

2.2 Eagle Pup WRSA

The Eagle Pup (EP) WRSA will be located to the north of the proposed Eagle pit, within the Eagle Pup watershed which has an overall northerly aspect. The EP WRSA has been designed using 45 m bench heights with 35°, angle of repose bench slopes. The toe of each bench will be set back a minimum of 50 m from the crest of the underlying bench, resulting in a final overall angle of approximately 2.5H:1V.

The lowest elevation will be 917 masl and the highest point will be 1,208 masl. The total maximum vertical stack of waste rock above the natural ground surface will be approximately 80 m. The EP WRSA will be constructed using a bottom up sequence.

Foundation soils consist of an approximately 0.3 m thick organic layer over mostly permafrost free or ice-poor colluvium soils. Colluvium soils typically consist of 0.5 to 10 m of poorly to well graded silt, sand and gravel mixtures with cobbles disseminated throughout. Potentially ice-rich soils are believed to exist within the EP WRSA footprint located primarily on northerly facing slopes, along some of the secondary swales. Additional details regarding permafrost and ice-rich soils are contained below in the Ice-rich Colluvium section.

2.3 90 Day Storage Area

The 90 Day Storage Area will be located northwest, slightly downslope of the Eagle pit. The foundation has an overall northerly aspect dipping towards Suttles Gulch.

The facility will consist of a cut/fill foundation pad with angle of repose side slopes of up to 30 m in height for fill. The fill material will consist of low grade ore that could potentially be processed at the end of mine life and/or waste rock. The top of the pad will be constructed at approximate elevation of 961 to 971 masl, sloped towards the north for drainage. Primary crushed ore will be stored on top of the foundation pad up to elevation 1,014 masl, with a maximum height of approximately 50 m at the peak.

Foundation soils consist of up to an approximately 0.3 m thick organic layer over mostly permafrost free or ice-poor colluvium soils; however, an area of ice-rich soil was encountered beneath the northeast corner of the foundation pad. Colluvium soils typically consisting of 2 to 5 m of poorly to well graded silt, sand and gravel mixtures make up the bulk of the colluvial overburden. Sand is the dominant soil component, while angular gravel makes up the coarse component. In places, the colluvium is underlain by boulders.

Warm permafrost (-0.1°C) with excess ice was identified during the 2018 permafrost investigation in a local area beneath the northeast corner of the foundation pad. A layer of ice with sand and silt approximately 1.3 m thick was observed in this area at a depth of 0.3 m. It is believed that this ice is a result of the area being located within a depression on the north-northeast facing slope that channels runoff, resulting in relatively high water and ice content.

3 Geotechnical Material Properties

A number of geotechnical field and laboratory investigations have been conducted to characterize subsoil and bedrock conditions across the site including the EP and PG WRSAs and 90 Day Storage Area (Knight Piesold 1996, BGC 2010, BGC 2011a, BGC 2012a, Tetra Tech 2017 and Tetra Tech 2018). Field investigations consisted of multiple solid stem auger, sonic and diamond core drilling campaigns as well as extensive excavator test pitting.

Based on the collective results of the previous site geotechnical field and laboratory investigations, foundation materials within the footprint for each facility were divided into five different material types for engineering purposes. Not all material types are present at all locations. The geotechnical units included the following:

- Waste rock;
- Ice-poor colluvium;
- Ice-rich colluvium;
- Weathered bedrock; and,
- Fresh bedrock.

Geotechnical material properties were initially evaluated by BGC (2012d) as part of the original Feasibility Study WRSA design. Since that time additional investigation was completed by Tetra Tech (2017 and 2018); the objectives of the additional work were to provide additional detail on permafrost conditions in the foundation soils of the proposed facilities. JDS has reviewed the properties with respect to the supplemental Tetra Tech (2018) geotechnical investigation and updates to the properties have been made where necessary. Details regarding properties selected to represent each material type are summarized below.

3.1 Waste Rock

The waste rock material that will be stored in the EP and PG WRSAs is anticipated to consist mostly of competent granodiorite and metasediments. A portion of the metasediments bedrock has potential to be anisotropic with the foliation or relict bedding forming planes of weakness. UCS testing carried out as part of the BGC (2012b) pit slope evaluation indicated average design UCS values of 83 and 135 MPa for the metasediments and granodiorite, respectively.

Due to the large particle size (i.e., typically greater than 10 cm) of typical waste rock materials, laboratory testing is very rarely able to be carried out at the actual particle size as the overall test sample size required would greatly exceed the size and loading capacities of conventional testing equipment. Research investigations conducted by Linero and Palma (2007), Marsal and Resendiz (1975), Leps (1970) and others have carried out large-scale testing of dumped rock fill samples and demonstrated that, for high rock fill dumps such as the EP and PG WRSAs, the shear strength envelope is non-linear, being more frictional at lower confinement stresses (or depths) and more cohesive at higher confinement. This non-linear shear strength relationship is commonly represented using the two-component power law:

$$\tau = A\,\sigma_n{}^b$$

where τ is the shear strength (kPa), σ_n is the normal stress (kPa) and A and b are material constants which are estimated based on large-scale triaxial or direct shear test results. The material constants are affected by size, strength and angularity of the intact waste rock particles as well as the density of the material after being placed.

Based on the large-scale triaxial tests carried out by Leps (1970) recommendations for material constants A and b were developed by Hawley & Cunning (2017). The recommended shear strength functions range from an upper bound shear strength behavior for high-density, well-graded, strong particles to a lower bound strength for low density, poorly graded, weak particles. The function developed by Hawley & Cunning (2017) to represent lower quartile shear strength (A of 1.576 and b of 0.899 kPa) was selected to represent the Eagle waste rock for the slope stability analyses. This strength function is likely conservative for the Eagle WRSAs because it assumes top-down construction which would result in a lower density and weaker shear strength. The WRSAs will be constructed in a mostly bottom-up sequence resulting in a higher density and strength.

3.2 Colluvium Soils

A layer of transported soils above bedrock referred to as colluvium exists across most of the site. The depth of the colluvium soils typically ranges from 1 to 10 m within the WRSAs and 90 Day Stockpile Area. Colluvium depth is typically shallow near the upper valleys and ridge tops and deepens towards lower elevations and valley bottoms.

According to the Permafrost Map of Canada, the Dublin Gulch area is located within the zone of extensive discontinuous permafrost, where 50% to 90% of the area is expected to be perennially frozen (Heginbottom et al.1995). When analyzing slope stability in permafrost areas, it is important to distinguish between frozen and unfrozen states as well as the actual ice content of the frozen soils and the time of year the observations are being made.

Frozen soils with low ice content (ice-poor) typically have a very low risk of becoming unstable if suddenly thawed due to the low amount of melt water. Ice-rich soils on the other hand can experience drastic strength reductions, becoming unstable when thawed. Whether or not an ice-rich soil is potentially thaw-unstable depends primarily on the particle size distribution of the material. Coarse grained soils generally have adequate pore space with hydraulic connectivity to dissipate the water as it forms from thawing, whereas fine grained soils do not drain as readily due to lower hydraulic connectivity within the pore spaces; this can lead to a sudden increase in pore water pressure and strength reduction. It is possible that some of the saturated or over saturated soils would displace/squeeze up into the waste rock voids and some would consolidate under the waste rock load, regaining strength. However, it would be very difficult to predict how much strength could be regained or where this would occur. Given the uncertainty this strength should not be relied upon in the WRSA design.

The threshold between ice-poor and ice-rich material is not exact but good rule of thumb may be 15 to 20 % visible ice by volume. Fine grained soils with greater than 15 to 20 % visible ice content have a high risk of being thaw-unstable. For the purpose of the slope stability analyses, the boundary for ice-rich materials was conservatively considered to be 10 % visible ice content to be consistent with the Tetra Tech (2018) permafrost characterization map. Materials with less than 10 % visible ice content (classified as Fn according to Tetra Tech, 2018) were considered low risk of being thaw-unstable and having low creep potential. Soils with greater than 10 % visible ice content (classified as Fv or Fi according to Tetra Tech,

2018) were considered to have a high potential for being thaw-unstable and having high creep potential. The areas of ice-rich (Fv and Fi) and ice-poor (Fn) or unfrozen (UF) are shown for the PG WRSA, EP WRSA and 90 Day Storage Area footprints on Figures 1, 2 and 3, respectively.

3.2.1 Ice-poor and Unfrozen Soils

Colluvium shear strength was initially tested by Knight Piesold (1996) on a sample obtained from a proposed heap leach pad location. The proposed heap leach pad at that time was further up the Dublin Gulch drainage nearer the headwaters and east of the current EP WRSA. However, the grain size distribution of the sample tested closely approximates those of the colluvium in the Eagle Pup WRSA (BGC 2012). The sample consisted of 45% gravel, 23% sand, 26% silt, and 6% clay.

A multi-stage consolidated-undrained (CU) triaxial test was conducted on the sample which was remolded to 95% Modified Proctor maximum dry density at approximately the natural moisture content. The sample was tested under confining stresses ranging from 35 to 1000 kPa. The results of the triaxial testing indicated an effective friction angle (φ’) of 38° with 68 kPa cohesion (c’).

In addition to the Knight Piesold (1996) triaxial test, four direct shear tests were conducted on samples of colluvium obtained from the Tetra Tech (2018) field investigation. The 2018 direct shear tests yielded very similar results with effective friction angles (φ’) ranging between 31° and 40° with 13 to 71 kPa cohesion (c’). The average effective shear strength of the four tests is 35° with 46 kPa which is consistent with the previous triaxial test. The percentages of gravel, sand, silt and clay for the 2018 direct shear samples are also quite similar to the 1996 test sample.

An effective strength of φ’ = 34° and c’ = 0 kPa was conservatively selected for the ice-poor and unfrozen colluvium in the slope stability models. Both direct shear and triaxial test results indicate a cohesive component to the shear strength envelopes of the tested colluvium samples. Cohesion values from the tests ranged between 13 and 71 kPa which is considered reasonable for coarse, colluvial soils such as those tested. The use of a zero cohesion shear strength envelope for the colluvial soils was initially adopted by BGC (2012d) and is considered representative of a long term, residual shear strength. JDS notes that this is a conservative approach but feels it is appropriate in this case to account for potential uncertainties in the foundation strength.

The colluvium layer was modeled as a 10 m thick continuous layer, parallel to the pre-mine ground surface for the WRSA analyses and 5 m for the 90 Day Storage Area. The 10 m thick colluvium layer used for the WRSA analyses is also a conservative model assumption and likely represents an upper bound colluvium thickness. Much of the WRSA footprints will have less than 10 m of colluvium soils which would result in more stable conditions. Reducing the layer to 5 m thick was tested for certain models and resulted in a slight increase in safety factor for some cases.

The thin layer of organic materials on the ground surface has not been incorporated into the stability analysis models as it is assumed that it is not thick enough to control large-scale failures. In addition, it is anticipated that these materials may be removed in some areas and stockpiled for reclamation purposes.

3.2.2 Ice-rich Soils

Ice-rich soils at the Eagle site generally occur in localized areas within drainage or valley bottoms and are relatively shallow, within approximately 3 m. Based on the Tetra Tech (2018) geotechnical investigation, permafrost mapping program (Tetra Tech 2017), and previous work by BGC (2010, 2011a, 2012a and

2012c) the highest potential for ice-rich materials within the WRSA footprints is along the Platinum Gulch drainage bottom as well as some of the drainage bottoms in the upper Eagle Pup valley. Ice-rich to very ice-rich soils have also been identified beneath the northeast corner of the 90 Day Storage Area.

Where present in an appreciable concentration, ice-rich colluvium was modeled conservatively using a zero friction, undrained shear strength of 80 kPa. This value is based on published shear strength test results for clayey silts and silty clays with high or medium ice content at a temperature of approximately -2° C (Johnson, 1981). Long-term climate warming may thaw some ice-rich materials but thaw would occur at a sufficiently slow rate to allow adequate dissipation of pore water pressures potentially created by melt water and would be unlikely to lead to instabilities.

3.3 Weathered Bedrock

Bedrock beneath the colluvium is typically moderately to completely weathered with the rock becoming less weathered and more competent with depth. The weathered bedrock typically consists of densely fractured bedrock that can be highly friable, readily breaking down to sand and gravel. In the WRSAs and 90 Day Storage Area, fresh rock (i.e., essentially non-weathered) is typically encountered at depths between 1 and 13 m below the base of colluvium.

Based on visual classifications, field observations, and limited in-situ penetration testing BGC (2012) assigned the completely weathered bedrock an effective strength of $\varphi' = 35°$ and $c' = 50$ kPa. Given the variability in thickness and geotechnical characteristics, the weathered bedrock zone was conservatively modeled as a continuous 20 m thick layer beneath the colluvial soils using the BGC (2012) completely weathered bedrock strength.

The transition from colluvium soils to weathered bedrock is gradational and difficult to distinguish in the field. Similarly, the contact between weathered and fresh bedrock is typically irregular and difficult to consistently and accurately log across a site. As such, the 20 m weathered bedrock thickness is a conservative estimate based on the borehole and test pit logs but most likely represents a maximum thickness beneath the facilities. Reducing the weathered bedrock thickness in the slope stability models would have negligible effects on the calculated safety factors in this case given that, all but one, of the critical slip surfaces were above bedrock, within the colluvium soil layer. The final EP WRSA configuration was the only case where shear stresses were high enough to result in shearing of the weathered bedrock layer.

3.4 Fresh Bedrock

Fresh bedrock was modeled as an ‘infinite strength’ material in the analyses. As a result of the dramatic differences in strength between the in-situ fresh bedrock and the overburden soils at Eagle, critical slip surfaces generated by the model preferentially occur through the much weaker overburden soils or (potentially) the upper, weathered bedrock layer. This assumption was also confirmed with the modeling results.

3.5 Pore Water Pressures

Piezometric surfaces were constructed in the slope stability models as a means of estimating hydrostatic pore water pressures. The piezometric surface was assumed to be coincident with the pre-mine ground surface for portions of slope stability cross sections near or in drainage valley bottoms. The water table was considered to be 5 m below the pre-mine ground surface for portions of slope stability sections that are on hillsides, up slope and out of the drainage bottoms.

The piezometric surface was used by the model to calculate hydrostatic pore water pressures within all foundation materials. It was assumed by BGC and for the analyses reported on herein that the waste rock and rock drains constructed beneath are sufficiently coarse to allow free drainage without the buildup of pore water pressures within the base of the WRSA.

JDS notes that the assumed piezometric levels used for the analyses represent an artificial and isolated occurrence which is relevant to the stability evaluation; further, this assumed local water table does not represent the regional groundwater table.

4 Slope Stability Analyses

4.1 Model Methodology

Based on the anticipated foundation materials and the proposed interim and ultimate WRSA design configurations, critical cross-sections were selected for detailed stability analyses. The cross-section locations were selected to represent idealized worst-case geometries and foundation conditions for the interim and final WRSA designs. The traces of the slope stability cross-sections are shown in Figures 1 and 2 for the Platinum Gulch and Eagle Pup WRSAs, respectively. The stability section trace for the 90 Day Storage Area is shown on Figure 3 while Figure 4 contains a typical slope stability cross section model showing the various geotechnical units.

The cross-section geometries were input into the software program Slide® 8.018 (Rocscience, 2018). Slide® is a two-dimensional, limit equilibrium slope stability analysis program that evaluates safety factors by various methods of slices. The analysis results are reported herein for the Spencer (1967) method of slices because it satisfies both force and moment equilibrium, leading to more realistic safety factor calculations. Because rigorous methods such as Spencer's satisfy all conditions of static equilibrium, they implicitly provide more realistic models of the physical mechanics of failure than do simplified methods (Hawley & Cunning, 2017).

Each section was analyzed for static and pseudostatic loading conditions. Pseudostatic analyses simulate seismic forces in terms of a horizontal acceleration expressed as a coefficient (or percent) of gravity (g). As recommended by the B.C. Mine Waste Rock Pile Research Committee (1991), the peak ground acceleration (PGA) corresponding to a 1:475 year event (or 10% probability of exceedance in 50 years) was used for the pseudostatic stability analyses. Based on the BGC (2011) Seismic Design report, the peak horizontal ground acceleration for the site corresponding to a 1:475 year return interval is 0.14 g.

A total of 147 cases were simulated each for static and pseudostatic loading conditions, between 13 separate models created along the 7 critical cross-sections analyzed. The geometry of each model is shown for each section and model in Attachment A.

