

Phase II Expansion Detailed Design – Revision 2 Dry Stack Tailings Facility Keno Hill District Mill Site, Yukon



PRESENTED TO
Alexco Keno Hill Mining Corp.

SEPTEMBER 18, 2024
ISSUED FOR USE
FILE: 704-ENG.WARC04307-01

This page intentionally left blank.

TABLE OF CONTENTS

1.0 INTRODUCTION	1
1.1 Detailed Design Revision 1 Update	1
2.0 BACKGROUND	2
2.1 General	2
2.2 Phase I Summary	2
2.3 Phase II Summary	4
3.0 PHASE II GEOTECHNICAL INVESTIGATION	4
3.1 General	4
3.2 Surface Conditions	4
3.3 Subsurface Conditions	5
3.4 Groundwater	5
3.5 Permafrost	5
3.6 Bedrock	6
3.7 Laboratory Testing	6
3.8 Ground Temperature Cables	7
4.0 PHASE II EXPANSION DESIGN	8
4.1 Design References and Background Documents	8
4.2 Design Classification and Criteria	8
4.3 Tailings Parameters	9
4.4 Considerations from Phase I Performance	10
4.5 Foundation Soil and Permafrost Conditions	10
4.6 Geometry	11
4.7 Foundation Components	12
4.7.1 Drainage Blanket	12
4.7.2 Geosynthetic Clay Liner	12
4.7.3 Geonet and Non-Woven Geotextile Drain	13
4.8 Seismicity	14
4.9 Stability of DSTF	14
4.9.1 General	14
4.9.2 Acceptance Criteria	15
4.9.3 Soil Strength Parameters	15
4.9.4 Analysis Results	16
4.10 Seismic Displacement	17
4.11 Thaw Consolidation	17
4.12 Liquefaction Assessment	17
4.13 Creep	18
4.14 Geothermal Analysis	18
4.14.1 Phase I Pre-Construction Thermal Analysis	18
4.14.2 Phase I Post-Construction Thermal Analysis	19
4.14.3 Phase II Thermal Analysis	25
4.15 Surface Water Management	28

4.15.1	General	28
4.15.2	Uphill Runoff Diversion Berm.....	28
4.15.3	Toe Runoff Collection Ditch	28
4.15.4	Collection Sump and Conveyance	28
5.0	FOUNDATION PREPARATION AND CONSTRUCTION	28
5.1	General	28
5.2	DSTF Foundation	29
5.3	Buttress Construction	29
5.4	Interior Shear Berm Construction	30
6.0	OPERATION, MAINTENANCE, AND SURVEILLANCE	30
6.1	OMS Manual	30
6.2	Tailings Placement and Operation	30
6.3	Instrumentation and Monitoring	31
7.0	DSTF CLOSURE PLAN	31
8.0	CLOSURE.....	32
	REFERENCES	33

LIST OF TABLES IN TEXT

Table 1: Phase I DSTF Instrumentation Summary	3
Table 2: Summary of Bedrock Encounters.....	6
Table 3: Quantity of Laboratory Tests Completed	6
Table 4: Ground Temperature Cables.....	7

APPENDIX SECTIONS

FIGURES

Figure 1	Overall DSTF Final Construction Plan
Figure 2	Phase II Final Construction Plan
Figure 3	Cross-sections 1 of 3
Figure 4	Cross-sections 2 of 3
Figure 5	Cross-sections 3 of 3
Figure 6	Typical Details
Figure 7	Instrumentation Plan
Figure 8	Phase I Instrumentation Plan

APPENDICES

Appendix A	Tetra Tech's Limitations on the Use of this Document
Appendix B	Borehole Logs and Laboratory Testing Results
Appendix C	Ground Temperature Cable Data
Appendix D	Tailings and Interface Direct Shear Laboratory Test Data
Appendix E	Stability Analysis Results
Appendix F	Geothermal Model Figures

1.0 INTRODUCTION

NND EBA Land Protection Corp., operating as NELPCo Limited Partnership (NELPCo) was retained by Alexco Keno Hill Mining Corp. (AKHM) to complete the design for the Phase II expansion of the Dry Stacked Tailings Facility (DSTF) at the Keno Hill mine site located near Keno City, YT.

NELPCo is a limited partnership corporation owned by the NND Development Corporation (NNDDC) and Tetra Tech Canada Inc. (Tetra Tech). Tetra Tech is NELPCo's exclusive engineering services provider.

The detailed design for the existing DSTF, known as Phase I, was submitted in 2011. Since then, Tetra Tech has completed monitoring and reviews of the facility's construction and performance.

This report presents the background information related to the existing DSTF design, construction, and performance; summarizes the subsurface conditions encountered during geotechnical evaluations; and details the Phase II expansion design.

Additional information related to Tetra Tech's limitations on the use of this report is included in Appendix A.

1.1 Detailed Design Revision 1 Update

This revised and updated design was completed to address feedback provided by Yukon Government, Energy, Mines and Resources (EMR) related to incorporating facility classification and design criteria from their "Guidelines for Mine Waste Facilities" document issued in February 2023 (EMR, 2023).

Key components in this design revision include:

- Classification of Facility as Class II per Table 4-1 of 2023 EMR Guidelines.
- Update of design criteria per Class II facility as in Table 5-2 of 2023 EMR Guidelines, including updated design earthquake event and Factors of Safety (FoS) for stability.
- Completion of interface direct shear testing on foundation components and incorporation of results into design.
- Incorporation of tailings laboratory testing data completed since previous submission.
- Modifications of facility geometry including:
 - Redesign and alignment of toe buttress feature to tie into P1 berm constructed in fall 2023;
 - Addition of interior shear berms for stability;
 - Final tailings design slope now 3.25H:1V; and
 - Minor adjustments to overall facility shape and extents.
- Updated stability analyses and estimation of seismic displacement.
- Per Table 5-2 of EMR Guidelines, surface water conveyance systems are to be designed for a 1:200-year event during operations and 1:500 year during closure. The system will be constructed to the 1:200-year event for operations. As the mine and area plans are confirmed prior to closure, the capacity of the system will be reviewed and improved to address closure requirements as necessary (pers. Communication, H. McIntyre, November 9, 2023).

2.0 BACKGROUND

2.1 General

The Keno Hill Silver District Operation (Keno Hill) consists of a silver-lead-zinc mine operated by Alexco Keno Hill Mining Corporation (AKHM), which was acquired by Hecla Mining Company (Hecla) in 2022. The mill site is located approximately 1 km west of Keno City, Yukon.

The site is operated under Quartz Mining License No. QML-0009.

2.2 Phase I Summary

The existing Phase I of the DSTF was designed in 2011 by EBA, a Tetra Tech Company (EBA, A Tetra Tech Company 2011). This design report summarized previously completed investigation, evaluation, and design work.

Phase I design drawings were updated in June 2022 to reflect the as-built conditions in the final design. The construction plan and typical cross-sections in profile views are shown in Figures 1 to 6.

Construction and operation of the Phase I area have generally progressed per the 2011 detailed design.

Tetra Tech understands that changes in mine planning led to the entire Phase I footprint not being constructed. An area included in the footprint immediately north of the mill is now used as a fuel storage area, turnaround, and laydown area.

Within Phase I, some areas of localized tension cracks and other near surface instabilities have been observed and are addressed by site staff as they occur with input from Tetra Tech. These issues have been attributed to poor surface grading on the lower bench allowing water to accumulate, expected permafrost thaw settlement, and in some cases inconsistent tailings placement and compaction. When instabilities were observed by Tetra Tech (i.e., during annual inspections), the location was identified, and mitigation measures were recommended accordingly. Typically, these recommended measures included excavating to competent tailings, replace, and compact, and cover per design. These noted instabilities were typically in locations where the final tailings surface was over-steepened relative to the design slopes and/or where cover was not placed to design thickness. The current monitoring and action plan for these situations are outlined in the OMS.

The poor grading of the lower bench noted above was improved in the spring of 2024.

Monitoring instrumentation was installed during the design and construction of Phase I, consisting of ground temperature cables (GTCs), slope indicators (SIs), and standpipe piezometer (SP).

In fall 2010, three slope inclinometers were installed in the perimeter of Phase I and in the surrounding area to monitor the occurrence of creep or movement within the foundation soils. SIs were monitored on a monthly basis over the following 3 to 4 years (after which all were damaged). No significant lateral movements were noted during the period of data collection.

In fall 2012, a standpipe monitoring well was installed in the lower bench of Phase I. Based on information in Tetra Tech's files, it is assumed this standpipe was damaged around 2014. Data collected during this time indicated ponding water at the surface of the DSTF and spring melt contributed to water observations within the standpipe in the spring. This water was noted to dissipate during the summer months. Based on the data collected and reviewed at the time it was concluded that there was no free water within the tailings.

Table 1 provides a summary of the Phase I instrumentation and conditions, and the locations of the Phase I instruments are presented in Figure 8.

Over the years since installations, most of these instruments have been damaged beyond function or repair. As part of AKHM’s efforts to quantify and reduce, as appropriate, the risk associated with DSTF Phase I, AKHM is planning a detailed site investigation and characterization program that will begin in the fall of 2024. As part of this program, damaged Phase I instrumentation will be replaced as appropriate, new instrumentation will be installed, and samples will be collected for detailed laboratory analysis.

Table 1: Phase I DSTF Instrumentation Summary

Borehole ID	Instrument Type	Northing	Easting	Date Installed	Range of Dates Collected	Condition
BH15	GTC #2207	7087047	483889	August 30, 2009	Nov 22, 2009 - July 22, 2023	Not Functioning. Erroneous readings at depth.
BH17	GTC #2263	7086849	483829	August 30, 2009	Nov 22, 2009 - July 22, 2023	Not functioning. Removed due to damaged casing. Readings could not be taken.
BH18	GTC #2209	7086959	483863	September 2, 2009	Nov 22, 2009 – July 17, 2024	Functioning
BH23	GTC #2210	7086870	483964	September 29, 2009	Nov 22, 2009 - Aug 26, 2021	Not functioning. Could not be located. Assumed destroyed.
BH28	SI	7086985	484026	December 14, 2011	Dec 14, 2011 - April 2, 2013	Not Functioning
BH30	SI	7087032	483969	October 26, 2010	Oct 26, 2010 - April 2, 2013	Not Functioning
BH31	GTC #2263	7087058	484016	February 22, 2011	Feb 23, 2011 - Sept 29, 2022	Not Functioning. Erroneous readings at depth.
BH32	GTC #2264	7086999	484077	February 22, 2011	Feb 23, 2011 – July 17, 2024	Functioning
BH36	SI	7086868	483930	December 14, 2011	Dec 14, 2011 - May 23, 2013	Not Functioning
BH39	Standpipe	7086938	483973	August 1, 2012	August 2012 - 2014	Not Functioning
BH40	GTC #NA	7086940	483978	August 2, 2012	Sep 29, 2012 – May 23, 2013	Not Functioning. Replaced with BH22-40B during the 2022 investigation program.
BH22-40B	GTC #2824	7086940	483978	February 10, 2023	February 2023 – July 2024	Functioning

The performance of Phase I to date has been considered in the design of Phase II. Phase II design includes modifications such as flattened slopes to account for more stringent seismic design standards and an emphasis on operational and quality controls such as standard operating procedures being implemented by AKHM. The overall instrumentation plan showing Phase II instruments is presented in Figure 7.

2.3 Phase II Summary

The Phase II expansion is located immediately south and southwest of the existing Phase I. The area is mostly undeveloped and undisturbed, except for a waste rock storage area along the western edge of the footprint, and existing roadways along the footprint perimeters. Immediately north and northwest of Phase II is the former Keno City waste dump and access road, respectively.

Preliminary geotechnical investigation and design work was previously completed by Tetra Tech (Tetra Tech EBA 2015). The 2015 preliminary geotechnical investigation consisted of 12 shallow testpits typically terminated due to refusal in frozen ice-rich silt, at an average depth of about 0.5 m, and up to 3 m below the existing ground surface. The detailed borehole logs for this program are attached in Appendix B.

The detailed design herein has expanded on the preliminary work completed and incorporates engineering observations and judgment of the performance of Phase I to date.

3.0 PHASE II GEOTECHNICAL INVESTIGATION

3.1 General

Tetra Tech completed a geotechnical investigation for the Phase II expansion consisting of a drilling program, laboratory testing on select samples, and installation of ground temperature monitoring instrumentation. Previously completed geotechnical investigative work was reviewed and referenced during the development of the drilling program. The program's goal for Phase II was to determine the subsurface conditions, prioritizing and characterizing the permafrost known to exist within the area. The boreholes were proposed to be terminated in bedrock to confirm the bedrock contact point, or to achieve a target minimum depth of 30 m. The boreholes that did not encounter bedrock were terminated in unfrozen materials.

AKHM retained Boart Longyear (Boart) to provide their track-mounted LS 250 MiniSonic drill rig for the geotechnical drilling program. The program was conducted from September 25, 2022 to October 4, 2022. Ten boreholes (BH22-01 through BH22-10) were advanced to termination depths that ranged from 15.2 m to 30.5 m.

The boreholes were logged in the field by Jacob Swartz, EIT, a geotechnical engineer from Tetra Tech's Whitehorse office. Each borehole was advanced in 1.5 m increments, and disturbed samples were collected and returned to Tetra Tech's Whitehorse laboratory for geotechnical index testing. Disturbed samples were also collected for field jar tests to estimate ground ice contents.

Upon completion of drilling, boreholes were backfilled using drill cuttings to restore the original ground surface. Borehole locations are shown in the drawing package, and borehole logs and laboratory test results for the 2022 field program are included in Appendix B.

Select boreholes were chosen for GTC installation based on encountered subsurface conditions and location within the proposed expansion. Details regarding The GTC installation can be found below in Section 3.8.

3.2 Surface Conditions

The site of the Phase II expansion generally slopes approximately 5 – 15% to the west or southwest.

The western extents near the mill site have been used as a temporary waste rock storage area. The surface of this storage area is generally flat with a slight slope to the southwest. At the time of drilling, the waste rock layer tapered out into existing topography to the east and south and was estimated to extend up to 7 m in thickness along the northwestern edge prior to this rock being removed in 2023.

The remaining extents of the site are generally bordered by existing gravel roadways.

The interior of the expansion area is vegetated with shrubs and spruce trees. Vegetation is generally thicker and more mature to the east and southeast.

3.3 Subsurface Conditions

Subsurface conditions encountered within the Phase II DSTF footprint were similar to the Phase I conditions, with the exception of generally lower ground ice contents and moisture contents. The soils consisted of a thin organic cover overlying a locally ice-rich silt/sand till with sand and gravel seams deposited throughout. Coarse-grained sand/gravels were encountered underlying the till above the bedrock interface in BH22-01 and BH22-05.

BH22-04 was an outlier as the soil consisted mainly of a sand and gravel matrix for the entire depth. BH22-04 is located on a possible kame that is suspected to be a coarse-grained deposit deposited by glacial outwash. Large gravel and boulders were encountered in multiple boreholes throughout the drilling and are estimated up to 0.5 m in diameter.

Detailed descriptions of the conditions encountered in each borehole are shown on the borehole logs and laboratory test results, which are attached in Appendix B.

3.4 Groundwater

Groundwater was not encountered during the drilling program.

3.5 Permafrost

The site is located within the Extensive Discontinuous Permafrost Zone in the Yukon, where permafrost can be expected under 50% to 90% of the ground surface. Permafrost within the DSTF Phase II footprint is generally warm (generally observed between -0.2 to -0.4 °C), discontinuous, and can contain ice-rich soil. Because of the variability in the area, the borehole locations were chosen to help classify the permafrost and its extent beneath the design footprint.

Permafrost was encountered in most areas throughout the proposed Phase II DSTF footprint, the exception being within the coarse-grained soil encountered near BH22-04. No massive ice was observed within the Phase II footprint during the investigation.

The ground ice contents estimated visually in the field ranged from non-visible and non-excess to visible. In the northwest extents of the footprint, within BH22-03 and BH22-10, up to 40% ground ice was estimated based on visual observations during drilling. Field jar tests completed on select samples ranged from no excess ice up to approximately 38% excess ice. Note that the higher zones of excess ice were limited to isolated layers within the upper sections of the glacial till, generally within 2.0 m to 4.0 m of original ground. The ground ice encountered in the upper 4 m contained randomly oriented and stratified lenses in the soil samples collected. Below this, the ground ice was non-visible and with no excess ice, i.e., ice-poor.

A detailed description of permafrost conditions encountered is shown on the borehole logs in Appendix B.

3.6 Bedrock

Bedrock in the Keno City area typically consists of quartzite or schist. Quartzite or suspected quartzite was encountered at depth in BH22-01, 04, 05, 07, 09, and 10. Bedrock is also visible at the surface in a few locations near the southern border of Phase I.

As mentioned in Section 3.1, bedrock was not encountered in every borehole as the contact was deeper than the chosen termination depth, and/or the subsurface conditions made for difficult drilling.

A summary of bedrock encounters and estimated elevations during the drilling program is listed in Table 2.

Table 2: Summary of Bedrock Encounters

Borehole ID	Termination Depth	Termination Elevation	Bedrock Encountered/Comments
BH22-01	15.2 m	902.5 m	Quartzite 12.2 m / 905.5 m,
BH22-02	30.5 m	885.1 m	No, target depth reached
BH22-03	18.2 m	901.3 m	Refusal / core barrel damage
BH22-04	20.4 m	910.4 m	Refusal on suspected quartzite bedrock
BH22-05	26.8 m	904.9 m	Refusal on suspected quartzite bedrock
BH22-06	30.5 m	902.5 m	No, target depth
BH22-07	27.4 m	897 m	Refusal on suspected quartzite bedrock
BH22-08	30.5 m	896.0 m	No, target depth reached
BH22-09	28.3 m	895.8 m	Refusal on suspected quartzite bedrock
BH22-10	23.2 m	895.0 m	Refusal on suspected quartzite bedrock

3.7 Laboratory Testing

Laboratory testing included determining moisture content on all samples, and particle size distributions (sieve/hydrometer) on selected samples. Table 3 below presents a summary of testing completed and the laboratory test results are included in Appendix B.

Table 3: Quantity of Laboratory Tests Completed

Laboratory Test	Number of Tests Completed	Comments
Moisture Content	174	<ul style="list-style-type: none"> ▪ Typically ranged up to 32% in the silt and / or sand TILL ▪ Typically ranged up to 10% in sand and gravel layers ▪ Maximum moisture contents of note: ▪ BH22-03 SA47 71% collected below stockpiled waste rock and at the surface of ice-rich till with noted organic inclusions ▪ BH22-05 SA72 – 290% (sample of organics at original surface) ▪ BH22-06 SA89 – 183% (sample of organics below drill pad fill) ▪ Generally, moisture contents in permafrost samples indicated ice poor, or in some cases localized ice-rich foundation soils.
Particle Size Distribution (Sieve Analysis)	19	<ul style="list-style-type: none"> ▪ Particle size distributions were consistent with expected typical ranges for silt tills, sand tills, and interbedded gravel/sand layers

3.8 Ground Temperature Cables

In Phase II, Ground Temperature Cables (GTCs) were installed in seven of the ten drilled locations. The cables installed consist of Tetra Tech cables that require manual readings (to be routed and connected to the data logger during construction) and Beaded Stream cables that read, record, and transmit the data via a data logger.

One borehole was drilled within the Phase I DSTF to replace the damaged instrumentation (BH40) that was originally drilled for the Phase I monitoring. The new borehole and GTC are labeled as BH22-40B and will be used for long-term monitoring of the Phase I DSTF.

Data collected from these instruments indicate that the permafrost within the DSTF footprint is warm, generally above -0.4°C. Table 4 below shows the instrumentation details installed at each borehole. The borehole logs in Appendix B show the bead depth placement.

Table 4: Ground Temperature Cables

Borehole Number	BH22-01	BH22-05	BH22-06	BH22-07	BH22-08	BH22-09	BH22-10	BH22-40B
GTC Cable Type & No.	Tetra Tech #2819	Tetra Tech #2820	Tetra Tech #2821	Tetra Tech #2822	Beaded Stream #4473	Tetra Tech #2823	Beaded Stream #4474	Tetra Tech #2824
No. of Beads	16	16	16	16	36	16	25	16
OG Elevation (m)	917	931.7	933	924.4	926.5	924.1	918.6	N/A
Bottom of Borehole Elevation (m)	902.5	904.9	902.5	909.9	903.6	895.8	896.0	906.6

Note: Ground temperature data for BH22-08 and BH22-10 is unavailable in 2024.

The existing GTCs in the Phase II footprint will be protected during construction and their leads extended to termination points outside of the footprint. The chosen central location(s) will allow for all the GTCs to be connected to data loggers removing the need for manual readings.

Additional details regarding the installation/maintenance will be included under separate cover in the Instrumentation and Monitoring Plan.

Tetra Tech personnel will be on-site to confirm the GTC extensions are properly installed during construction.

Charts illustrating the compiled ground temperature measurements up to July 2024, along with historical data from previous year are included in Appendix C.

4.0 PHASE II EXPANSION DESIGN

4.1 Design References and Background Documents

The following guidelines, references, and existing designs were reviewed during design:

- Guidelines for Mine Waste Management Facilities (EMR 2023).
- Guidelines for Mine Waste Dump and Stockpile Design by Mark Hawley and John Cuning (Hawley and Cuning 2017).
- Mined Rock and Overburden Piles – Investigation and Design Manual – British Columbia Mine Waste Rock Pile Research Committee (Piteau 1991).
- Detailed Design Dry-Stacked Tailings Facility, Keno Hill District Mill Site (EBA, A Tetra Tech Company 2011).
- Preliminary Engineering Design and Management Plan, Dry-Stacked Tailings Facility, Bellekeno Mine Mill Site (EBA 2010a).
- Runoff Diversion Structures Specifications, Dry-Stacked Tailings Facility, Keno Hill District Mill, YT (EBA 2010b).
- Various inspection reports, memorandums, and correspondence in relation to Phase I construction, operations, etc.

4.2 Design Classification and Criteria

The 2023 EMR Guidelines require filtered tailings facilities to be classified using Table 4-1 and designed using criteria for that classification in Table 5-2.

Using Table 4-1, a classification of Class II for this facility is appropriate (based on presence of permafrost, and use of PAG materials). While the guidance suggests presence of permafrost that is not removed is rationale for a Class III designation, it is Tetra Tech's opinion based on experience monitoring Phase I and analyses of Phase II foundation soils that a reduction in designation for this criteria to Class II is appropriate.

As discussed in Section 3.5, the permafrost within the footprint and greater area is warm (generally observed between 0.2 - 0.4°C) and discontinuous. No massive ice was observed within the Phase II footprint and the ice-rich permafrost encompassed a small portion of the overall footprint, and was generally limited to shallow depths below original ground surface. However, the design accounts for variable ground ice conditions, and was considered during the facility classification.

Design criteria from Table 5-2 was used during the design including:

- Design earthquake event – 1:2,475-year event;
- Lower bound shear strength properties including interface friction angles;
- Upper bound phreatic surfaces;
- Limit equilibrium methods of stability calculations;
- Pseudo-static calculations for earthquake design including deformation analyses;

- Lower bound shear strength properties;
- Static Factor of Safety of 1.5; and
- Pseudo-static Factor of Safety of 1.0.

4.3 Tailings Parameters

Assumed parameters related to tailings, tailings production, and placement are shown in Table 5.

Table 5: Tailings Parameters

Criteria	Value
Tailings Production Rate	See Section 6.2
Percentage of Tailings Stored in DSTF	
Typical Particle Size Description	SILT, sandy to and SAND, trace clay
Bulk Density	2250 kg/m ³
Moisture Content	10-20%
Maximum Dry Density / Optimum Moisture	1885 – 1960 kg/m ³ at 17% - 12%
Permeability, k	9.65E-8 m/s
Effective friction angle, ϕ'	30-32°
Effective cohesion, c'	8-30 kPa

Tetra Tech has completed laboratory testing on tailings produced in early 2011 and also between December 2021 and August 2024. Tailings samples are collected by AKHM at the hopper discharge and shipped to Tetra Tech’s Whitehorse laboratory. Testing has consisted of hydrometer particle size testing, standard proctor maximum dry density, specific gravity testing, and direct shear testing.

Generally, tailings are composed of SILT, sandy to and SAND, trace clay, to a SAND and SILT, trace clay. There is some variability in composition due to milling processes and host rock composition. Table 6 shows the typical grain size distribution limits for tailings. The laboratory testing results are included in Appendix D.

Table 6: Upper and Lower Percent Passing Limits for Tailings

Particle Size (mm)	Percent Passing (by mass)	
	Lower Limit	Upper Limit
2	100	100
0.85	100	100
0.425	99.7	100
0.25	97	100
0.15	80.8	100
0.075	55.5	95
0.0349	32.9	80
0.0226	24.6	60
0.0133	18.1	45
0.0095	14.4	40
0.0068	10.9	35
0.0034	5.4	20
0.0014	2.5	10

During production and deposition into Phase II, tailings samples should continue to be collected and provided to Tetra Tech for laboratory analyses to confirm assumptions related to geotechnical properties. The minimum testing requirements are outlined as follows:

- Hydrometers / Particle Size Distribution (PSD) - Monthly
- Specific Gravity - Monthly
- Direct Shear Testing - Quarterly or when PSD falls outside of approved gradation limits
- Proctors - Monthly

We understand that AKHM may like to explore options to incorporate a fine-grained sludge product into the pressing procedure to ultimately deposit a mixed final tailings product in the DSTF. Tetra Tech has completed some testing to date on this product, however a mixing ratio is not included in this design. Additional testing is required to be completed and options related to mixing ratios and proper control of mixing to create a uniform product will be reviewed prior to placement of any such material within the DSTF.

4.4 Considerations from Phase I Performance

Some movements and distortions have been observed in the Phase I area and have manifested as several longitudinal tension cracks perpendicular to the slope, and several small sinkholes.

Constructed slopes in Phase I are generally 2H:1V to 2.5H:1V, with some localized steeper areas. The observed localized instabilities may be attributed to these steeper slopes, combined with occurrences of inconsistent placement and compaction procedures, as well as possible consolidation due to thaw of the underlying ice-rich permafrost. We understand areas of steepened slopes are to be regraded to design as required for closure

Phase II design included modifications including flattened slopes to account for more stringent seismic design standards, as well as an emphasis on operational and quality controls such as standard operating procedures being implemented by AKHM.

Tetra Tech understands that the Phase II facility will be constructed and operated to a higher standard than historically observed in Phase I. AKHM and Tetra Tech are currently planning a geotechnical investigation of Phase I to better characterize the in-situ tailings and foundation conditions. AKHM is also developing standard procedures associated with the tailings placement and compaction, and general operations of the facility. These efforts are also being coupled with more emphasis on staff training than has previously been observed.

4.5 Foundation Soil and Permafrost Conditions

Generally, subsurface conditions within the Phase II expansion footprint consist of a thin organic layer, underlain by ice-rich silt or sand till, underlain by bedrock. Sands and gravels were noted to be interbedded in some boreholes.

Up to 7 m of waste rock was located along the western edge of the footprint, near the toe of the proposed Phase II expansion at the time of the drilling program. Since then, construction activities have sourced some of this rock and the thickness of this layer varies. Tetra Tech understands that most waste rock has been removed from the Phase II footprint and that any remaining waste rock and/or imported fill materials (i.e., such as access road materials) will be removed prior to construction and will not be buried within the foundation.

A bedrock surface was inferred based on the drilling program as well as contact locations previously provided by AKHM.

Permafrost is expected to exist under most of the Phase II footprint. For stability purposes, the ice-rich silt till layer was assumed to extend to bedrock or indefinitely. This is considered conservative, as ground ice contents estimated based on field observations, jar tests, and laboratory moisture contents, were observed to decrease with depth. The long-term thaw of the ice-rich silt layer was also reviewed.

Tetra Tech completed a review of the potential estimated thaw settlement (Differential Settlement and Imposed Strains on GCL, Technical Memorandum dated May 31, 2024), and the findings are summarized as follows:

- Considering all boreholes, test pits, and samples collected, permafrost in the southern-facing Phase II area consists of localized ice-rich till with no abrupt changes in ground ice content.
- In the Phase II footprint, the presence of localized massive ground ice that would contribute to more than 5% strain in the GCL is highly unlikely.
- Tetra Tech expects strains imposed on the GCL caused by differential settlement to remain within the acceptable limits of the GCL and to not exceed 5%.

AKHM has informed Tetra Tech that there are no underground workings beneath the Phase II DSTF footprint.

4.6 Geometry

The location and geometry of the Phase II expansion are shown in the drawing package. The final geometry of the Phase II expansion is generally based on the preliminary design concepts. Boundaries have been assumed based on limits provided by AKHM.

Generally, the expansion ties into the southern extents of Phase I, expanding to the east and west as it advances to the south. Final tailings slopes of 3.25H:1V have been designed.

A toe buttress has been incorporated into the final design to assist in achieving minimum factors of safety against failures through the foundation materials. This buttress will also be utilized to collect and convey surface runoff along the western slope and toe. The surface of the buttress is expected to have a gradient of approximately 2%, sloping from the north to the south. The north end of the buttress has been designed to tie into the P1 Berm constructed in the Fall of 2023.

To meet interim stability requirements, interior shear berm structures of granular fill are incorporated into the staged construction design. Stability analyses were completed to verify slopes were within acceptable factors of safety.

A summary of geometric details is shown below in Table 7.

Table 7: Summary of Phase II Geometry and Volumes

Criteria	Value
Approximate Footprint	30,000 m ²
Final Tailings Slope	3.25H:1V
Slope Degrees	17.1°
Slope Percent	30.7%
Final Approximate Crest Elevation	940 m
Estimated Volume of Tailings	237,000 m ³

4.7 Foundation Components

The foundation design for the expansion is generally consistent with that of Phase 1. Components of the foundation are discussed below, in order of construction.

4.7.1 Drainage Blanket

A 0.6 m thick layer of free-draining granular material will be placed directly on the existing organic surface. This drainage blanket layer will allow for drainage of water generated from near-surface permafrost thaw out of the footprint, if required. It also allows for site preparation and a suitable bearing surface for the other seepage collection system components.

50 mm minus granular fill should be used for the drainage blanket and consist of hard durable particles, be free of roots, topsoil, snow, ice and other deleterious material and have a particle size distribution such that the maximum size is 50 mm and no more than 5% passes the 0.08 mm.

Particle size analyses will be completed in accordance with ASTM D7928 and C136 at the following minimum frequencies:

- 1 test per 500 m³ of material produced.

Moisture density relationship shall be completed in accordance with ASTM D698 at the following minimum frequency:

- 1 test per 5,000 m³ of material produced.

4.7.2 Geosynthetic Clay Liner

A geosynthetic clay liner (GCL) is to be installed above the drainage blanket to intercept any seepage from the DSTF and minimize tailings seepage from infiltrating into the drainage layer and underlying foundation soils.

The GCL consists of a layer of bentonite clay between layers of woven geotextile and non-woven geotextile. The non-woven geotextile should be oriented upwards.

Tetra Tech understands that AKHM will be procuring Bentomat ST for the use of GCL. Tetra Tech approves this product and should be contacted for review if another product is preferred. The material property specifications for Bentomat ST are provided below in Table 8.

Table 8: Bentomat ST Properties

Material Property	Test Standard	Test Frequency	Required Values
Bentonite Swell Index	ASTM D 5890	1 per 50 tonnes	24 ml/2g min
Bentonite Fluid Loss	ASTM D 5891	1 per 50 tonnes	18 ml max
Bentonite Mass/Area	ASTM D 5993	40,000 ft ² (4,000 m ²)	0.75 lb/ft ² (3.6 kg/m ²) min
GCL Grab Strength	ASTM D 6768	200,000 ft ² (20,000 m ²)	30 lbs/in (53 N/cm) MARV
GCL Peel Strength	ASTM D 6496	40,000 ft ² (4,000 m ²)	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux	ASTM D 5887	Weekly	1 x 10 ⁻⁸ m ³ /m ² sec max
GCL Hydraulic Conductivity	ASTM D 5887	Weekly	5 x 10 ⁻⁹ cm/sec max
GCL Hydrated Internal Shear Strength	ASTM D5321 ASTM D 6243	Periodic	500 psf (24kPa) typ @ 200 psf

Note – these testing frequencies are those completed by the manufacturer.

Regarding freeze-thaw concerns, Koerner (2005) discusses this issue as follows:

“The central property of a hydrated GCL insofar as freeze-thaw behavior is concerned is its permeability. Daniel et al. used a rectangular laboratory flow box and subjected the entire assembly to 10 freeze-thaw cycles. The permeability showed a slight increase from 1.5×10^9 to 5.5×10^9 cm/sec. Kraus et al. report no change in flexible wall permeability tests of the specimens evaluated after 20 freeze-thaw cycles.

While the moisture in the bentonite of the GCL can freeze, causing disruption of the soil structure, upon thawing the bentonite is very self—healing and apparently returns to its original state. In this regard, it is fortunate that most GCLs have geotextile or geomembrane coverings so that fugitive soil particles cannot invade the bentonite structure during the expansion cycle.”

4.7.3 Geonet and Non-Woven Geotextile Drain

A geonet topped with non-woven geotextile is placed above the GCL and directly underneath the layer of confining gravel. This drain will aid in alleviating porewater pressure build-up.

This foundation system was designed for Phase I under the assumption that porewater from the DSTF would drain after placement. Performance and observations of Phase I, including a standpipe piezometer installed on the lower bench of Phase I, have not indicated the presence of seepage water within the geocomposite drain. For this reason, preliminary designs for Phase II excluded the GCL and drain. However, these components were re-instated into a revised preliminary design (Tetra Tech 2015) in response to comments from the Yukon Water Board.

Tetra Tech understands that AKHM will be procuring HydraNet Biplanar-220 (270 g/m^2 (8 oz/yd²)) for the use of geonet and LP 8 Non-Woven for the geotextile. It is understood that a single bonded product such as the HydraNet Biplanar Geocomposite is also being considered. The HydraNet geosynthetic contains a geotextile bonded to one or both sides of a geonet helping prevent the movement of soil fines into the drainage path. Tetra Tech approves these products and should be contacted for review if another product is preferred. The material property specifications for the HydraNet Biplanar-220 are provided below in Table 9.