Figure 1: Location of Platinum Gulch WRSA Slope Stability Cross Sections

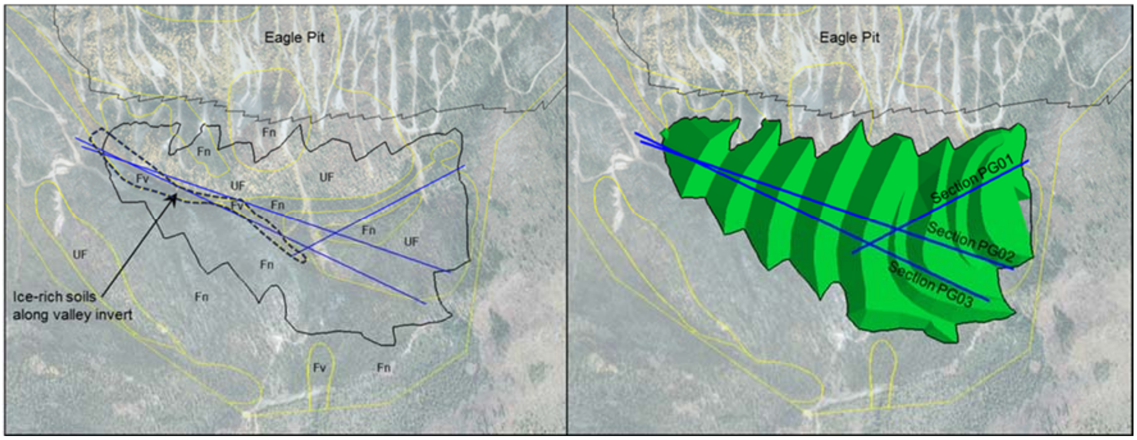


Figure 2: Location of Eagle Pup WRSA Slope Stability Cross Sections

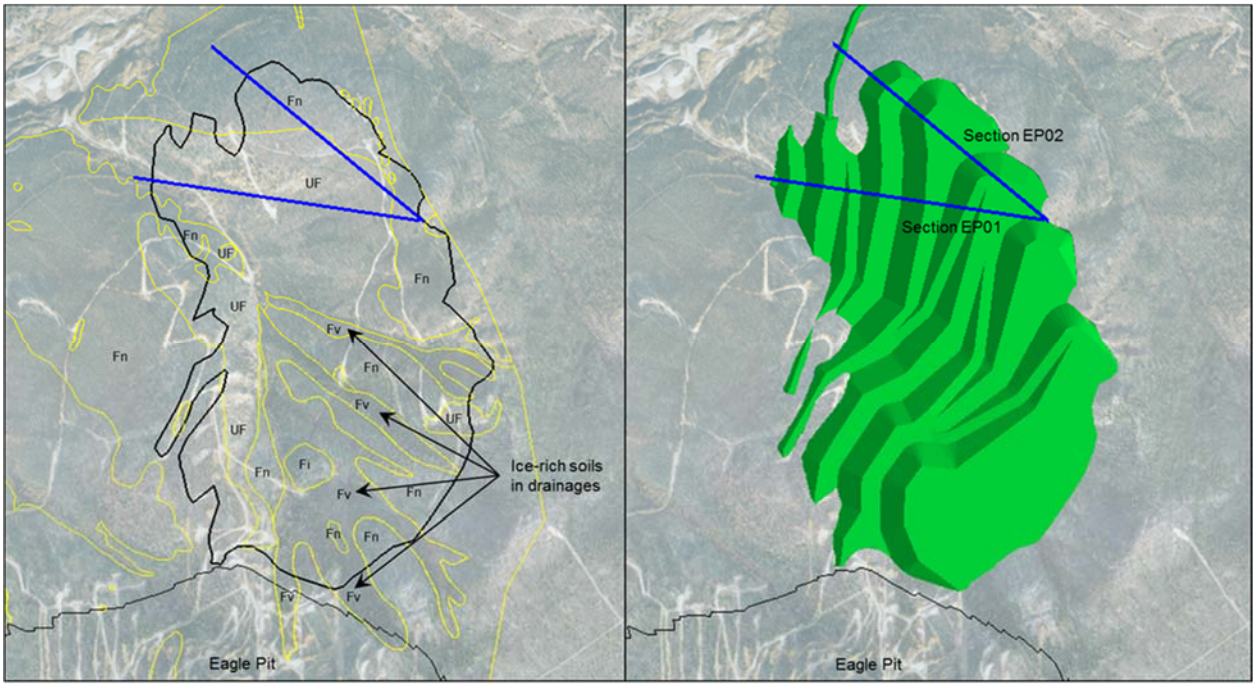


Figure 3: Location of 90 Day Storage Area Slope Stability Cross Section

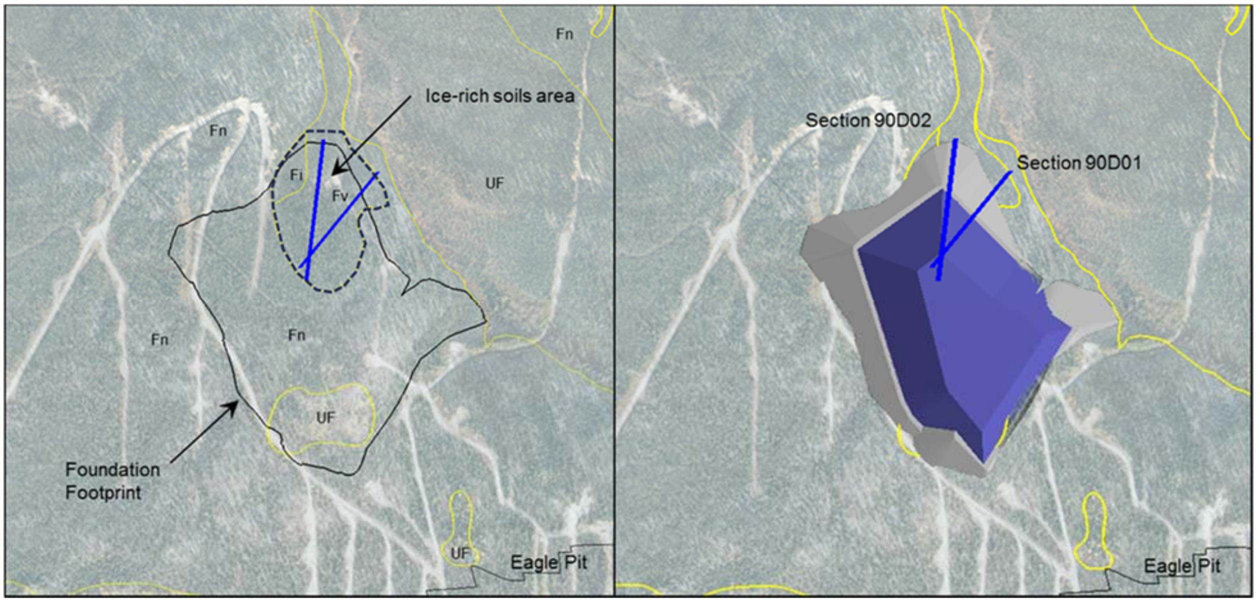
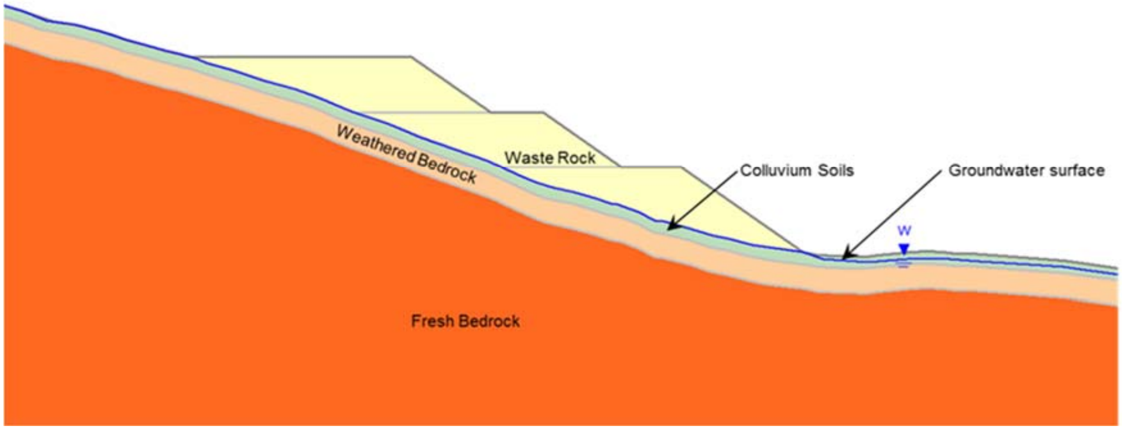


Figure 4: Slope Stability Cross Section Model (PG-M6-SE-C03)



When incorporating PGA in a slope stability model, it is common practice to reduce the PGA by a factor of 0.5 based on the research conducted by the U.S. Army Corps of Engineers (Hynes-Griffen and Franklin, 1984). In summary, this reduction in acceleration is justified for earth and rock structures for the following reasons:

- Realization that sustained ground acceleration is typically less than half of the PGA, which is an instantaneous acceleration; and,
- Consideration that earth and rock structures effectively attenuate earthquake-induced accelerations; and,
- Determination that deformations of less than one meter would result with this criterion.

Based on these guidelines, a pseudostatic seismic coefficient of 0.07 g was selected for the analyses.

4.2 Design Acceptability Criteria

Design acceptability criteria for the analyses are based on the "*Guidelines for Mine Waste Dump and Stockpile Design*" (Hawley & Cunning, 2017). The suggested minimum factor of safety (FoS) presented in the guidelines are re-produced in Table 2 with the minimum FoS reflecting different levels of confidence in the understanding of site conditions, material parameters, and consequences of instability. As previously discussed, the recently published Hawley & Cunning (2017) guidelines are considered an update and improvement to the previous (BCMWRPRC, 1991) interim design acceptability criteria, which did not distinguish between important factors such as the size of facility, consequence of failure or confidence in foundation conditions.

JDS considers the current EP and PG WRSA designs to fall within the moderate consequence and high confidence categories. Corresponding minimum recommended factors of safety are 1.2 to 1.3 for static and 1.0 to 1.05 for pseudostatic loading conditions according to the guidelines.

Table 1: Suggested WRSF stability acceptance criteria (Hawley & Cunning, 2017)

Consequence[1,3]	**Confidence**[2,3]	**Static analysis**		**Pseudostatic**	**Maximum allowable strain**
		Minimum FoS	**Maximum PoF**	**Minimum FoS**	
Low	Low	1.3 - 1.4	10 - 15%	1.05 - 1.1	≤ 1%
	Medium	1.2 - 1.3	15 - 25%	1.0 - 1.05	≤ 1.5%
	High	1.1 - 1.2	25 - 40%	1.0	≤ 2%
Moderate	Low	1.4 - 1.5	2.5 - 5%	1.1 - 1.15	≤ 0.75%
	Medium	1.3 - 1.4	5 - 10%	1.05 - 1.1	≤ 1%
	High	**1.2 - 1.3**	**10 - 15%**	**1.0 - 1.05**	**≤ 1.5%**
High	Low	≥ 1.5	≤ 1%	1.15	≤ 0.5%
	Medium	1.4 - 1.5	1 - 2.5%	1.1 - 1.15	≤ 0.75%
	High	1.3 - 1.4	2.5 - 5%	1.05 - 1.1	≤ 1%

Notes:

1. **Consequence**

   Low Consequence: waste dumps and stockpiles with overall fill slopes less than 25° and less than 100 m high and repose angle slopes less than 50 m high. No critical infrastructure or unrestricted access within potential runout shadow. Limited potential for environmental impact. Long-term (> 5 years) exposure for sites subject to very low to low (< 350 mm) annual precipitation; medium-term (1-5 years) exposure for sites subject to moderate (350-1000 mm) annual precipitation; short-term (< 1 year) exposure for sites subject to high (1000-2000 mm) annual precipitation; dry season construction/operation only for sites subject to very high (> 2000 mm) annual precipitation or intensive rainy season(s).

   Moderate Consequence: waste dumps with overall fill slopes less than 30° and less than 250 m high, or with repose angle slopes less than 100 m high. No critical infrastructure or unrestricted access, or robust containment/mitigative measures to protect critical infrastructure and access within potential runout shadow. Potential for moderate environmental impact, but manageable. Long-term (> 5 years) exposure for sites subject to moderate (350-1000 mm) annual precipitation; medium-term (1-5 years) exposure for sites subject to high (1000-2000 mm) annual precipitation; short-term (< 1 year) exposure for sites subject to very high (> 2000 mm) annual precipitation or intensive rainy season(s).

   High Consequence: waste dumps with overall fill slopes more than 30° and more than 250 m high, or with repose angle slopes more than 200 m high. Critical infrastructure or unrestricted access within potential runout shadow with limited runout mitigation/containment measures. Potential for high environmental impact that would be difficult to manage. Long-term exposure (> 5 years) for sites subject to high (1000 – 2000 mm) annual precipitation; medium (1-5 years) exposure for sites subject to very high (> 2000m) annual precipitation or intensive rainy season(s).

2. **Confidence**

   Low Confidence: limited confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Poorly defined or optimistic input parameters; high data variability. For proposed structures, investigations at the conceptual level with limited supporting data. For existing structures, poorly documented or unknown construction and operational history; lack of monitoring records; unknown or poor historical performance.

   Moderate Confidence: – moderate confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Input parameters adequately defined; moderate data variability. For proposed structures, investigations at the pre-feasibility level with adequate supporting data. For existing structures, reasonably complete construction documentation and monitoring records; fair historical performance.

   High Confidence: high confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or potential instability mechanism(s). Well-defined, conservative input parameters; low data variability. For proposed structures, investigations at the feasibility level with comprehensive supporting data. For existing structures, well documented construction and monitoring records and good historical performance.

3. In cases where the guidance for consequence or confidence conflicts or is unclear, selection of the appropriate level should be based on judgment, and the rational for the selection should be documented.

4.3 Slope Stability Modeling Results

Results of the stability analysis are tabulated and discussed below. The results are in terms of Factors of Safety (FOS) for each model and section for static and pseudostatic loading conditions.

Graphical outputs of each model analyzed for each of stability section are contained in Attachment A. Each result in Attachment A also contains a graphic illustrating the location of the respective cross-section and the construction stage for the respective model.

4.3.1 Platinum Gulch WRSA

Results of the Platinum Gulch WRSA stability analysis are summarized in Table 2. The analysis results indicate acceptable safety factors and can be summarized as follows:

- The critical portions of the PG WRSA are the toes of individual lifts founded on colluvium soils. The analyses demonstrate static safety factors of 1.3 (1.1 to 1.2 pseudostatic) for these cases except for the upper (1552.5 m and 1297.5 m benches) which yielded static safety factors of 1.2 (1.0 pseudostatic) due to the steeper natural topography in the upper PG drainage valley;
- Individual lifts placed above existing waste rock rather than native foundation soils indicate a safety factor of 1.5 for static loading conditions and 1.3 for pseudostatic loading;
- Safety factors for failures through multiple (2 or 3) benches ranged between 1.4 and 1.6 for static loading and from 1.1 to 1.3 for pseudostatic loading conditions. Multi-bench failures involving 4 or more benches would result in greater safety factors.

4.3.2 Eagle Pup WRSA

Results of the Eagle Pup WRSA stability analysis are summarized in Table 3. The analysis results indicate acceptable safety factors and can be summarized as follows:

- The critical areas of the EP WRSA are the toes of individual lifts founded on colluvium soils. The analyses demonstrate static safety factors of 1.3 (1.1 pseudostatic) for these cases;
- Safety factors for a double bench failure were 1.6 and 1.3 for static and pseudostatic loading conditions, respectively;
- Large-scale failures were evaluated for slip surfaces through the lower approximately 50 % of the final WRSA and then for the full final WRSA height. The results indicate a 1.9 static safety factor for and 1.6 for pseudostatic loading conditions.

Table 2: Factors of Safety Results: Platinum Gulch WRSA

Section	Model	Mine Period	FoS (Static)	FoS (Pseudostatic)	Critical Failure Description
PG01	M1	2019 - 1	1.2	1.0	Failure of 1252.5 m bench
	M2	2019 - 2	1.2	1.0	Failure of lowest (1252.5 m) bench only
		2019 - 2	1.4	1.1	Through both 1252.5 & 1297.5 m benches
		2019 - 2	1.5	1.3	Failure of upper (1297.5 m) bench only
PG02	M3	2019 - 3	1.3	1.1	Failure of lowest (1162.5 m) bench
	M4	2020 - 1	1.3	1.1	Failure of lowest (1162.5 m) bench only
		2020 - 1	1.5	1.3	Failure of middle (1207.5 m) bench only
		2020 - 1	1.5	1.2	Failure through 1162.5 and 1207.5 m benches
	M7	2021/ Final	1.3	1.2	Failure of lowest (1027.5 m) bench
		2021/ Final	1.5	1.3	Failure through 1027.5 & 1072.5 m benches
		2021/ Final	1.5	1.3	Failure through 1027.5, 1072.5 & 1117.5 m benches
PG03	M5	2020 - 2	1.3	1.1	Failure of lowest (1027.5 m) bench
	M6	2020 - 3	1.3	1.1	Failure of lowest (1027.5 m) bench only
		2020 - 3	1.4	1.3	Failure through 1027.5 & 1072.5 m benches
		2020 - 3	1.6	1.3	Failure through 1027.5, 1072.5 & 1117.5 m benches

Table 3: Factors of Safety Results: Eagle Pup WRSA

Section	Model	Mine Period	FoS (Static)	FoS (Pseudostatic)	Critical Failure Description
EP01	M1	2021 - 1	1.3	1.1	Failure of 947.5 m bench
	M2	2021 - 2	1.3	1.1	Failure of lowest (947.5 m) bench only
		2021 - 2	1.6	1.3	Failure through 947.5 & 982.5 m benches
	M3	2029 / Final	1.3	1.1	Failure of lowest (947.5 m) bench only
		2029 / Final	1.9	1.6	Failure through 947.5, 982.5 & 1027.5 m benches
		2029 / Final	1.9	1.6	Failure of full height, all benches
EP02	M4	2027 - 1	1.3	1.1	Failure of lowest (1027.5 m) bench only

4.3.3 90 Day Storage Area

Two sections were analyzed in the northeast corner of the 90 Day Storage Area where ice-rich soils have been identified (Figure 3). Slope stability was first analyzed for the ore and waste rock foundation pad slopes with the ice-rich colluvium soil left in place. Results of the stability analysis for the 90 Day Storage Area are summarized in Table 4.

With the ice-rich colluvium left in place, static safety factors of 0.6 and 0.8 were calculated for an overall slope failure through the ore stockpile and foundation soils. Behavior of ice and ice-rich materials is such that a 0.7 safety factor does not necessarily imply immediate collapse of the slope as it would with unfrozen materials, but rather that loading of the slope as proposed would likely result in relatively slow displacements (creep) of the foundation in that area.

Slope stability was then analyzed for a second case with the ice-rich soils removed and replaced with waste rock which indicated suitable minimum safety factors of 1.3 and 1.1 for static and pseudostatic loading conditions, respectively.

Table 4: Factors of Safety Results: 90 Day Storage Area

Section	Model	Mine Period	FoS (Static)	FoS (Pseudostatic)	Critical Failure Description
90D01	M1	-	1.3	1.1	Failure through full ore stockpile height
		-	0.8	0.6	Overall failure through ice-rich soils
		-	1.6	1.4	Failure of waste rock foundation layer only
90D02	M2	-	1.4	1.2	Failure through full ore stockpile height
		-	0.6	0.5	Overall failure through ice-rich soils
		-	1.2	1.0	Failure of waste rock foundation layer only

4.4 Liquefaction Considerations

As described by Hawley & Cunning (2017), liquefiable soils are those that experience significant strength loss when pore pressures in the soil approach or exceed the overburden or confining stress. The increase in pore water pressures and subsequent liquefaction can be triggered by static loading (e.g. excessive rate of loading) or by dynamic loading (e.g. earthquake shaking). In either case, saturation (or near-saturation) and generation of excess pore pressures under undrained conditions are required. Liquefied soils have extremely low shear strength and behave more like a fluid than a soil.

Soils with high liquefaction susceptibility are very uniform (poorly graded) with rounded particles, low clay content and are very loose with high void ratios. Well graded (non-uniform) soils are less susceptible to liquefaction than uniformly graded soils because the voids between the coarse particles in a well-graded soil are more likely to be filled with fines. Well graded soils are typically subject to less volume change, and hence lower pore pressure generation, when subject to shear loading in undrained conditions (Hawley & Cunning, 2017).

Geologically, the most liquefaction susceptible soils are recently deposited sediments such as finer grained alluvial, fluvial, marine, deltaic and windblown deposits. Pleistocene-age colluvial soils such as those that cover slopes beneath the WRSA and stockpile at Eagle, which are non-uniform and well graded would be classified as low susceptibility to liquefaction during strong seismic shaking according to Youd & Perkins (1978) and Idriss & Boulanger (2008).

No cases of liquefaction of waste rock dump or stockpile foundations are noted in literature (Hawley & Cunning, 2017). However, there may be cases where, given the right set of circumstances, liquefaction failure could also occur in a waste dump or stockpile foundation; consequently the potential for liquefaction failure was considered in the design process.

Liquefaction potential was evaluated according to the simplified procedures described by Idriss & Boulanger (2008) for the 475 year and MCE events using the measured SPT N-values and the unsaturated groundwater conditions encountered with the SPT tests performed as part of the site investigations as well as a second (worst) case scenario, assuming fully saturated conditions.