Table 9: Geonet Properties

Material Property	Test Standard	Material Specification
Fabric Weight	ASTM D 5261	270 g/m ² (8 oz/yd ²)
Grab Tensile	ASTM D 4632	1001 N (225 lb)
Grab Elongation	ASTM D 4632	50%
Trapezoid Tear	ASTM D 4533	289 N (65 lb)
CBR Puncture	ASTM D 6241	2670 N (600 lb)
Water Flow	ASTM D 4491	4075 l/min/m ² (100 gpm/ft ²)
Permittivity	ASTM D 4491	1.26 sec ⁻¹
Permeability	ASTM D 4491	0.30 m/sec
AOS	ASTM D 4751	0.180 mm (80 US Sieve)

A minimum confining layer of 300 mm of gravel will be placed cover over the liner system immediately after liner placement to provide confinement for the GCL (per supplier guidelines). This confining material should adhere to the same specifications outlined for the drainage blanket in Section 4.7.1. Interface Direct Shear Testing

Interface direct shear testing was completed on the following interfaces:

- Tailings and Geotextile;

- Geotextile and Geonet;
- Geonet and GCL; and
- GCL and Drainage Blanket material.

Results of interface direct shear testing are included in Appendix D.

4.8 Seismicity

The design seismic event selected was a 1 in 2,475-year return period as required by a Class II facility in Table 5-2 of EMR's 2023 Guidelines. A seismic site designation of Class D was selected.

4.9 Stability of DSTF

4.9.1 General

The stability of the Phase II expansion was evaluated using GeoStudio 2021 Slope/W limit equilibrium slope stability software, commercially available from Geo-Slope International Ltd.

Cross-sections for analyses were selected based on:

- Location relative to existing infrastructure;
- Final height of placement; and
- Existing topography grades.

All stability models assumed a subgrade slope (i.e., slope of drainage blanket material on which the liner is installed) of 4H:1V, or 14°. This was selected to account for any as-built or survey discrepancies with vegetation and increased conservatism in the stability models. The expected maximum subgrade or installed drainage blanket and liner slope along the footprint is flatter at approximately 5.5H:1V or 10°.

Three cases were evaluated to assess the stability of the Phase II DSTF under both short-term (construction and operation) and long term (operation and closure) conditions. These three cases are detailed and explained below.

- Case One - Fully Frozen - to model the short-term stability assuming that the permafrost is still frozen within the DSTF Phase II footprint.
- Case Two - Fully Thawed - to model the long-term stability assuming that the permafrost is fully thawed.
- Case Three - Foundation Scenario / Failure along liner - to evaluate a forced failure along the interface between the liner materials.

During Phase I design the intermediate scenario of "Permafrost thawed to 1.0 m" was analyzed to model the condition where tailings are placed, and a rapid thaw of the upper ice-rich silt and generation of pore water pressures occurred within the first months of placement. Experience from ground temperatures collected during the early stages of the Phase I DSTF since construction and tailings placement began indicates that there was no rapid thaw of permafrost due to construction of the DSTF, and that thaw is gradual with corresponding negligible release of porewater when it thaws.

For example, BH40, installed in the centre of the lower bench of Phase I in 2012, after several years of tailings placement indicated frozen foundation soils from the base of tailings to bedrock. The last reading on this cable before it was damaged was from May 2013. This cable was replaced in 2022 and readings indicate that the foundation soils have thawed to bedrock.

This intermediate stability scenario was subsequently excluded from consideration during the Phase I expansion design following a review of the 2013 data. For further details, refer to the document titled “Dry Stacked Tailings Facility – Risk Assessment Stability Model Update”, submitted by EBA, A Tetra Tech Company to Alexco Resource Corp. on February 26, 2013 – File W14103122.

4.9.2 Acceptance Criteria

Acceptance criteria for stability analyses was selected from Table 5-2 of the EMR Guidelines based on a Class II facility and is shown below in Table 10.

Table 10: Slope Stability Factors of Safety

Case	Factor of Safety
Static Operations	1.5
Static Closure	1.5
Seismic (Pseudo-static)	1.0

As noted above in Section 4.8, the design seismic event selected was a 1 in 2,475-year return period. Pseudo-static analysis was used to evaluate the potential effect of seismic loading on the DSTF. This method simulates seismic loading by applying constant horizontal and/or vertical forces. A summary of seismic parameters used during the design is summarized below in Table 11.

Table 11: Seismic Stability Criteria

	Selected Value	Source / Comment
Design Event	1:2475 year	2023 EMR Guidelines
Horizontal Seismic Coefficient (k_h) of	$\frac{1}{2}$ x PGA (0.139), up to 1.0 x PGA (0.278) for Site Class D	Hynes-Griffin and Franklin, 1984

4.9.3 Soil Strength Parameters

During the stability analyses, seven material types were modelled. These are shown in Table 12 and described in further detail in Sections 4.9.3.1 to 4.9.3.6 below.

Table 12: Soil Strength Parameters in Stability Analysis

Material	Unit Weight (kN/m ³)	Frictional Strength	
		Friction (Φ)	Cohesion (kPa)
Bedrock	Bedrock was considered impenetrable in this analysis.		
Frozen Ice-Rich Silt Till	11.8	30°	0
Thawed Silt Till	19.1	30°	0
Tailings	22.5	30°	8
Cover and Drainage Blanket Gravel	24	35°	0
Geocomposite Liner and Drain	20	16°	0
Buttress Gravel	24	40°	0

4.9.3.1 Bedrock

Tetra Tech understands bedrock encountered in the area is typically competent quartzite. The strength of this material is assumed to be much greater than that of the foundation soils and overburden material. The bedrock has been assumed to be impenetrable for modelling purposes.

4.9.3.2 Frozen Ice-Rich Silt Till

The existing DSTF design assumed that the ice-rich silt till layer extended down to bedrock.

In Phase I, the ice-rich till was evaluated for short-term conditions (i.e., construction, operations, pseudo-static case), assuming it behaved as a frictional material, and for long-term conditions (i.e., closure) assuming only cohesive properties of frozen soil and negating any frictional strength.

For Phase II analyses, based on Tetra Tech's understanding through instrumentation monitoring completed for Phase I to date, and the updated thermal modelling discussed in Section 4.14, the frozen foundation soils are likely to thaw in the long term. Therefore, we have chosen to assume only frictional behaviour in the long-term case.

4.9.3.3 Thawed Silt Till

Under the long-term scenario, Tetra Tech has assumed the ice-rich till has thawed. Tetra Tech considers the assumed strengths which were determined by direct shear testing during Phase I design appropriate for application here.

4.9.3.4 Tailings

Tetra Tech has completed several iterations of direct shear testing on tailings produced. The lower bound limits of angle of friction and cohesion were used for stability purposes. Bulk density has been estimated by assuming 15% moisture content applied to the laboratory determined maximum dry density.

4.9.3.5 Surface Cover and Drainage Blanket Gravels

The friction angle of the gravel was conservatively assumed as 35° based on Tetra Tech's experience with gravels in the Keno City area. This was reduced to 30° for gravel placed in a loose state. The bulk density was based on a maximum dry density of 2385 kg/m³. It is assumed that the gravel would be placed at 95% standard proctor maximum dry density and 8% moisture for the drain area and 90% density and 4% moisture for the cover material.

4.9.3.6 Foundation Materials

As noted in Section 0, interface direct shear testing was completed on foundation materials. The lower bound equivalent angle of friction from these tests was utilized during slope stability analyses – further reduced by 20% per recommendations by Hynes-Griffin and Franklin, 1984.

4.9.4 Analysis Results

A summary of the determined FoS for each of the evaluated scenarios is provided below in Table 13. Slope stability figures are included in Appendix E.

Table 13: Phase II Slope Stability Analysis Results

Evaluated Scenario	Minimum FoS	Calculated FoS				
		Section A	Section B	Section C	Section D	Section E
Fully Frozen - Static Shallow (short-term)	1.5	2.2	2.2	2.2	1.9	1.7
Fully Frozen - Static Deep (short-term)	1.5	1.9	2.0	1.8	1.9	2.0
Fully Frozen – Pseudo-static Shallow (short-term)	1.0	1.5	1.4	1.5	1.4	1.4
Fully Frozen – Pseudo-static Deep (short-term)	1.0	1.3	1.4	1.3	1.3	1.4
Fully Thawed - Static Shallow (long-term)	1.5	2.1	2.1	2.2	2.0	1.7
Fully Thawed - Static Deep (long-term)	1.5	2.1	2.1	2.0	2.0	2.2
Fully Thawed – Pseudo-static Shallow (long-term)	1.0	1.4	1.4	1.5	1.4	1.0
Fully Thawed – Pseudo-static Deep (long-term)	1.0	1.4	1.4	1.3	1.4	1.3
Foundation Analysis - Static Deep (long-term)	1.5	2.1	1.6	1.5	1.5	1.6
Foundation Analysis – Pseudo-static Deep (long-term)	1.0	1.1	1.0	1.0	1.0	1.0

All calculated FoS met the minimums required.

4.10 Seismic Displacement

Seismic displacement was estimated using methods by Bray and Macedo for shallow crustal earthquakes. Assuming a relatively large 7.5 magnitude earthquake, displacements along different sections were estimated at approximately 35 cm with a probability of exceedance of 5%, and 54 cm with a probability of exceedance of 2%.

4.11 Thaw Consolidation

During the preliminary design of Phase I, thaw consolidation testing on select samples and one-dimensional thaw analysis were completed (EBA 2010a). This analysis attempted to provide upper-bound estimates of the possible accumulative distortion in perpetuity due to the thaw of the ice-rich and ice-poor silt till. This analysis was considered conservative, and only applicable to the selected and analyzed borehole. The detailed design (EBA 2011) took a more generalized approach, indicating a potential and anticipation for localized differential movement and settlement to occur under the DSTF.

The Phase II expansion has been designed with a similar consideration, noting that in general the ground ice and moisture contents encountered within the Phase II footprint were lower than those encountered under Phase I, and therefore less overall thaw consolidation movement is expected. For additional information, see Differential Settlement and Imposed Strains on GCL, Technical Memorandum dated May 31, 2024, as discussed in Section 4.5.

4.12 Liquefaction Assessment

A liquefaction assessment was completed during the Phase I detailed design. This assessment concluded:

- The tailings are not considered to be liquifiable as they are expected to be drained and unsaturated; and

- A FoS greater than or equal to 1.0 was determined against cyclic liquefaction in the foundation soils for an earthquake magnitude less than 8.0, which is considered to be an extreme event. It was estimated that the consequences of any liquefaction would amount to limited movement and cracking of the tailings, as opposed to catastrophic failure.

The foundation soils within Phase II are similar to those encountered in Phase I, with typically lower ground ice and moisture contents. The liquefaction assessment completed for Phase I was reviewed and considered appropriate and applicable to the Phase II expansion.

During the July 2024 tailings placement and compaction field trial, Dynamic Cone Penetrometer (DCP) testing was completed. If the recommendations for tailings placement and compaction from this field trial are followed, liquefaction of tailings is not expected (see technical memorandum “DSTF Tailings Placement and Compaction Field Trial Summary” dated August 17, 2024). To further confirm this, advanced laboratory testing on tailings, including triaxial shear and cyclic shear testing is currently being planned.

4.13 Creep

Ice and ice-rich soils can creep over time. The magnitude of movement due to creep is a function of stresses developed in the ice or soils.

Previous monitoring of slope inclinometer (SI) instrumentation installed within and around the Phase I footprint provided no indication of significant movement in the existing DSTF in the early years of operations (i.e., during the period of SI operation), refer to Section 2.2.

No massive ice was encountered during the geotechnical investigation of Phase II. Ground ice contents, estimated visually and based on moisture contents on collected samples, are lower compared to those encountered in Phase I. Ice-rich materials located under critical structure components (i.e., buttress and interior shear berms) will be removed during foundation preparation.

Based on these considerations, coupled with the understanding that in the long-term, complete thaw of the permafrost and ground ice is anticipated, negligible creep deformation is expected within or under Phase II. Continued visual and survey monitoring of the DSTF throughout its life is recommended.

4.14 Geothermal Analysis

4.14.1 Phase I Pre-Construction Thermal Analysis

Thermal analysis was previously completed in 2011 (Tetra Tech EBA 2011) to investigate the long-term impact of dry stacked tailings placement on the thermal regime of the underlying ground in the DSTF area under climatic conditions including a climate change scenario. The thermal analysis was completed using GEOTHERM, Tetra Tech’s proprietary two-dimensional finite element software. Climatic conditions (e.g., monthly air temperatures, wind speed, solar radiation, snow cover) were obtained from the Mayo weather station.

Historical air temperature data at Mayo for the period of 1970 to 2010 indicated that the long-term climatic trend at Mayo is warming. The climate change thermal analysis considered a moderate greenhouse gas emission scenario with 1971-2000 baseline, as summarized in Table 14 following CSA (2010) for Zone W1. As will be discussed in Section 4.14.2.5.2, the newer climate models show warmer temperature changes than what was originally used in this previous assessment.

Table 14: Predicted Seasonal Air Temperature Changes in Zone W1 (CSA 2010)

Time of Year	2011 to 2040 (Celsius Degrees)	2041 to 2070 (Celsius Degrees)	2071 to 2100 (Celsius Degrees)
December to February	0.9	2.3	4.3
March to May	0.9	2.0	2.8
June to August	0.6	1.6	2.5
September to November	0.6	2.2	2.9

Several assumptions were made regarding the placement of the dry stacked tailings as summarized below. No records are available after the issuance of this thermal analysis memo to confirm these assumptions during construction of the facility.

- Removing trees in the tailings placement area;
- Placing 0.5 m sand and gravel fill as drainage blanket over the area in February 2011;
- Placing tailings overlying the sand and gravel blanket beginning in June 2011;
- The total height of placed tailings was assumed to be 10 m by 2013;
- The initial temperature for sand and gravel drainage blanket was assumed to be -5°C; and
- The initial temperature for dry stacked tailings was assumed to be +20°C.

The predicted rate of thaw into the permafrost is negligible during the first several years after completion of the tailings placement and then starts to increase with time after that period. Of the several cases simulated in the thermal model to investigate the influence of climate change, it was predicted that the permafrost will disappear between 22 and 29 years after construction, while the ice layer will disappear between 46 and 53 years.

4.14.2 Phase I Post-Construction Thermal Analysis

4.14.2.1 General

The commercially-available finite element software Temp/W in GeoStudio 2021 R2 (Seequent 2022) was used to model and analyze the thermal performance of the dry-stack tailings facility post-construction. Temp/W can analyze simple conduction problems to complex surface energy simulations using a rigorous phase change formulation, providing an accurate solution to problems involving freeze-thaw of saturated-unsaturated porous media. Temp/W has been used in the industry to simulate cyclic changes in ground temperatures for the purpose of exploring frost protection layers below trafficable surfaces, insulation configurations for foundations, or studying the preservation of frost in permafrost zones, mine wastes, and soil covers.

Two borehole locations have available thermistor data. BH40 was installed in February 2012 and has snapshot temperature with depth data available between installation and May 2013. BH22-40B was installed in February 2023 and has snapshot temperature with depth data available for April through June 2023.

The conceptual model for BH40 from 2012 consists of 5.25 m of tailings, 0.5 m of drainage blanket, 0.5 m of sand and gravel fill, 1.0 m of peat layer overlying 9.6 m of ice-rich silt, 0.9 m of massive ice, 1.8 m of silt and gravel, 2.7 m of massive ice, 3.1 m of gravel, 2.2 m of silt and gravel, and 0.9 m of sand over bedrock.

The conceptual model for BH22-40B from 2023 consists of 7.4 m of tailings, 0.5 m of drainage blanket, 0.5 m of sand and gravel fill, 1.0 m of peat layer overlying 8.35 m of ice-rich silt, 1.8 m of silt and gravel, 2.7 m of massive ice, 3.1 m of gravel, 2.2 m of silt and gravel, and 0.9 m of sand over bedrock. The soil layers below the drainage blanket were assumed to be the same with BH40, with thinner ice-rich silt and no massive ice between ice-rich silt and silt and gravel layers.

These conceptual borehole models are considered conservative as related to permafrost and ground ice conditions, as they are based on the poorest conditions encountered in the area, and not necessarily modelled based on actual conditions as now known.

4.14.2.2 Material Properties

The material properties from the nearby BH35, completed during Phase I design, were used to model the temperature behavior at BH40. The material properties for BH35 were previously reported in Tetra Tech EBA (2011) and are summarized in Table 15. The snow layer during the winter months was assumed to have a constant thermal conductivity of 0.25 W/m² (see Section 4.14.2.3).

Table 15: Material Properties at BH40

Material	Water Content (%)	Bulk Density (Mg/m ³)	Thermal Conductivity (W/m-°C)		Specific Heat (kJ/kg-°C)		Latent Heat (MJ/m ³)
			Frozen	Unfrozen	Frozen	Unfrozen	
Dry-stack Tailings	17	1.98	3.2	1.9	0.93	1.23	96
Sand and Gravel (Fill)	5	2.1	1.33	1.5	0.8	0.9	33
Peat before thaw consolidation	150	0.75	0.49	0.3	1.92	2.19	150
Peat after thaw consolidation	60	1.6	2.36	1.02	1.24	2.03	200
Silt (Till)	40	1.81	2.36	1.12	1.12	1.72	172
Ice	-	0.91	2.2	10	2.1	4.2	334
Silt and Gravel No. 1	10	2.25	2.21	1.71	0.86	1.05	68
Gravel	10	2.31	2.67	2	0.86	1.05	70
Silt and Gravel No. 2	15.5	2.19	2.59	1.7	0.92	1.2	98
Sand	10	2.25	2.27	1.73	0.86	1.05	68
Bedrock	1	2.63	4	4	0.75	0.77	9

4.14.2.3 Boundary Conditions

Mean monthly air temperatures from January 2010 to April 2023 for Environment Canada’s Mayo Station are shown in Figure F-1 (Appendix F). Other climatic data needed for the Surface Energy Balance boundary condition in Temp/W is summarized in Table 16. The Surface Energy Balance boundary condition considers the coupled soil-atmosphere process that affects the thermal response of the ground. The monthly air temperatures in Table 16 were used to establish the initial ground conditions prior to tailings placement. The wind speed, snow cover, and solar radiation were assumed to be constant for each year of the analysis. Only the historical monthly air temperatures from the Mayo Station were varied in the analysis period.

The albedo was assumed to be equal to 0.7 when snow is present on the ground, and 0.35 when there is no snow. Albedo is the amount of solar radiation reflected by a surface, where 1.0 being a perfect reflector and 0 absorbing all incoming solar radiation. A heat flux of 0.089 W/m² was applied at the base of the model to account for the geothermal heat.

Table 16: Mean Climatic Conditions at Keno Hill

Month	Measured Monthly Air Temperature ^(a) (°C)	Measured Monthly Wind Speed ^(b) (km/h)	Estimated Monthly Snow Cover ^(c) (m)	Estimated Daily Solar Radiation ^(d) (W/m ²)
January	-14.7	7.7	0.57	7.9
February	-14.0	5.4	0.57	32.9
March	-14.4	12.4	0.53	93.3
April	-4.9	11.8	0.41	174.2
May	3.4	8.8	0	224.2
June	9.6	7.5	0	240.8
July	10.8	8.2	0	208.3
August	8.0	8.7	0	157.5
September	1.9	8.5	0	90.4
October	-5.1	8	0.34	36.7
November	-13.6	8.9	0.48	11.3
December	-10.2	5.5	0.56	3.8
Mean Annual	-3.6	-	-	-

Notes:

- (a) Based on measured monthly air temperatures at Mayo for the periods of 1971 to 2010, measured air temperatures at Galena Hill station for the period of 2007 to 2010
- (b) Based on measured data at Galena Hill station for the period of 2007 to 2010
- (c) Based on mean month-end snow data at Mayo (Climate Normals 1971-2000, Environment Canada website) and environmental conditions report (Access Consulting Group, 2009)
- (d) Based on Photovoltaic Potential and Solar Resource Maps of Canada

4.14.2.4 Climate Change Projection

The latest iteration of the General Circulation Models (GCMs) for the Coupled Model Intercomparison Project Phase 6 (CMIP6) was released in 2021. The results of these GCMs were used in the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report (AR6) (IPCC 2021). A particular feature of the CMIP6 climate scenarios is the addition of the Shared Socio-economic Pathways (SSPs) that aim to include different mitigations and adaptations to ongoing growth in emissions. The SSPs are considered plausible narratives by the IPCC of global societal developments in the future without considering climate change, or mitigation or adaptation responses. SSP-based scenarios combine elements with the previous iteration of scenarios, the Representative Concentration Pathways (RCPs), which describe trajectories of change in atmospheric GHG and aerosol concentrations (and corresponding changes in radiative forcing) over time.

Two climate scenarios from the CMIP6 models were considered, as summarized below. Table 17 provides an overview of the corresponding for the two climate scenarios used in the analysis.

- SSP3-7.0, radiative forcing between RCP6.0 (6 W/m²) and RCP8.5 (8.5 W/m²) and represents the medium to high end of the range of future forcing pathways.
- SSP4-6.0, radiative forcing of RCP6.0 (6 W/m²) and fills in the range of medium forcing pathways.

Table 17: Overview of SSP Scenarios

Climate Scenario	Narrative
SSP3-7.0	<ul style="list-style-type: none"> ▪ A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues. ▪ Policies shift over time to become increasingly oriented toward national and regional security issues. ▪ Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. ▪ Investments in education and technological development decline. ▪ Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time. ▪ Population growth is low in industrialized and high in developing countries. ▪ A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions.
SSP4-6.0	<ul style="list-style-type: none"> ▪ Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. ▪ Over time, a gap widens between an internationally-connected society that contributes to knowledge- and capital-intensive sectors of the global economy, and a fragmented collection of lower-income, poorly educated societies that work in a labor intensive, low-tech economy. ▪ Social cohesion degrades and conflict and unrest become increasingly common. ▪ Technology development is high in the high-tech economy and sectors. ▪ The globally connected energy sector diversifies, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. Environmental policies focus on local issues around middle and high income areas.

Figure F-2 (Appendix F) from Riahi et al. (2016) shows a comparison of the temperature change at the Earth’s surface between CMIP5 and CMIP6 models, and between each RCP and SSP climate scenarios. The CMIP6 models are slightly warmer than those projected from the CMIP5 models. SSP4-6.0 is analogous to the intermediate case in the previous iterations of the climate change models along with RCP4.5 (i.e., in CMIP5) and SSP2-4.5 (i.e., in CMIP6). Hausfather and Peters (2020) have demonstrated that both SSP5-8.5 and SSP3-7.0 are both highly unlikely and unlikely scenarios, respectively. Given the current climate policies, Hausfather and Peters (2020) showed that the likely plausible trajectory follows SSP4-6.0. SSP3-7.0 was still used in the climate change assessment as part of the sensitivity analysis. The mean annual air temperature for the two climate scenarios is provided in Figure F-3 (Appendix F). The 50th percentile for the region of Yukon averaged over 20 years was selected. Only the mean annual temperatures are shown in Figure F-3, but the analysis considered the temperature change with respect to seasonal variability relative to a reference period of 1995-2014 as summarized in Table 18 and Table 19 for SSP3-7.0 and SSP4-6.0, respectively. The temperature change is added at the beginning of the timestep (e.g., adding 1.90°C for the monthly mean temperatures of December to February for SSP3-7.0) and held constant for the subsequent 20 years. At year 2041, the increment between 2021-2040 and 2041-2060 is added to the temperatures calculated at 2040 (e.g., adding increment of 0.54°C for the monthly mean temperatures of December to February for SSP3-7.0) and held constant again for the subsequent 20 years. This process is repeated for each time of year and every 20 year period until 2100. As noted in the AR6 (IPCC 2021), the radiative forcing for SSP4-6.0 is expected to stabilize at the end of the century, hence the temperatures between 2080 and 2100 are less than that of the SSP3-7.0 values. SSP3-7.0 is projected to continue to increase after 2100.

Given the range of natural climate variability and uncertainties regarding future greenhouse gas emission pathways and climate responses, the literature suggests changes projected by one climate model should not be used in isolation (ECCC n.d.). Therefore, both SSP3-7.0 and SSP4-6.0 climate scenarios considered in the analysis used

a multi-model ensemble that includes several GCM models. This data is publicly available in <https://climate-scenarios.canada.ca/?page=cmip6-scenarios>.

Table 18: Changes in Temperature using CMIP6 for SS3-7.0 (50th percentile)-Celsius Degrees

Time of Year	2021 to 2040	2041 to 2060	2061 to 2081	2081 to 2100
December to February	1.16	2.69	4.11	5.76
March to May	1.13	1.93	3.35	4.44
June to August	0.95	1.88	2.93	4.22
September to November	1.30	2.39	3.60	4.66
Annual	1.12	2.17	3.52	4.77

Table 19: Changes in Temperature using CMIP6 for SSP4-6.0 (50th percentile)-Celsius Degrees

Time of Year	2021 to 2040	2041 to 2060	2061 to 2081	2081 to 2100
December to February	0.94	2.97	4.53	5.48
March to May	1.07	2.11	2.94	4.00
June to August	1.25	2.14	2.83	3.52
September to November	1.26	2.63	4.10	4.39
Annual	1.16	2.46	3.67	4.37

The climate scenarios have been projected by climate modelers to 2100 but projected air temperature data is not available past 2100. There have been efforts to extend the models beyond 2100 but studies that focus on time horizons beyond 2100 have used reduced complexity because of the additional computational cost and not having available experiments to compare those results (Lyon et al. 2021, IPCC 2021). In this climate change assessment, both climate scenarios terminate at the end of 2100. It was assumed that the wind speed, snow depth, and solar radiation provided above are constant to 2100.

4.14.2.5 Results and Discussion

4.14.2.5.1 Calibration

Figures F-4 to F-7 (Appendix F) show the model results for BH40 between the months of September 2012 and May 2013. The general trend of modelled temperatures follows that of the measured values, which provides confidence in model results. The original permafrost layer prior to placement of the tailings was simulated in the model. The simulated top of permafrost is at El. 911.5 m, with an active layer thickness of 2.8 m with respect to the original ground surface. Both measured and model temperatures indicate that part of the tailings is below 0°C during this monitored period. Placement of the tailings raised the 0°C isotherm within the tailings during the monitoring period. No temperature readings are available after May 2013 at BH40. Extending the model to April 2023 indicates that the permafrost is still at or near its initial elevation prior to the placement of tailings.

Figure F-8 (Appendix F) shows the snapshot model result at BH22-40B in April 2023. A frozen layer was identified at El. 911.2 m in the borehole log during the placement of the PVC pipe for the thermistor cable. This frozen layer is not reflected in the thermistor reading below the original ground surface. The model temperatures between El. 910 and 915 m are within a thermal difference of 0.5°C in reference to the measured temperatures. Measured temperatures below El. 910 m are slightly above 0°C, while the model temperatures are slightly below 0°C. The thermal difference between measured and model temperatures below 0°C are within 0.5°C. The model results follow the general trend of measured temperatures and therefore considered acceptable, given that the actual placement of the tailings and corresponding temperatures during construction is not available.

The predicted thawing in Tetra Tech EBA (2011) is generally 0.0 m/yr between 2013 and 2015, and on average 0.15 m/yr between 2015 and 2035. The conditions simulated and calibrated in the current model is considered to supersede the previously modelled results in 2011. The model temperatures at the end of April 2023 for both boreholes are used as the initial thermal regime at the start of the climate change analysis.

4.14.2.5.2 Climate Change Projected Temperatures

The results of the climate change analysis for BH40 using SSP3-7.0 and SSP4-6.0 are shown in Figures F-9 and F-10 (Appendix F), respectively. The depth of the 0°C isotherm between 2030 and 2100 for both climate scenarios below the original ground surface are summarized in Table 20. On average, the depth of the 0°C isotherm and the thickness of the active layer with reference to the original ground surface between the two climate scenarios is generally the same. By 2040, the top of permafrost will be 4.3 m below original ground surface, which is equivalent to 1.6 m of degradation. Based on these climate scenarios, the permafrost will degrade by approximately 6.5 m by 2100 (i.e., 9.2 m from original ground surface), with the permafrost thickness reduced to 12.9 m. The average permafrost temperature in 2100 is -0.05°C. It is likely that the previous analysis in Tetra Tech EBA (2011) considered a cut-off temperature (e.g., -0.1°C) to delineate the permafrost for conservatism. Considering this cut-off temperature indicates that the permafrost will disappear between 2050 and 2070, consistent with the previous prediction noted in Section 4.14.1.

Table 20: Depth of Permafrost Thaw at BH40 from Original Ground Surface Elevation

Timestep	SSP3-7.0 (m)	SSP4-6.0 (m)	Average (m)	Permafrost Thickness (m)	Average Permafrost Temperature (°C)
2030	3.31	3.34	3.3	> 20.0	-0.13
2040	4.28	4.37	4.3	19.7	-0.12
2050	5.29	5.28	5.3	18.0	-0.11
2070	6.80	6.85	6.8	15.8	-0.08
2100	9.21	9.17	9.2	12.9	-0.05

The results of the climate change analysis for BH22-40B using SSP3-7.0 and SSP4-6.0 are shown in Figures F-11 and F-12 (Appendix F), respectively. The depth of the 0°C isotherm between 2030 and 2100 for both climate scenarios below the original ground surface are summarized in Table 21. On average, the depth of the 0°C isotherm and the thickness of the active layer with reference to the original ground surface between the two climate scenarios is generally the same. By 2040, the top of permafrost will be 3.3 m below original ground surface, which is equivalent to 0.8 m of degradation. Based on these climate scenarios, the permafrost will degrade by approximately 6.0 m by 2100 (i.e., 8.5 m from original ground surface), with the permafrost thickness reduced to 11.6 m. The average permafrost temperature in 2100 is -0.05°C.

Table 21: Depth of Permafrost Thaw at BH22-40B from Original Ground Surface Elevation

Timestep	SSP3-7.0 (m)	SSP4-6.0 (m)	Average (m)	Permafrost Thickness (m)	Average Permafrost Temperature (°C)
2030	2.29	2.43	2.4	> 20.3	-0.13
2040	3.16	3.31	3.3	20.3	-0.11
2050	4.05	4.16	4.1	17.5	-0.10
2070	5.56	5.64	5.6	15.0	-0.08
2100	8.48	8.49	8.5	11.6	-0.05

Continuous monitoring at BH22-40B will provide additional thermal data to track its thermal performance and the trend of climate change for the dry-stack tailings facility, in conjunction with climatic data for the region using available weather stations and thermistor readings throughout the site.

4.14.3 Phase II Thermal Analysis

4.14.3.1 General

Two thermistor cables were installed in February 2023 at BH22-08 and BH22-10 to monitor the ground temperatures at the two locations where the footprint of the dry-stack facility will be placed. Snapshot temperature readings with depth to date for BH22-08 are shown in Figures F-13 and F-14 (Appendix F), while temperature readings for BH22-10 are shown in Figures F-15 and F-16 (Appendix F, see also Section 4.14.3.5.1).

In the absence of a construction schedule and tailings placement, it was assumed that the tailings material is deposited at increments of 2 m per year until the design surface elevation is achieved. The total tailings placed in BH22-08 and BH22-10 are 13 m and 2.4 m, respectively. It was assumed that placement of tailings material will commence in May 2024.

The conceptual model for BH22-08 consists of 13 m of tailings, 0.5 m of drainage blanket, 0.9 m of sand and gravel fill, 0.25 m of peat layer overlying 7.95 m of silt, 0.6 m of sand and gravel, and 3.6 m of silt overlying 17.5 m of sand over bedrock. The conceptual model for BH22-10 consists of 2.4 m of tailings, 0.5 m of drainage blanket, 6.4 m of sand and gravel, 0.2 m of peat layer overlying 1.7 m of till, 0.9 m of massive ice, and 1.4 m of peat overlying 13.5 m of till over bedrock. It should be noted that this conceptual stratigraphy was assumed for modelling purposes only. Massive ice was not encountered during the geotechnical investigation in Phase II.

4.14.3.2 Material Properties

Material properties used in the thermal analyses for BH22-08 and BH22-10 are provided in Table 22 and Table 23, respectively using the most recent boreholes completed during the Phase II drilling program. The underlying stratigraphy was divided to several units to account for the change in water content with depth. These properties were determined indirectly from well-established correlations with soil index properties, gravimetric water content, grain size distribution, and bulk density (Farouki 1986, Johnston 1981). Uncertainties related to material properties and interpreted stratigraphy were reduced by comparing model results with measured temperature data from the ground temperature cables (see Section 4.14.3.5).

Table 22: Material Properties at BH22-08

Material	Water Content (%)	Bulk Density (Mg/m ³)	Thermal Conductivity (W/m-°C)		Specific Heat (kJ/kg-°C)		Latent Heat (MJ/m ³)
			Frozen	Unfrozen	Frozen	Unfrozen	
Dry-stack Tailings	17	1.98	3.2	1.9	0.93	1.23	96
Sand and Gravel (Fill)	5	2.1	1.33	1.5	0.8	0.9	33
Bedrock	1	2.63	4	4	0.75	0.77	9
Silt No. 1	21.6	1.86	1.69	1.31	1.08	1.35	79
Silt No. 2	10.9	1.70	0.96	0.94	0.99	1.07	24
Silt No. 3	6.7	1.63	0.68	0.68	0.94	0.95	3
Sand and Gravel	10	1.90	1.44	1.34	0.86	1.05	58
Sand No. 1	22.2	1.99	2.18	1.51	1.04	1.36	102
Sand No. 2	8.3	1.77	0.97	1.12	0.91	1.00	27

Table 23: Material Properties at BH22-10

Material	Water Content (%)	Bulk Density (Mg/m ³)	Thermal Conductivity (W/m-°C)		Specific Heat (kJ/kg-°C)		Latent Heat (MJ/m ³)
			Frozen	Unfrozen	Frozen	Unfrozen	
Dry-stack Tailings	17	1.98	3.2	1.9	0.93	1.23	96
Sand and Gravel (Fill)	5	2.1	1.33	1.5	0.8	0.9	33
Bedrock	1	2.63	4	4	0.75	0.77	9
Till No. 1	19.8	2.56	2.39	1.87	1.02	1.30	106
Till No. 2	12.2	2.18	2.07	1.76	0.95	1.11	57
Till No. 3	26.1	2.45	2.39	1.87	1.07	1.45	147
Till No. 4	12.5	2.18	2.11	1.77	0.95	1.12	59
Sand and Gravel	5.5	2.21	1.57	1.75	0.84	0.91	25

4.14.3.3 Boundary Conditions

The boundary conditions described in Section 4.14.2.3 (i.e., climate data, geothermal heat flux) from Phase I are applied in the same manner for the calibration of BH22-08 and BH22-10 between January 2022 and April 2023. The tailings material was assumed to have a placement temperature of 10°C (i.e., activation temperature) at each year of placement.