During the BGC (2011 and 2012) field investigations a total of 33 SPT tests were carried out in colluvium soils across the site. Of the 33 tests, only 21 yielded valid results; the remaining 12 tests resulted in refusal from very stiff ground conditions. The 21 valid tests ranged from ‘Medium Dense’ to ‘Very Dense’ based on the SPT $N_{(60)}$ values. Using the simplified procedures described by Idriss & Boulanger (2008), Safety Factors against liquefaction exceeded 2.0 for all 21 colluvium tests indicating very low liquefaction potential.

Given that the Idriss & Boulanger (2008) methods are based heavily on the SPT $N_{(60)}$ values and that some of the values could have been impacted by frozen temperatures or ice within the samples, laboratory test results were also evaluated independent of the SPT tests. In particular, samples with low bulk density or high excess ice content could indicate liquefaction potential in the event they were rapidly thawed and were sufficiently poorly graded.

Bulk densities were measured for 4 colluvium samples during the Tetra Tech (2018) field investigation: one each within the EP and PG footprints and two within the 90 Day Storage Area. Bulk densities of 1,860 kg/m^3 for a clayey silt sample and 2,076 kg/m^3 for a gravelly sand sample were measured for from the PG and EP WRSA samples, respectively. Frozen samples with bulk densities greater than approximately 1.6 to 1.7 kg/m^3 are generally considered ‘ice-poor’ indicating that they would be likely have low liquefaction potential if thawed.

Seven samples tested for excess ice within the PG and EP WRSA footprints indicated 0% excess ice. One sample obtained within the PG WRSA indicated 16% excess ice but was obtained from a local area within the PG drainage invert where higher ice content from permafrost and/or seasonal freezing would be expected.

Four samples obtained from within the 90-day Storage Area indicated excess ice contents of up to 52%. However, given the non-uniform particle size distributions of these materials and the coarse particle fraction (approximately 50% or more sand and gravel) it is likely that these materials would freely melt and not develop adequately high pore water pressures necessary for liquefaction to occur. Regardless, this material will still require removal and replacement with waste rock or free draining granular fill for stability reasons, as previously discussed.

5 Conclusions

JDS concludes the following from the results of the slope stability analyses:

- Stability of the bottom lifts, founded on colluvium soils control stability of both the PG (1027.5 m bench) and EP (947.5 m bench) WRSAs with static safety factors of 1.3 calculated for the lowest bench of each facility. Safety factors for the initial, temporary waste rock benches planned in the upper PG valley (1252.5 m and 1162.5 m benches) indicate static safety factors of 1.2 due to the steeper natural ground surface;
- Individual lifts placed over existing waste rock rather than native foundation soils indicate significantly higher safety factor of 1.5 for static loading which exceeds the minimum acceptable safety factor;
- Safety factors for large-scale failures involving multiple waste rock benches exceed minimum requirements with safety factors of 1.4 to 1.9 for the EP and PG WRSAs;
- The minimum acceptable safety factor for pseudostatic analyses of 1.05 was met or exceeded for all cases except the initial, temporary PG 1252.5 m bench which yielded a 1.03 safety factor and the 90 Day Storage Area for the case with the ice-rich soils left in place;
- Sensitivity analyses indicate that WRSA stability is sensitive to pore water pressures within the bottom waste rock benches and foundation soils beneath the toes for both the PG (1027.5 m bench) and EP (947.5 m bench) facilities. The stability analyses have been conducted assuming that the rock drains beneath the bottom benches will work as designed and drain freely, and that static water levels will not exceed more than 1 or 2 meters above the pre-mine ground surface;
- Analyses of the ice-rich materials located beneath the northeast portion of the 90 Day Storage Area yielded unacceptably low safety factors, if left in place. Consequently, any ice-rich soils within this area of the footprint must be removed and replaced with rock or coarse, granular fill prior to construction of the waste rock foundation pad (Figure 3). Based on recent photos of the area, a portion of this area has already been stripped but it is uncertain to what extent or depth;
- The ice-rich soils boundary shown on Figure 3 (Fv and Fi polygons) is an estimate based on available field investigations and permafrost mapping. Excavation will either confirm the extent of ice-rich soils or may demonstrate that the extent of ice-rich soils is more or less than currently estimated;
- Potentially thaw-unstable ice-rich materials have also been identified in the upper Eagle Pup drainage. The EP WRSA has been re-designed since the Tetra Tech (2018) field investigation to be constructed in a bottom-up sequence, thereby buttressing the upper lifts potentially founded on ice-rich materials; and,
- Liquefaction potential of colluvium soils beneath the WRSAs and the 90 Day Storage Area is considered to be low.

6 Closure

JDS is pleased to have the opportunity to be of service to Victoria Gold and trust that we have addressed the pertinent issues related to stability of the WRSA and 90 Day Stockpile slopes at this time. Should you, however, have any queries or comments on our visit or on the contents of this report, please do not hesitate to contact us.

Yours truly,

JDS Energy & Mining Inc.

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MICHAEL E. LEVY
22 Jan 2019

Michael Levy, P.E., P.G., P.Eng.
Geotechnical Manager

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Attachment A

Eagle Gold Project

Attachment A: Slope Stability Analysis Results for WRSAs & 90 Day Stockpile

Platinum Gulch WRSA Results

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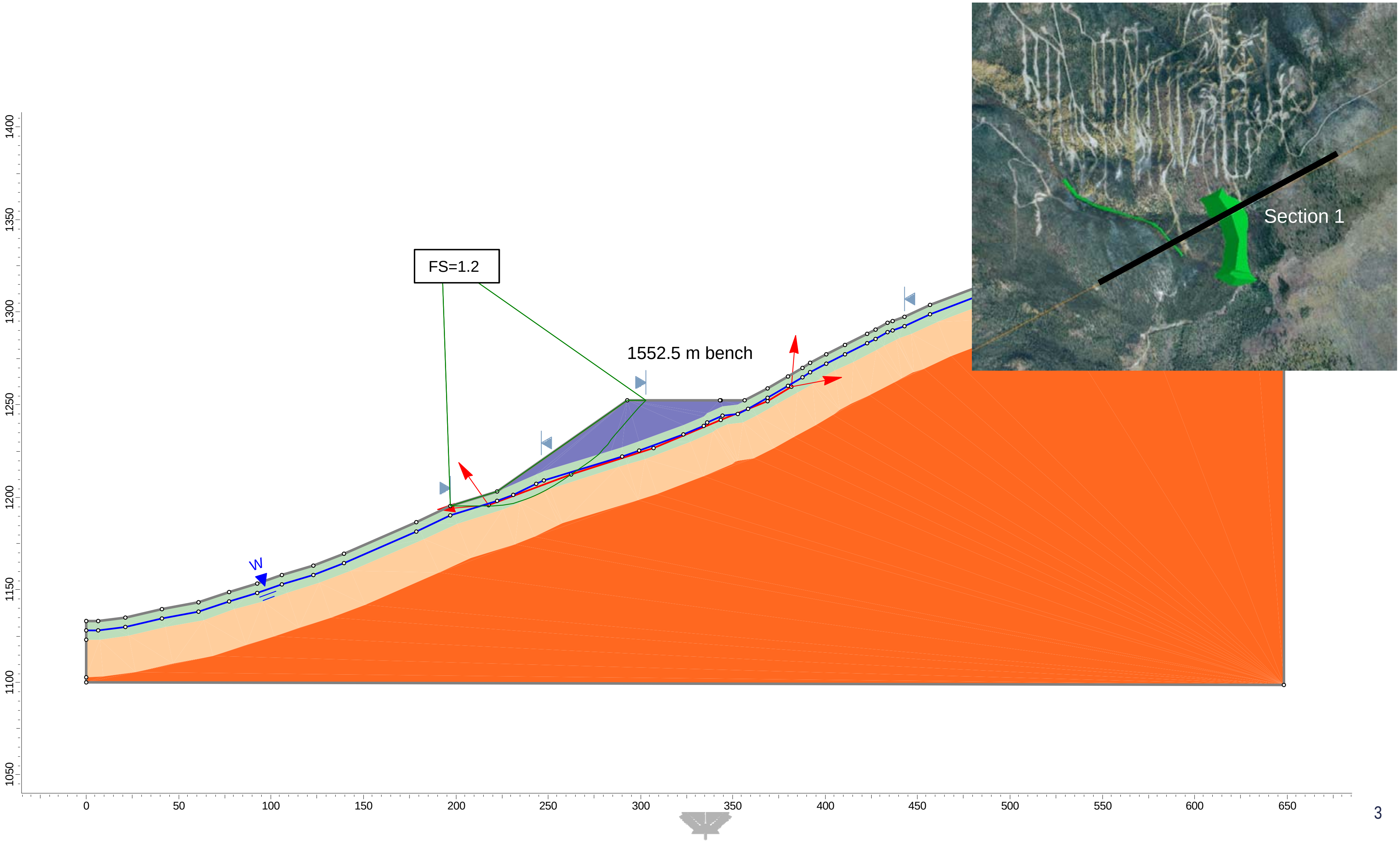
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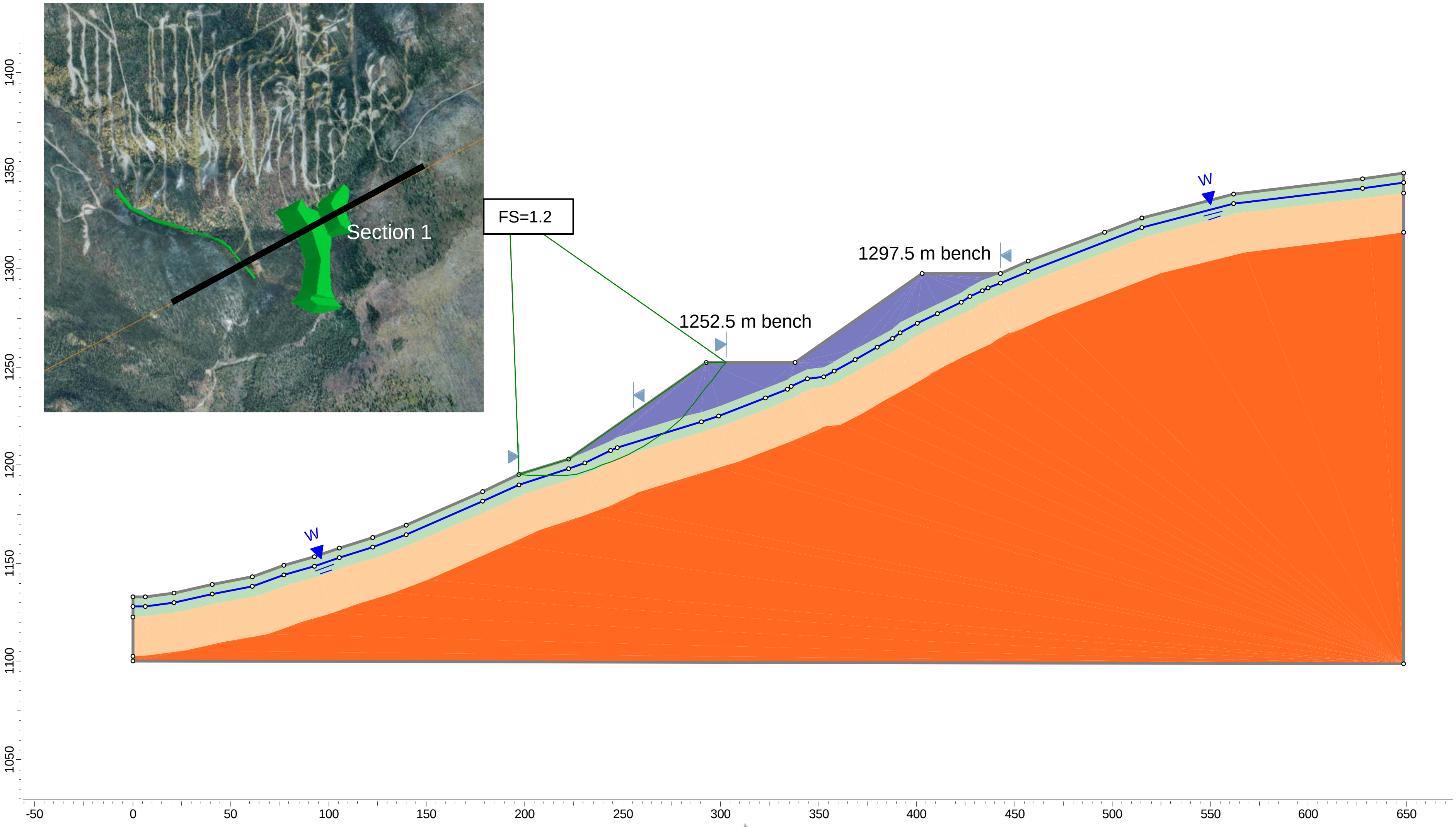

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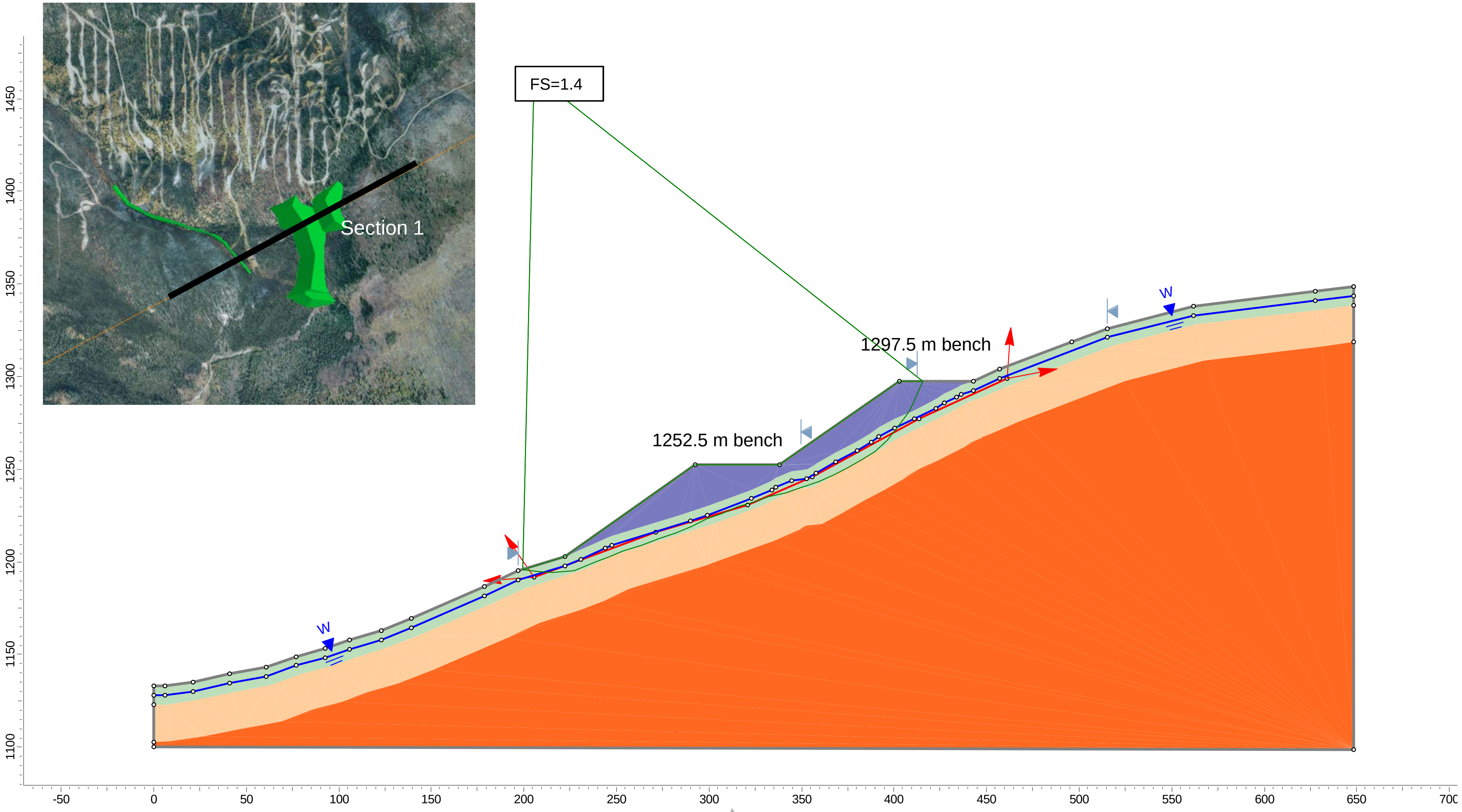

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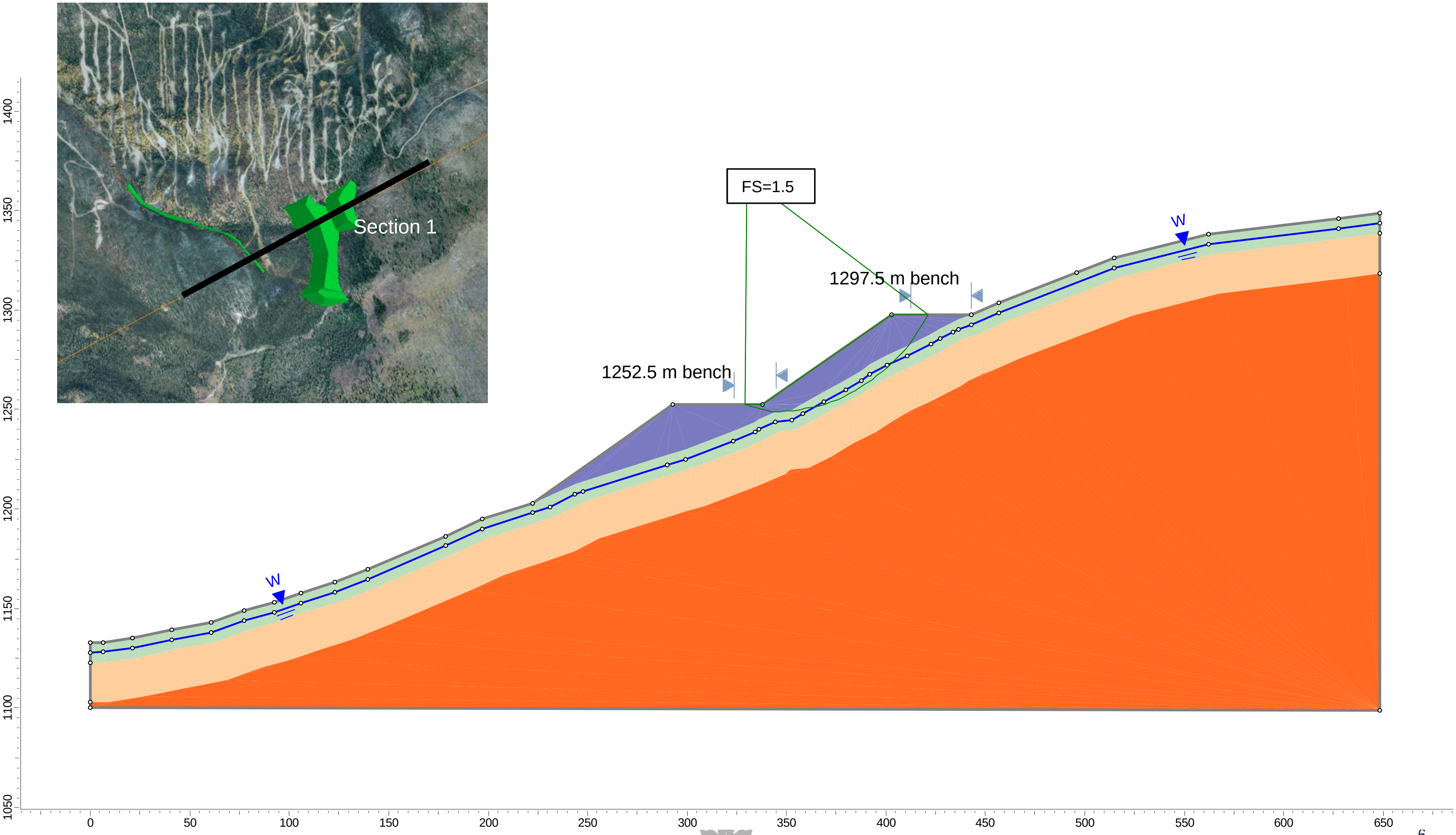