4.14.3.4 Climate Change Projection

The climate scenarios SSP3-7.0 and SSP4-6.0 described in Section 4.14.2.4 are applied in the same manner for the climate change assessment of BH22-08 and BH22-10.

4.14.3.5 Results and Discussion

4.14.3.5.1 Calibration

The results of model calibration for BH22-08 are shown in Figures F-13 and F-14 (Appendix F) for the months of March and April 2023, respectively. The modelled temperatures for the two months shown generally follow the trend of observed temperatures in the field. The depth of active layer is approximately 4.2 m, with top of permafrost layer at El. 922.3 m. The depth where temperatures are at or below 0°C extends to El. 907 m, with the permafrost having an approximate thickness of 15 m.

The results of model calibration for BH22-10 are shown in Figures F-15 and F-16 (Appendix F) for the months of March and April 2023, respectively. The modelled temperatures for the two months shown generally follow the trend of observed temperatures in the field but there were differences observed in the active layer, which is primarily attributed to the three-dimensional effect of the surrounding facilities influencing its thermal regime. The depth of active layer is approximately 6 m, with top of permafrost layer at El. 912.7 m. The depth where temperatures are at or below 0°C extends to El. 900.9 m, with the permafrost having an approximate thickness of 12 m.

For both boreholes, additional data throughout the year will support future calibration of the proposed dry stack facility at this location.

4.14.3.5.2 Climate Change Projected Temperatures

The results of the climate change analysis for BH22-08 using SSP3-7.0 and SSP4-6.0 are shown in Figures F-17 and F-18 (Appendix F), respectively. The depth of the 0°C isotherm between 2030 and 2100 for both climate scenarios below the original ground surface are summarized in Table 24. On average, the depth of the 0°C isotherm

and the thickness of the active layer with reference to the original ground surface between the two climate scenarios is generally the same. By 2040, the top of permafrost will be 5.5 m below original ground surface, which is equivalent to 1.3 m of degradation. Based on these climate scenarios, the permafrost will degrade by approximately 11.7 m by 2100 (i.e., 15.7 m from original ground surface), with the permafrost thickness reduced to 3.3 m. The average permafrost temperature in 2100 is -0.01°C.

Table 24: Depth of Permafrost Thaw at BH22-08 from Original Ground Surface Elevation

Timestep	SSP3-7.0 (m)	SSP4-6.0 (m)	Average (m)	Permafrost Thickness (m)	Average Permafrost Temperature (°C)
2030	4.72	1.34	3.1	> 14.0	-0.10
2040	6.13	4.78	5.5	14.0	-0.07
2050	7.38	6.33	6.9	12.6	-0.05
2070	13.29	11.28	12.3	6.7	-0.03
2100	15.89	15.45	15.7	3.3	-0.01

The results of the climate change analysis for BH22-08 using SSP3-7.0 and SSP4-6.0 are shown in Figures F-17 and F-18 (Appendix F), respectively. The depth of the 0°C isotherm between 2030 and 2070 for both climate scenarios below the original ground surface are summarized in Table 25. The permafrost is degrading beyond to 2070 until 2075 when the 0°C isotherm reaches the top of bedrock. Once the 0°C isotherm is in contact with the bedrock, significant thermal flow occurs owing to the high thermal conductivity of the bedrock layer. The model results indicate that there will be no permafrost in the vicinity of BH22-10 by 2076. Ground temperatures by 2100 at the top of bedrock are projected to be approximately 3°C. Similar to BH22-08, on average, the depth of the 0°C isotherm and the thickness of the active layer with reference to the original ground surface between the two climate scenarios is generally the same. By 2040, the top of permafrost will be 11.0 m below original ground surface, which is equivalent to 5.0 m of degradation. Based on these climate scenarios, the permafrost will degrade by approximately 9.4 m by 2075 (i.e., 15.4 m from original ground surface), with the permafrost thickness reduced to 2.6 m. The average permafrost temperature in 2075 is -0.02°C.

Table 25: Depth of Permafrost Thaw at BH22-10 from Original Ground Surface Elevation

Timestep	SSP3-7.0 (m)	SSP4-6.0 (m)	Average (m)	Permafrost Thickness (m)	Average Permafrost Temperature (°C)
2030	7.17	7.15	7.2	11.3	-0.06
2040	11.00	10.95	11.0	7.5	-0.05
2050	12.83	12.78	12.8	5.3	-0.03
2070	14.86	14.84	14.9	3.2	-0.02
2075	15.36	15.33	15.4	2.6	-0.02

It should be noted that a lower albedo (i.e., higher absorptivity) during the summer months, reduced snow cover during the winter months, and warmer air temperatures will accelerate the thawing of the permafrost. Continuous monitoring at BH22-08 and BH22-10 before, during, and after tailings placement will provide additional thermal data to track its thermal performance and the trend of climate change applicable to the new facility, in conjunction with climatic data using available weather stations for the region and thermistor readings throughout the site.

4.15 Surface Water Management

4.15.1 General

The general surface water management structures for the DSTF consist of runoff collection ditches leading to a collection sump. As necessary, water collected in the sump is conveyed to the water collection pond southeast of the mill. Tetra Tech understands that the Mill Pond has a capacity of approximately 3,500 m³, exceeding the volume expected to be generated by a 10-day freshet with a 1:200-year return period (Clearwater, 2009). However, due to excessive sediment accumulation in the Mill Pond, the Phase II sump will be initially sized to retain 100% of the runoff from the Phase II expansion. AKHM plans to evaluate options to increase the capacity of the Mill Pond in 2025. If the Mill Pond capacity is increased, AKHM will re-evaluate the required size of the Phase II sump.

Based on the EMR Guidelines, the 1:200-year event is considered appropriate for operations. For closure, design should account for a 1:500-year event. At the present time, we understand mine plans are being developed. A final review and design for closure will be completed to ensure this design criteria is met.

4.15.2 Uphill Runoff Diversion Berm

The uphill runoff diversion berm is to be constructed in accordance with Construction Specifications.

4.15.3 Toe Runoff Collection Ditch

Toe runoff collection ditches consist of conveyance channels lined with the seepage collections system materials, extending from under the footprint of the DSTF. Contact water from runoff and/or seepage is contained and directed to the collection sump, conveyance system, and eventually to the Mill Pond.

Toe runoff collection ditches are to be constructed in accordance with the Construction Specifications.

4.15.4 Collection Sump and Conveyance

A lined sump will be required at the southwest corner of the facility to collect surface water from the Phase II expansion. This water is to be conveyed to the existing surface water collection pond using an appropriate conveyance system.

5.0 FOUNDATION PREPARATION AND CONSTRUCTION

5.1 General

During foundation preparation, non-acid metal leaching (NAML) and potentially acid metal leaching (PAML) materials will be removed from the DSTF Phase II footprint, including material within the former waste rock storage area, existing site access roads, etc., to ensure these materials are not buried during construction. If areas exist within the footprint where NAML material cannot be removed (i.e., under or within the Phase I buttress), appropriate drainage infrastructure will direct subsurface water to collection points for treatment as necessary.

5.2 DSTF Foundation

It is anticipated that construction of Phase II will take place over two years. Tetra Tech recommends the entire foundation footprint be prepared prior to tailings placement, or at a minimum, all vegetation larger than 50 mm in diameter be removed. If a staged approach to foundation preparation is adopted, AKHM must ensure adequate drainage for control of surface runoff. This may necessitate temporary lined ditches and/or collection sumps.

Foundation preparation and construction shall consist of:

- Removal of imported material within the footprint such as waste rock, access road fill, or other deleterious materials, to ensure these materials are not present within the foundation;
- Removal of organics and ice-rich permafrost within the footprint of the toe buttress and interior shear berms;
- Removal of all trees and vegetation larger than 50 mm in diameter with minimal disturbance to the organic surface;
- An as-built survey of the existing ground surface;
- Construction and placement of the foundation components comprising a 0.6 m thick granular drainage blanket, GCL, geocomposite drain, and ballast material. The installation details are discussed in Section 4.7 and described in the Construction Specifications;
- The liner materials should be installed on drainage blanket material at grades no steeper than 4H:1V, unless otherwise approved by the engineer; and
- An as-built survey of the surface of the foundation components.

5.3 Buttress Construction

Buttress construction is to take place prior to the placement of tailings. The upstream toe of the buttress may be required for runoff collection purposes prior to the final configuration of tailings placement. It is anticipated some field adjustments will be required at the north and south ends of the buttress.

The buttress should be constructed as follows:

- Height as shown in the construction drawings;
- Minimum crest width of 5 m;
- Upstream slope of 2H:1V; and
- Downstream slope of 2.5H:1V.

Waste rock and access road materials will be removed from the buttress footprint and will not be reused during construction. Surficial organic layer and underlying ice-rich materials will be removed within the buttress footprint. A subgrade inspection should be completed by Tetra Tech to confirm suitable conditions, or provide additional recommendations prior to placement of material. Tetra Tech understands that AKHM plans to use the Lightning Creek Placer tailings (i.e., alluvial granular source) for the buttress construction and has confirmed this material meets the applicable geochemical criteria. Waste rock is not being considered for DSTF Phase II construction.

The buttress materials should be placed in maximum 500 mm lifts and compacted using a vibratory soil compactor (Caterpillar CS563E, or similar), completing at least eight full passes. The as-built survey shall be completed after buttress construction.

5.4 Interior Shear Berm Construction

The interior shear berm structures should be constructed following the geometries shown in the construction drawings. Berm structures are to be built prior to liner deployment.

Surficial organic layer and underlying ice-rich materials will be removed within the interior shear berm footprint. The berm will be constructed of Lightning Creek placer tailings placed in maximum 500 mm lifts and compacted using a vibratory soil compactor (Caterpillar CS563E, or similar), completing at least eight full passes. The as-built survey shall be completed after berm construction.

6.0 OPERATION, MAINTENANCE, AND SURVEILLANCE

6.1 OMS Manual

Operations, Maintenance, and Surveillance (OMS) are to be completed in accordance with the active and most recent OMS manual.

At the time of this submission, Tetra Tech and AKHM are updating the OMS under a separate cover.

It is expected that the OMS manual will be updated as required and reviewed for necessary updates at least annually.

6.2 Tailings Placement and Operation

Tailings placement can proceed once the foundation has been prepared, surveyed, and approved as discussed in the previous sections.

Tailings should be loaded from the stockpile location and placed and compacted within the DSTF as soon as possible. Placement should promote positive drainage away from the working face and tailings slopes.

Tailings shall be placed and compacted within the DSTF as per the requirements developed and summarized in the technical memorandum “DSTF Tailings Placement and Compaction Field Trial Summary” dated August 17, 2024.

This includes placement in maximum 500 mm lifts, and compaction by a minimum of six passes completed by a D6 dozer (or similar), and two passes using a vibratory roller having a weight of 12,000 kg, which is cumulatively expected to achieve at least 95% Standard Proctor Maximum Dry Density (SPMDD). Tailings may require moisture conditioning prior to compaction. Snow, ice, or other deleterious materials should be removed prior to placement. Tailings must be placed and compacted prior to freezing. Additional requirements related to monitoring and QAQC are also included in the OMS.

AKHM estimates that approximately 11,160 tonnes of tailings will be generated per month and disposed of in the DSTF. Based on discussions with AKHM, we understand that tentatively, beginning in 2025, a portion of generated

tailings will be used as paste backfill for underground workings. Specifics on scheduling, volumes of paste backfill, etc., have not been provided, therefore the projected timeline to fill Phase II to capacity has not been estimated.

6.3 Instrumentation and Monitoring

Instrumentation and monitoring shall be completed as outlined in the Instrumentation and Monitoring Plan and OMS manual.

Visual inspections are expected to be completed weekly by AKHM / site staff. Inspections by the Engineer of Record will be completed at frequencies described in the OMS manual.

Readings should be collected from existing ground temperature cables on at least a monthly basis, or as directed by Tetra Tech.

Additional instrumentation is recommended for DSTF Phase II, including survey monuments, vibrating wire piezometers, and slope indicators as described in the Instrumentation and Monitoring Plan.

AKHM is responsible for implementing the Instrumentation and Monitoring Plan, as well as completing any necessary maintenance or adjustments to instruments as required. Instrumentation data is to be collected by AKHM and quality assurance measurements will be completed by Tetra Tech at the frequencies noted in the plan. Tetra Tech has provided tailings placement monitoring recommendations, as noted in Section 6.2. Tailings placement record surveys shall be completed monthly during tailings placement operations.

7.0 DSTF CLOSURE PLAN

Closure planning for the Phase II expansion is consistent with that for Phase I. Once tailings placement for a portion of the DSTF is complete, a soil evapo-transpirative cover of 0.5 m of loosely placed mixture of granular and organic materials will be placed over the surface of the compacted tailings to temporarily store runoff and allow it to evaporate or to be used by vegetation. Once the final tailings geometry is established, the evapo-transpirative cover material should be placed as soon as practicable to minimize erosion within the stacked tailings.

At this time, it is assumed that the water collection pond and diversion berms and ditches will be left in place, and the berms will continue to divert runoff water away from the DSTF area. Tetra Tech understands that the entire footprint will be re-vegetated with plants to promote soil evapotranspiration.

The DSTF will require an annual geotechnical inspection for at least five years after closure. This requirement should be reviewed after five years.

8.0 CLOSURE

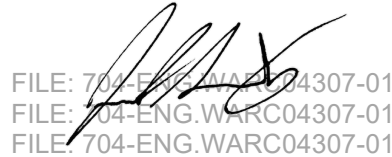
We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.



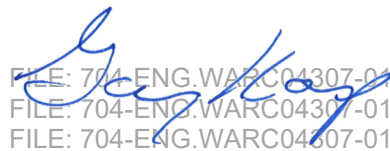
FILE: 704-ENG.WARC04307-01
FILE: 704-ENG.WARC04307-01
FILE: 704-ENG.WARC04307-01

Prepared by:
Ian MacIntyre, P.Eng.
Geotechnical Engineer, Arctic Group
Engineering Practice
Direct Line: 867.668.9240
Ian.MacIntyre@tetrattech.com



FILE: 704-ENG.WARC04307-01
FILE: 704-ENG.WARC04307-01
FILE: 704-ENG.WARC04307-01

Prepared by:
Jacob Swartz
Geotechnical Engineer-In-Training, Arctic Group
Engineering Practice
Direct Line: 867.668.9241
Jacob.Swartz@tetrattech.com



FILE: 704-ENG.WARC04307-01
FILE: 704-ENG.WARC04307-01
FILE: 704-ENG.WARC04307-01

Reviewed by
Gary Koop, M.Eng., P.Eng.
Principal Consultant – Arctic Group
Engineering Practice
Direct Line: 780.777.5467
Gary.Koop@tetrattech.com

FILE: 704-ENG.WARC04307-01
FILE: 704-ENG.WARC04307-01
FILE: 704-ENG.WARC04307-01

Reviewed by
Richard Trimble, M.Sc. (Eng.), P.Eng., FEC
Principal Consultant, Arctic Region
Engineering Practice
Direct Line: 867.668.9216
Richard.Trimble@tetrattech.com

/et

REFERENCES

- ASTM C136–06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates, ASTM International, West Conshohocken, PA, 2006, www.astm.org
- ASTM D698-12 (Reapproved 2021), Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³))
- ASTM D4491–99a, Standard Test Methods for Water Permeability of Geotextiles by Permittivity, ASTM International, West Conshohocken, PA, 1999, www.astm.org
- ASTM D4533/D4533M-15, Standard Test Method for Trapezoid Tearing Strength of Geotextiles, ASTM International, West Conshohocken, PA, 2015, www.astm.org
- ASTM D4632–91 (Reapproved 1996), Standard Test Method for Grab Breaking Load and Elongation of Geotextiles, ASTM International, West Conshohocken, PA, 1991, www.astm.org
- ASTM D4751–99a, Standard Test Method for Determining Apparent Opening Size of a Geotextile, ASTM International, West Conshohocken, PA, 1999, www.astm.org
- ASTM D 5261–92 (Reapproved 1996), Standard Test Method for Measuring Mass per Unit Area of Geotextiles, ASTM International, West Conshohocken, PA, 1992, www.astm.org
- ASTM D5321–92 (Reapproved 1997), Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method, ASTM International, West Conshohocken, PA, 1992, www.astm.org
- ASTM D5887–99, Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter, ASTM International, West Conshohocken, PA, 1999, www.astm.org
- ASTM D5890–95, Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, 1995, www.astm.org
- ASTM D5891–95, Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, 1995, www.astm.org
- ASTM D5993–14, Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, 2014, www.astm.org
- ASTM D6241–99, Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile Related Products Using a 50-mm Probe, ASTM International, West Conshohocken, PA, 1999, www.astm.org
- ASTM D6243–98, Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method, ASTM International, West Conshohocken, PA, 1998, www.astm.org
- ASTM D6496–99, Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, 1999, www.astm.org
- ASTM D6768–04 (Reapproved 2009), Standard Test Method for Tensile Strength of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, 2004, www.astm.org

- ASTM D7928-21, Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis, ASTM International, West Conshohocken, PA, 2021, www.astm.org
- Clearwater, 2009. “Bellekeno Mine Project – Freshet Runoff Assessment.” Clearwater Consultants Ltd., August 20, 2009.
- CSA, 2010. Technical Guide Infrastructure in Permafrost: A Guideline for Climate Change Adaptation. Canadian Standard Association, 97p.
- EBA, 2010a. Preliminary Engineering Design and Management Plan Dry Stacked Tailings Facility. Bellekeno Mine Mill Site, Yukon. EBA File No. W14101178-003
- EBA, 2010b. Runoff Diversion Structure Specs Dry Stack Tailings Facility, Keno Hill District Mill, YT. EBA File No. W14101178.011
- EBA, A Tetra Tech Company, 2011. Phase I Design. Detailed Design Dry Stack Tailings Facility, Keno Hill District Mill Site, YT. Report Prepared for Alexco Resources Group, May 2011. EBA File No. W14101178
- EMR, 2023. Guidelines for Mine Waste Facilities, issued in February 2023.
- Environment and Climate Change Canada (ECCC), n.d. Multi-model ensemble scenarios. CMIP6 climate scenarios. Retrieved April 24, 2023, from <https://climate-scenarios.canada.ca/?page=multimodel-ensembles>
- Farouki, O.T., 1986. Thermal Properties of Soils. TransTech Publications, Germany, 136 p.
- Hausfather, Z. and Peters, G. P., 2020. Emissions – the ‘business as usual’ story is misleading. Nature, 577, pp. 618-620.
- Hawley and Cunning, 2017. Guidelines for Mine Waste Dump and Stockpile Design, Mark Hawley and Josh Cunning, 2017.
- Hynes-Griffin and Franklin, 1984. Rationalizing the Seismic Coefficient Method. Department of the Army Waterways Experiment Station, Vicksburg, Mississippi.
- Intergovernmental Panel on Climate Change (IPCC), 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp.
- Johnston G.H., 1981. Permafrost Engineering Design and Construction. Hunter Rose Company Ltd., Toronto, Ontario, Canada. McCreath P.S., 2009.
- Koerner, Robert M. 2005. Designing with Geosynthetics. Pearson Prentice Hall.
- Lydick, Larry D. and Zagorski, George 1991. Interface Friction of Geonets: A Literature Survey. Geotextiles and Geomembranes 10 (1991) 549-558.
- Lyon, C. et al., 2021. Climate change research and action must look beyond 2100. Global Change Biology, 28, pp. 349–361.
- Piteau Associates Engineering Ltd. 1991. “Investigation and Design of Mine Dumps – Interim Guidelines.” Prepared for British Columbia Mine Waste Rock Pile Research Committee, May 1991.

- Riahi, K. et al., 2017. The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change* 42, pp. 153-168.
- Seequent, 2022. TEMP/W Manual: Heat and Mass Transfer Modelling with Geostudio.
- State of California, Department of Water Resources, Division of Engineering. 2006. Basic Tools for Review of Slope Stability Reports for Waste Containment Facilities.
- Tetra Tech EBA. 2011. Thermal Analysis of Dry Stacked Tailings Facility Area, Keno Hill Silver District YT. EBA File No. W14101178.011 dated March 28, 2011.
- Tetra Tech EBA 2015. Dry Stacked Tailings Facility Phase II Expansion Preliminary Design, Keno Hill Silver District, YT. EBA File No. W14103548-01 dated June 2, 2015

FIGURES

Figure 1	Overall DSTF Final Construction Plan
Figure 2	Phase II Final Construction Plan
Figure 3	Cross-sections 1 of 3
Figure 4	Cross-sections 2 of 3
Figure 5	Cross-sections 3 of 3
Figure 6	Typical Details
Figure 7	Instrumentation Plan
Figure 8	Phase I Instrumentation Plan

\\t:\local\ball\Legacy\Whitehorse\Data\2021\Drawings\Keno Hill\ENG.WARC04307-02 DSTF Phase II Interface Direct Shear Testing & Stability Model Updates\ENG.WARC04307-02 Fig.1.R2.dwg [FIGURE 1] September 17, 2024 - 4:36:52 pm (BY: JUI, YVONNE)



	VOLUME	TONNAGE *
PHASE 1 (ORIGINAL DESIGN) **	125,000 m ³	286,000
PHASE 1 (AS-BUILT)	100,000 m ³	229,090
PHASE 2 (DESIGN)	237,000 m ³	542,730
TOE BUTTRESS (DESIGN)	6,700 m ³	N / A

* TONNAGE BASED ON 2.29 T / m³ PER HECLA

** FULL FOOTPRINT OF ORIGINAL DESIGN NOT CONSTRUCTED



Scale: 1:2,000 @ 11"x17"

LEGEND

- DSTF TAILINGS FOOTPRINT
- PHASE I AS-BUILT FOOTPRINT
- PHASE II TAILINGS FOOTPRINT
- EXISTING SURFACE RUNOFF DITCH
- PROPOSED SURFACE RUNOFF DITCH (SHOWN WHITE)
- PHASE I ORIGINAL DESIGN FOOTPRINT

NOTE

- DRONE IMAGERY COLLECTED BY HECLA IN OCTOBER 2023

CLIENT



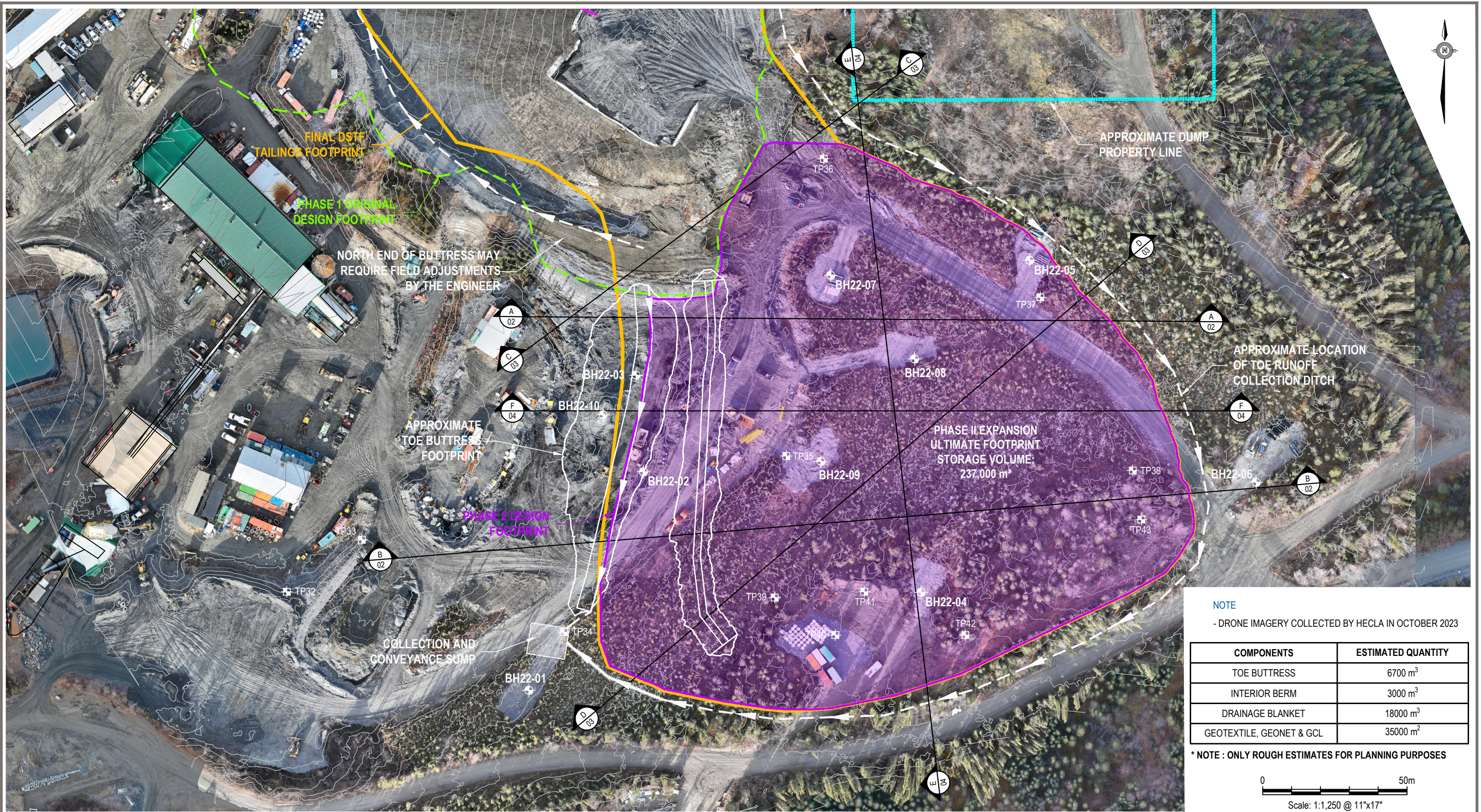
**DRY-STACKED TAILINGS FACILITY PHASE 2 DESIGN
KENO HILL DISTRICT MILL SITE, YUKON**

OVERALL DSTF FINAL CONSTRUCTION PLAN

PROJECT NO. ENG.WARC04307-02	DWN CB	CKD IM	REV 0
OFFICE EBA-WHSE	DATE March 29, 2024		

Figure 1

\\localheal\Legacy\Whitehorse\Data\0201\Drawings\Keno Hill\Phase II\Interface Direct Shear Testing & Stability Model Updates\ENG.WARC04307-02.DSTF Phase II\Interface Direct Shear Testing & Stability Model Updates\ENG.WARC04307-02.Fig.2-5-F2.dwg [FIGURE 2] September 17, 2024 - 5:00:15 pm (BY: OUI, YVONNE)



NOTE
- DRONE IMAGERY COLLECTED BY HECLA IN OCTOBER 2023

COMPONENTS	ESTIMATED QUANTITY
TOE BUTTRESS	6700 m ³
INTERIOR BERM	3000 m ³
DRAINAGE BLANKET	18000 m ³
GEOTEXTILE, GEONET & GCL	35000 m ²

* NOTE : ONLY ROUGH ESTIMATES FOR PLANNING PURPOSES

0 50m
Scale: 1:1,250 @ 11"x17"

LEGEND

- DSTF TAILINGS FOOTPRINT
- PHASE I ORIGINAL DESIGN FOOTPRINT
- PHASE I AS-BUILT FOOTPRINT
- PHASE II TAILINGS FOOTPRINT
- EXISTING SURFACE RUNOFF DITCH
- PROPOSED SURFACE RUNOFF DITCH (SHOWN WHITE)
- + - BOREHOLE LOCATION
- + - TESTPIT LOCATION

CLIENT

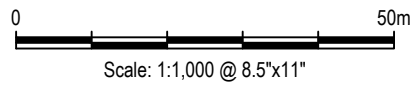
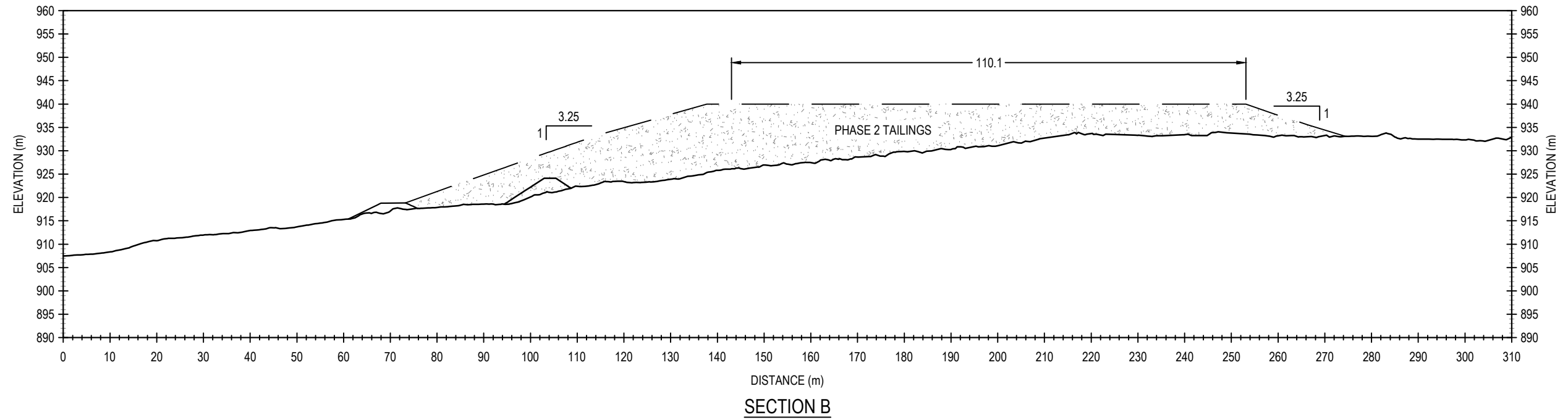
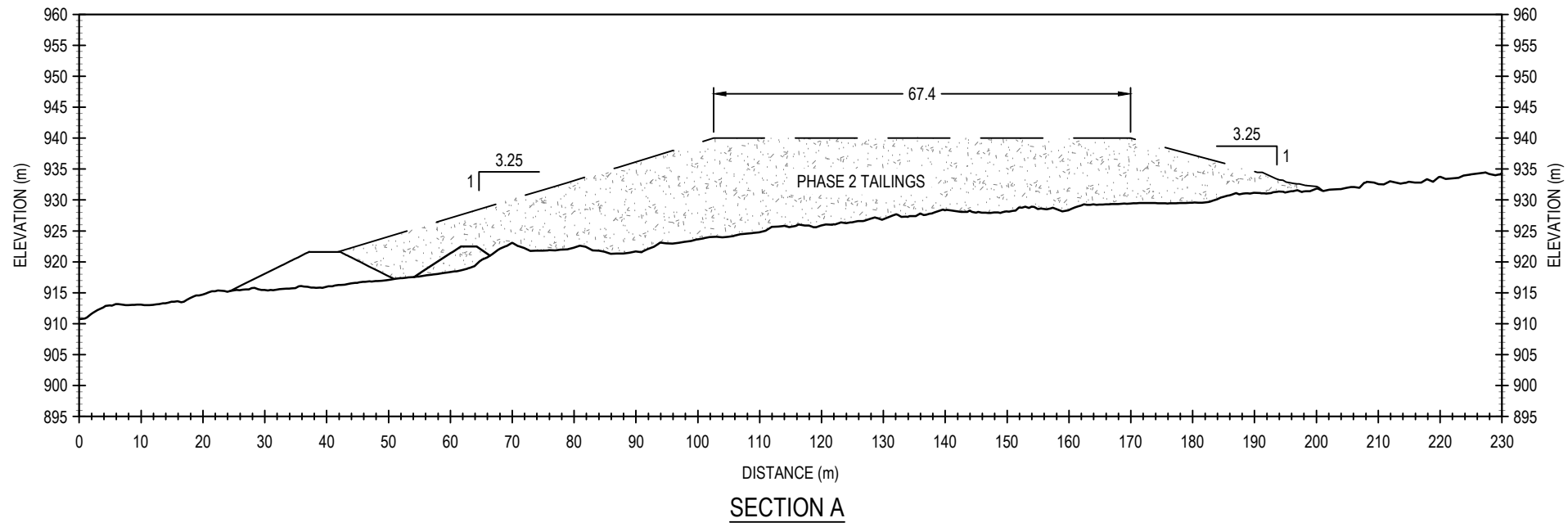
Hecla
MINING COMPANY

TETRA TECH

DRY-STACKED TAILINGS FACILITY PHASE 2 DESIGN
KENO HILL DISTRICT MILL SITE, YUKON

PHASE 2 FINAL CONSTRUCTION PLAN

PROJECT NO. ENG.WARC04307-01	DWN CB	CKD IM	REV 0	Figure 2
OFFICE EBA-WHSE	DATE March 26, 2024			



\\f:\local\ba\Legacy\Whitehorse\Data\0201\drawings\Kenp\ENG.WARC04307-02.DSTF Phase II Interfac Direct Shear Testing & Stability Model Updates\ENG.WARC04307-02 Fig.2-5-R2.dwg [FIGURE 3] September 17, 2024 - 4:57:14 pm (BY: OIU, YVONNE)