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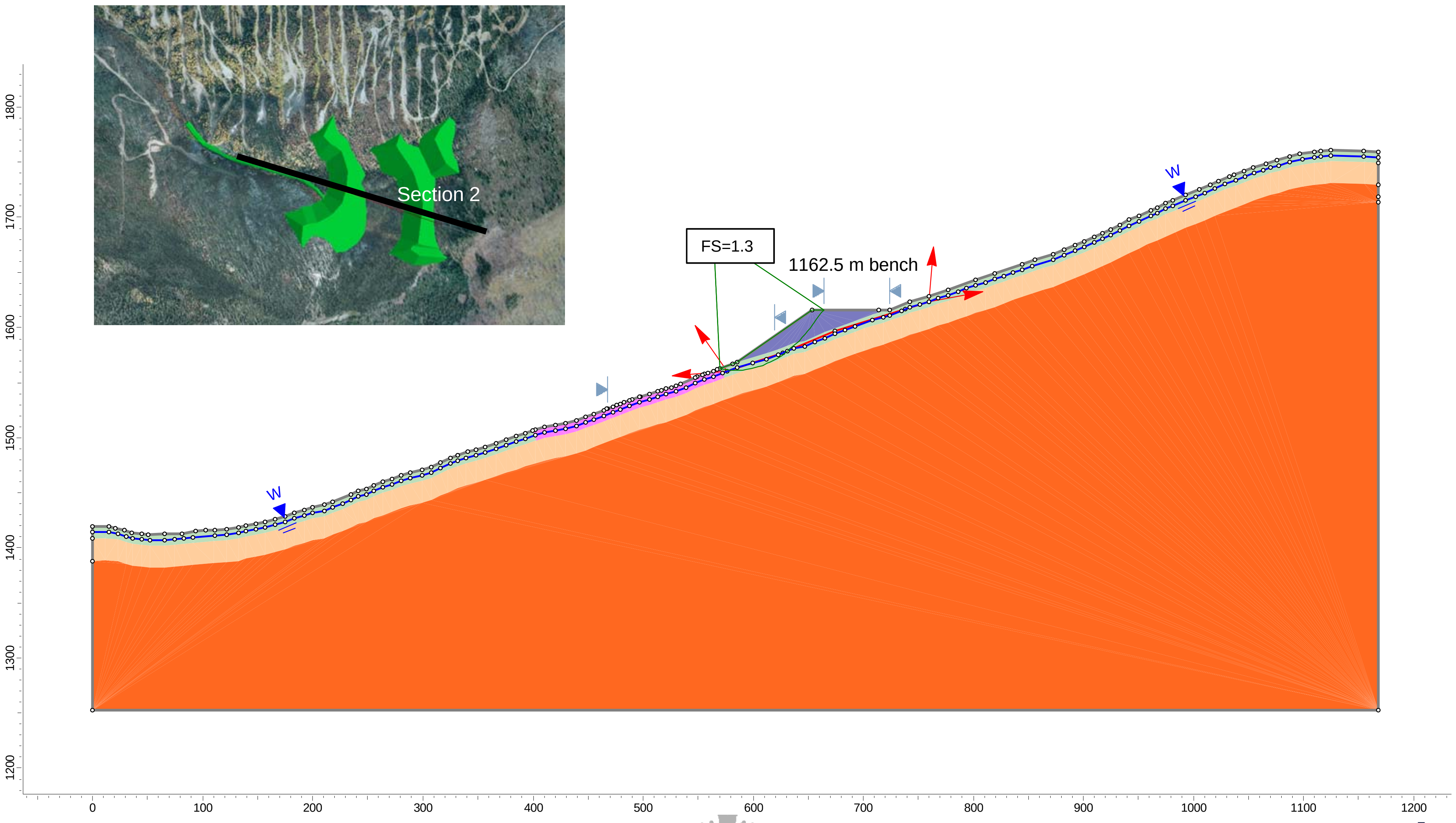

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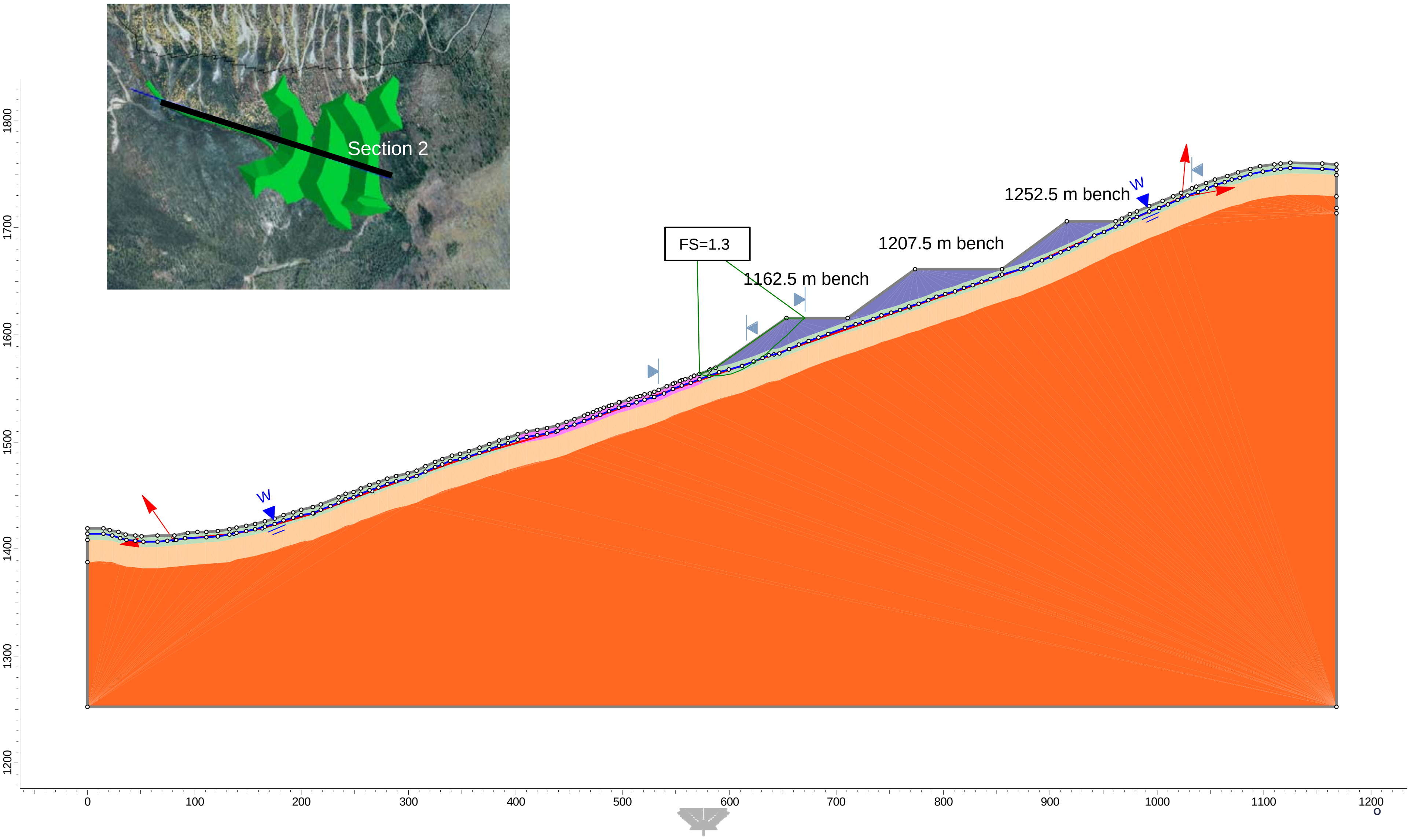

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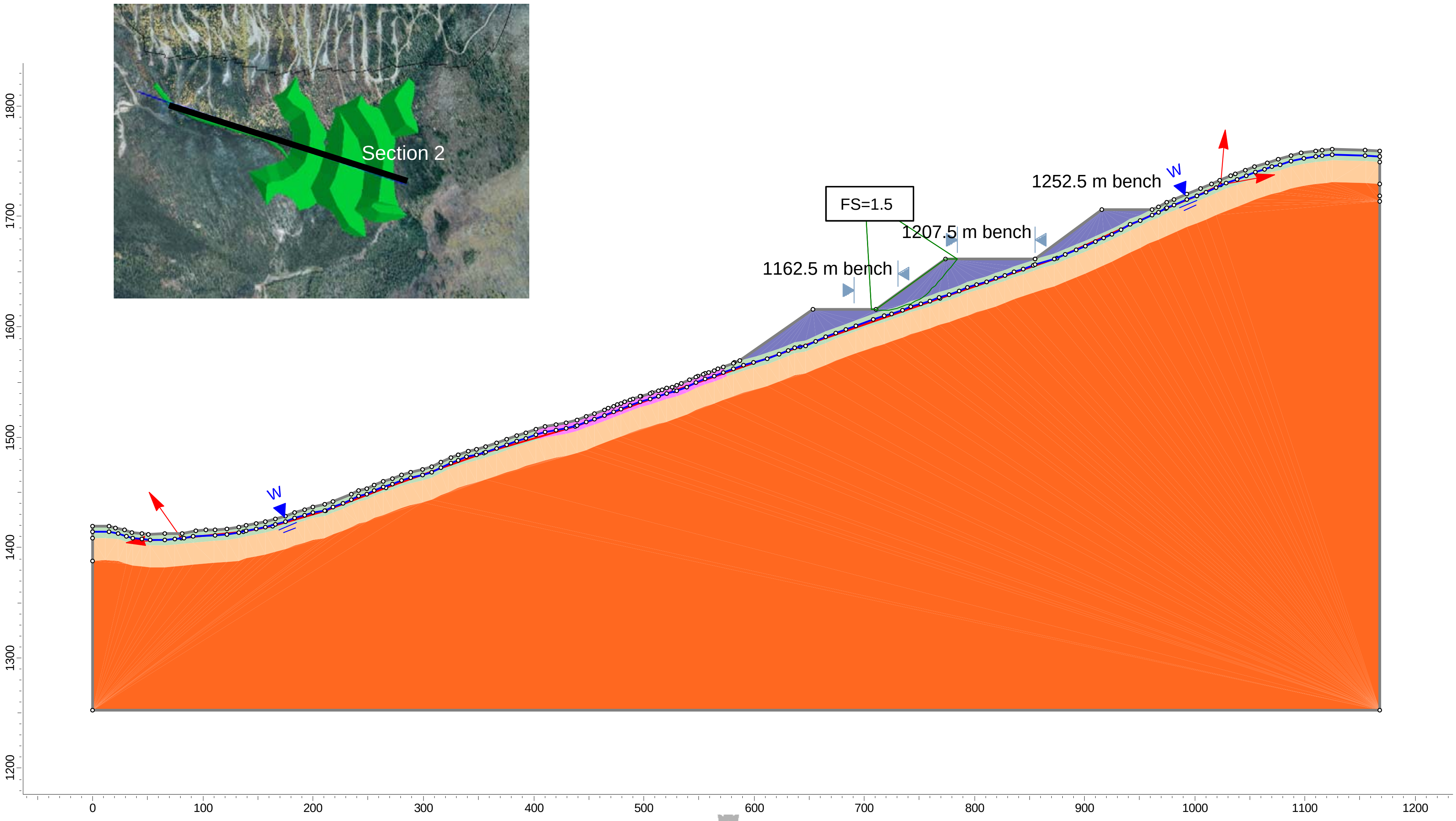
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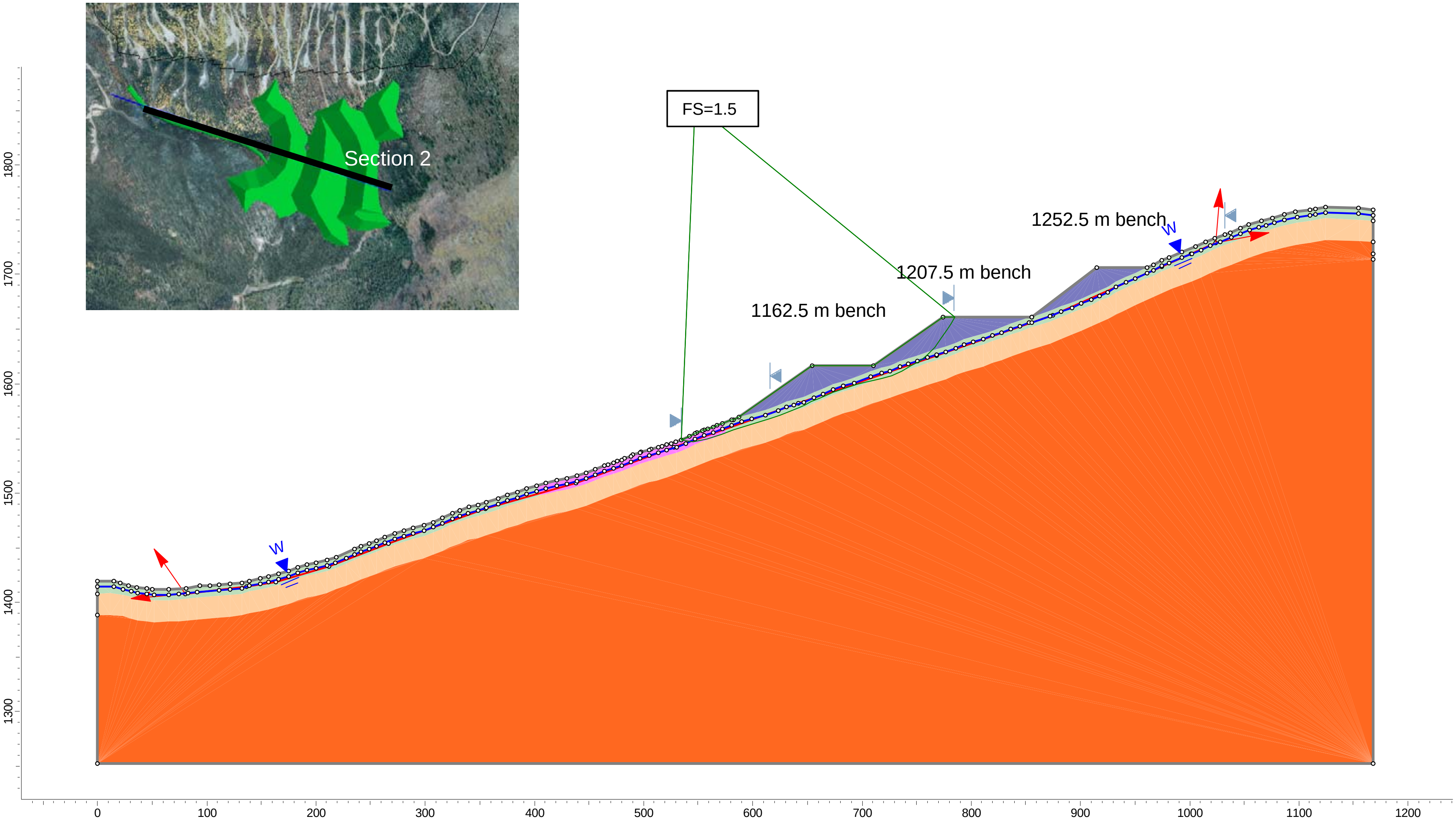
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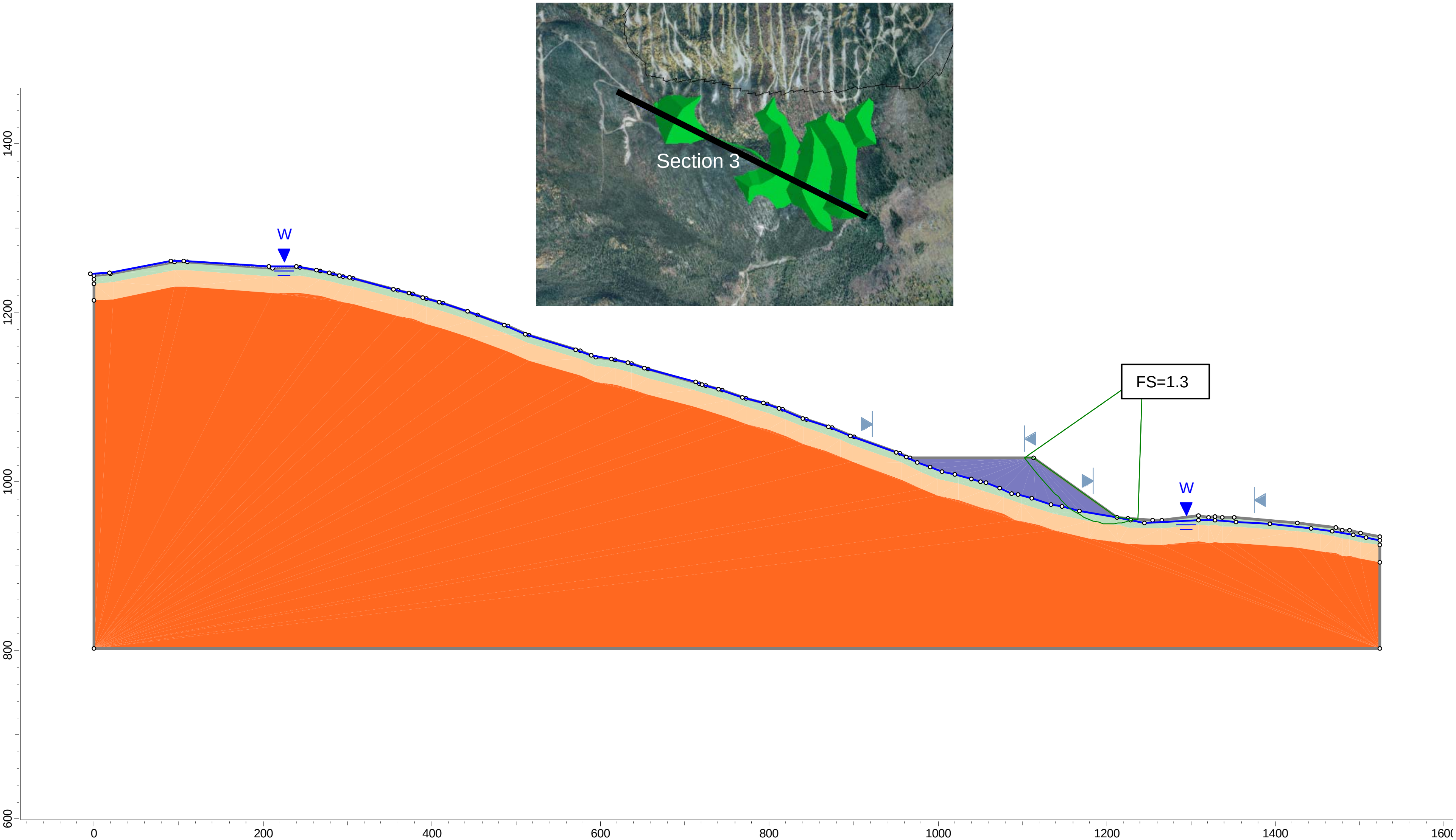
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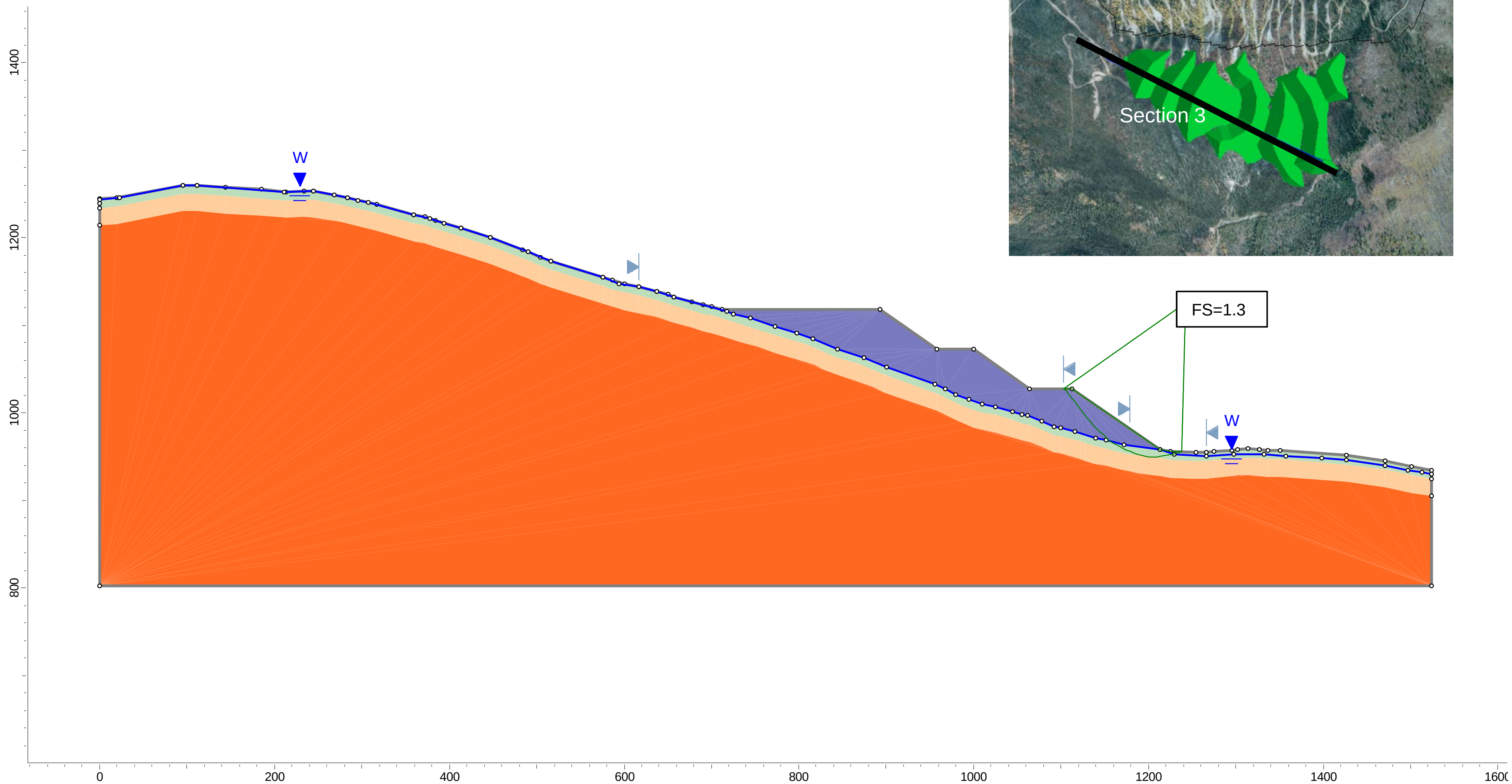

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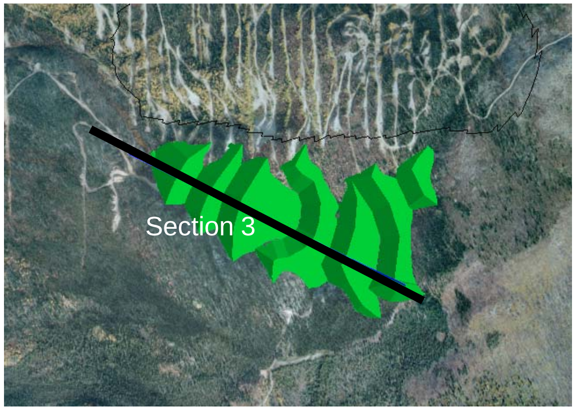

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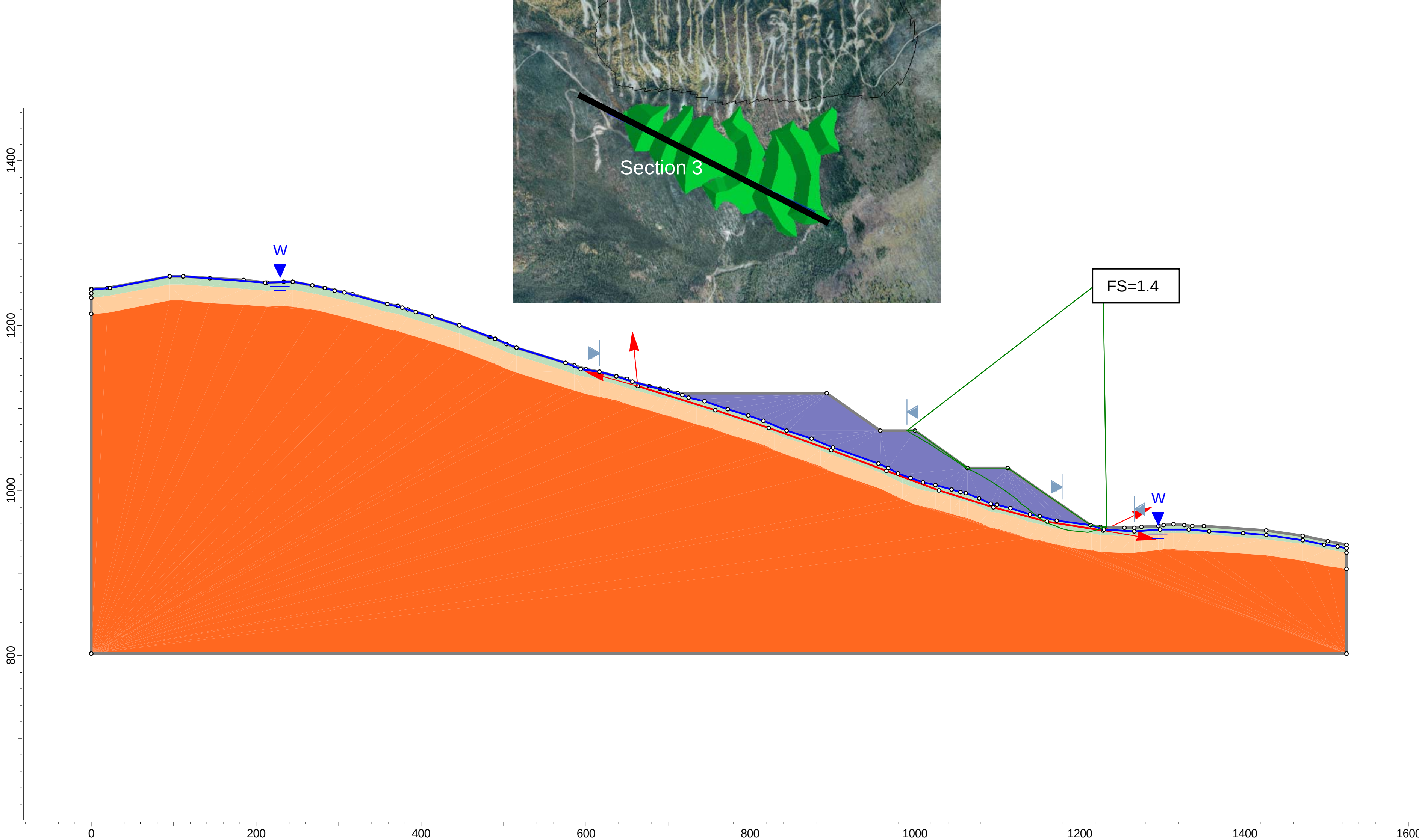
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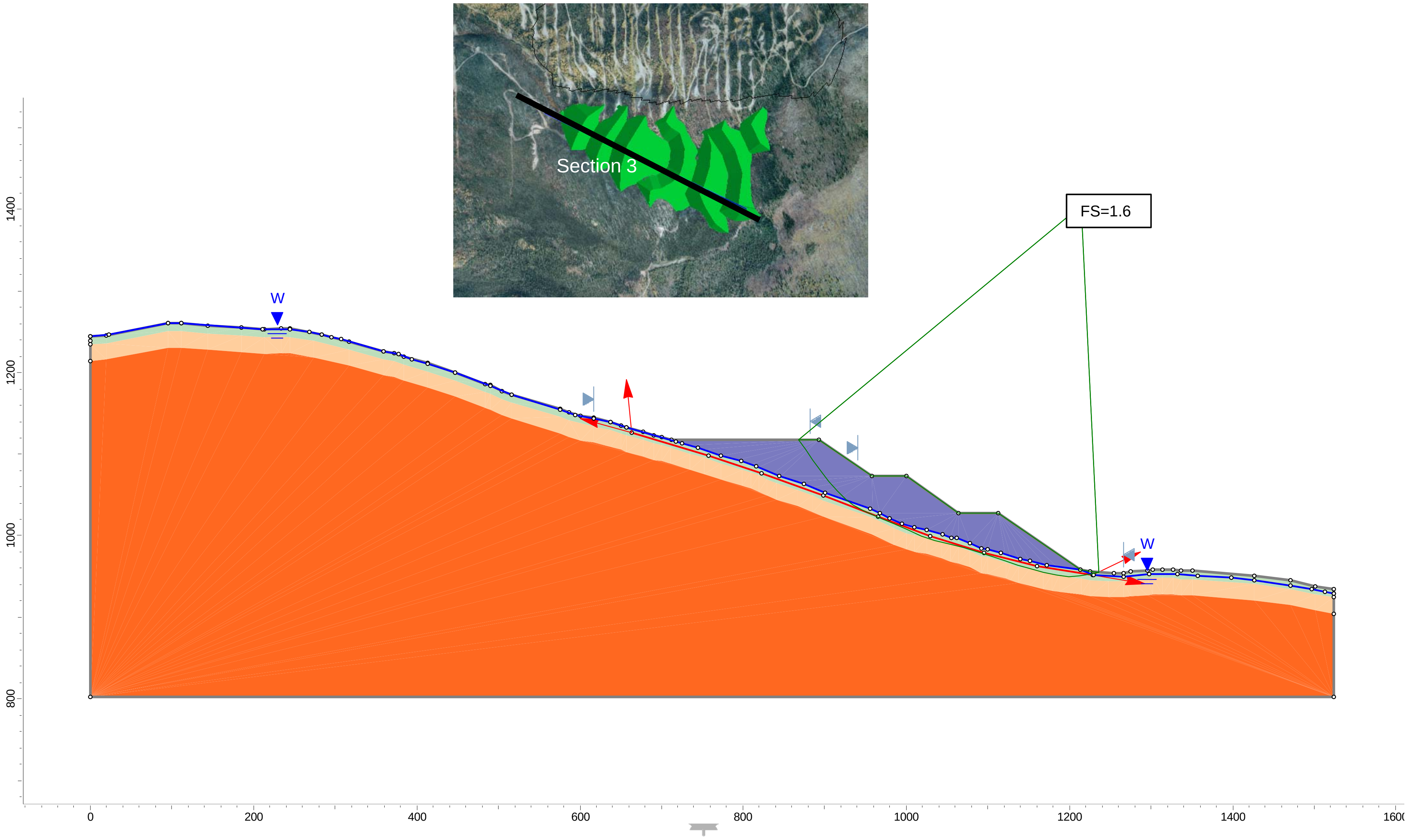
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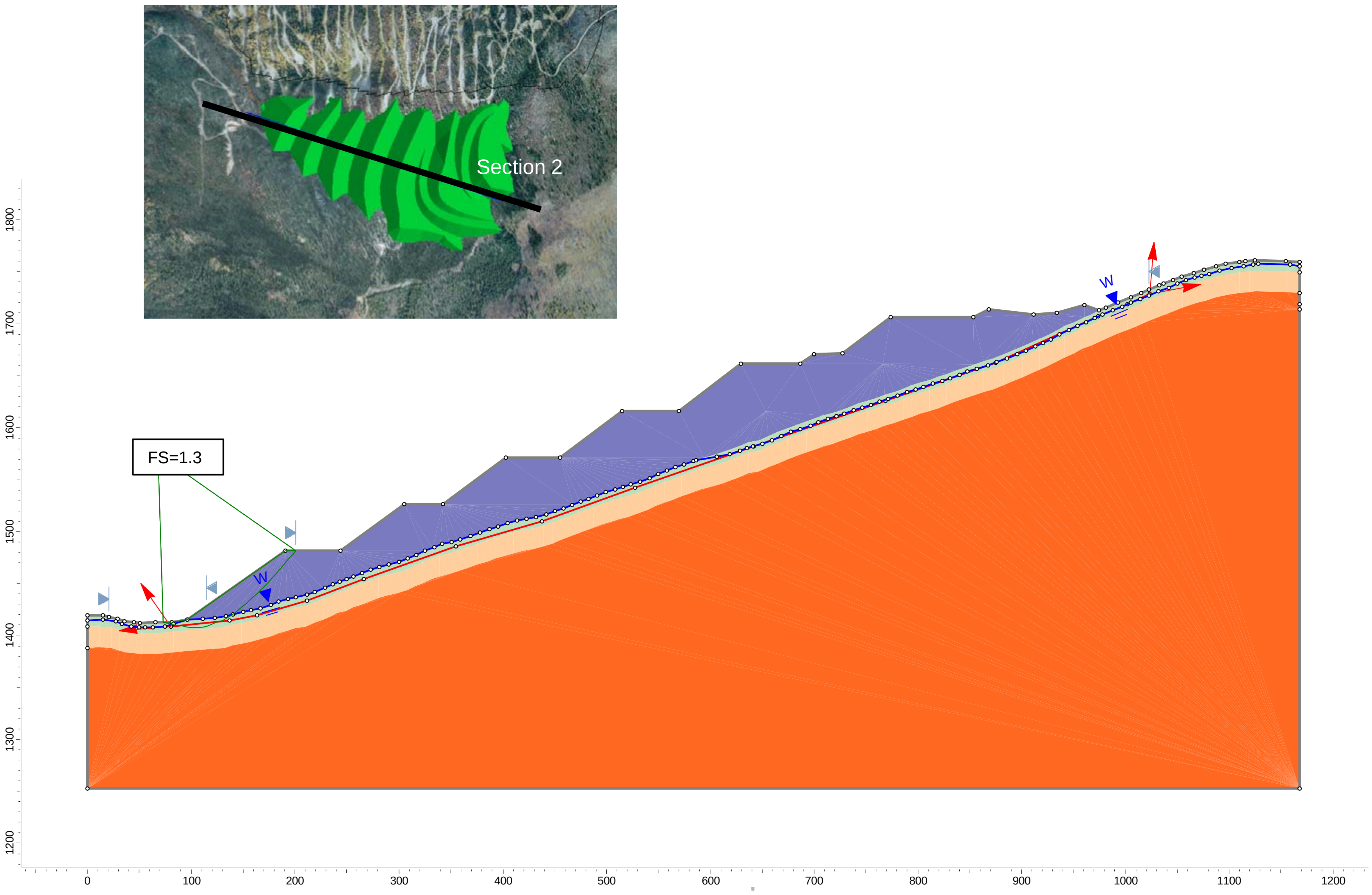
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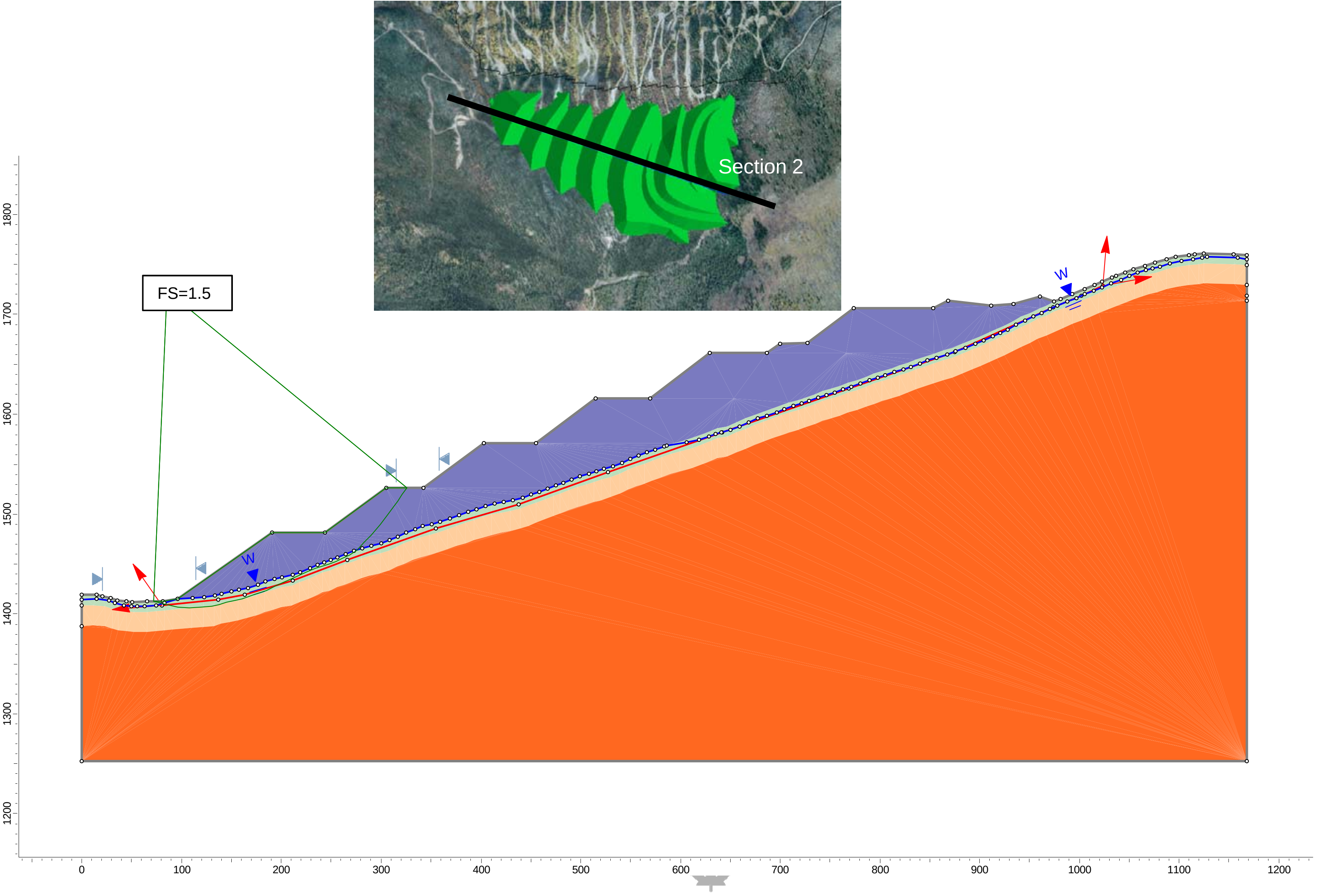
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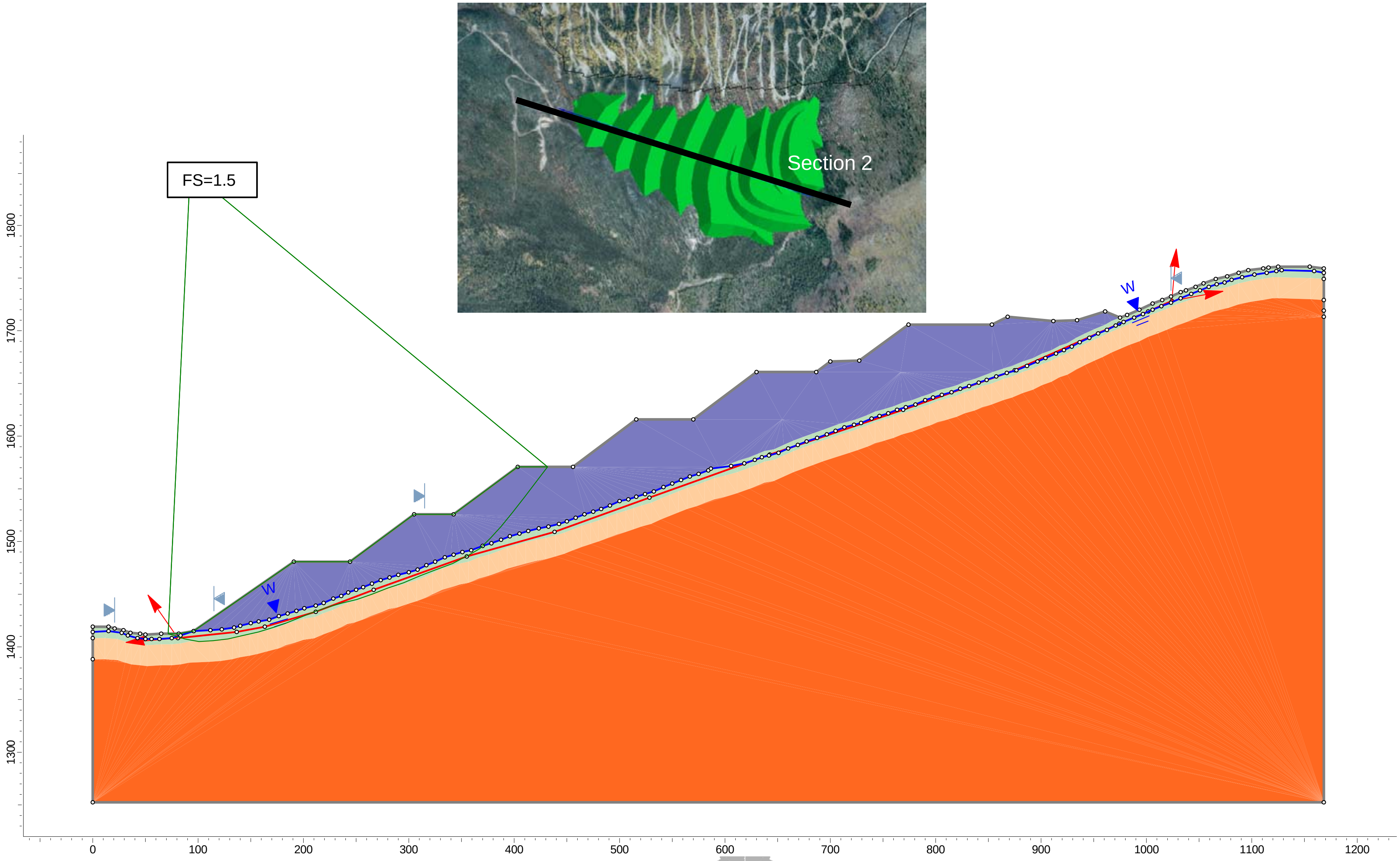
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Eagle Pup WRSA Results