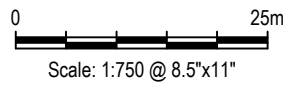
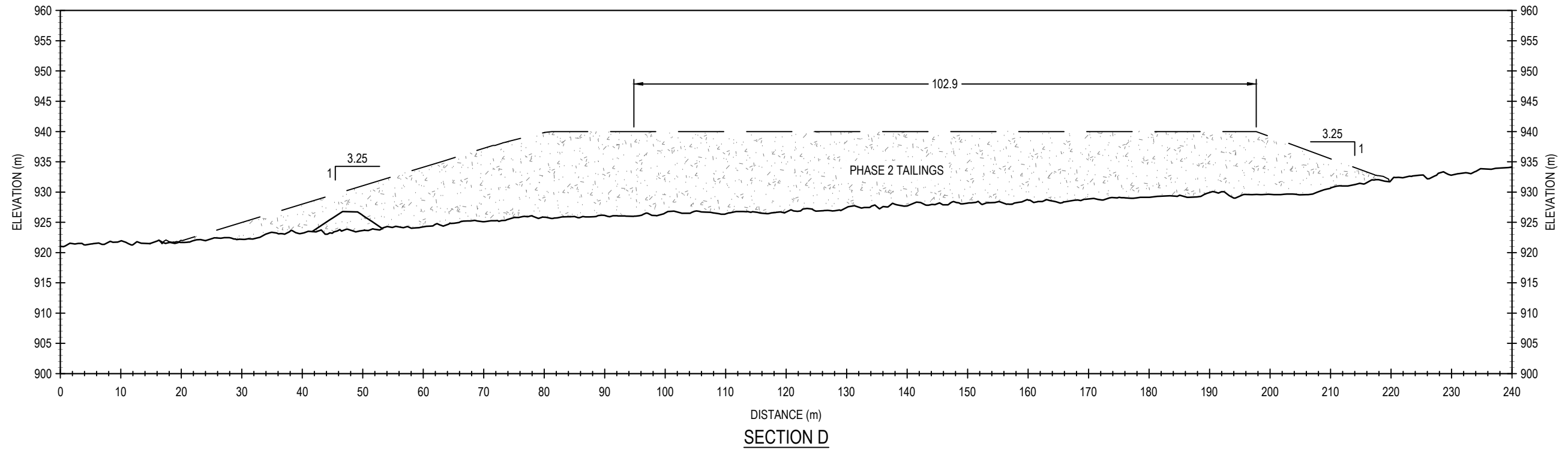
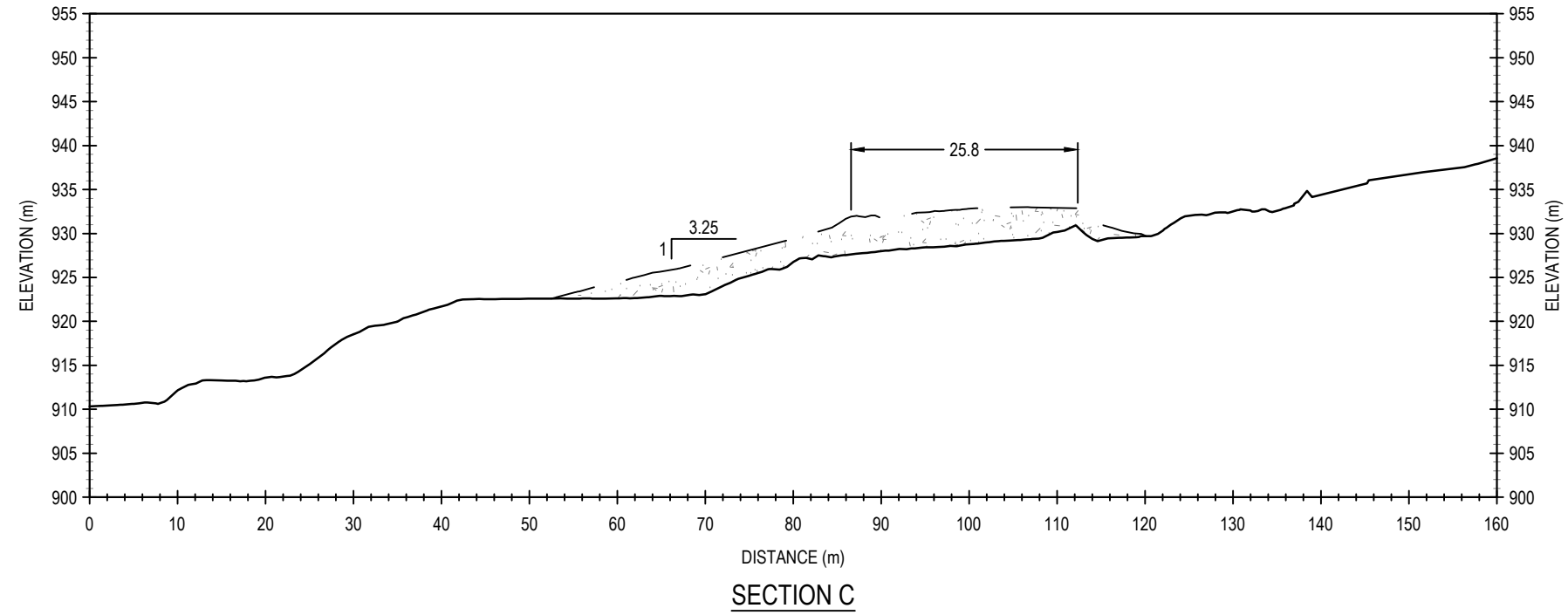
**DRY-STACKED TAILINGS FACILITY PHASE 2 DESIGN
KENO HILL DISTRICT MILL SITE, YUKON**

**CROSS-SECTIONS
(1 OF 3)**

PROJECT NO. ENG.WARC04307-01	DWN CB	CKD IM	REV 0
OFFICE EBA-WHSE	DATE March 26, 2024		

Figure 3

\\fs01\local\hba\Legacy\Whitehorse\Data\0201\Drawings\Kenb\ENG.WARC04307-02\DISTF Phase II\Interfaces\Direct Shear\Testing & Stability Model Updates\ENG.WARC04307-02_Fig.2-5-R2.dwg [FIGURE 4] September 17, 2024 - 4:56:22 pm (BY: OIU, YVONNE)



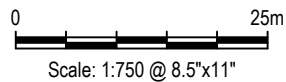
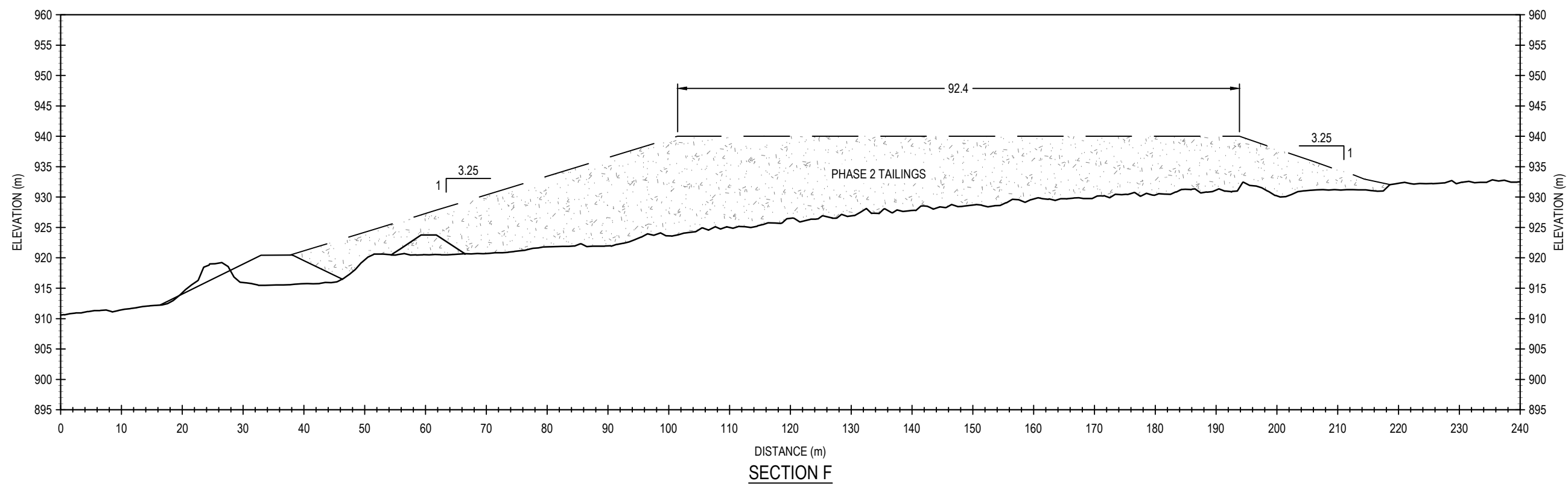
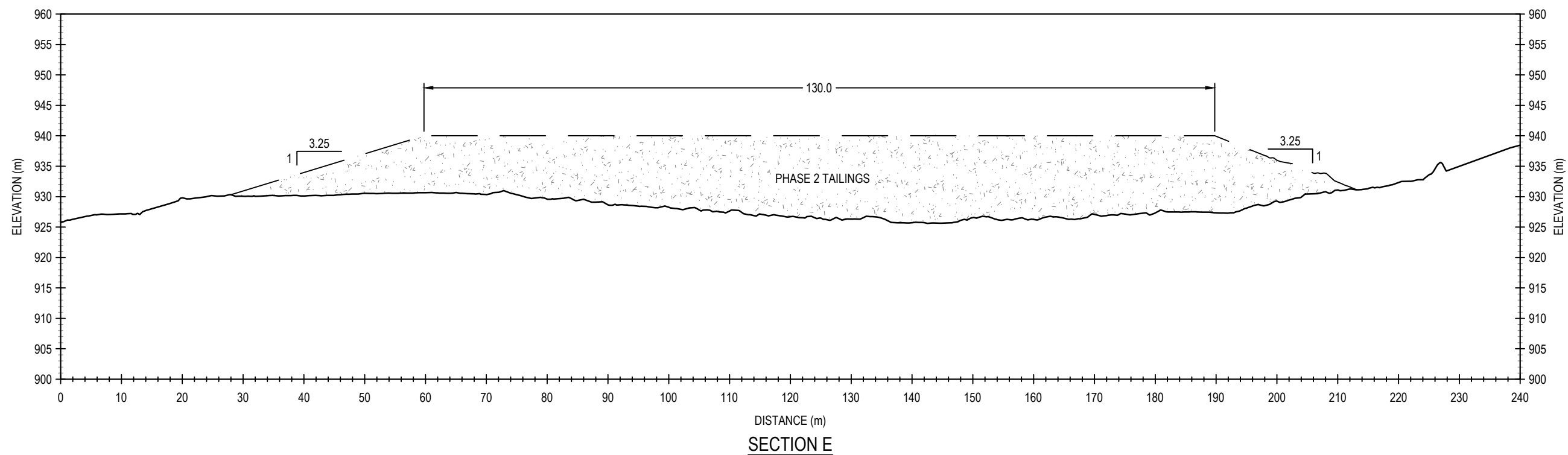
**DRY-STACKED TAILINGS FACILITY PHASE 2 DESIGN
KENO HILL DISTRICT MILL SITE, YUKON**

**CROSS-SECTIONS
(2 OF 3)**

PROJECT NO. ENG.WARC04307-01	DWN CB	CKD IM	REV 0
OFFICE EBA-WHSE	DATE March 26, 2024		

Figure 4

\\fs01\local\hba\Legacy\Whitehorse\Data\0201\Drawings\Kenb\ENG.WARC04307-02.DSTF Phase II Interfaco Direct Shear Testing & Stability Model Updates\ENG.WARC04307-02 Fig.2-5-R2.dwg [FIGURE 5] September 17, 2024 - 4:56:51 pm (BY: OIU, YVONNE)

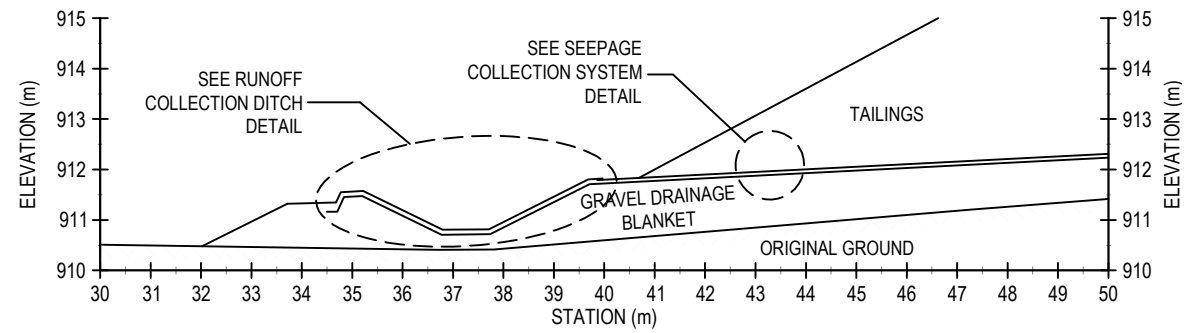


**DRY-STACKED TAILINGS FACILITY PHASE 2 DESIGN
KENO HILL DISTRICT MILL SITE, YUKON**

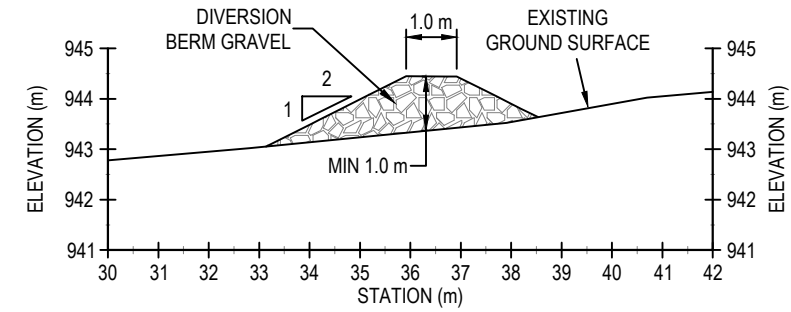
**CROSS-SECTIONS
(3 OF 3)**

PROJECT NO. ENG.WARC04307-01	DWN CB	CKD IM	REV 0	Figure 5
OFFICE EBA-WHSE	DATE March 26, 2024			

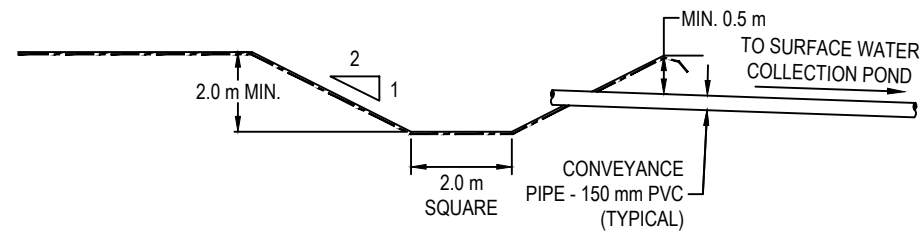
I:\local\ball\Legacy\Whitehorse\Data\201\Drawings\Keno\ENG.WARC04307-02.DSTF Phase II Interface Direct Shear Testing & Stability Model Updates\ENG.WARC04307-02.Fig.6-7.R2.dwg [FIGURE 6] September 17, 2024 - 4:49:27 pm (BY: OIU, YVONNE)



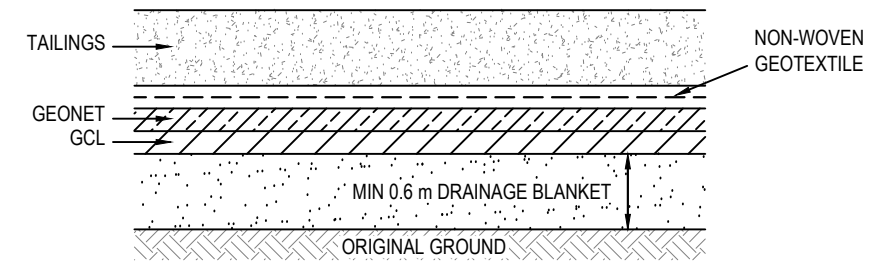
RUNOFF COLLECTION DITCH - TYPICAL SECTION



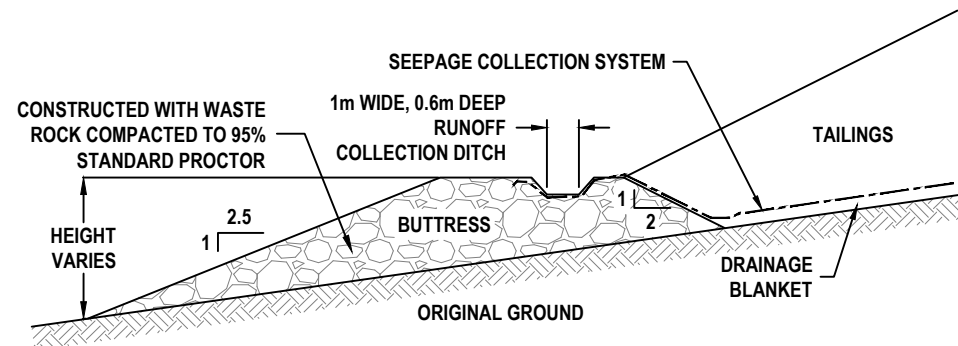
UPHILL DIVERSION BERM DETAIL



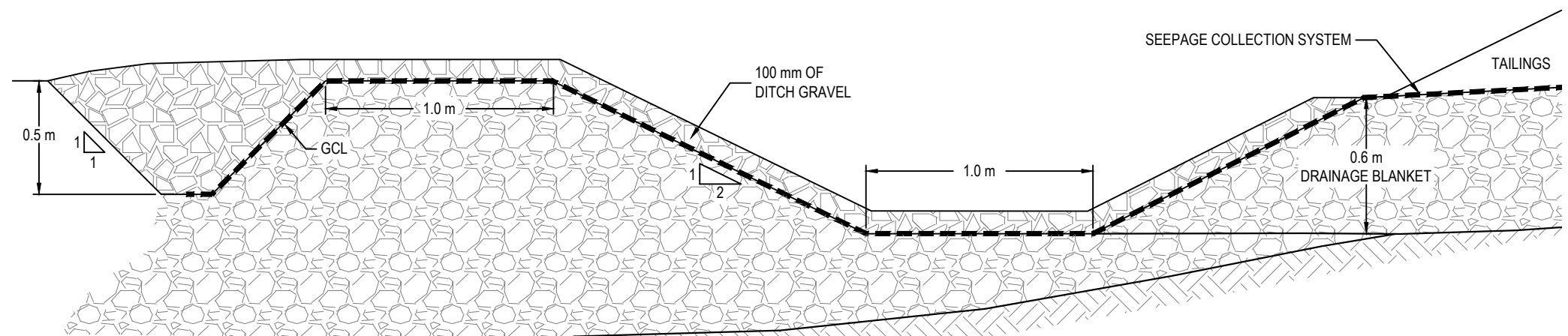
COLLECTION SUMP & CONVEYANCE PIPE



SEEPAGE COLLECTION SYSTEM DETAIL



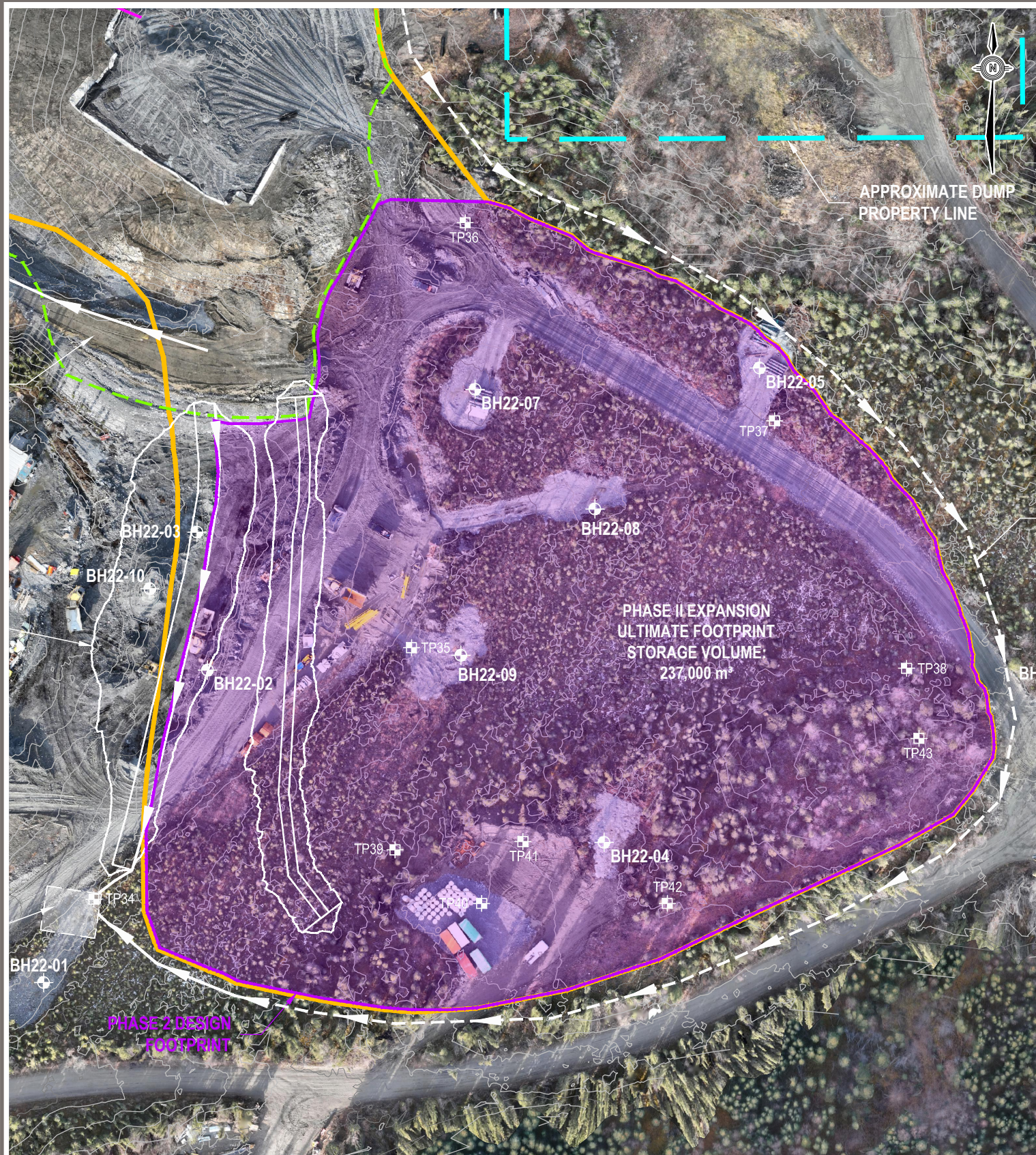
TYPICAL TOE BUTTRESS AND RUNOFF COLLECTION DITCH DETAIL



TOE RUNOFF COLLECTION DITCH DETAIL

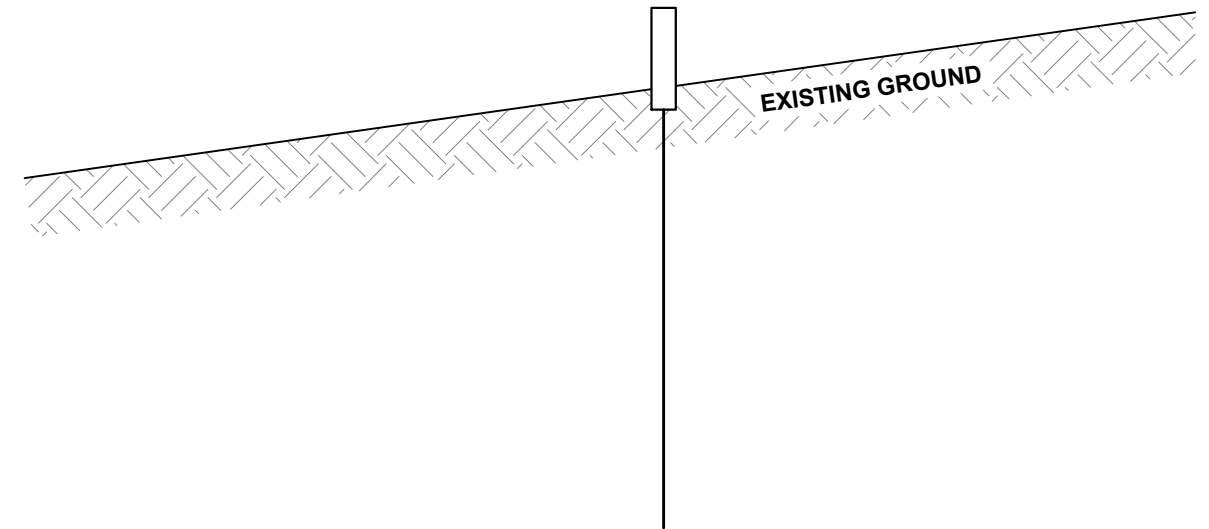
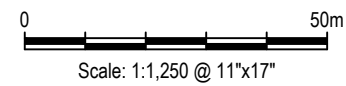
CLIENT 	DRY-STACKED TAILINGS FACILITY PHASE 2 DESIGN KENO HILL DISTRICT MILL SITE, YUKON			
	TYPICAL DETAILS			
PROJECT NO. ENG.WARC04307-02	DWN CB	CKD IM	REV 0	Figure 6
OFFICE EBA-WHSE	DATE March 29, 2024			

\\local\h\Legacy\Whitehorse\Drawings\Keno Hill\ENG.WARC04307-02.DSTF Phase II Interface Direct Shear Testing & Stability Model Updates\ENG.WARC04307-02 Fig.6-7.R2.dwg [FIGURE 7] September 17, 2024 - 4:50:30 pm (BY: OUI, YVONNE)



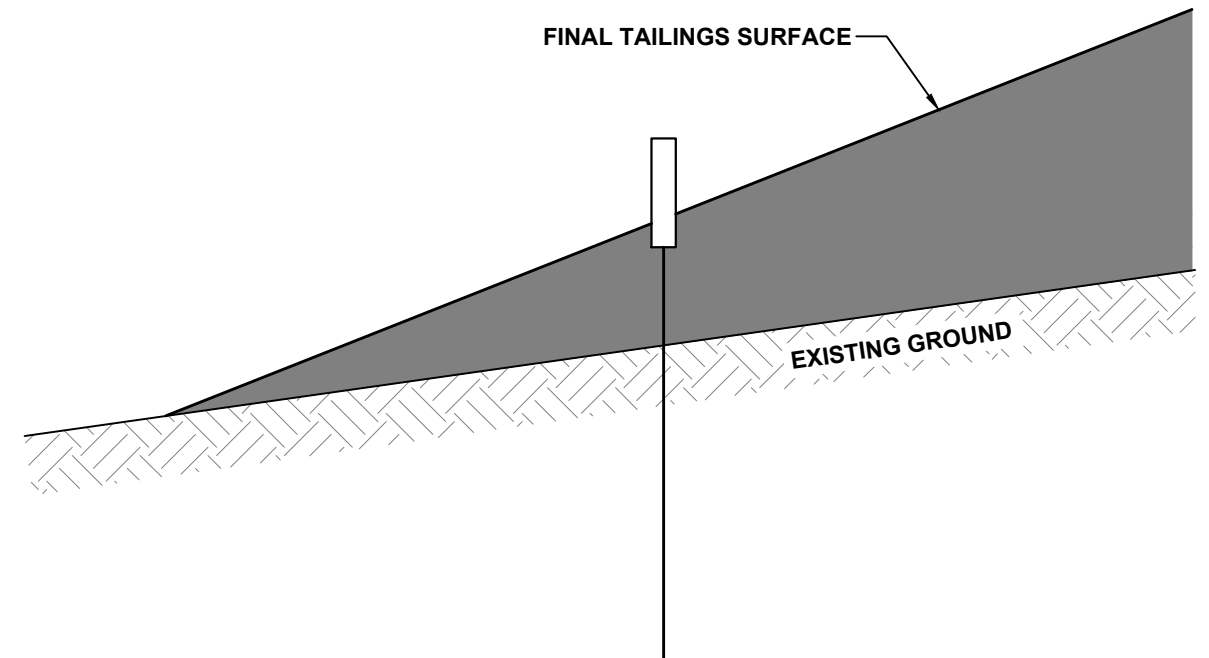
LEGEND

- ⊕ - TETRATECH THERMISTOR CABLE LOCATION
- ⬮ - BEADED STREAM CABLE AND LOGGER LOCATION



* CABLES AND PROTECTIVE CASINGS TO BE PROTECTED AND RAISED AS NECESSARY DURING DSTF CONSTRUCTION

PRIOR TO TAILINGS PLACEMENT (TYP.)



AFTER TAILINGS PLACEMENT (TYP.)

CLIENT



**DRY-STACKED TAILINGS FACILITY PHASE 2 DESIGN
KENO HILL DISTRICT MILL SITE, YUKON**

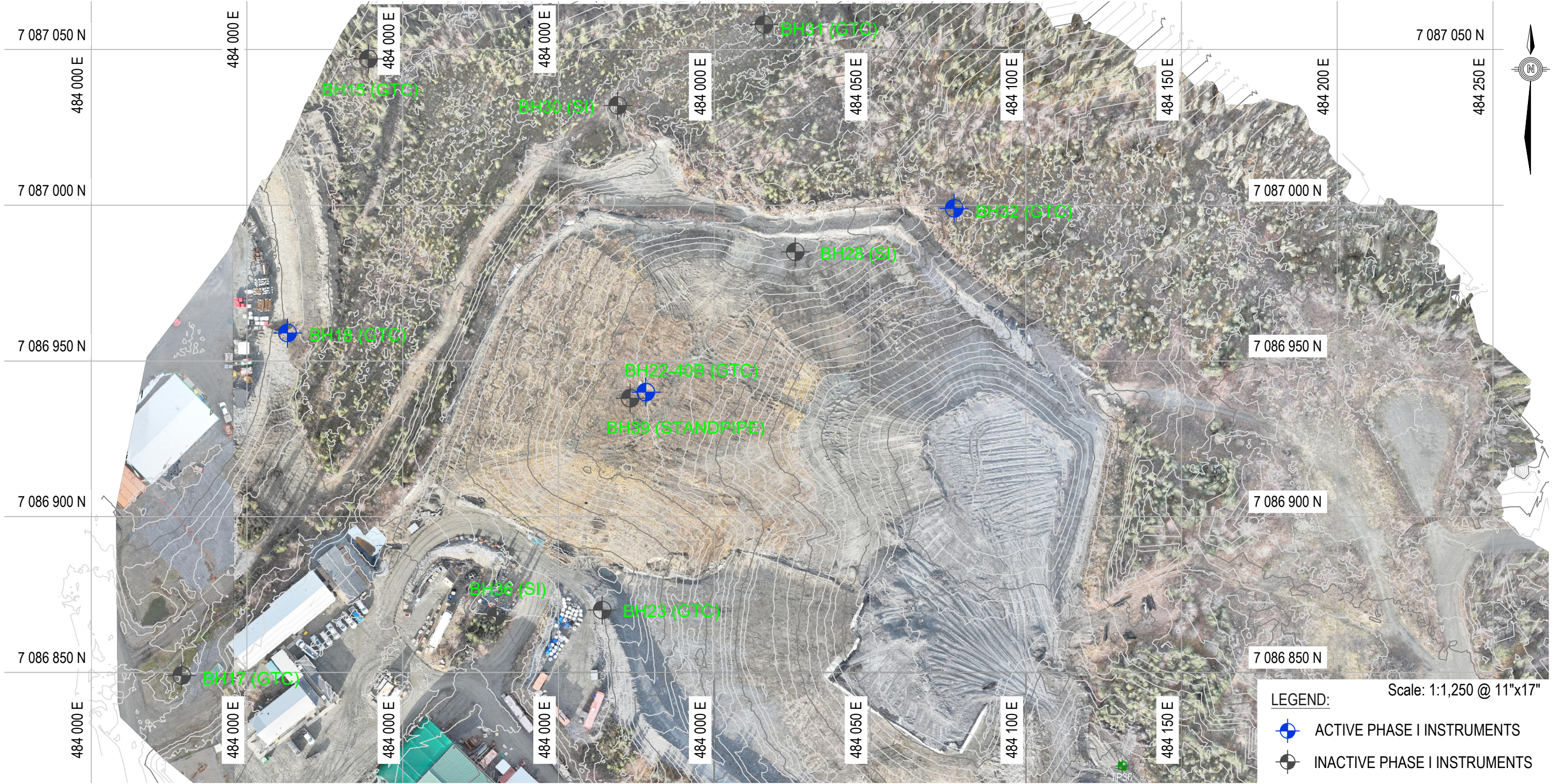
INSTRUMENTATION PLAN



PROJECT NO. ENG.WARC04307-02	DWN CB	CKD IM	REV 0
OFFICE EBA-WHSE	DATE March 29, 2024		



Figure 7

C:\Users\YVONNE.QIU\OneDrive - Tetra Tech, Inc\Desktop\Phase 1 Instruments.dwg [FIGURE 1] September 13, 2024 - 2:05:09 pm (BY: QIU, YVONNE)



Scale: 1:1,250 @ 11"x17"

LEGEND:

-  ACTIVE PHASE I INSTRUMENTS
-  INACTIVE PHASE I INSTRUMENTS

CLIENT




**DRY STACKED TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

**PLAN VIEW SHOWING
PHASE 1 INSTRUMENTS**

PROJECT No. ENG.WARC04415-10	OFFICE EDMONTON	DES YQ	CKD -	REV A	DRAWING
DATE: SEPTEMBER 13, 2024	SHEET No. 01 of 01	DWN YQ	APP -	STATUS A	FIGURE 8

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE 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, 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 third parties 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 document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, 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 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. 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 historical 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 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

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. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

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

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.

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. TETRA TECH 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 B

BOREHOLE LOGS AND LABORATORY TESTING RESULTS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 TO 20%	0 to 4
Loose	20 TO 40%	4 to 10
Compact	40 TO 75%	10 to 30
Dense	75 TO 90%	30 to 50
Very Dense	90 TO 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (KPA)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.

Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.

Laminated - composed of thin layers of varying colour and texture.

Interbedded - composed of alternate layers of different soil types.

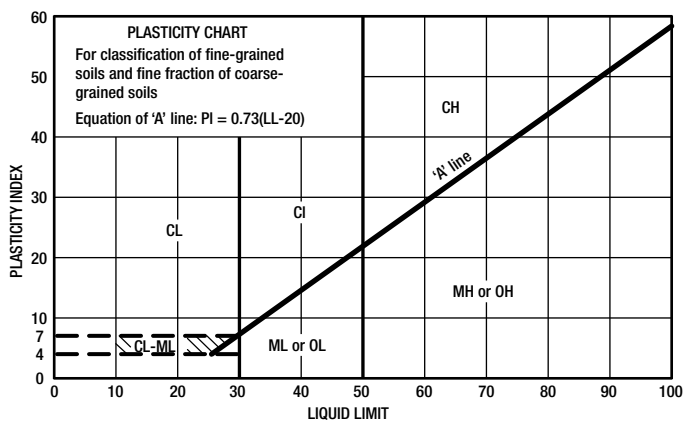
Calcareous - containing appreciable quantities of calcium carbonate.;

Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.

Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION		GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA			
COARSE - GRAINED SOILS More than 50% retained on No. 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines GW, GP, SW, SP GM, GC, SM, SC 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 and plasticity index greater than 7	
		SANDS More than 50% of coarse fraction passes No. 4 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 above 'A' line and 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 and plasticity index greater than 7	



* Based on the material passing the 75 mm sieve
 † ASTM Designation D 2487, for identification procedure see D 2488 USC as modified by PFRA

GROUND ICE DESCRIPTION

ICE NOT VISIBLE				VISIBLE ICE LESS THAN 50% BY VOLUME			
GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION		GROUP SYMBOL	SYMBOL	SUBGROUP DESCRIPTION	
N	Nf	Poorly-bonded or friable		V	Vx	Individual ice crystals or inclusions	
	Nbn	No excess ice, well-bonded			Vc	Ice coatings on particles	
	Nbe	Excess ice, well-bonded			Vr	Random or irregularly oriented ice formations	
					Vs	Stratified or distinctly oriented ice formations	
				VISIBLE ICE GREATER THAN 50% BY VOLUME			
ICE	ICE + Soil Type	Ice with soil inclusions			ICE	Ice without soil inclusions (greater than 25 mm thick)	

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

LEGEND: Soil Ice

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



Undisturbed

Lithology - Graphical Legend¹



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



Borehole No: BH22-01

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 917.7 m

Yukon

UTM: 484024.9195 E; 7086634.494 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	GTC	Elevation (m)
						Gravel (%)	Silt & Clay (%)					
							Sand (%)	Silt (%)				
0		SAND AND GRAVEL (PAD FILL) - some silt, gravel to 300 mm diameter, wet, grey, (300 mm thick)	Unfrozen		SA11				20.1		917	
1	Sonic	ORGANICS - (75 mm thick)	Frozen, Vs, Vr 10%		SA12				14.1		916	
2		SILT - some gravel, trace sand, wet, brown, organic inclusions, (225 mm thick)										
3		SAND AND GRAVEL - silty, wet, brown	Vs		SA13				1		914	
4		SILT (TILL) - some gravel, trace to some sand, wet, brown										
5		- large boulder, SA13 has low moisture due to sample containing only rock										
6		SILT AND SAND (TILL) - gravelly, gravel to 75 mm diameter, wet, brown	Nbn		SA14				12.4		912	
7					SA15				28.6		911	
8					SA16				5.9		910	
9					SA17	29	35	36	7.4		909	
10		SILT (TILL) - trace sand, grave gravel, wet, brown			SA18				23.5		908	
11		SAND AND GRAVEL - silty, gravel to 75 mm diameter, wet, brown	Unfrozen		SA19				5.9		907	
12	BEDROCK - dark grey, white streaks	Unfrozen		SA20				0.4		905		
13												
14	- reddish grey			SA21				3.7		904		
15										903		
16		END OF BOREHOLE (15.2 metres) 25 mm PVC installed to 15.2 metres Ground temperature cable installed inside PVC pipe to 14.50 metres Note: Target depth reached									902	
17											901	
18											900	
19											899	
20											898	



Contractor: Boart Longyear

Completion Depth: 15.2 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 September 27

Logged By: JS

Completion Date: 2022 September 27

Reviewed By: IM

Page 1 of 1



Borehole No: BH22-02

Project: DSTF Phase 2 Detailed Design Project No: ENG.WARC04307-01
 Location: Keno Hill Mine Ground Elev: 915.6 m
 Yukon UTM: 484047.3037 E; 7086693.741 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)			
								Silt (%) Clay (%)			
0		SAND AND GRAVEL (FILL) - silty, moist, grey	Unfrozen								
1	Sonic				SA22	54	40	6	12.7	●	915
2		ORGANICS - (100 mm thick) SILT (TILL) - some sand, some gravel, wet, brown, organic inclusions - no visible organics	Frozen, N/Nf		SA23				18.9	●	914
3			Unfrozen		SA24				10.7	●	913
4			Frozen, Nf		SA25				17.4	●	912
5		GRAVEL - sandy, silty, gravel to 50 mm diameter, very wet, greyish brown	Unfrozen		SA26				10.1	●	911
6					SA27				6.2	●	910
7		SILT (TILL) - some sand to sandy, some gravel, wet, brown	Frozen, Nbe/Nbn		SA28				23.8	●	909
8		- trace gravel, trace sand	Nbn		SA29	0	6	94	26	●	908
9					SA30				21.8	●	907
10					SA31				15.4	●	906
11		- some gravel to gravelly	Nbn/Nf		SA32				9.3	●	905
12			Unfrozen		SA33				12.2	●	904
13					SA34	8	33	59	10.3	●	903
14		- trace to some gravel, moist to wet, dense			SA35				11.2	●	902
15		- sandy, trace cobbles, moist			SA36				13.9	●	901
16											900
17											899
18		- gravelly seam									900
19		- large cobble									898
20										897	



Contractor: Boart Longyear Completion Depth: 30.5 m
 Equipment Type: Track Mounted LS250 Mini Sonic Start Date: 2022 September 28
 Logged By: JS Completion Date: 2022 September 28
 Reviewed By: IM Page 1 of 2



Borehole No: BH22-02

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 915.6 m

Yukon

UTM: 484047.3037 E; 7086693.741 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution				Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)				
								Silt (%)	Clay (%)			
20												
21	Sonic	SAND AND GRAVEL - silty, fine to coarse grained sand, subrounded to subangular gravel to 75 mm diameter, dry to damp, light brown			SA37					1.1		895
22		SILT (TILL) - gravelly, some sand, subrounded to subangular gravel to 100 mm diameter, dry to damp, loose, light brownish grey			SA38					1.5		894
23												893
24		- sandy				SA39				5.5		892
25		- gravelly layer, trace sand				SA40				8.5		891
26		- large cobble										890
27		GRAVEL - sandy, silty, fine to coarse grained sand, large cobble, subrounded to subangular gravel to 100 mm diameter, moist, brown				SA41				3.7		889
28		- some silt										888
29		- gravel to 75 mm diameter				SA42	58	30	12	3.6		887
30		- damp, brown grey				SA43				1.6		886
31		END OF BOREHOLE (30.5 metres) Note: Target depth reached									885	
32											884	
33											883	
34											882	
35											881	
36											880	
37											879	
38											878	
39											877	
40											876	



Contractor: Boart Longyear

Completion Depth: 30.5 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 September 28

Logged By: JS

Completion Date: 2022 September 28

Reviewed By: IM

Page 2 of 2



Borehole No: BH22-03

Project: DSTF Phase 2 Detailed Design
 Location: Keno Hill Mine
 Yukon

Project No: ENG.WARC04307-01
 Ground Elev: 919.6 m
 UTM: 484066.38 E; 7086745.73 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)			
0		SAND (FILL) - gravelly, silty, subangular to angular gravel to 30 mm diameter, moist, grey	Unfrozen								919
1					SA44				13.2		918
2					SA45				4		917
3		GRAVEL (FILL) - sandy, silty, very wet, dark grey, wood and metal inclusions			SA46				12.3		916
4											915
5		SILT (TILL) - trace gravel, trace sand, wet, dark brown, organic inclusions	Frozen, Nbn/Nf		SA47				70.8		914
6		- sandy, some gravel	Vr 40%		SA48				58.6		913
7					SA49				30.8		912
8			Vx, Vr 30%		SA50				14.3		911
9		- trace sand, trace gravel			SA51				21.5		910
10		- gravel to 25 mm diameter	Nb/Nf		SA52				13.3		909
11		- sandy			SA53	19	37	44	12.7		908
12											907
13			Nbn		SA54				27.4		906
14		- some sand to sandy, some gravel, some cobbles, moist	Unfrozen		SA55				9.8		905
15											904
16		- some sand to sandy			SA56				10.8		903
17											902
18					SA57				9.7		901
19		END OF BOREHOLE (18.3 metres) Note: Stopped due to refusal Core barrel fell off									900



Contractor: Boart Longyear
 Equipment Type: Track Mounted LS250 Mini Sonic
 Logged By: JS
 Reviewed By: IM

Completion Depth: 18.3 m
 Start Date: 2022 September 28
 Completion Date: 2022 September 29
 Page 1 of 1



Borehole No: BH22-04

Project: DSTF Phase 2 Detailed Design Project No: ENG.WARC04307-01
 Location: Keno Hill Mine Ground Elev: 930.8 m
 Yukon UTM: 484165.2557 E; 7086670.469 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	Elevation (m)	
						Gravel (%)	Sand (%)	Silt & Clay (%)				
								Silt (%) Clay (%)				
0		SAND AND GRAVEL (PAD FILL) - silty, moist, grey	Unfrozen									
1	Sonic	ORGANICS - (50 mm thick)			SA58				5.1		930	
1		SILT - sandy, trace gravel, moist, brown, organic inclusions, (250 mm thick)										
2		SILT - sandy, some gravel, wet, greyish brown				SA59				10.2		929
2		SAND - gravelly, some silt, fine to coarse grained sand, subrounded to subangular gravel to 50 mm diameter, moist, brown, organic inclusions										928
3		- silty, some gravel, finer grained sand, wet										928
3		- trace gravel										927
4		- gravelly, some silt, well graded, damp to moist				SA60				2.7		927
5		- trace gravel										926
5		- gravelly				SA61				7.9		926
6												925
6		- 300 mm thick gravel seam										924
7		- silty, some gravel				SA62	58	33	9	2.4		924
7		- gravelly, some silt										923
8						SA63				4		923
9												922
10		SILT - sandy, some gravel, wet, greyish brown				SA64				10.5		921
10		SAND - gravelly, some silt, fine to coarse grained sand, subrounded to subangular gravel to 50 mm diameter, damp, brown										920
11		- trace silt				SA65				2.2		920
12												919
12		- silty, some gravel, gravel to 100 mm diameter, moist, brown										918
13					SA66				7.6		917	
14	- gravelly, some silt, damp										917	
14	- no visible gravel				SA67				7.6		916	
14	- some silt to silty										916	
15	- silty, trace to some gravel										915	
16	- gravelly, some silt				SA68				10.9		915	
17	- silty, trace to some gravel										914	
18					SA69				11.8		913	
18	- gravelly, some silt, subangular to angular gravel, wet										912	
19	- silty, trace gravel, grey										911	
20					SA70				15.3		911	



Contractor: Boart Longyear Completion Depth: 20.4 m
 Equipment Type: Track Mounted LS250 Mini Sonic Start Date: 2022 September 29
 Logged By: JS Completion Date: 2022 September 29
 Reviewed By: IM Page 1 of 2



Borehole No: BH22-04

Project: DSTF Phase 2 Detailed Design Project No: ENG.WARC04307-01
 Location: Keno Hill Mine Ground Elev: 930.8 m
 Yukon UTM: 484165.2557 E; 7086670.469 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution				Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)				
								Silt (%)	Clay (%)			
20			Unfrozen		SA71					4.1		910
21		END OF BOREHOLE (20.4 metres) Note: Stopped due to refusal on suspected bedrock										910
22												909
23												908
24												907
25												906
26												905
27												904
28												903
29												902
30												901
31												900
32												899
33												898
34												897
35												896
36												895
37												894
38												893
39												892
40												891



Contractor: Boart Longyear Completion Depth: 20.4 m
 Equipment Type: Track Mounted LS250 Mini Sonic Start Date: 2022 September 29
 Logged By: JS Completion Date: 2022 September 29
 Reviewed By: IM Page 2 of 2



Borehole No: BH22-05

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 931.7 m

Yukon

UTM: 484206.6407 E; 7086784.693 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	GTC	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)						
						Silt (%)	Clay (%)							
0		SAND AND GRAVEL (FILL) - silty, moist, grey, (150 mm thick) ORGANICS - (100 mm thick) SILT AND ORGANICS - some sand, dark brown	Unfrozen Frozen, Vx 25%		SA72				290.2					931
1														930
2		SAND (TILL) - silty, some gravel, greyish brown			SA73				13.9					929
3		- gravelly	Vx, N, frozen intermittently		SA74				14.1					928
4		- some silt, trace gravel												927
5					SA75	10	76	14	17.5					926
6		- some gravel, moist			SA76				7.7					925
7														924
8		- gravelly, coarse grained sand seams throughout			SA77				8.1					923
9														922
10	Sonic	- some gravel	Nb		SA78				22.1					921
11					SA79				11.3					920
12		- gravelly												919
13					SA80				9.7					918
14		GRAVEL AND SAND - some silt, wet, brown	Unfrozen		SA81	49	37	14	12.6					917
15														916
16														915
17		- damp			SA82				5.6					914
18														913
19		- some silt to silty			SA83				6.5					912



Contractor: Boart Longyear

Completion Depth: 26.8 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 September 30

Logged By: JS

Completion Date: 2022 September 30

Reviewed By: IM

Page 1 of 2



Borehole No: BH22-05

Project: DSTF Phase 2 Detailed Design Project No: ENG.WARC04307-01
 Location: Keno Hill Mine Ground Elev: 931.7 m
 Yukon UTM: 484206.6407 E; 7086784.693 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution				Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	GTC	PVC	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)						
								Silt (%)	Clay (%)					
20														
21	Sonic	GRAVEL - sandy, silty, medium to coarse grained sand, subangular to subrounded gravel, damp, brown			SA84					5.1				911
22		SAND AND GRAVEL - silty, medium to coarse grained sand, subrounded to subangular gravel, damp, brown			SA85					4.7				910
23		SAND - gravelly, silty, fine to coarse grained sand, subrounded to subangular gravel to 75 mm diameter, moist, brown			SA86					4.5				909
24		GRAVEL - trace sand, trace silt, subangular to subrounded gravel, damp, greyish brown			SA87					0.9				908
25													907	
26													906	
27													905	
28		END OF BOREHOLE (26.8 metres) 25 mm PVC installed to 26.8 metres Ground temperature cable installed inside PVC pipe to 25.20 metres Note: Stopped due to refusal on suspected bedrock Beds 1-5 are coiled up outside of the monument and will be installed accordingly throughout the construction process											904	
29													903	
30													902	
31													901	
32													900	
33													899	
34													898	
35													897	
36													896	
37													895	
38													894	
39													893	
40													892	



Contractor: Boart Longyear Completion Depth: 26.8 m
 Equipment Type: Track Mounted LS250 Mini Sonic Start Date: 2022 September 30
 Logged By: JS Completion Date: 2022 September 30
 Reviewed By: IM Page 2 of 2



Borehole No: BH22-06

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 933 m

Yukon

UTM: 484291.6924 E; 7086718.514 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	GTC	Elevation (m)	
						Gravel (%)	Sand (%)	Silt & Clay (%)							
						Silt (%)	Clay (%)								
0			Unfrozen											933	
1	Sonic	SAND AND GRAVEL (FILL) - silty, moist, grey, (150 mm thick)	Nbn		SA88				37.6					932	
1.5		ORGANICS - (50 mm thick)		SA89				182.9						931	
2		SAND (FILL) - silty, trace gravel, fine to coarse grained sand, wet, brown		SA90					11.8						930
2.5		- organic inclusions		SA91					3.6						929
3		ORGANICS - peat, dark brown to black, wood chunks		SA92	45	30	25		17.7						928
3.5		SAND (TILL) - silty, trace gravel, moist, greyish brown		SA93					8.8						927
4		- gravelly		SA94					21.7						926
4.5		SILT (TILL) - sandy, trace to some gravel, moist, greyish brown		SA95					7.3						925
5		SAND (TILL) - gravelly, some silt, medium to coarse grained sand, wet		SA96					2.4						924
5.5		- damp		SA97					1						923
6	SILT (TILL) - sandy, gravelly, fine to coarse grained sand, wet, brown	Vx	Nbn-Nf		SA98				24.1					922	
7	- sand and gravel seam			SA99	34	46	20		8.6						921
8	- large gravel and cobbles pieces to 100 mm diameter, moist			SA100					8.8						920
9	GRAVEL - silty, some sand, subrounded to subangular gravel to 50 mm diameter, wet														919
9.5	SILT (TILL) - sandy, gravelly, wet, brown														918
10	SAND (TILL) - some silt, medium to coarse grained sand														917
10.5	- 300 mm thick cobble														916
11	- silty, gravelly, fine to coarse grained sand, moist, brown														915
12	- damp														914
13	GRAVEL - subrounded to angular gravel to 75 mm diameter														913
14	SAND (TILL) - silty, occasional gravel, fine grained sand, brown												912		
15	- gravelly, some silt, fine to coarse grained sand, wet												911		
16	- medium to coarse grained sand												910		
17	- trace gravel												909		



Contractor: Boart Longyear

Completion Depth: 30.5 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 September 30

Logged By: JS

Completion Date: 2022 September 30

Reviewed By: IM

Page 1 of 2



Borehole No: BH22-06

Project: DSTF Phase 2 Detailed Design Project No: ENG.WARC04307-01
 Location: Keno Hill Mine Ground Elev: 933 m
 Yukon UTM: 484291.6924 E; 7086718.514 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	GTC	PVC	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)							
20		- some silt, fine grained sand, damp													943
21	Sonic	- trace silt, fine to medium grained sand, wet													912
22		- some silt													911
23		- damp													910
24															909
25		- silty, some gravel, moist - gravelly, some silt - occasional gravel													908
26															907
27															906
28		- damp													905
29		- silty, wet, dark brown													904
30		- some silt, moist, light brown													903
31		END OF BOREHOLE (30.5 metres) 25 mm PVC installed to 30.5 metres Ground temperature cable installed inside PVC pipe to 29.33 metres Note: Target depth reached Beads 1 and 2 are coiled up outside of the monument and will be installed accordingly throughout the construction process													902
32															901
33															900
34															899
35															898
36															897
37															896
38															895
39															894
40															893



Contractor: Boart Longyear Completion Depth: 30.5 m
 Equipment Type: Track Mounted LS250 Mini Sonic Start Date: 2022 September 30
 Logged By: JS Completion Date: 2022 September 30
 Reviewed By: IM Page 2 of 2



Borehole No: BH22-07

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 924.4 m

Yukon

UTM: 484130.6059 E; 7086777.122 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	GTC	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)						
0		SAND AND GRAVEL (PAD FILL) - silty, moist, grey	Unfrozen											924
1		ORGANICS - (50 mm thick)	Frozen, Nbn		SA106B				20.1					923
2		ORGANICS AND SILT - trace sand, trace gravel, wet, brown, organics inclusions	Vx 25%		SA107B				12.5					922
3		SILT (TILL) - sandy, some gravel, wet, brown	Nbe, Nbn		SA108				15.2					921
4					SA109	38	36	26	24.6					920
5		SAND (TILL) - gravelly, silty			SA110				19.8					919
6		- trace gravel			SA111				18.4					918
7			Nbn		SA112				7.8					917
8		- some gravel			SA113	45	35	20	9.2					916
9		- gravelly			SA114				6.7					915
10		- silty, some gravel, suspected cobble, gravel to 100 mm diameter, moist, brown			SA115				18.8					914
11		- gravelly, some silt, wet			SA117				9.4					913
12					SA116				23.3					912
13		- wet												911
14		- 150 mm thick gravel layer												910
15		- coarse grained sand												909
16		GRAVEL - sandy, silty, subrounded to subangular gravel to 75 mm diameter, medium to coarse grained sand, very wet, brown												908
17		SAND - silty, no visible gravel, wet, brown												907
18		- fine to coarse grained sand												906
19		- trace gravel, fine to medium grained sand	Nbn-Nf		SA118				13.7					905
20		- some gravel, fine to coarse grained sand	Nf		SA119				24.2					905
		- trace gravel, medium to coarse grained sand, weak foliated flat rock throughout	Nbn											



Contractor: Boart Longyear

Completion Depth: 27.4 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 October 2

Logged By: JS

Completion Date: 2022 October 2

Reviewed By: IM

Page 1 of 2



Borehole No: BH22-07

Project: DSTF Phase 2 Detailed Design Project No: ENG.WARC04307-01
 Location: Keno Hill Mine Ground Elev: 924.4 m
 Yukon UTM: 484130.6059 E; 7086777.122 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	GTC	PVC	Elevation (m)	
						Gravel (%)	Sand (%)	Silt & Clay (%)						
														Silt (%)
20		- fine to medium grained sand, no visible foliated rock											904	
21	Sonic	SILT - sandy, no visible gravel, brown, grey laminations throughout - sandy seam			SA120				19.5				903	
22					SA121				22.7				902	
23		SAND - some silt, no visible gravel, fine to medium grained sand, brown - some silt, wet	Unfrozen			SA122				23.4				901
24														900
25		- fine grained sand, damp				SA123				11.3				899
26		- silty, wet				SA124				15.6				898
27		- suspected bedrock											897	
28		END OF BOREHOLE (27.4 metres) slough - 14.5 metres at completion PVC installed to 14.5 metres Ground temperature cable installed inside PVC pipe to 13.42 metres Note: Stopped due to refusal on suspected bedrock Beads 1-10 are coiled up outside of the monument and will be installed accordingly throughout the construction process											896	
29													895	
30													894	
31													893	
32													892	
33													891	
34													890	
35													889	
36													888	
37													887	
38													886	
39													885	
40													885	



Contractor: Boart Longyear Completion Depth: 27.4 m
 Equipment Type: Track Mounted LS250 Mini Sonic Start Date: 2022 October 2
 Logged By: JS Completion Date: 2022 October 2
 Reviewed By: IM Page 2 of 2



Borehole No: BH22-08

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 926.5 m

Yukon

UTM: 484162.3135 E; 7086750.62 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	GTC	PVC	Elevation (m)		
						Gravel (%)	Sand (%)	Silt & Clay (%)									
						Silt (%)	Clay (%)										
0		SAND AND GRAVEL (PAD FILL) - silty, wet, grey	Unfrozen												926		
1	Sonic	ORGANICS - (125 mm thick)	Frozen, Vx 10% Vx, Nb		SA125				32.7						925		
1.5		SILT AND ORGANICS - dark brown															
2		SILT - trace sand, trace gravel, brown, organic inclusions - sandy, some gravel	Nbn-Nf						21.1							924	
3		- coarse grained sand layers throughout															
4		- some sand, moist		Nbn				1	45	54	22.1						923
5		- grey	Frozen intermittently							11.4						922	
6																	
7											10.6						921
8											10.6						920
9																	919
10		SAND AND GRAVEL - silty, coarse grained sand, gravel to 50 mm diameter, wet, brown	Frozen intermittently														918
10.5		SILT - gravelly, some sand, gravel to 50 mm diameter, wet, brown									8.5						917
11		SAND AND GRAVEL - silty, fine to coarse grained sand, moist, brown	Nf Nb-Nf							4.8							916
12																	915
13																	914
14		SAND - some silt, no visible gravel, fine to coarse grained sand									23.2						913
15																	912
16		- coarser grained sand									22.1						911
17																	910
18									20.8						909		
19	- silty								21.1						908		
20									23.5						907		



Contractor: Boart Longyear

Completion Depth: 30.5 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 October 2

Logged By: JS

Completion Date: 2022 October 2

Reviewed By: IM

Page 1 of 2



Borehole No: BH22-08

Project: DSTF Phase 2 Detailed Design
 Location: Keno Hill Mine
 Yukon

Project No: ENG.WARC04307-01
 Ground Elev: 926.5 m
 UTM: 484162.3135 E; 7086750.62 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution				Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	GTC	PVC	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)						
								Silt (%)	Clay (%)					
20		- trace gravel, damp	Untrozen											906
21	Sonic				SA138					2.9				905
22		- silty, fine grained sand			SA139					13.3				904
23		- 300 mm thick fine to coarse grained sand layer												903
24		- trace gravel, moist, dense, greyish brown				SA140					10.5			902
25		- some silt, brown												901
26		- silty, some gravel, moist, grey				SA141					10.9			900
27						SA142					9.7			899
28		- some silt, medium to coarse grained sand												898
29		- silty, fine to coarse grained sand				SA143					2.6			897
30						SA144					8.4			896
31		END OF BOREHOLE (30.5 metres) 25 mm PVC installed to 22.9 metres Ground temperature cable installed inside PVC pipe to 22.47 metres Note: Target depth reached Beads 1-13 are coiled up outside of the monument and will be installed accordingly throughout the construction process												895
32														894
33														893
34														892
35														891
36														890
37														889
38														888
39														887
40														887



Contractor: Boart Longyear
 Equipment Type: Track Mounted LS250 Mini Sonic
 Logged By: JS
 Reviewed By: IM

Completion Depth: 30.5 m
 Start Date: 2022 October 2
 Completion Date: 2022 October 2
 Page 2 of 2



Borehole No: BH22-09

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 924.1 m

Yukon

UTM: 484129.5937 E; 7086715.272 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	GTC	Elevation (m)
						Gravel (%)	Sand (%)	Silt & Clay (%)						
						Silt (%)	Clay (%)							
0		SAND AND GRAVEL (PAD FILL) - silty, wet, grey, (250 mm thick) ORGANICS - (50 mm thick) SILT - sandy, gravelly, fine to coarse grained sand - some gravel, moist to wet	Unfrozen Frozen, V 5-10%											924
1			Vx 30% Nf	SA145				24.9						923
2			Nb-Nf	SA146				10.2						922
3		- trace gravel, moist												921
4				SA147	7	31	62	14.9						920
5				SA148				11						919
6			Intermittently frozen, Nbn											918
7		- gravelly, coarse grained sand		SA149				24.3						917
8		SAND - gravelly, silty, fine to coarse grained sand, wet, brown - trace gravel	Nf	SA150				10.9						916
9		- some gravel, wet												915
10	Sonic			SA151				7.9						914
11			Intermittently frozen											913
12		- trace gravel, fine grained grained	Nbn	SA152				32.8						912
13		SILT (TILL) - sandy, some gravel, subrounded to subangular gravel to 50 mm diameter, moist, greyish brown		SA153				11.4						911
14		- trace clay, dark grey												910
15			Unfrozen	SA154				11						909
16		- trace sand												908
17		- cobbles for 600 mm		SA155	18	39	43	9						907
18				SA156				8.7						906
19		- dense - some sand, fine to coarse grained sand												905
20														



Contractor: Boart Longyear

Completion Depth: 28.3 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 October 3

Logged By: JS

Completion Date: 2022 October 3

Reviewed By: IM

Page 1 of 2



Borehole No: BH22-09

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 924.1 m

Yukon

UTM: 484129.5937 E; 7086715.272 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution				Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	GTC	PVC	Elevation (m)			
						Gravel (%)	Sand (%)	Silt & Clay (%)											
								Silt (%)	Clay (%)										
20		- damp														904			
21	Sonic				SA157					7.7						903			
22					SA158					7.2								902	
23						SA159					9.1								901
24						SA160					8.3								900
25						SA161					6.9								899
26																			898
27																897			
28																896			
29		END OF BOREHOLE (28.3 metres) 25 mm PVC to 28.3 metres Ground temperature cable installed inside PVC pipe to 27.63 metres Note: Stopped due to refusal Beads 1-8 are coiled up outside of the monument and will be installed accordingly throughout the construction process														895			
30																894			
31																893			
32																892			
33																891			
34																890			
35																889			
36																888			
37																887			
38																886			
39																885			
40																885			



Contractor: Boart Longyear

Completion Depth: 28.3 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 October 3

Logged By: JS

Completion Date: 2022 October 3

Reviewed By: IM

Page 2 of 2



Borehole No: BH22-10

Project: DSTF Phase 2 Detailed Design

Project No: ENG.WARC04307-01

Location: Keno Hill Mine

Ground Elev: 918.7 m

Yukon

UTM: 484054.54 E; 7086731.18 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit	Moisture Content	Liquid Limit	GTC	Elevation (m)
						Gravel (%)	Silt & Clay (%)							
							Silt (%)	Clay (%)						
0		SAND AND GRAVEL (FILL) - silty, angular to subangular fine grained gravel, moist, grey	Unfrozen											918
1														917
2					SA163	62	28	10	5.8					916
3		- no recovery to 6.1 metres												915
4														914
5														913
6														912
7		ORGANICS - (50 mm thick) SILT AND ORGANICS - (150 mm thick) SILT (TILL) - sandy, some gravel, brown	Frozen, Nbn		SA164				18.9					911
8			V, 10-40% ice		SA165				20.6					910
9		- 150 mm thick organic layer - wood pieces	10-20% ice		SA166				45.3					909
10	Sonic				SA167				14.2					908
11		- gravelly, cobbles, wet			SA168	35	33	32	10.2					907
12			Nbn											906
13		- some gravel			SA169				31.7					905
14		- some sand, trace gravel - clean sand layers throughout	Vx 5%, small ice inclusion Nbn		SA170				20.4					904
15														903
16														902
17		- sandy, some gravel, moist			SA171				9.7					901
18			Intermittently frozen											900
19														899
20			Nbn		SA172				26.1					899



Contractor: Boart Longyear

Completion Depth: 23.2 m

Equipment Type: Track Mounted LS250 Mini Sonic

Start Date: 2022 October 4

Logged By: JS

Completion Date: 2022 October 4

Reviewed By: IM

Page 1 of 2



Borehole No: BH22-10

Project: DSTF Phase 2 Detailed Design
 Location: Keno Hill Mine
 Yukon

Project No: ENG.WARC04307-01
 Ground Elev: 918.7 m
 UTM: 484054.54 E; 7086731.18 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution			Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	GTC	PVC	Elevation (m)		
						Gravel (%)	Sand (%)	Silt & Clay (%)							
														Silt (%)	Clay (%)
20															
21	Sonic	- gravelly, coarse grained sand - trace gravel, fine to medium grained sand	Untrozen		SA173				13.7	●			898		
22															897
23		- coarse grained angular gravel			SA174				0.6	●					
24		END OF BOREHOLE (23.2 metres) 25 mm PVC installed to 22.6 metres Ground temperature cable installed inside PVC pipe to 20.04 metres Note: Stopped due to refusal Beads 1 and 2 are coiled up outside of the monument and will be installed accordingly throughout the construction process											895		
25													894		
26													893		
27													892		
28													891		
29													890		
30													889		
31													888		
32													887		
33													886		
34													885		
35													884		
36													883		
37													882		
38													881		
39													880		
40													879		



Contractor: Boart Longyear	Completion Depth: 23.2 m
Equipment Type: Track Mounted LS250 Mini Sonic	Start Date: 2022 October 4
Logged By: JS	Completion Date: 2022 October 4
Reviewed By: IM	Page 2 of 2



Borehole No: BH22-40B

Project: DSTF Phase 2 Detailed Design
 Location: Keno Hill Mine
 Yukon

Project No: ENG.WARC04307-01
 Ground Elev: 919.84 m
 UTM: 483978.2 E; 7086940 N; Z 8

Depth (m)	Method	Soil Description	Ground Ice Description	Sample Type	Sample Number	Particle Size Distribution				Moisture Content (%)	Plastic Limit Moisture Content Liquid Limit	PVC	Elevation (m)	
						Gravel (%)	Sand (%)	Silt & Clay (%)						
								Silt (%)	Clay (%)					
0		ORGANICS - (100 mm thick) SAND AND SILT (TAILINGS) - moist, grey	Unfrozen											
1	Sonic	- more compact to dense	Frozen, Nbn		SA01					11.4			919	
2					SA02					12.4			918	
3					SA03					12.4			917	
4					SA04					16.9			916	
5					SA05					13.1			915	
6				SILT - trace sand, trace gravel, organics, gravel to 50 mm diameter, wet, brown, liner pieces - 600 mm thick organic layer - trace to some gravel, trace to some sand, gravel to 100 mm diameter - 50 mm thick drier layer		SA06					12.5			914
7						SA07					5.6			913
8						SA08					11.8			912
9						SA09					0.4			911
10						SA10					0.6			910
11		BEDROCK										909		
12		END OF BOREHOLE (13.4 metres) 25 mm PVC installed to 13.4 metres Note: Target depth reached										908		
13												907		
14												906		
15												905		
16												904		
17												903		
18												902		
19												901		
20												900		



Contractor: Boart Longyear
 Equipment Type: Track Mounted LS250 Mini Sonic
 Logged By: JS
 Reviewed By: IM

Completion Depth: 13.4 m
 Start Date: 2022 September 26
 Completion Date: 2022 September 26
 Page 1 of 1

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project: AKHM DSTF Phase 2 Detailed Design Sample No.: Various
Project Number: ENG.WARC04307-01 Date Tested: November 9, 2022
Client: Hecla Tested By: BW
Project Manager: Ian MacIntyre Page: 1 of 8

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH22-04B	SA01	11.4	
	SA02	12.4	
	SA03	12.4	
	SA04	16.9	
	SA05	13.1	
	SA06	12.5	
	SA07	5.6	
	SA08	11.8	
	SA09	0.4	
	SA10	0.6	
BH22-01	SA11	20.1	
	SA12	14.1	
	SA13	1.0	
	SA14	12.4	
	SA15	28.6	
	SA16	5.9	
	SA17	7.4	SILT and SAND - gravelly
	SA18	23.5	
	SA19	5.9	
	SA20	0.4	
	SA21	3.7	
BH22-02	SA22	12.7	GRAVEL and SAND - trace silt
	SA23	18.9	
	SA24	10.7	
	SA25	17.4	

Reviewed By:  P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project: AKHM DSTF Phase 2 Detailed Design Sample No.: Various
Project Number: ENG.WARC04307-01 Date Tested: November 9, 2022
Client: Hecla Tested By: BW
Project Manager: Ian MacIntyre Page: 2 of 8

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH22-02	SA26	10.1	
	SA27	6.2	
	SA28	23.8	
	SA29	26.0	SILT - trace sand
	SA30	21.8	
	SA31	15.4	
	SA32	9.3	
	SA33	12.2	
	SA34	10.3	SILT - sandy, trace gravel
	SA35	11.2	
	SA36	13.9	
	SA37	1.1	
	SA38	1.5	
	SA39	5.5	
	SA40	8.5	
	SA41	3.7	
SA42	3.6	GRAVEL - sandy, some silt	
SA43	1.6		
BH22-03	SA44	13.2	
	SA45	4.0	
	SA46	12.3	
	SA47	70.8	
	SA48	58.6	
	SA49	30.8	
	SA50	14.3	

Reviewed By:  P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	Various
Project Number:	ENG.WARC04307-01	Date Tested:	November 10, 2022
Client:	Hecla	Tested By:	BW
Project Manager:	Ian MacIntyre	Page:	3 of 8

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH22-03	SA51	21.5	SILT and SAND - some gravel
	SA52	13.3	
	SA53	12.7	
	SA54	27.4	
	SA55	9.8	
	SA56	10.8	
	SA57	9.7	
BH22-04	SA58	5.1	GRAVEL - sandy, trace silt
	SA59	10.2	
	SA60	2.7	
	SA61	7.9	
	SA62	2.4	
	SA63	4.0	
	SA64	10.5	
	SA65	2.2	
	SA66	7.6	
	SA67	7.6	
	SA68	10.9	
	SA69	11.8	
	SA70	15.3	
	SA71	4.1	
BH22-05	SA72	290.2	SAND - some silt, trace gravel
	SA73	13.9	
	SA74	14.1	
	SA75	17.5	

Reviewed By: P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project: AKHM DSTF Phase 2 Detailed Design Sample No.: Various
Project Number: ENG.WARC04307-01 Date Tested: November 11, 2022
Client: Hecla Tested By: BW
Project Manager: Ian MacIntyre Page: 4 of 8

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil	
BH22-05	SA76	7.7		
	SA77	8.1		
	SA78	22.1		
	SA79	11.3		
	SA80	9.7		
	SA81	12.6	GRAVEL and SAND - some silt	
	SA82	5.6		
	SA83	6.5		
	SA84	5.1		
	SA85	4.7		
	SA86	4.5		
	SA87	0.9		
	BH22-06	SA88	37.6	
		SA89	182.9	
SA90		11.8		
SA91		3.6		
SA92		17.7	GRAVEL - sandy silty	
SA93		8.8		
SA94		21.7		
SA95		7.3		
SA96		2.4		
SA97		1.0		
SA98		24.1		
SA99		8.6	SAND - gravelly, some silt	
SA100		8.8		

Reviewed By:  P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project: AKHM DSTF Phase 2 Detailed Design Sample No.: Various
Project Number: ENG.WARC04307-01 Date Tested: November 15, 2022
Client: Hecla Tested By: BW
Project Manager: Ian MacIntyre Page: 5 of 8

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH22-06	SA101	5.4	
	SA102	16.1	
	SA103	5.2	
	SA104	4.4	
	SA105	19.5	
	SA106A	5.5	
	SA107A	23.8	
BH22-07	SA106B	20.1	
	SA107B	12.5	
	SA108	15.2	
	SA109	24.6	GRAVEL and SAND - silty
	SA110	19.8	
	SA111	18.4	
	SA112	7.8	
	SA113	9.2	GRAVEL - sandy, some silt
	SA114	6.7	
	SA115	18.8	
	SA116	9.4	
	SA117	23.3	
	SA118	13.7	
	SA119	24.2	
	SA120	19.5	
	SA121	22.7	
SA122	23.4		
	SA123	11.3	

Reviewed By:  P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project: AKHM DSTF Phase 2 Detailed Design Sample No.: Various
Project Number: ENG.WARC04307-01 Date Tested: November 16, 2022
Client: Hecla Tested By: BW
Project Manager: Ian MacIntyre Page: 6 of 8

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH22-07	SA124	15.6	
BH22-08	SA125	32.7	
	SA126	20.1	
	SA127	22.1	SILT and SAND - trace gravel
	SA128	11.4	
	SA129	10.6	
	SA130	10.6	
	SA131	8.5	
	SA132	4.8	
	SA133	23.2	
	SA134	22.1	
	SA135	20.8	
	SA136	21.1	
	SA137	23.5	SAND and SILT
	SA138	2.9	
	SA139	13.3	
	SA140	10.5	
	SA141	10.9	
	SA142	9.7	
	SA143	2.6	
	SA144	8.4	
BH22-09	SA145	24.9	
	SA146	10.2	
	SA147	14.9	SILT - sandy, trace gravel
	SA148	11.0	

Reviewed By:  P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	Various
Project Number:	ENG.WARC04307-01	Date Tested:	November 17, 2022
Client:	Hecla	Tested By:	BW
Project Manager:	Ian MacIntyre	Page:	7 of 8

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH22-09	SA149	24.3	
	SA150	10.9	
	SA151	7.9	
	SA152	32.8	
	SA153	11.4	
	SA154	11.0	
	SA155	9.0	SILT and SAND - some gravel
	SA156	8.7	
	SA157	7.7	
	SA158	7.2	
	SA159	9.1	
	SA160	8.3	
	SA161	6.9	
	BH22-10	SA162	5.1
SA163		5.8	GRAVEL - sandy, trace silt
SA164		18.9	
SA165		20.6	
SA166		45.3	
SA167		14.2	
SA168		10.2	GRAVEL - sandy, silty
SA169		31.7	
SA170		20.4	
SA171		9.7	
SA172		26.1	
SA173		13.7	

Reviewed By: P.Eng.