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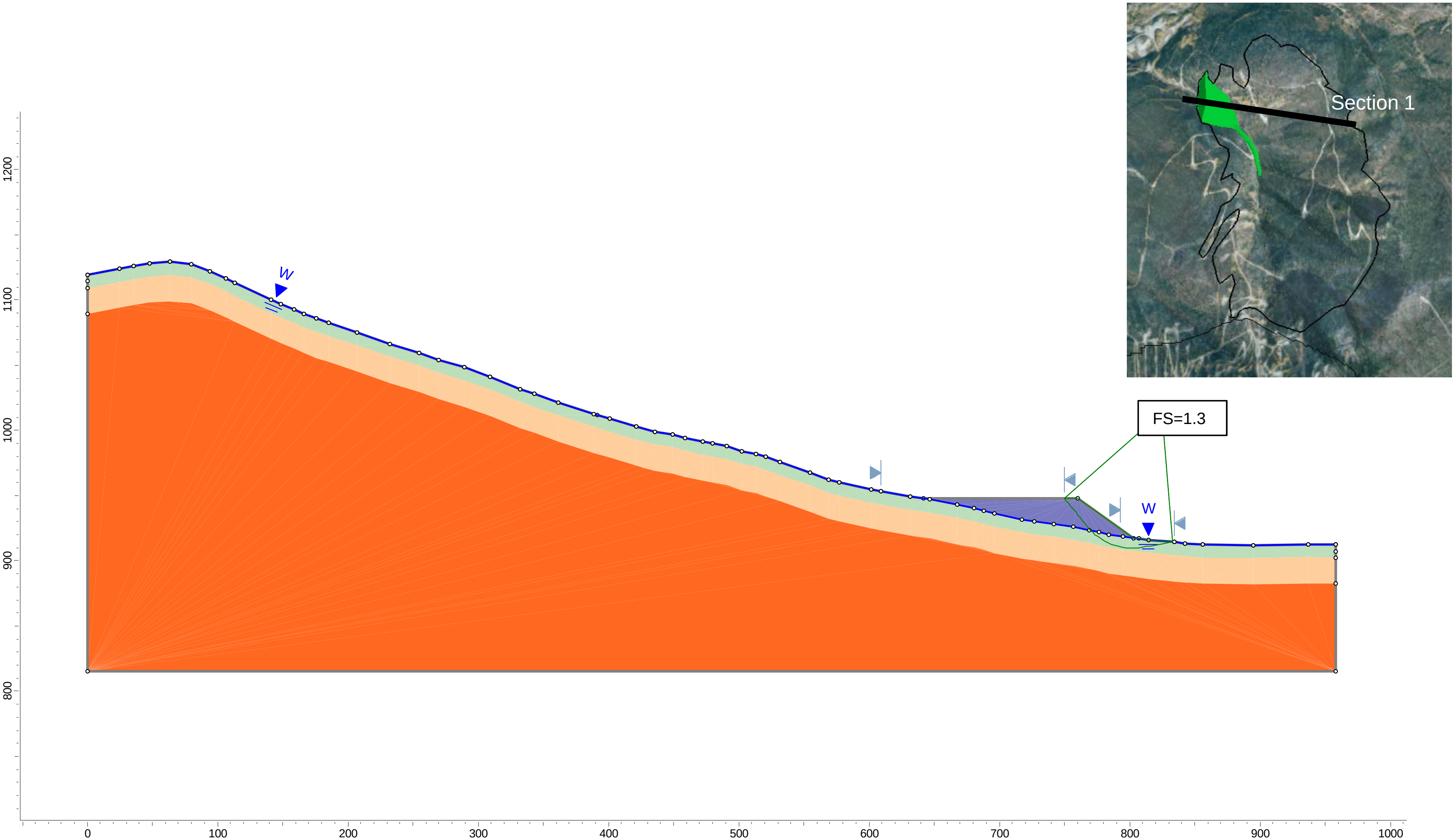