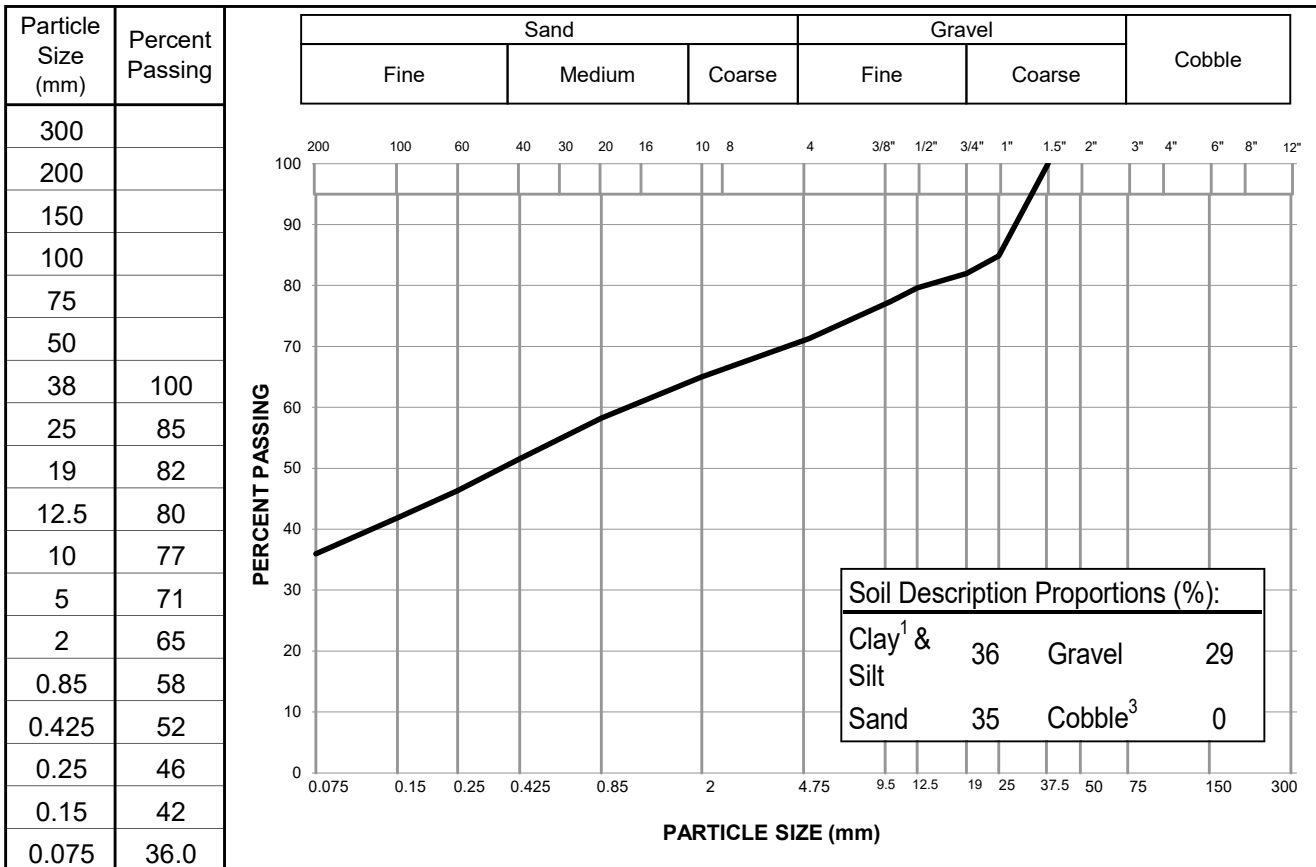
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA17
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-01
Client:	Hecla	Sample Depth:	8.2 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 14, 2022	By:	KD
Date Tested:	November 14, 2022	Date Sampled:	-
Soil Description ² :	SILT and SAND - gravelly	Sampled By:	JS
		USC Classification:	ML Cu: #N/A
Moisture Content:	7.4%		Cc: #N/A



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.

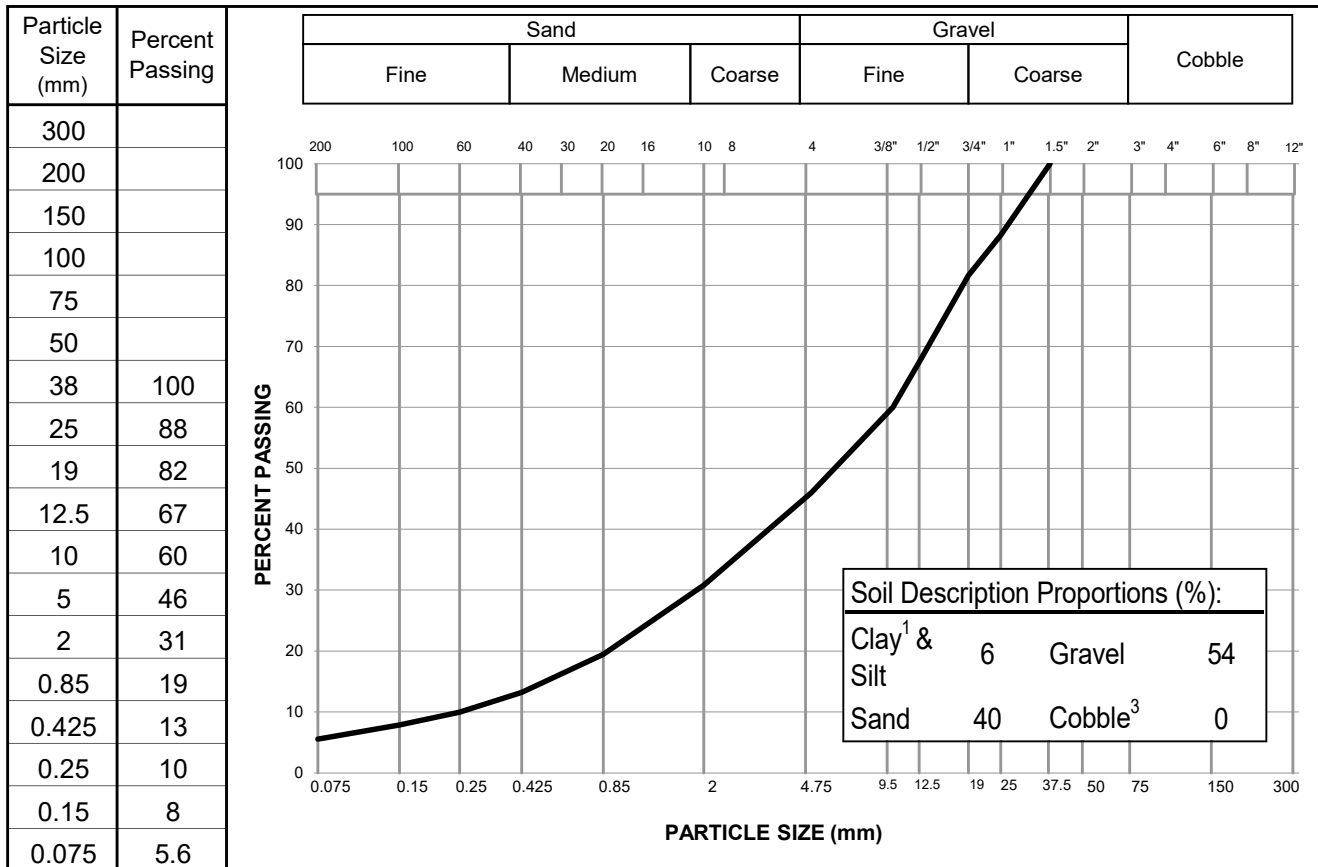
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA22
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-02
Client:	Hecla	Sample Depth:	0.8 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 14, 2022	By:	KD
Date Tested:	November 14, 2022	Date Sampled:	-
Soil Description ² :	GRAVEL and SAND - trace silt	Sampled By:	JS
		USC Classification:	GW Cu: 39.8
Moisture Content:	12.7%		Cc: 1.5



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.

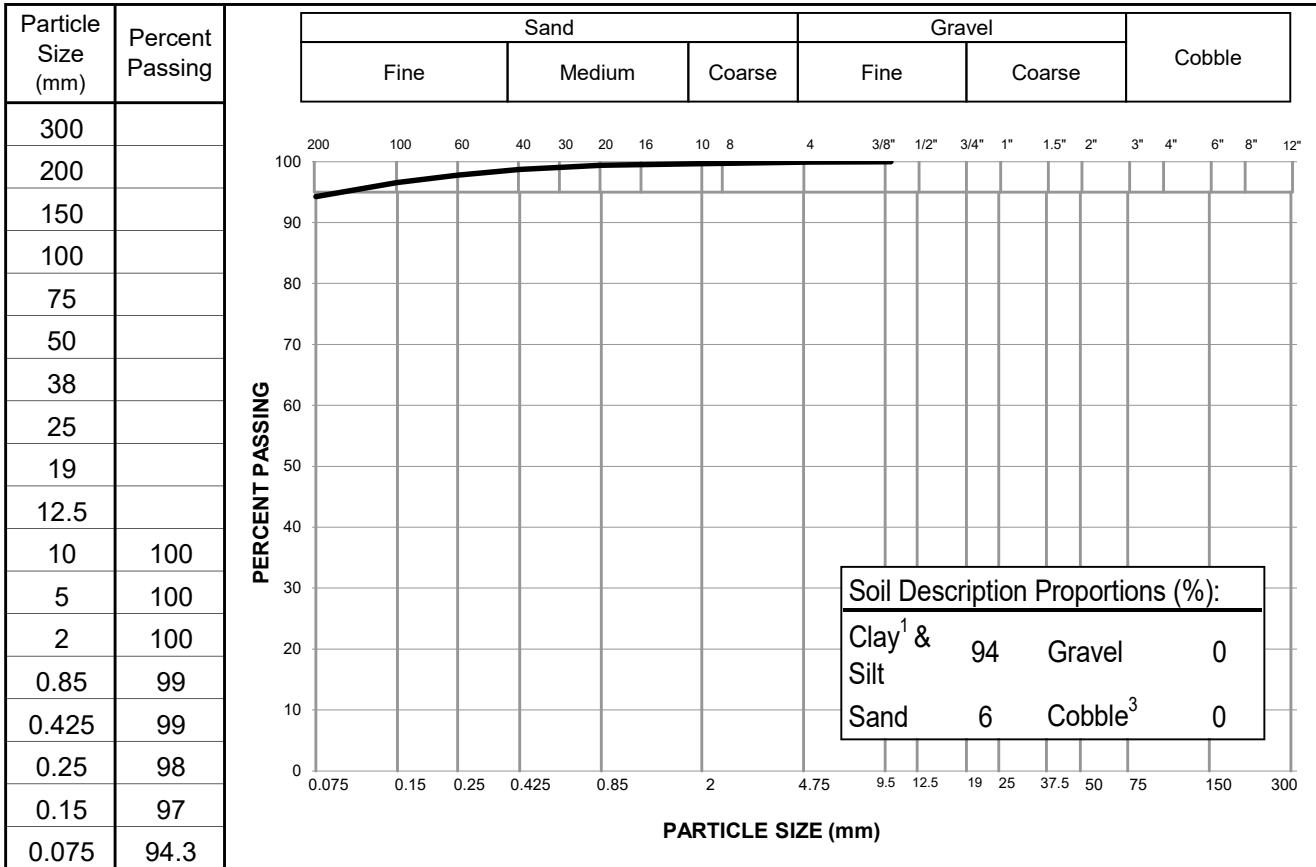
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA29
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-02
Client:	Hecla	Sample Depth:	7.9 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 14, 2022	By:	KD
Date Tested:	November 14, 2022	Date Sampled:	-
Soil Description ² :	SILT - trace sand	Sampled By:	JS
		USC Classification:	ML Cu: #N/A
Moisture Content:	26.0%		Cc: #N/A



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.

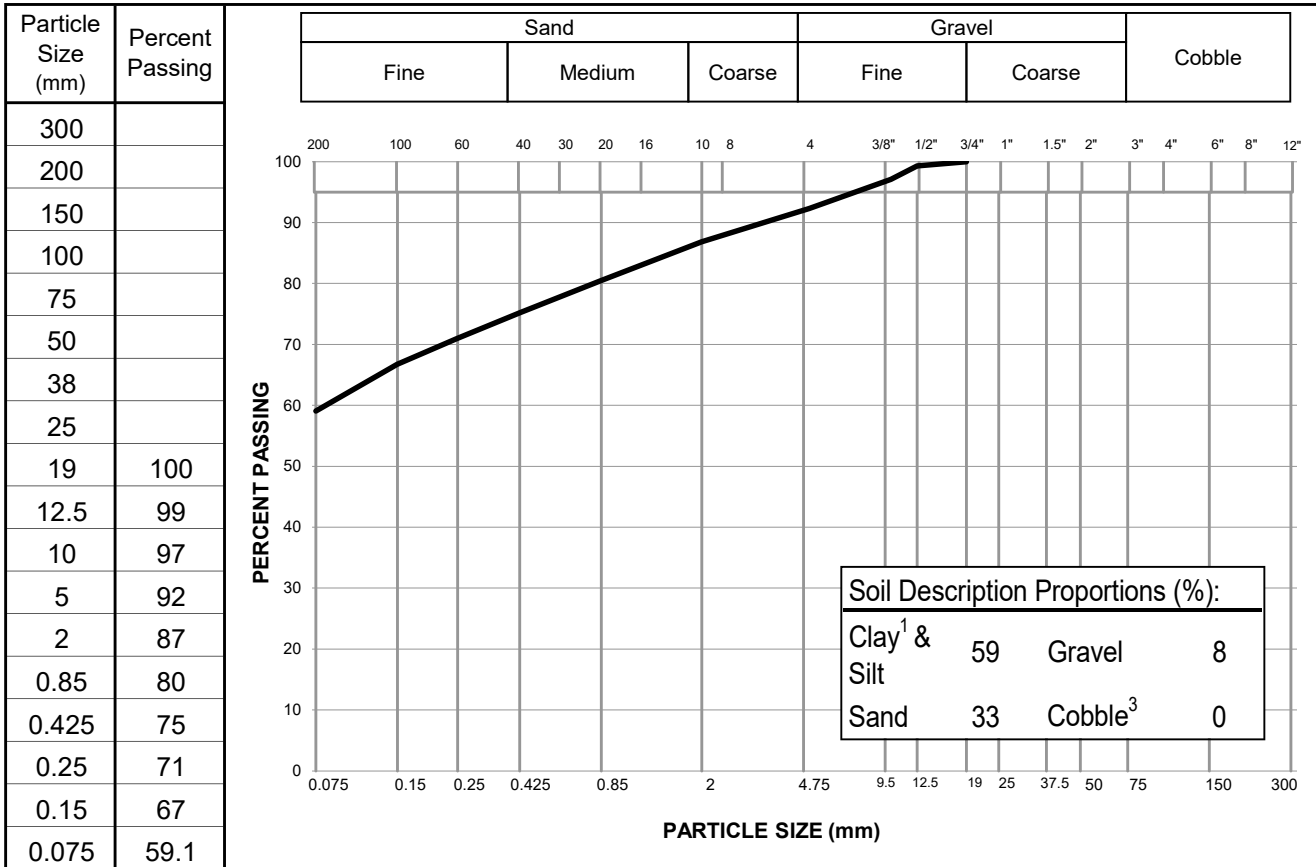
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA34
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-02
Client:	Hecla	Sample Depth:	15.8 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Date Tested:	November 17, 2022	Date Sampled:	-
Soil Description ² :	SILT - sandy, trace gravel	Sampled By:	JS
		USC Classification:	ML Cu: #N/A
Moisture Content:	10.3%		Cc: #N/A



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.

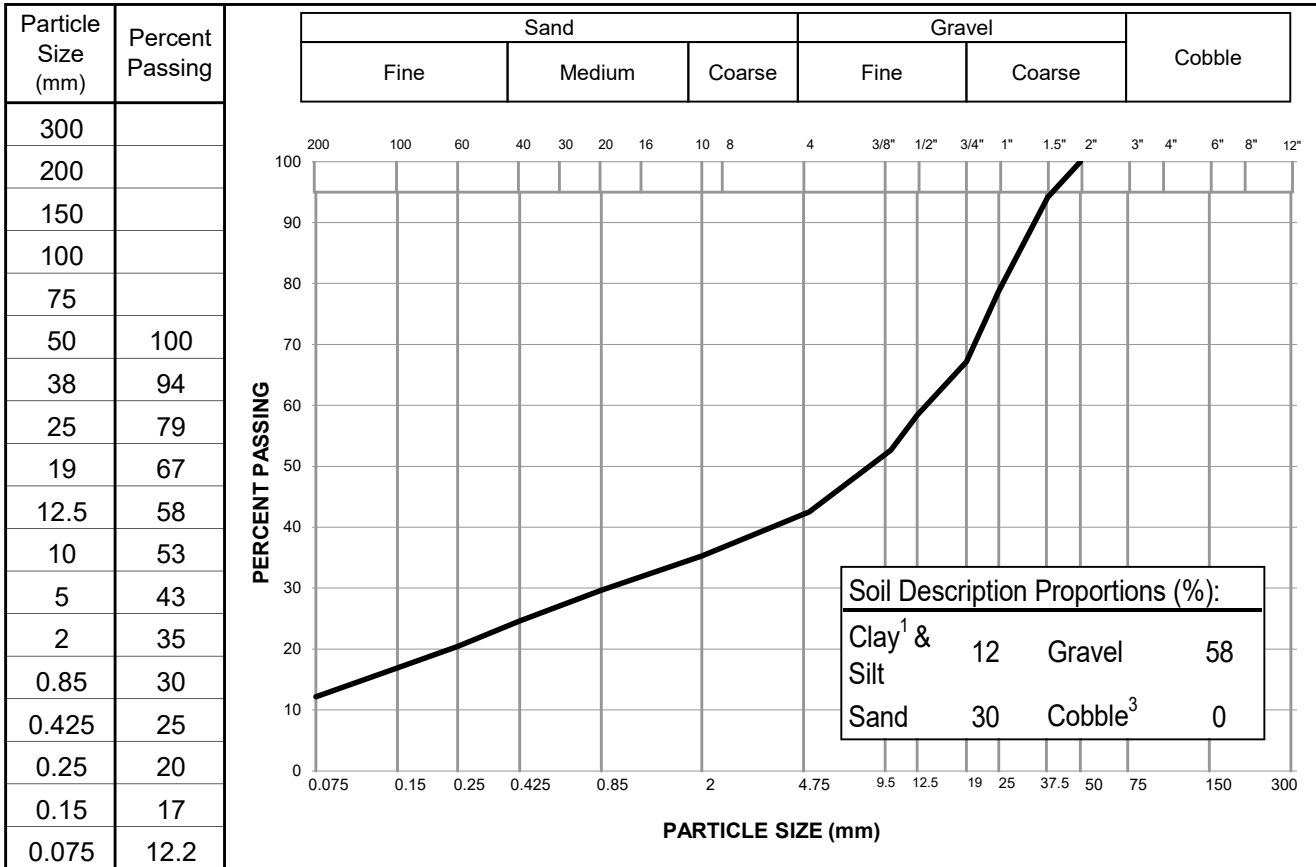
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA42
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-02
Client:	Hecla	Sample Depth:	28.3 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Date Tested:	November 17, 2022	Date Sampled:	-
Soil Description ² :	GRAVEL - sandy, some silt	Sampled By:	JS
		USC Classification:	GP
		Cu:	#N/A
Moisture Content:	3.6%	Cc:	#N/A



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.

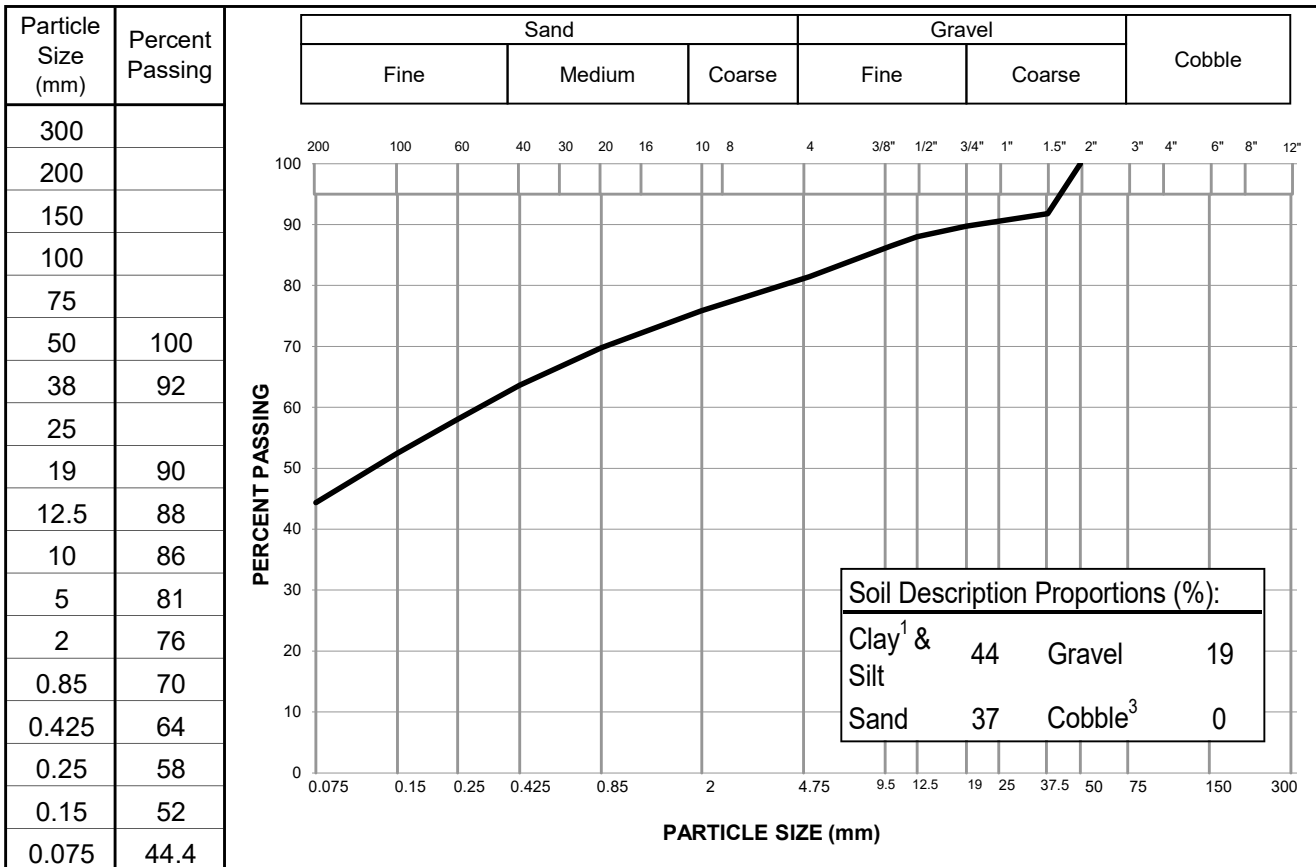
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA53
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-03
Client:	Hecla	Sample Depth:	11.3 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 14, 2022	By:	KD
Date Tested:	November 14, 2022	Date Sampled:	-
Soil Description ² :	SILT and SAND - some gravel	Sampled By:	JS
		USC Classification:	ML Cu: #N/A
Moisture Content:	12.7%		Cc: #N/A



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.

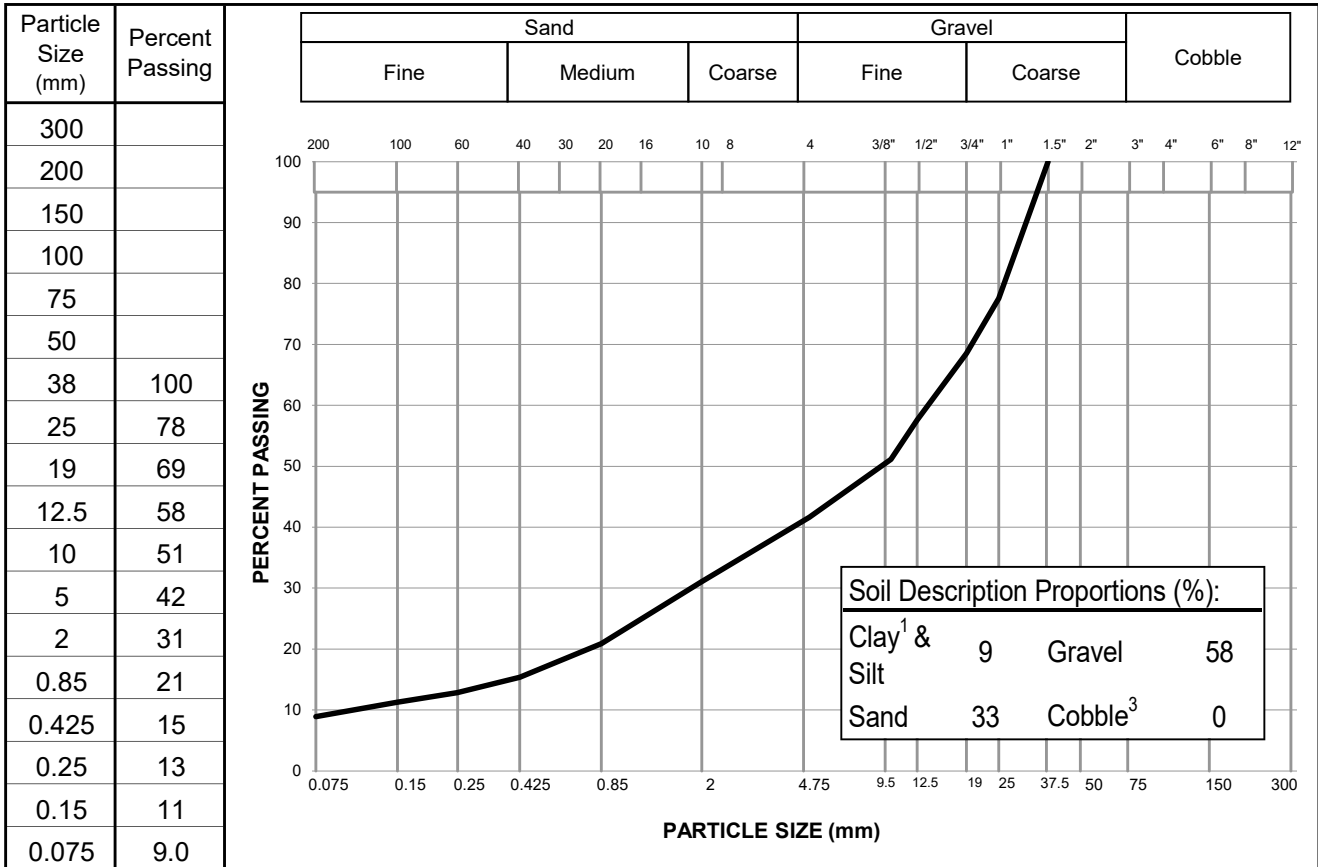
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA62
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-04
Client:	Hecla	Sample Depth:	7.3 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Date Tested:	November 17, 2022	Date Sampled:	-
Soil Description ² :	GRAVEL - sandy, trace silt	Sampled By:	JS
		USC Classification:	GW Cu: 128.7
Moisture Content:	2.4%		Cc: 2.3



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.

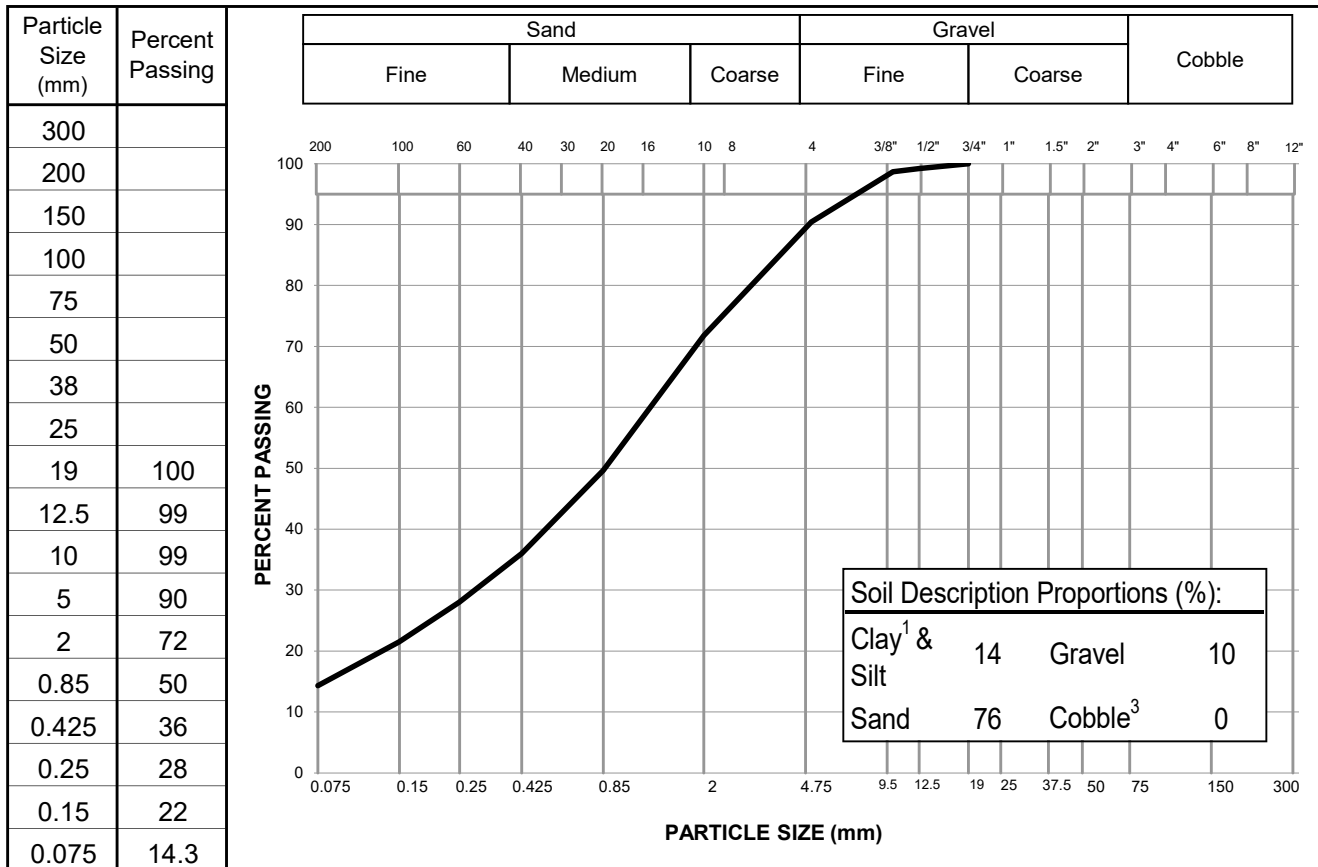
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA75
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-05
Client:	Hecla	Sample Depth:	5.2 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 18, 2022	By:	BW
Soil Description ² :	SAND - some silt, trace gravel	Date Sampled:	-
		Sampled By:	JS
		USC Classification:	GM-ML Cu: #N/A
Moisture Content:	17.5%		Cc: #N/A



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.

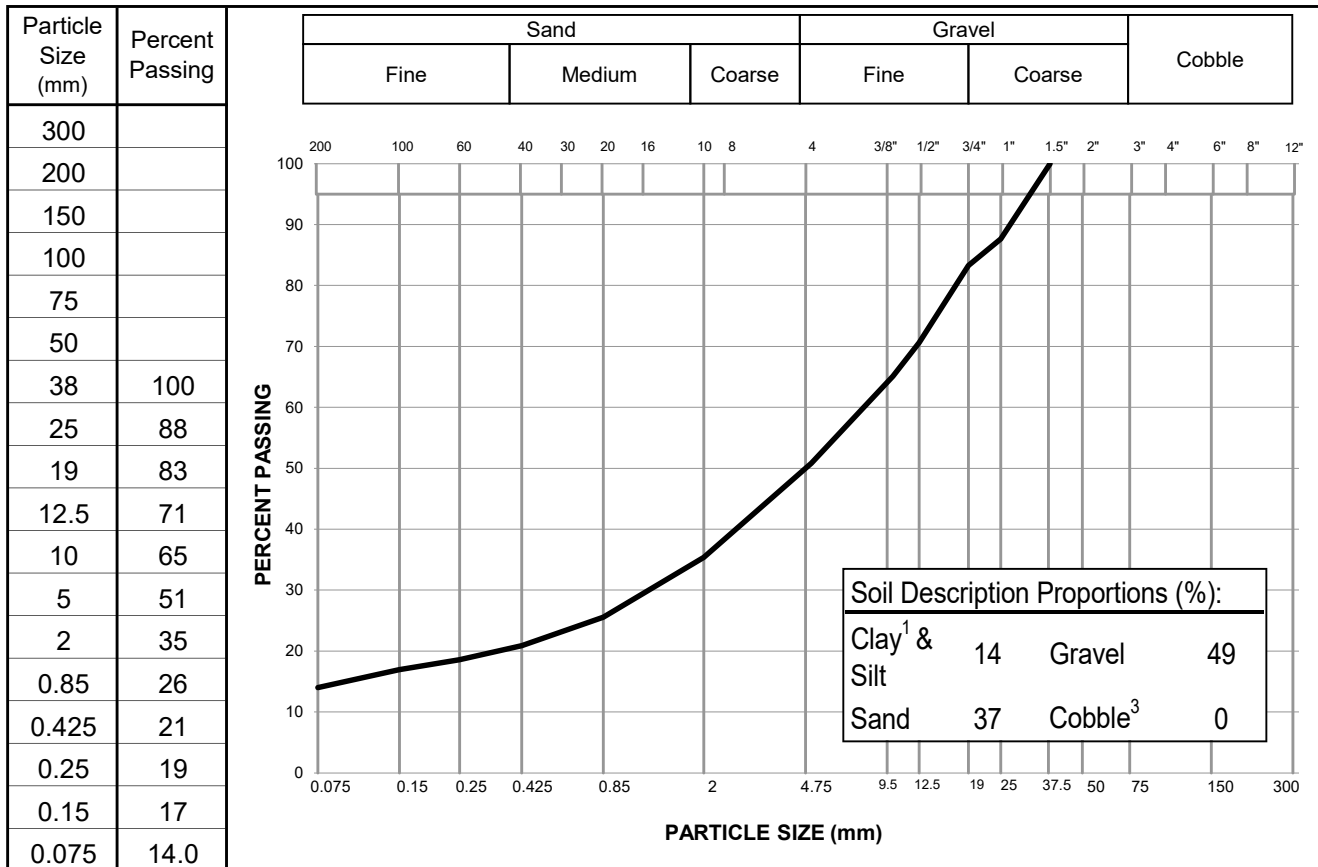
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA81
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-05
Client:	Hecla	Sample Depth:	2.1 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Soil Description ² :	GRAVEL and SAND - some silt	Date Sampled:	-
		Sampled By:	JS
		USC Classification:	GP-GM Cu: #N/A
Moisture Content:	12.6%		Cc: #N/A



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.

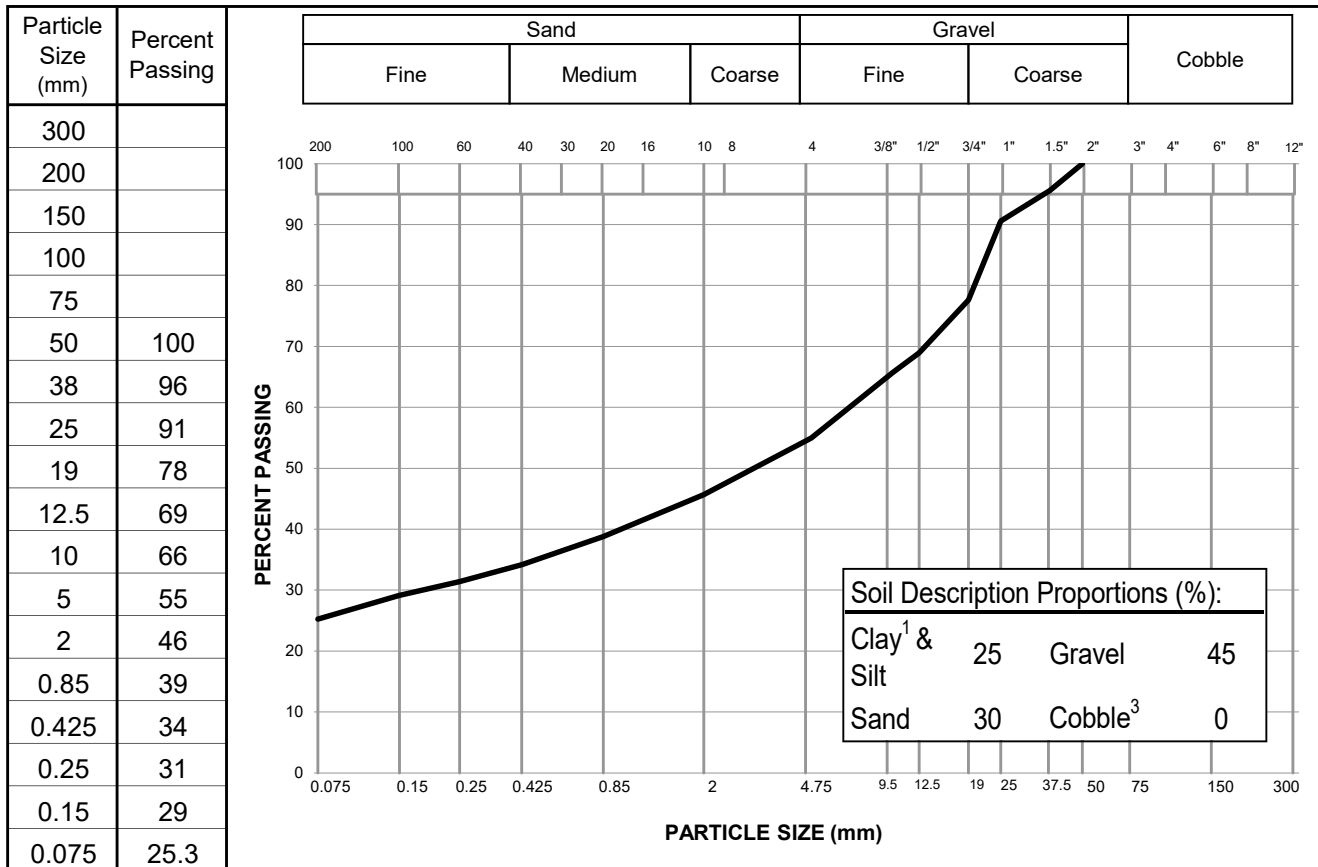
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: AKHM DSTF Phase 2 Detailed Design	Sample No.: SA92
Project No.: ENG.WARC04307-01	Material Type: Foundation Soil
Site: Alexco Keno Hill Mine	Sample Loc.: BH22-06
Client: Hecla	Sample Depth: 6.7 m
Client Rep.: Peter Johnson	Sampling Method: Grab
Date Tested: November 18, 2022 By: BW	Date Sampled: -
Soil Description ² : GRAVEL - sandy, silty	Sampled By: JS
	USC Classification: GM-ML Cu: #N/A
Moisture Content: 17.7%	Cc: #N/A



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.

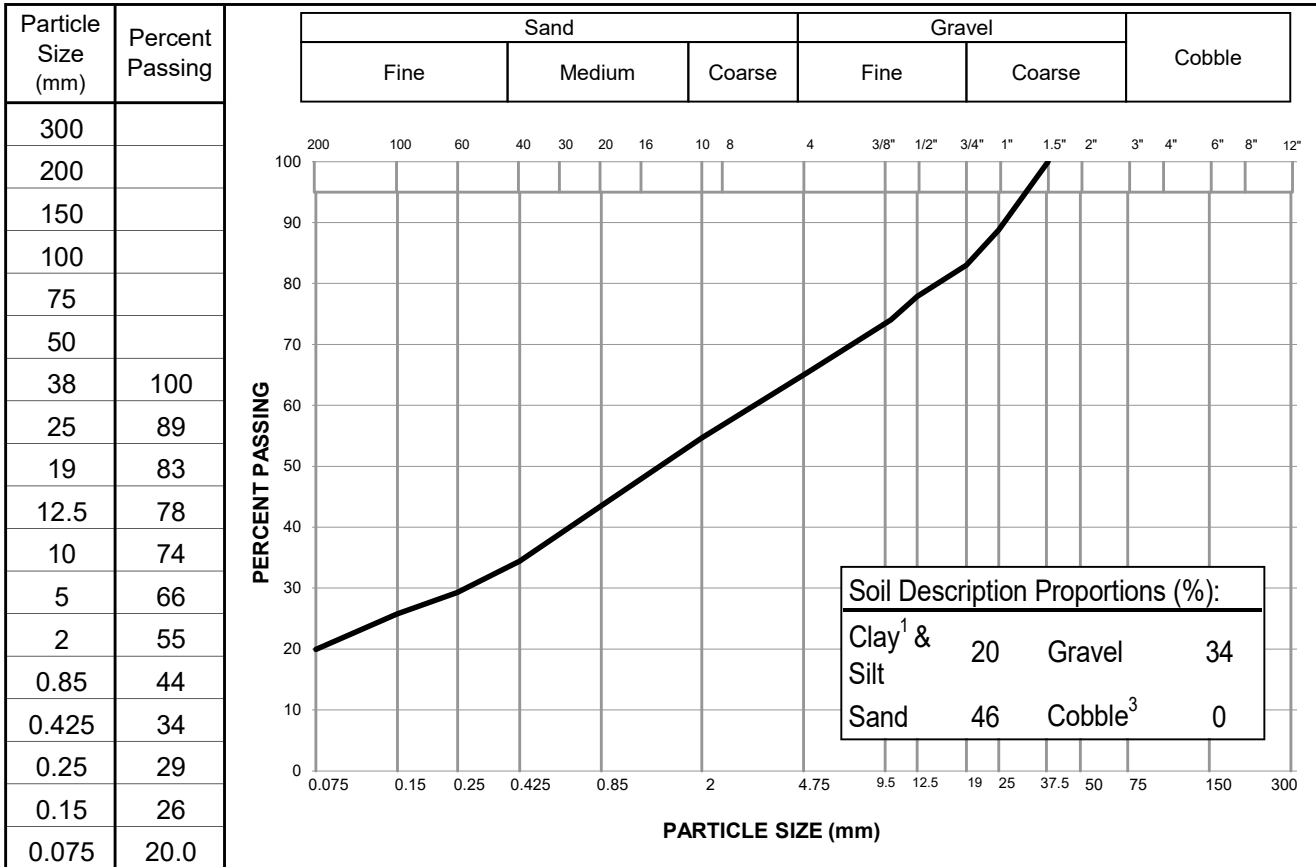
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA99
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-06
Client:	Hecla	Sample Depth:	17.4 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Date Tested:	November 17, 2022	Date Sampled:	-
Soil Description ² :	SAND - gravelly, some silt	Sampled By:	JS
		USC Classification:	SP-SM Cu: #N/A
Moisture Content:	8.6%		Cc: #N/A



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.

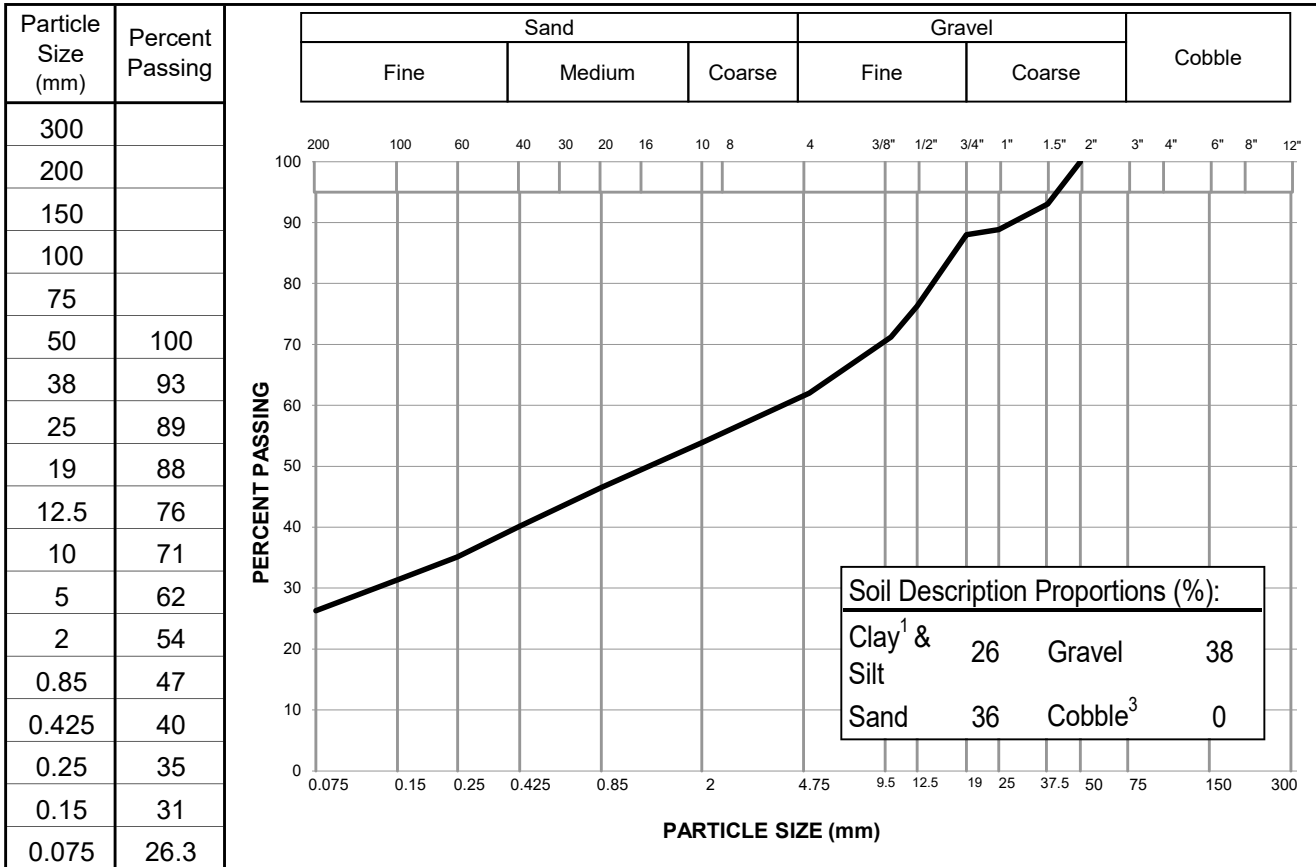
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA109
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-07
Client:	Hecla	Sample Depth:	5.2 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 21, 2022	By:	BW
Date Tested:	November 21, 2022	Date Sampled:	-
Soil Description ² :	GRAVEL and SAND - silty	Sampled By:	JS
		USC Classification:	GM-ML Cu: #N/A
Moisture Content:	24.6%		Cc: #N/A



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.

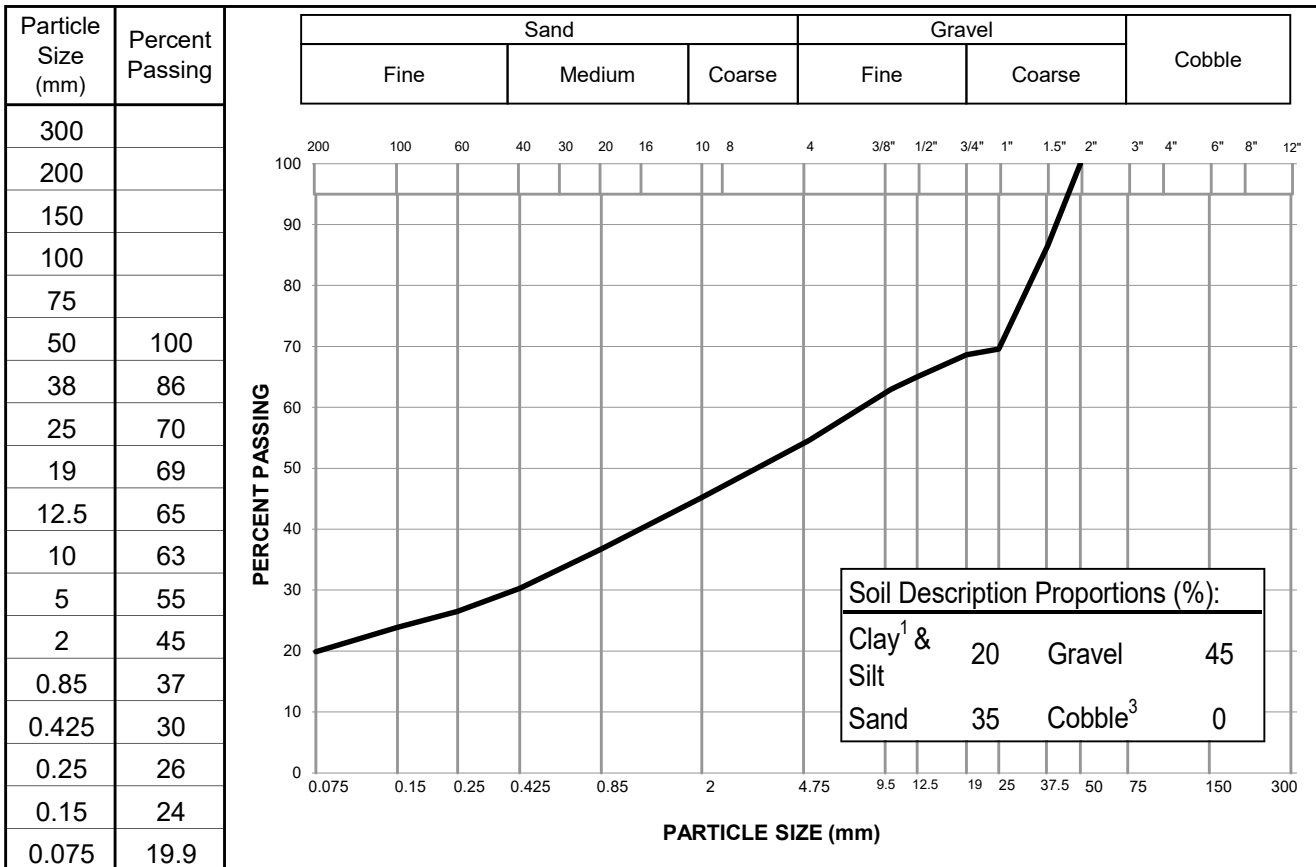
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA113
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-07
Client:	Hecla	Sample Depth:	11.6 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 21, 2022	By:	BW
Date Tested:	November 21, 2022	Date Sampled:	-
Soil Description ² :	GRAVEL - sandy, some silt	Sampled By:	JS
		USC Classification:	GP-GM Cu: #N/A
Moisture Content:	9.2%		Cc: #N/A



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.

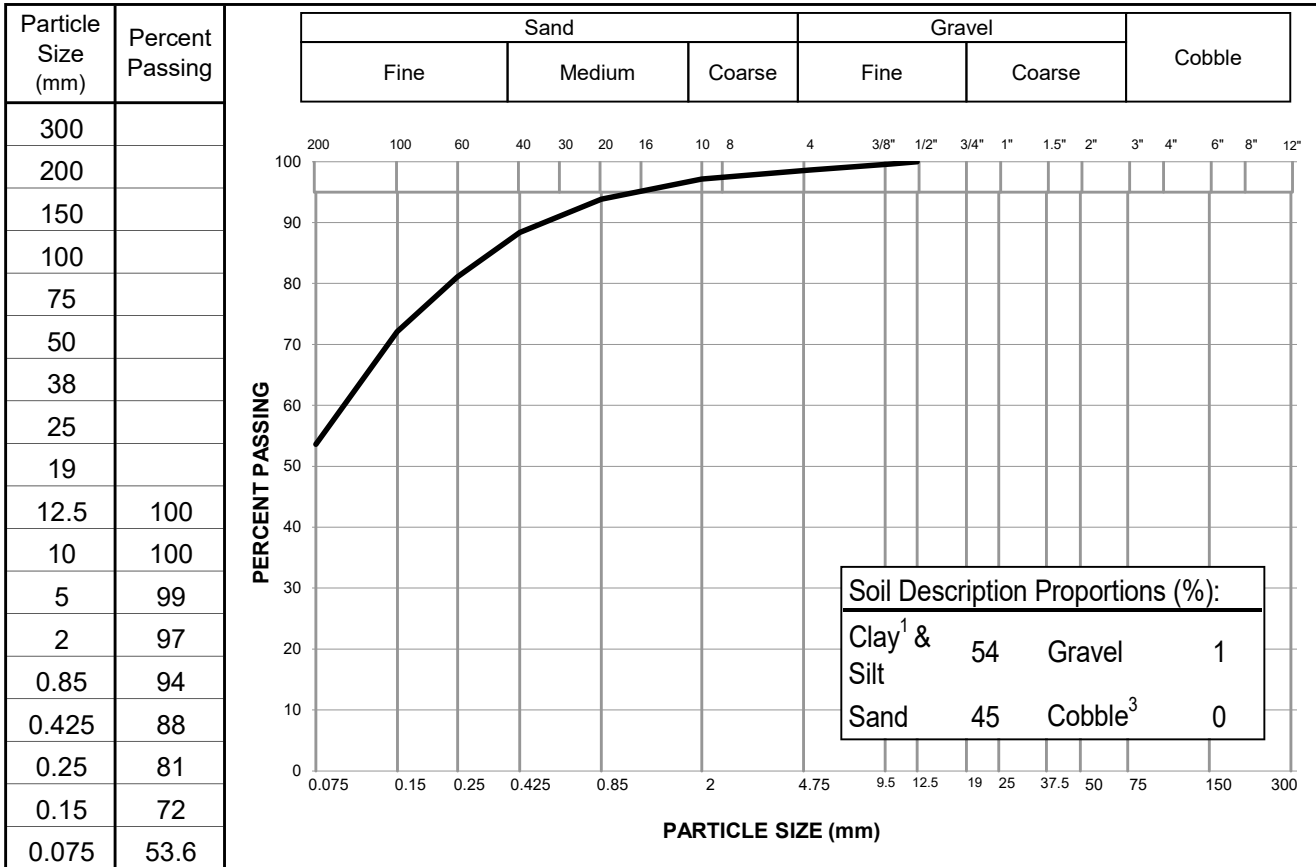
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA127
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-08
Client:	Hecla	Sample Depth:	3.7 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Soil Description ² :	SILT and SAND - trace gravel	Date Sampled:	-
		Sampled By:	JS
		USC Classification:	ML
		Cu:	#N/A
Moisture Content:	22.1%	Cc:	#N/A



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.

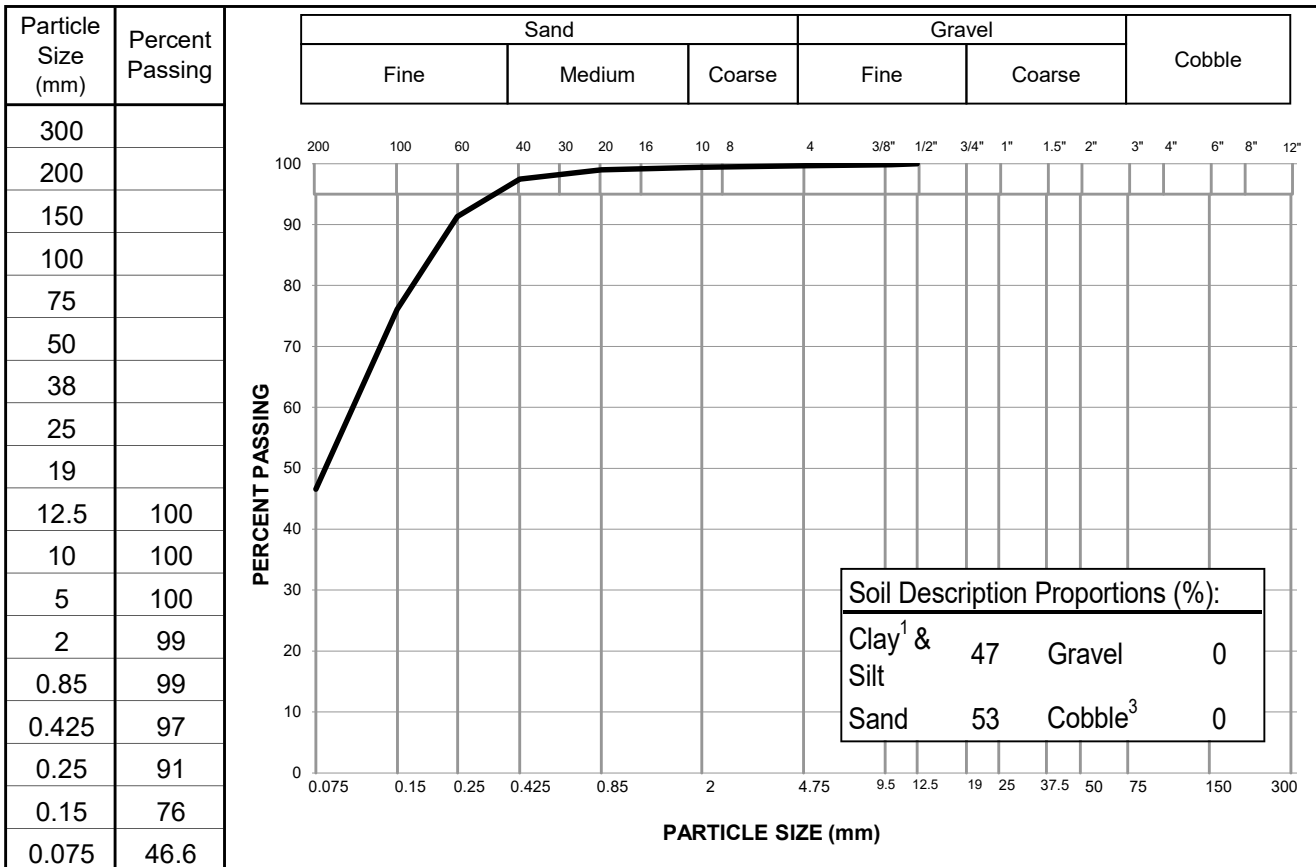
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA137
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-08
Client:	Hecla	Sample Depth:	18.9 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 18, 2022	By:	BW
Soil Description ² :	SAND and SILT	Date Sampled:	-
		Sampled By:	JS
		USC Classification:	SM-ML Cu: #N/A
Moisture Content:	23.5%		Cc: #N/A



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.

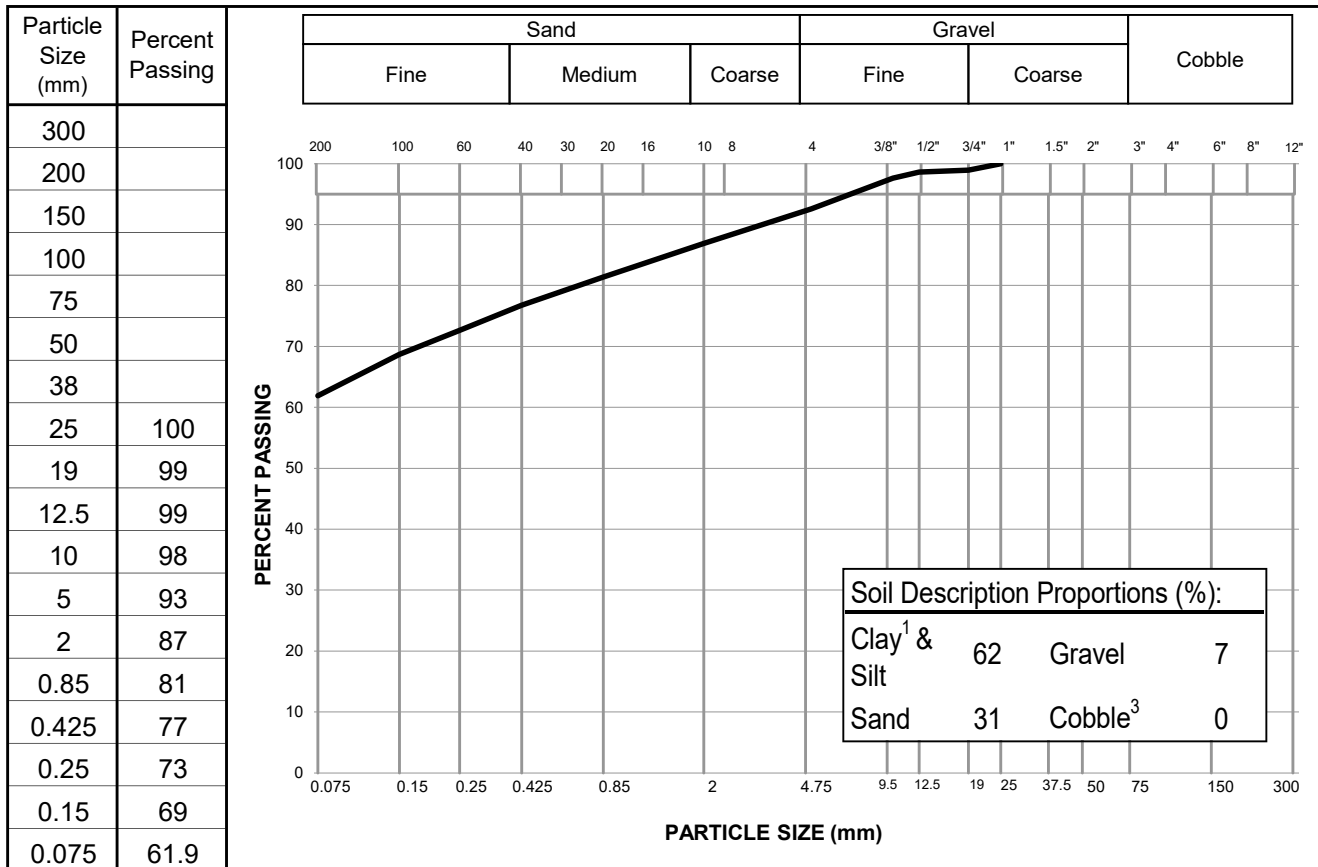
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA147
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-09
Client:	Hecla	Sample Depth:	3.7 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Soil Description ² :	SILT - sandy, trace gravel	Date Sampled:	-
		Sampled By:	JS
		USC Classification:	ML
		Cu:	#N/A
Moisture Content:	14.9%	Cc:	#N/A



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.