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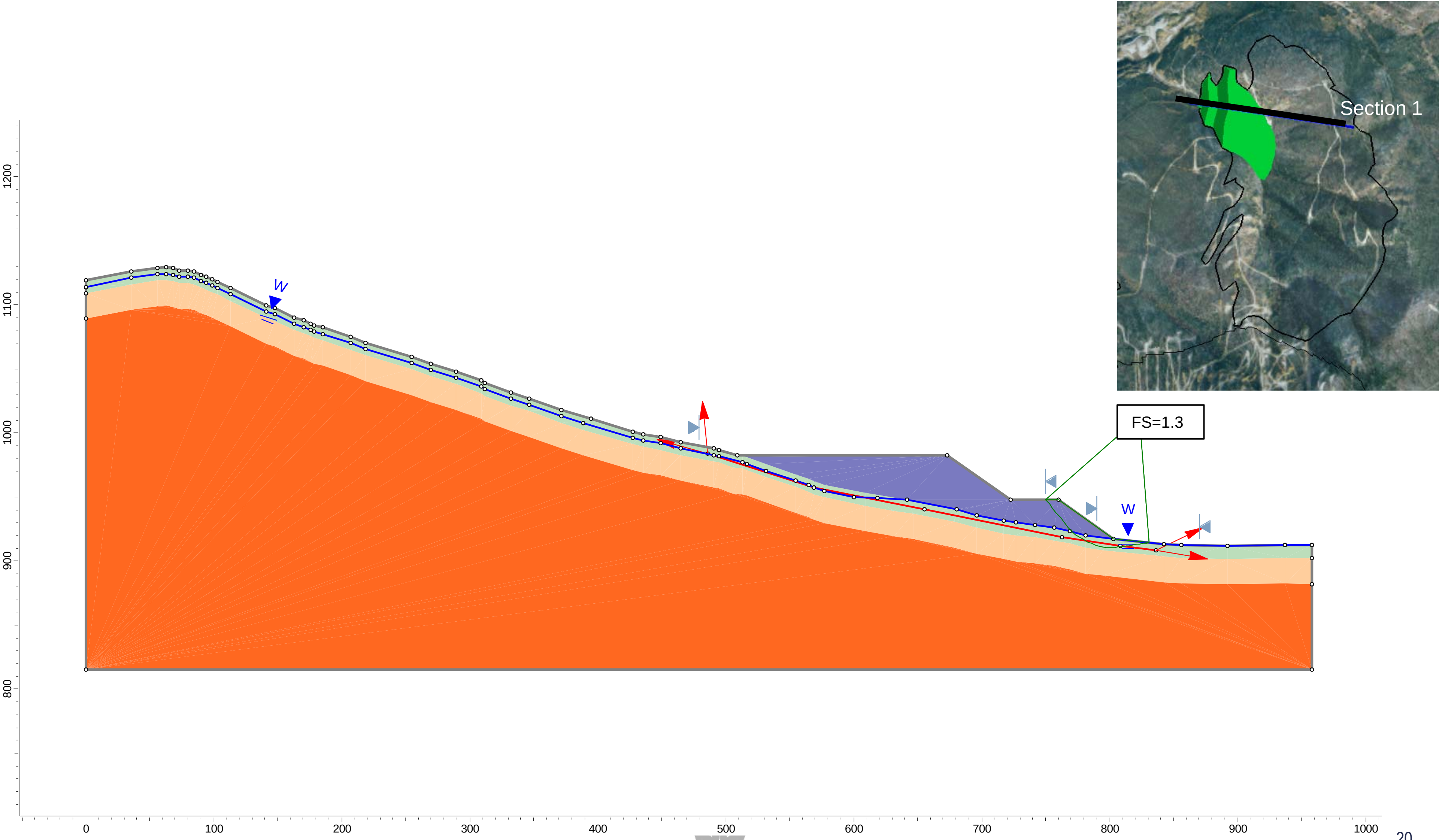
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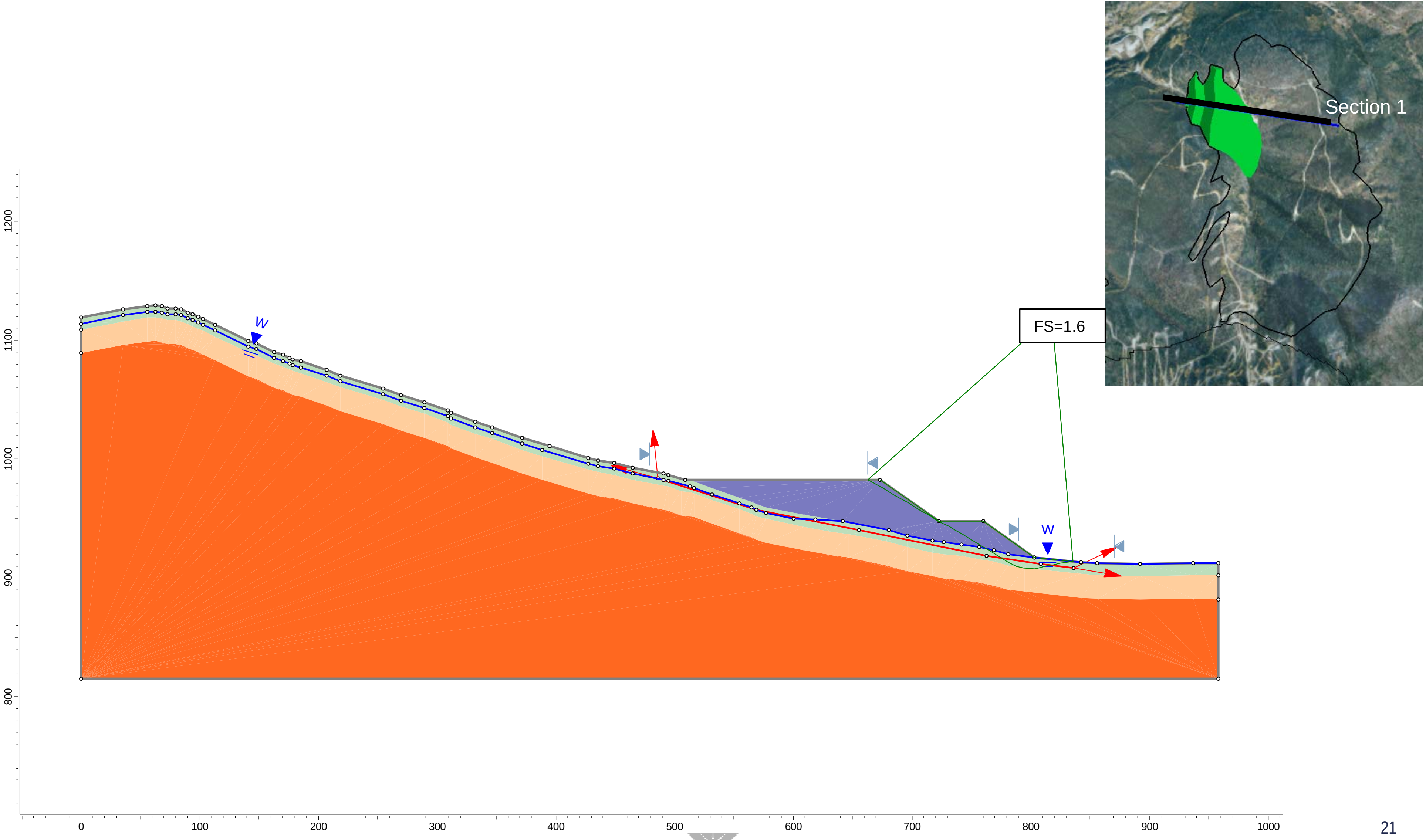
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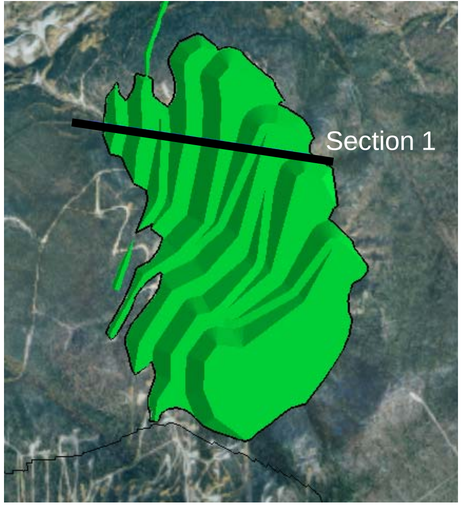
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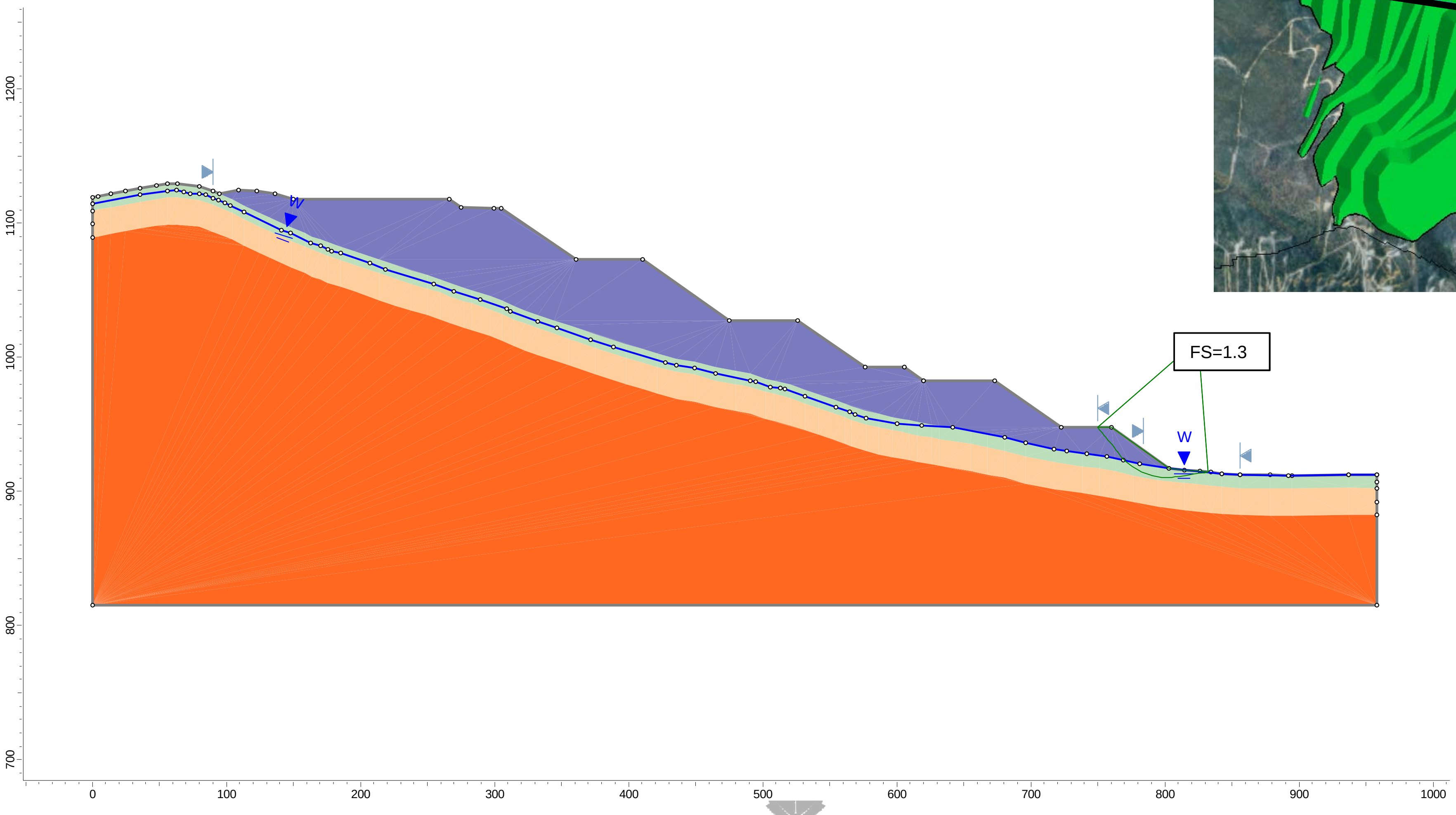
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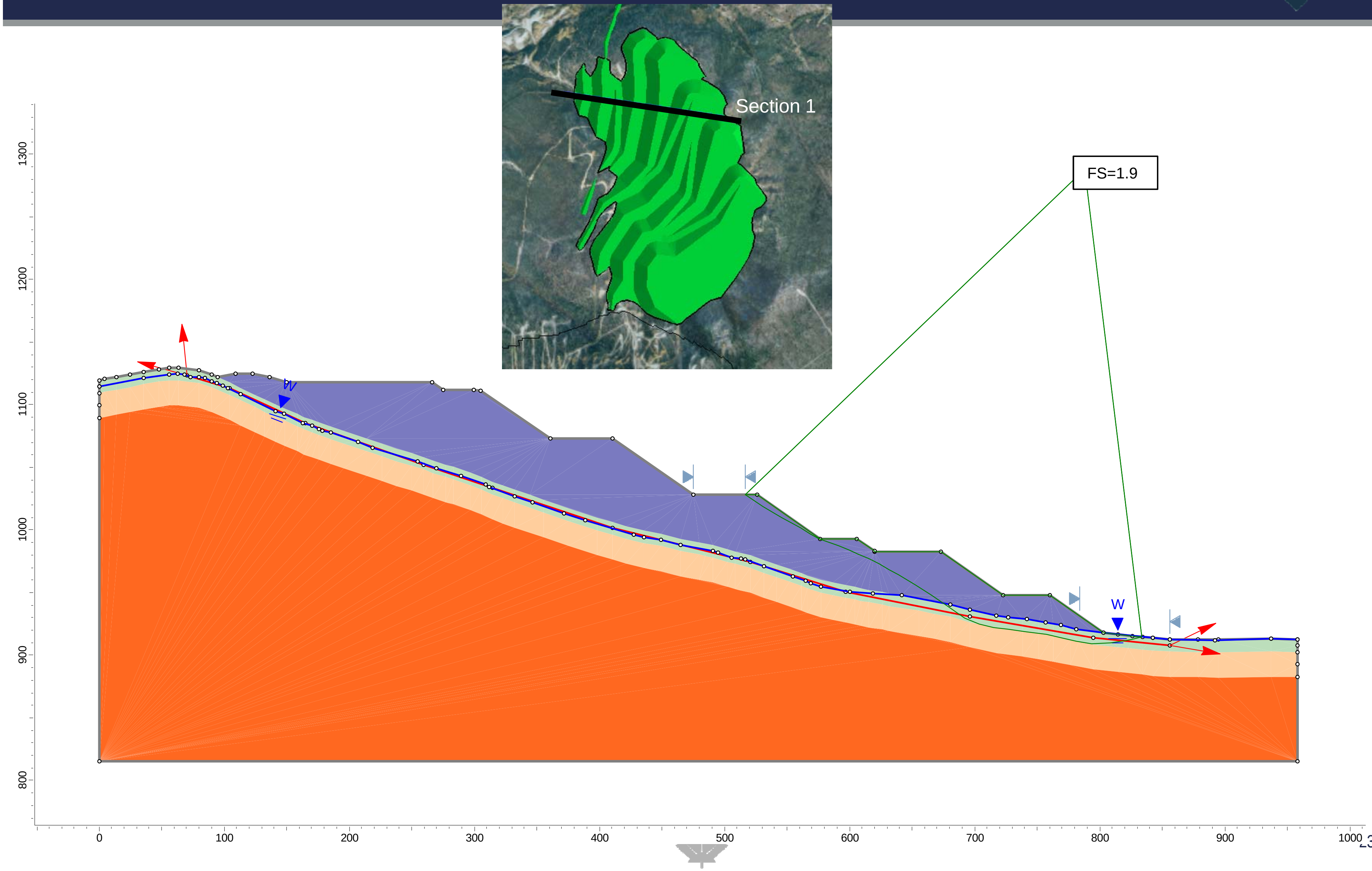
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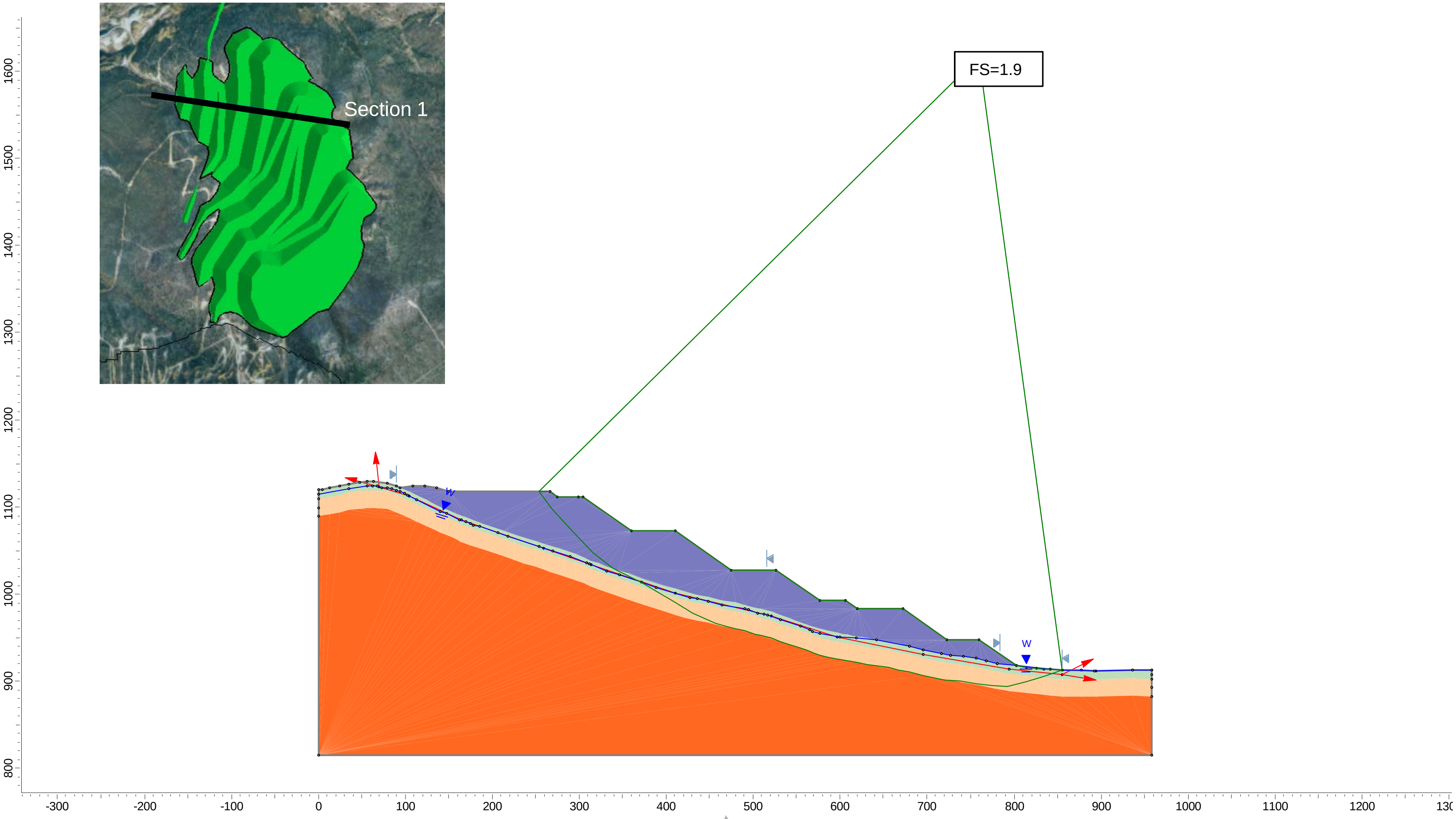

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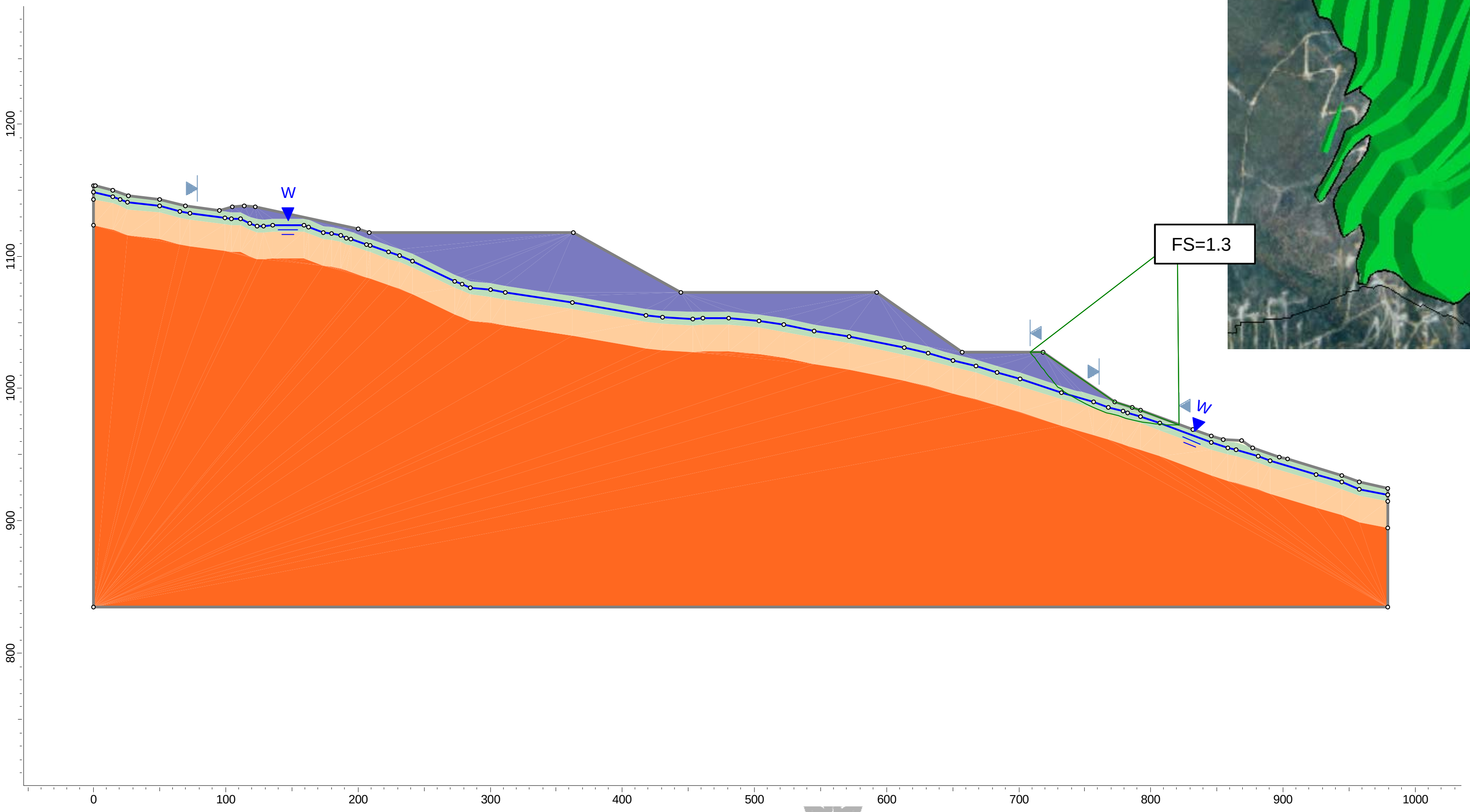
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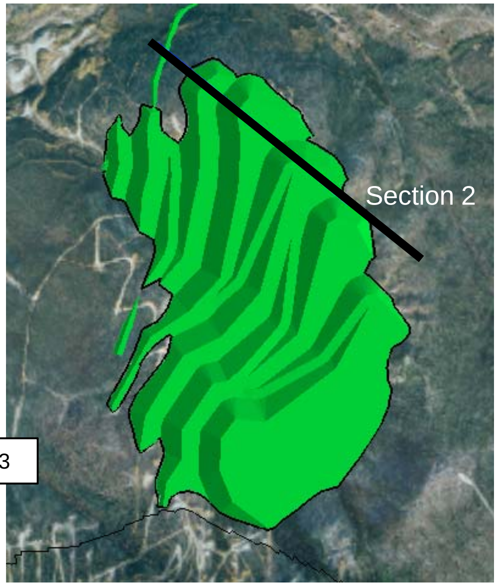
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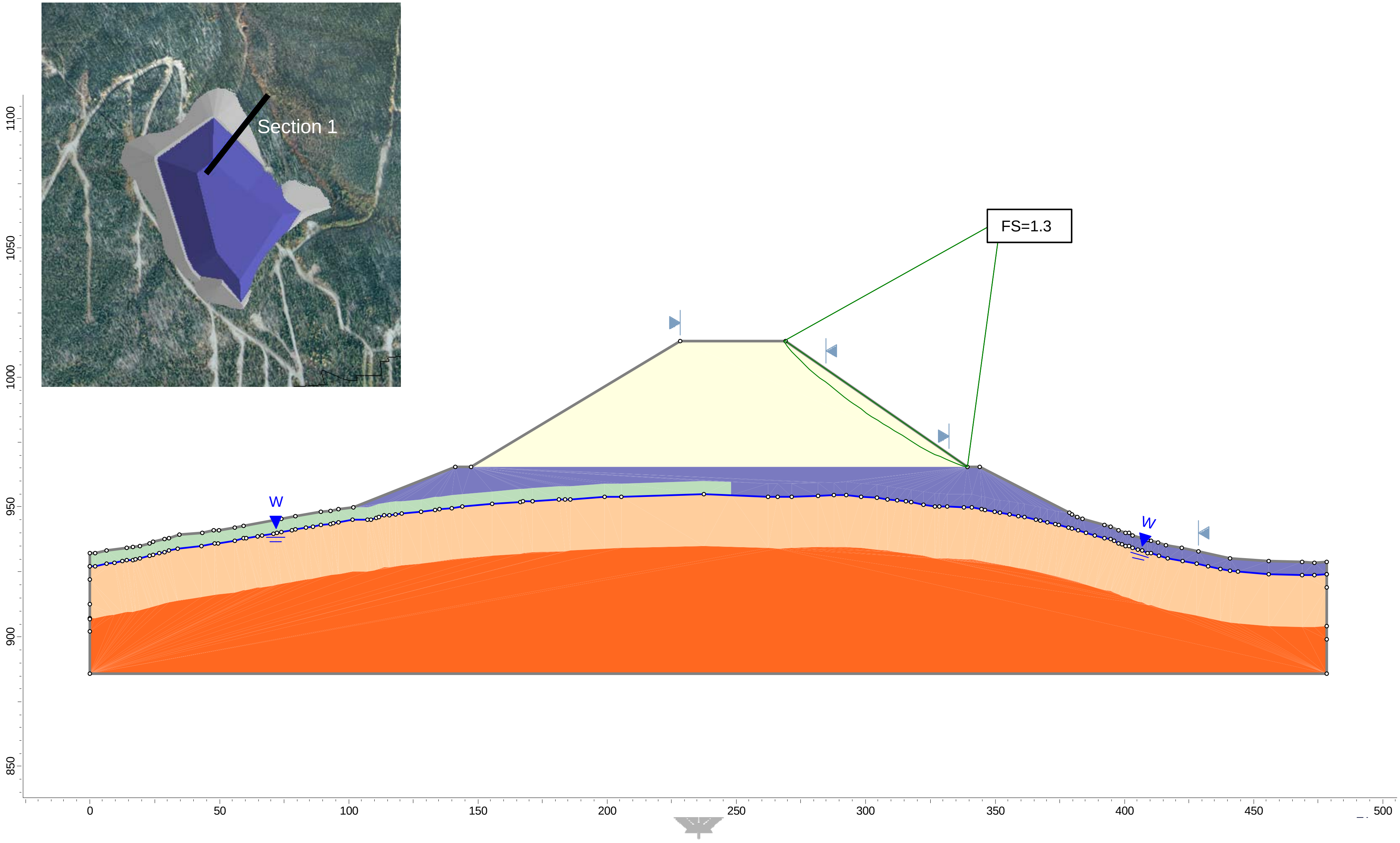
90 Day Storage Area Results

90D-M1-SEC-01

JDS Energy & Mining Inc.



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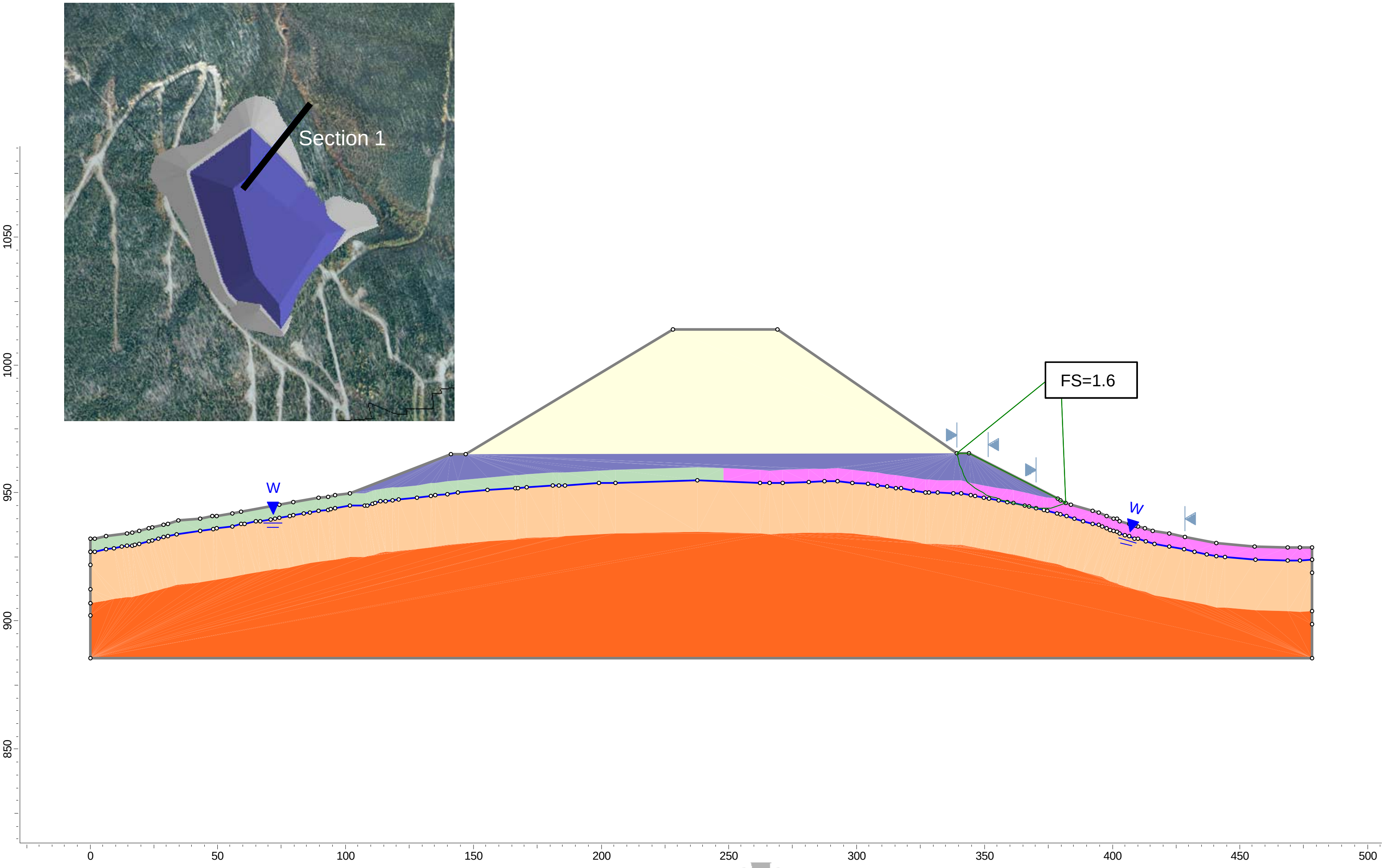
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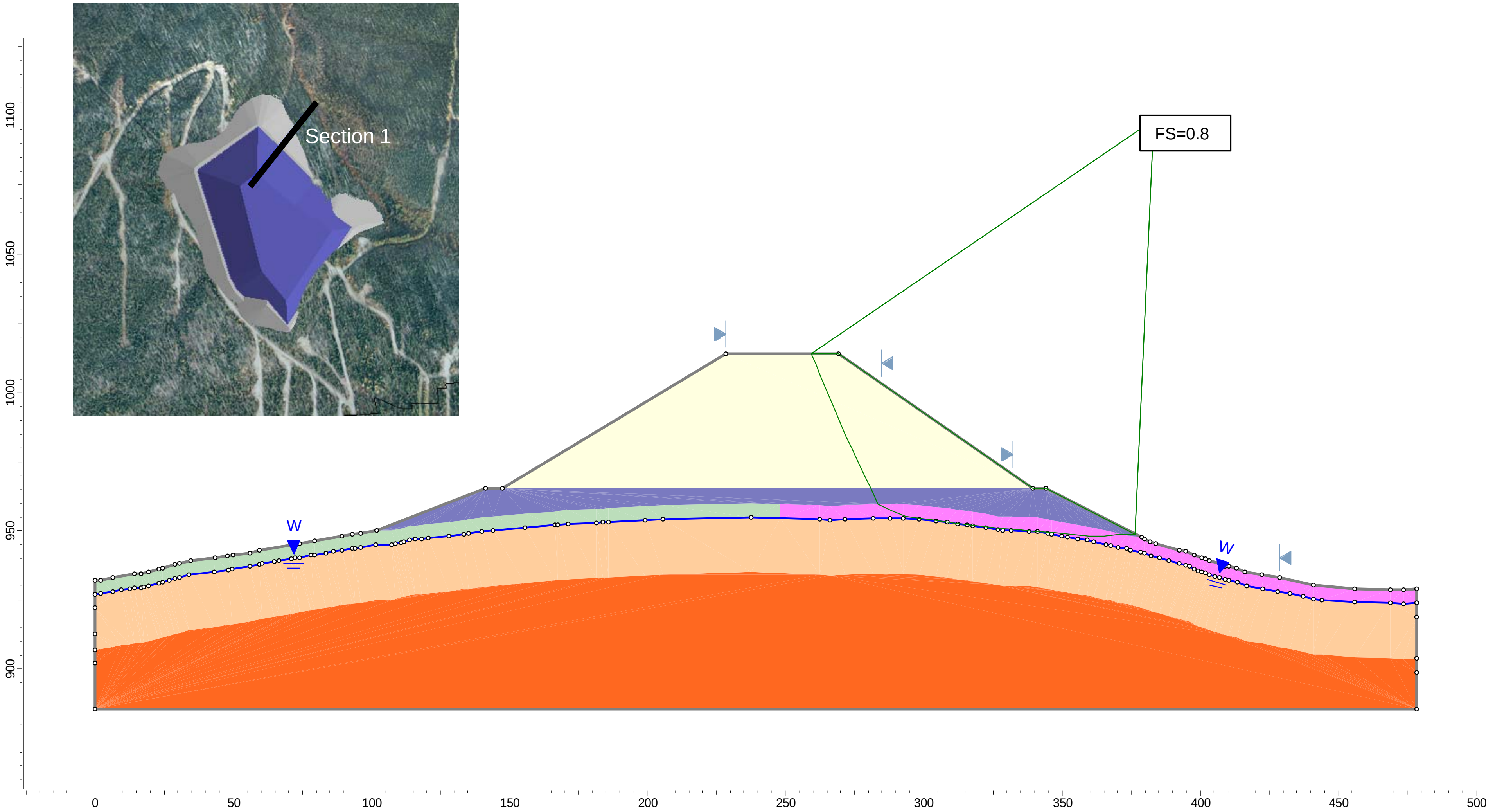
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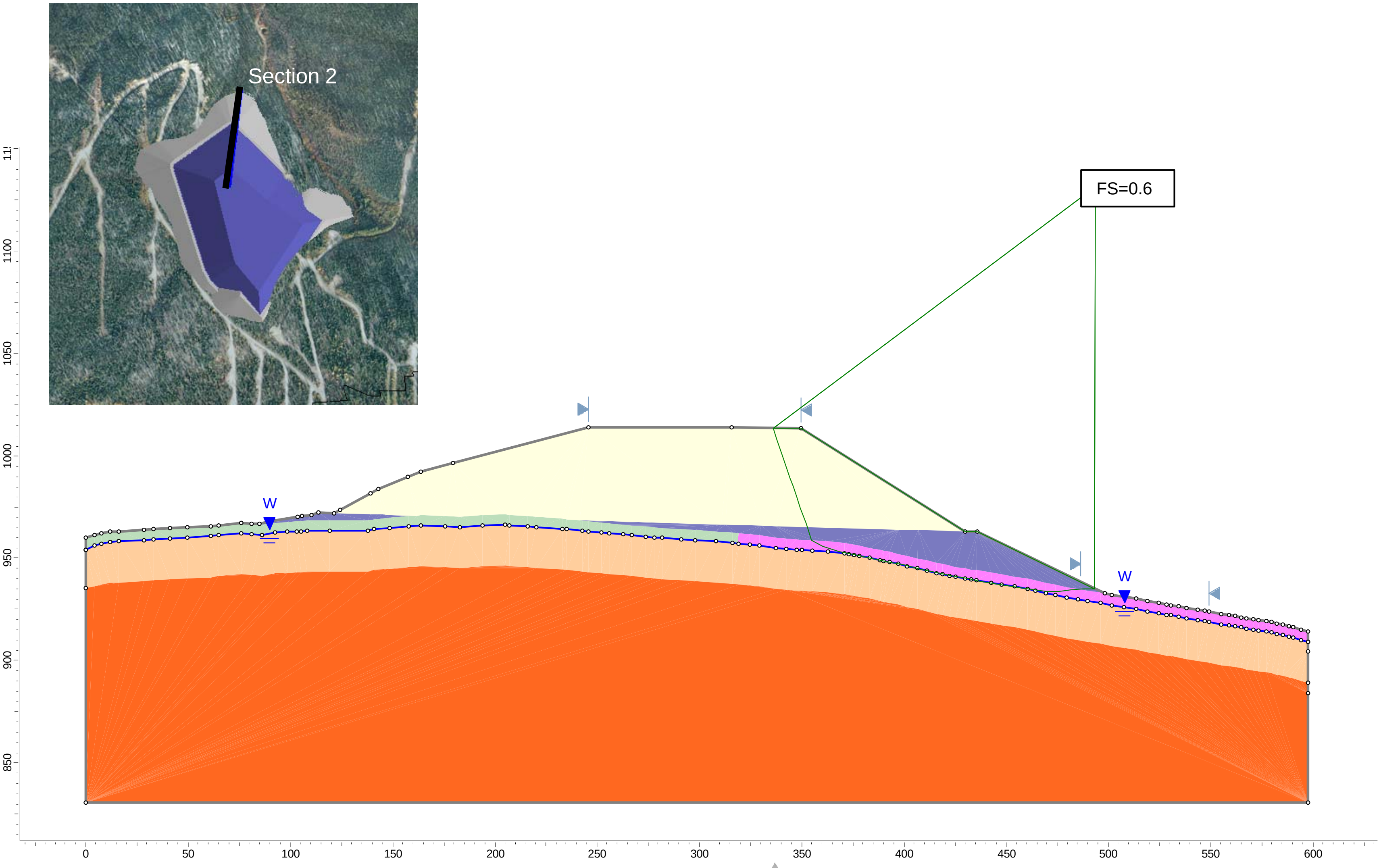
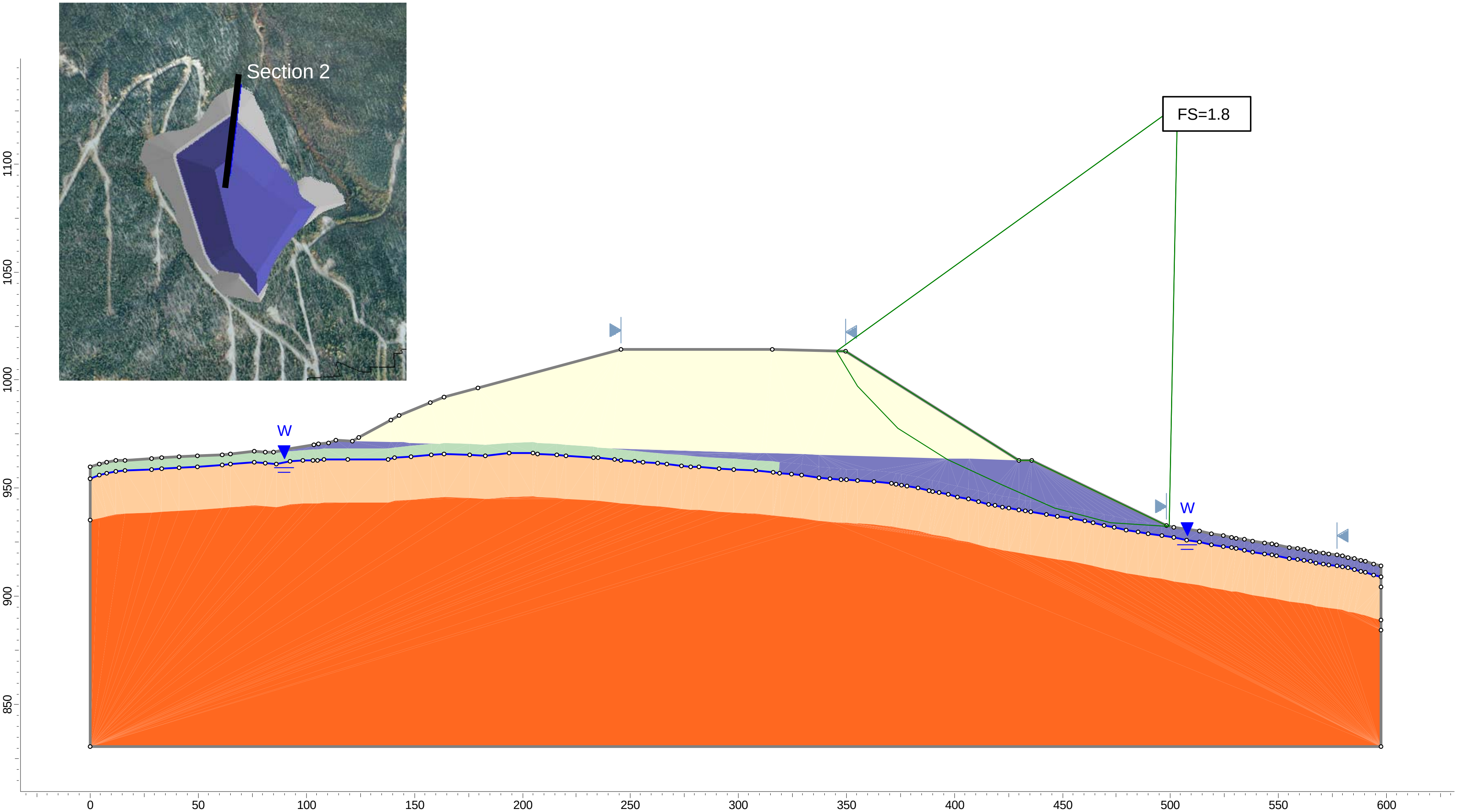
90D-M2-SEC-02

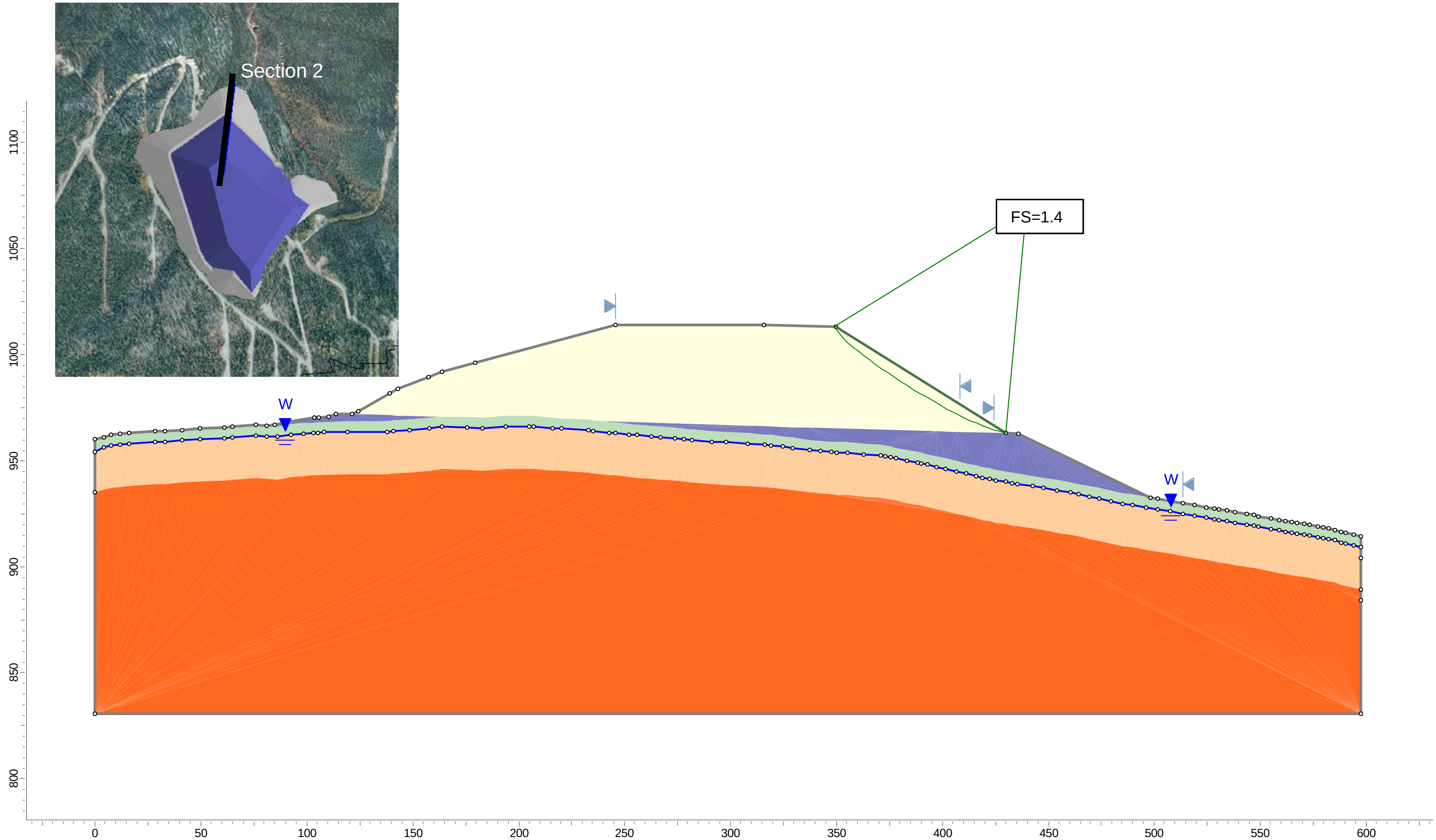

Section 2
FS=0.6
W
W
1100
1050
1000
950
900
850
0
50
100
150
200
250
300
350
400
450
500
550
600

90D-M2-SEC-02



Section 2
FS=1.8
W
W
1100
1050
1000
950
900
850
0
50
100
150
200
250
300
350
400
450
500
550
600

90D-M2-SEC-02


Section 2
FS=1.4
W
W
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1050
1000
950
900
850
800
0
50
100
150
200
250
300
350
400
450
500
550
600

JDS Energy & Mining Inc.