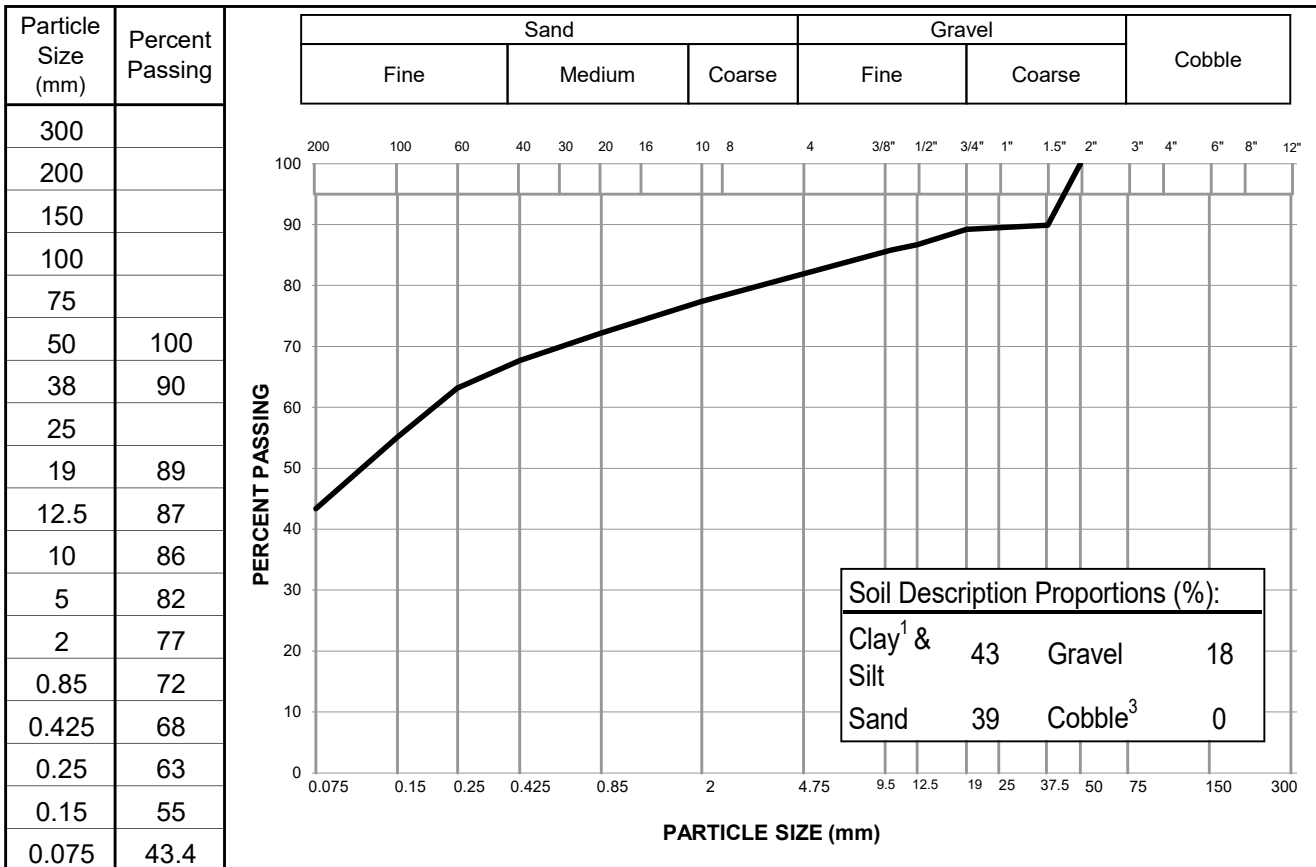
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA155
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-09
Client:	Hecla	Sample Depth:	16.2 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Soil Description ² :	SILT and SAND - some gravel	Date Sampled:	-
		Sampled By:	JS
		USC Classification:	ML Cu: #N/A
Moisture Content:	9.0%		Cc: #N/A



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.

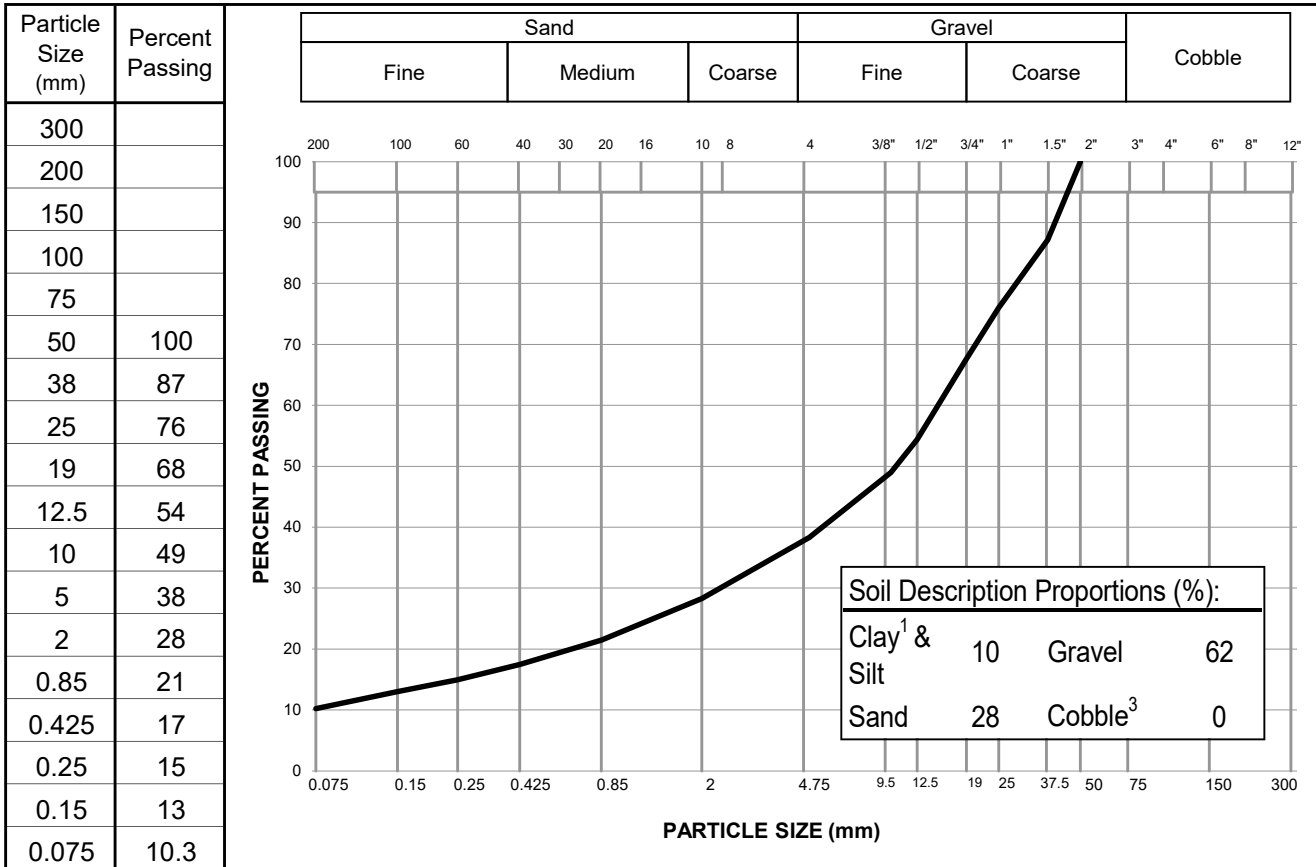
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA163
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-09
Client:	Hecla	Sample Depth:	2.1 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 18, 2022	By:	BW
Soil Description ² :	GRAVEL - sandy, trace silt	Date Sampled:	-
		Sampled By:	JS
		USC Classification:	GP
		Cu:	#N/A
Moisture Content:	5.8%	Cc:	#N/A



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.

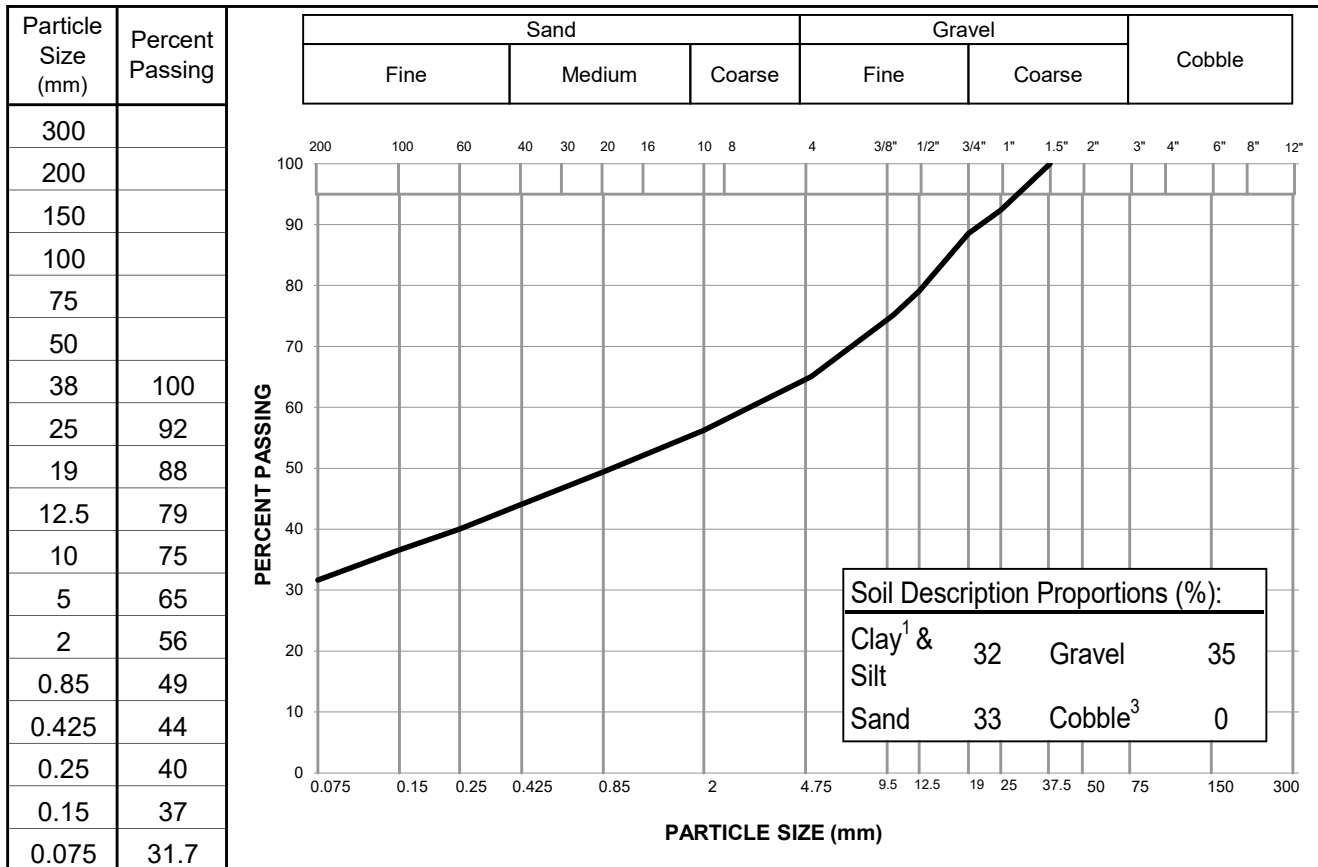
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	AKHM DSTF Phase 2 Detailed Design	Sample No.:	SA168
Project No.:	ENG.WARC04307-01	Material Type:	Foundation Soil
Site:	Alexco Keno Hill Mine	Sample Loc.:	BH22-10
Client:	Hecla	Sample Depth:	11.3 m
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	November 17, 2022	By:	BW
Date Tested:	November 17, 2022	Date Sampled:	-
Soil Description ² :	GRAVEL - sandy, silty	Sampled By:	JS
		USC Classification:	GM-ML Cu: #N/A
Moisture Content:	10.2%		Cc: #N/A



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.


Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP32
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086670N; 483945E; Zone 8	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C. LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
				20	40	60	80	20	40	60	80	20	40	60	80	
0	PEAT - woody, roots, organics		FROZEN, Nbe													0
	END OF TESTPIT @ 0.3 m (refusal in permafrost)															
1																5
2																10
3																15
4																16
5																

	LOGGED BY: JTP	COMPLETION DEPTH: 0.3m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP33
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086688N; 783971E; Zone 8	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C. LIQUID		◆ CLAY (%) ◆	● SILT (%) ●	▲ SAND (%) ▲	◆ GRAVEL (%) ◆	Depth (ft)
				20	40	60	80	20	40	60		
0	PEAT - woody, roots, organics		FROZEN, Nbe									0
	END OF TESTPIT @ 0.4 m (refusal in permafrost)											0.4
1												1
2												2
3												3
4												4
5												5
												10
												15
												16

 A TETRA TECH COMPANY	LOGGED BY: JTP	COMPLETION DEPTH: 0.4m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP34
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086656N; 484041E; Zone 8	

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input checked="" type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input checked="" type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C.		LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
					20	40	60	80	20	40	60	80	20	40	60	80	20	40	
0	PEAT - woody, roots, organics SILT - some gravel, some sand, non-plastic, olive grey, cobbles throughout			FROZEN, Nbe FROZEN, Vr, Vc, 5%															0
1	END OF TESTPIT @ 1.0 m (refusal in permafrost)	<input checked="" type="checkbox"/>	SA01																5
2																			10
3																			15
4																			16
5																			16

 A TETRA TECH COMPANY	LOGGED BY: JTP	COMPLETION DEPTH: 1m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP35
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086717N; 484118E; Zone 8	

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C.		LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
					20	40	60	80	20	40	60	80	20	40	60	80	20	40	
0	PEAT - woody, roots, organics			FROZEN, Nbe															0
	SILT - some gravel, some sand, non-plastic, olive grey, cobbles throughout			FROZEN, Vr, Vc, 25%															
	END OF TESTPIT @ 0.6 m (refusal in permafrost)	SA02																	
1																			5
2																			10
3																			15
4																			16
5																			

	LOGGED BY: JTP	COMPLETION DEPTH: 0.6m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP36
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086820N; 484131E; Zone 8	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C. LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
				20	40	60	80	20	40	60	80	20	40	60	80	
0	PEAT - woody, roots, organics		FROZEN, Nbe													0
	SILT - some gravel, some sand, non-plastic, olive grey, cobbles throughout		FROZEN, Vr, Vc, 25%													
	END OF TESTPIT @ 0.5 m (refusal in permafrost)															
1																
2																
3																
4																
5																

	LOGGED BY: JTP	COMPLETION DEPTH: 0.5m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP37
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086772N; 484206E; Zone 8	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C. LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
				20	40	60	80	20	40	60	80	20	40	60	80	
0	PEAT - woody, roots, organics		FROZEN, Nbe													0
	SILT - some gravel, some sand, non-plastic, olive grey, cobbles throughout		FROZEN, Vr, Vc, 25%													
	END OF TESTPIT @ 0.5 m (refusal in permafrost)															
1																5
2																10
3																15
4																16
5																

	LOGGED BY: JTP	COMPLETION DEPTH: 0.5m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP38
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086712N; 484238E; Zone 8	

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input checked="" type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input checked="" type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C. LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
					20	40	60	80	20	40	60	80	20	40	60	80	
0	PEAT - woody, roots, organics			FROZEN, Nbe													0
	SILT - some gravel, trace sand, non-plastic, olive grey, cobbles and boulders throughout		SA03	FROZEN, Vr, Vc, 10%													
	END OF TESTPIT @ 0.4 m (refusal in permafrost)																
1																	5
2																	10
3																	15
4																	16
5																	

	LOGGED BY: JTP	COMPLETION DEPTH: 0.4m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP39
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086668N; 484114E; Zone 8	

SAMPLE TYPE	<input checked="" type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C.		LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
					20	40	60	80	20	40	60	80	20	40	60	80	20	40	
0	PEAT - woody, roots, organics SILT - some gravel, trace sand, non-plastic, olive grey, cobbles throughout		SA04	FROZEN, Nbe FROZEN, Vr, Vc, 10%															0
1	END OF TESTPIT @ 0.6 m (refusal in permafrost)																		5
2																			10
3																			15
4																			16

	LOGGED BY: JTP	COMPLETION DEPTH: 0.6m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP40
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086655N; 484135E; Zone 8	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C.		LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
					20	40	60	80	20	40	60	80	20	40	60	80	20	40	
0	ORGANIC COVER																		0
	SILT - some gravel, trace sand, firm (est.), damp, non-plastic, olive grey, cobbles throughout																		
1																			
	SAND and GRAVEL - trace silt, well graded, medium grained, sub-rounded, loose (est.), damp, brown, cobbles throughout		SA05																5
2																			
			SA06																
3																			10
4																			
	END OF TESTPIT @ 4.5 m (machine extent)																		15
5																			16

 A TETRA TECH COMPANY	LOGGED BY: JTP	COMPLETION DEPTH: 4.5m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP41
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086670N; 484145E; Zone 8	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C. LIQUID		CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)	Depth (ft)
					20	40	60	80	20	40	60	80	
0	ORGANIC COVER												0
	SILT - some gravel, trace sand, firm (est.), damp, non-plastic, olive grey, cobbles throughout												
1													
2													
	SAND and GRAVEL - trace silt, well graded, medium grained, sub-rounded, loose (est.), damp, brown, cobbles throughout		SA07										
3													
4													
	END OF TESTPIT @ 4.5 m (machine extent)		SA08										
5													15
													16

	LOGGED BY: JTP	COMPLETION DEPTH: 4.5m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP42
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086655N; 484180E; Zone 8	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND


Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C. LIQUID		CLAY (%)		SILT (%)		SAND (%)		GRAVEL (%)		Depth (ft)
				20	40	60	80	20	40	60	80	20	40	60	80	
0	ORGANIC COVER															0
	SILT - sandy, some gravel, firm (est.), damp, non-plastic, olive grey, cobbles throughout															
1																
	- becomes some sand, some gravel, cobbles and boulders throughout															5
2																
3	END OF TESTPIT @ 3.0 m (desired depth)															10
4																
5																15
																16

 A TETRA TECH COMPANY	LOGGED BY: JTP	COMPLETION DEPTH: 3m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

Dry Stack Tailings Facility Phase II Expansion	CLIENT: Alexco Keno Hill Mining Corp	TESTPIT NO: W14103303-TP43
Keno Hill District Mill Site	EXCAVATOR: Hitachi 270 Excavator	PROJECT NO: W14103303-01
Keno City, YT	7086695N; 484241E; Zone 8	

SAMPLE TYPE	<input type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> SPT	<input type="checkbox"/> A-CASING	<input type="checkbox"/> SHELBY TUBE	<input type="checkbox"/> CORE
BACKFILL TYPE	<input type="checkbox"/> BENTONITE	<input type="checkbox"/> PEA GRAVEL	<input type="checkbox"/> SLOUGH	<input type="checkbox"/> GROUT	<input type="checkbox"/> DRILL CUTTINGS	<input type="checkbox"/> SAND

Depth (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND ICE DESCRIPTION AND COMMENTS	SPT (N)		PLASTIC M.C.		LIQUID		Depth (ft)
					20	40	60	80	20	40	
0	ORGANIC COVER SAND and GRAVEL - silty, well graded, medium grained, sub-rounded, compact (est.), damp, brown, cobbles throughout										0
1											5
2			SA09								10
3	END OF TESTPIT @ 3.0 m (desired depth)										15
4											16
5											16

 A TETRA TECH COMPANY	LOGGED BY: JTP	COMPLETION DEPTH: 3m
	REVIEWED BY: CPC	COMPLETE: 9/11/2013
	DRAWING NO:	Page 1 of 1

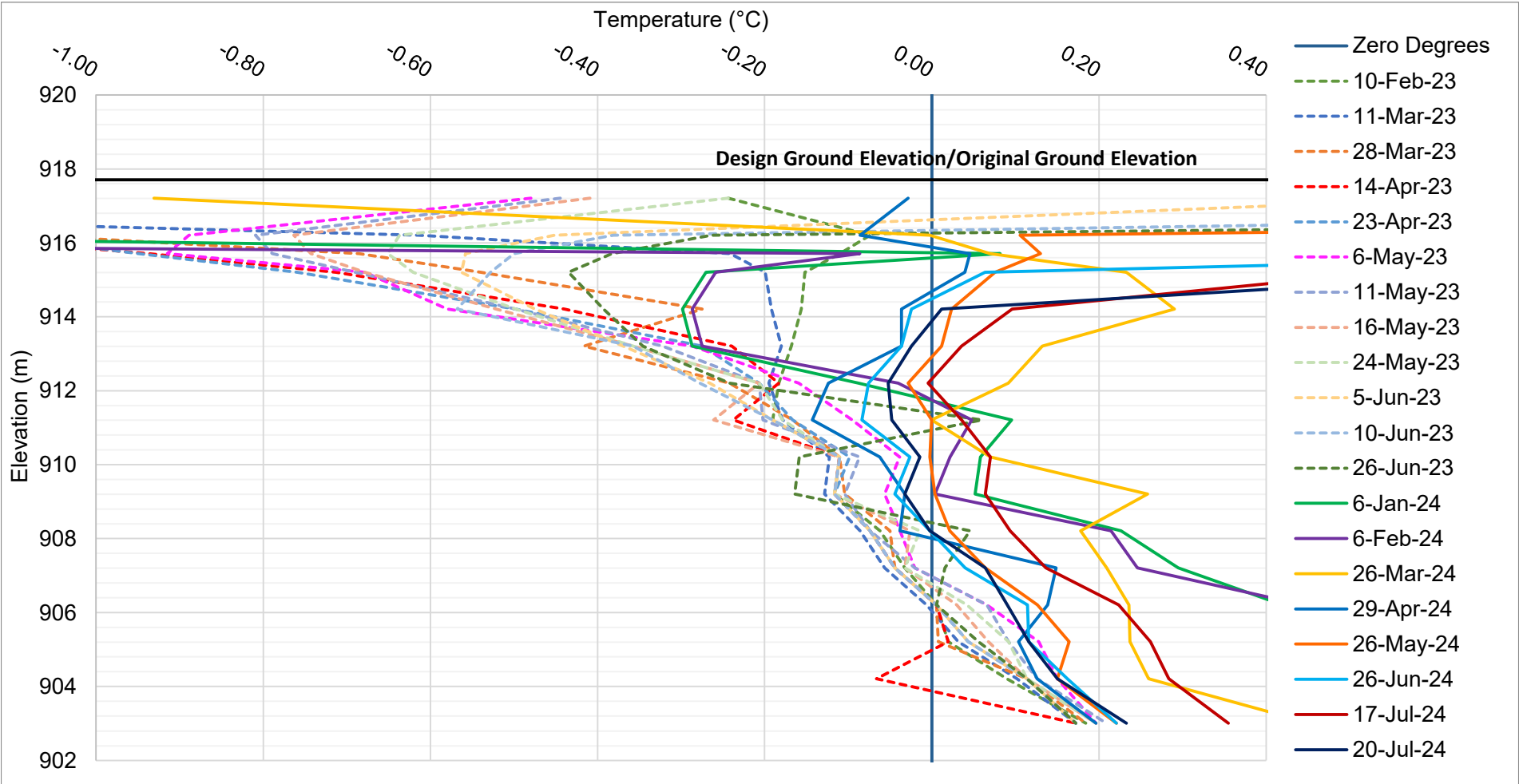
APPENDIX C

GROUND TEMPERATURE CABLE DATA

Ground Temperature Readings

Project: AKHM DSTF Phase II Detailed Design
Project No: 704-ENG.WARC04307-01
Client: Hecla

ISSUED FOR USE
Ground Temperature Data (2023 to 2024)



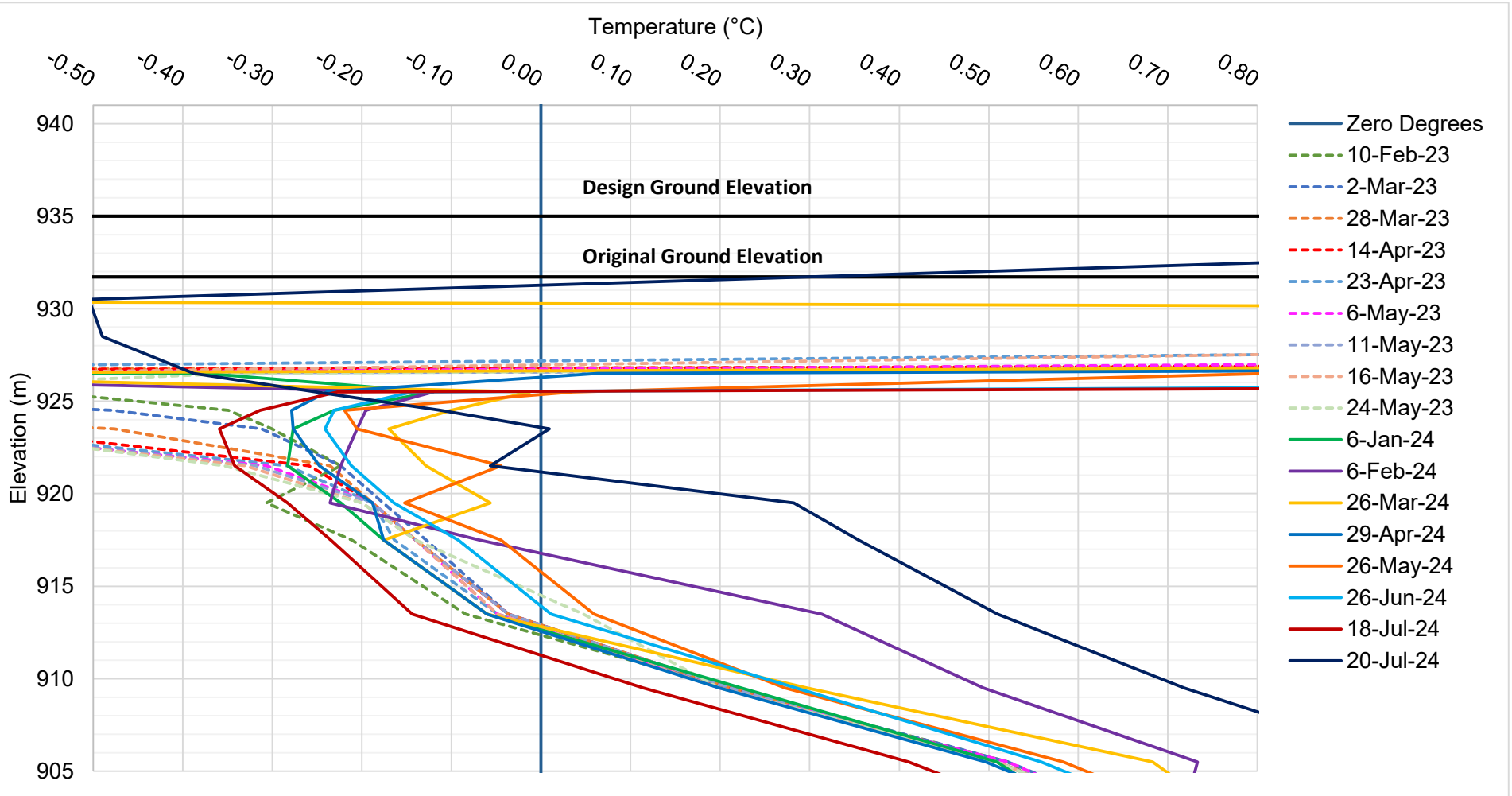
Instrument ID: BH22-01
Cable ID: 2819



Ground Temperature Readings

Project: AKHM DSTF Phase II Detailed Design
Project No: 704-ENG.WARC04307-01
Client: Hecla

ISSUED FOR USE
Ground Temperature Data (2023 to 2024)



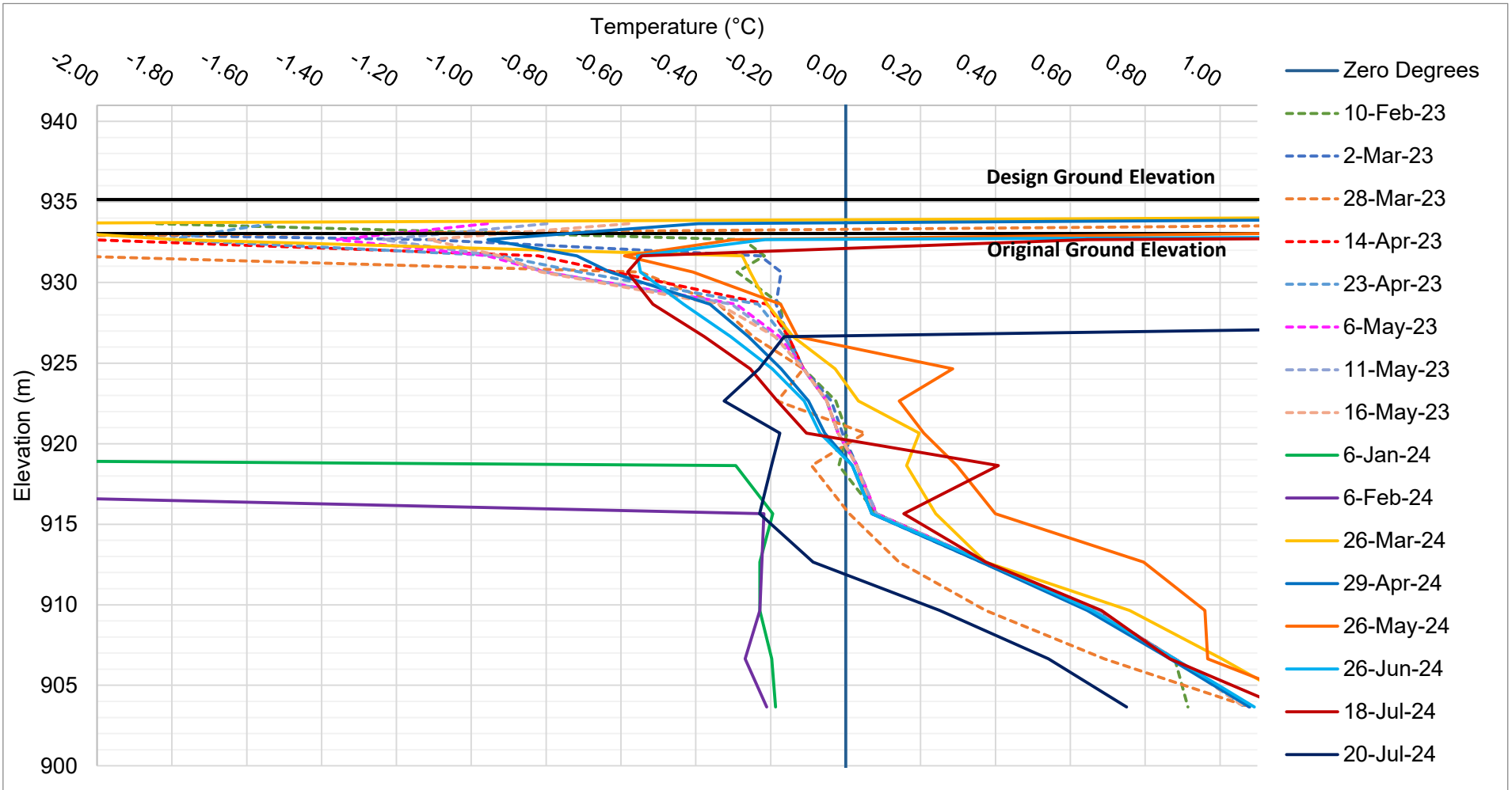
Instrument ID: BH22-05
Cable ID: 2820



Ground Temperature Readings

Project: AKHM DSTF Phase II Detailed Design
 Project No: 704-ENG.WARC04307-01
 Client: Hecla

ISSUED FOR USE
 Ground Temperature Data (2023 to 2024)



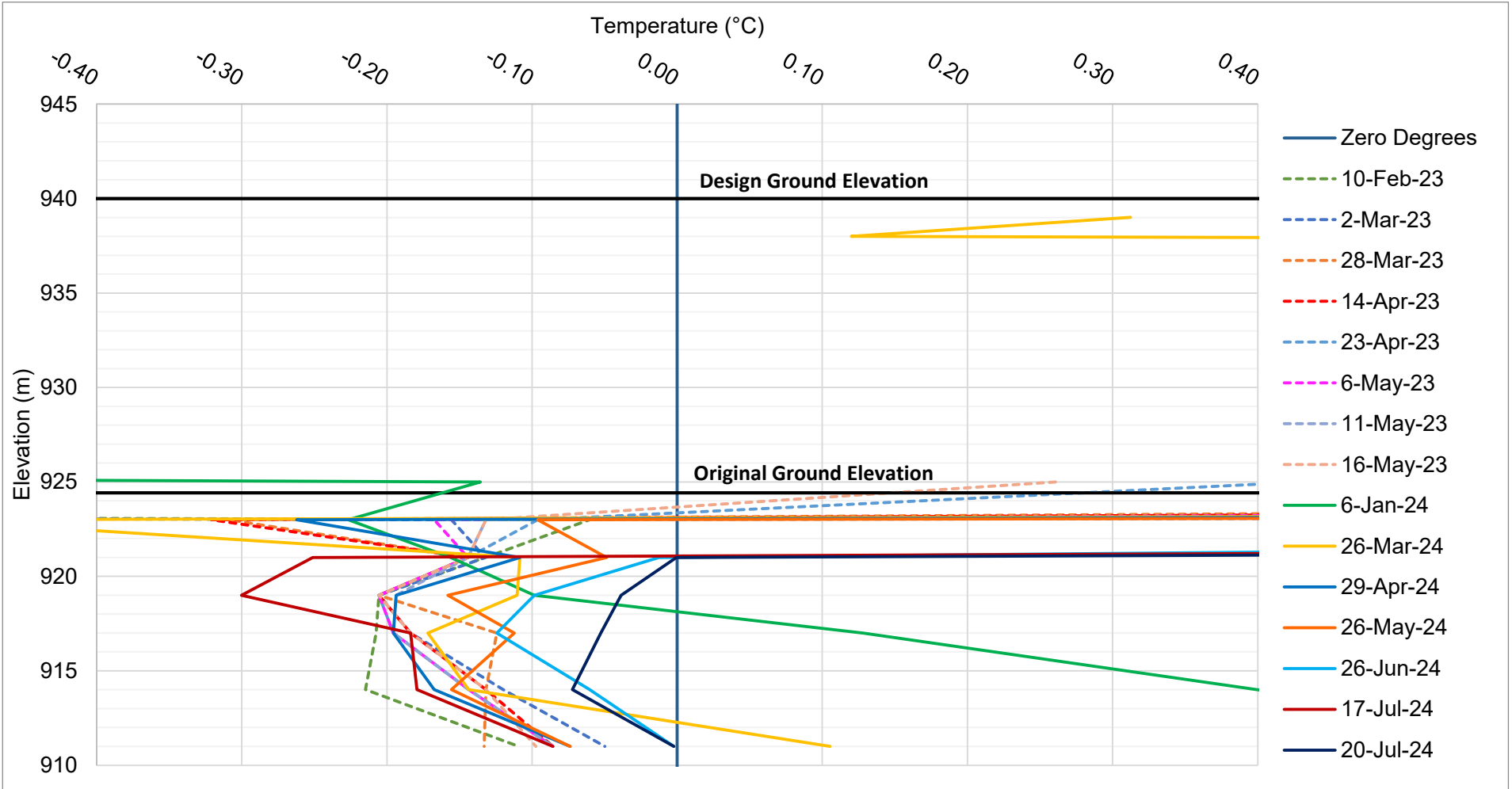
Instrument ID: BH22-06
 Cable ID: 2821



Ground Temperature Readings

Project: AKHM DSTF Phase II Detailed Design
Project No: 704-ENG.WARC04307-01
Client: Hecla

ISSUED FOR USE
Ground Temperature Data (2023 to 2024)



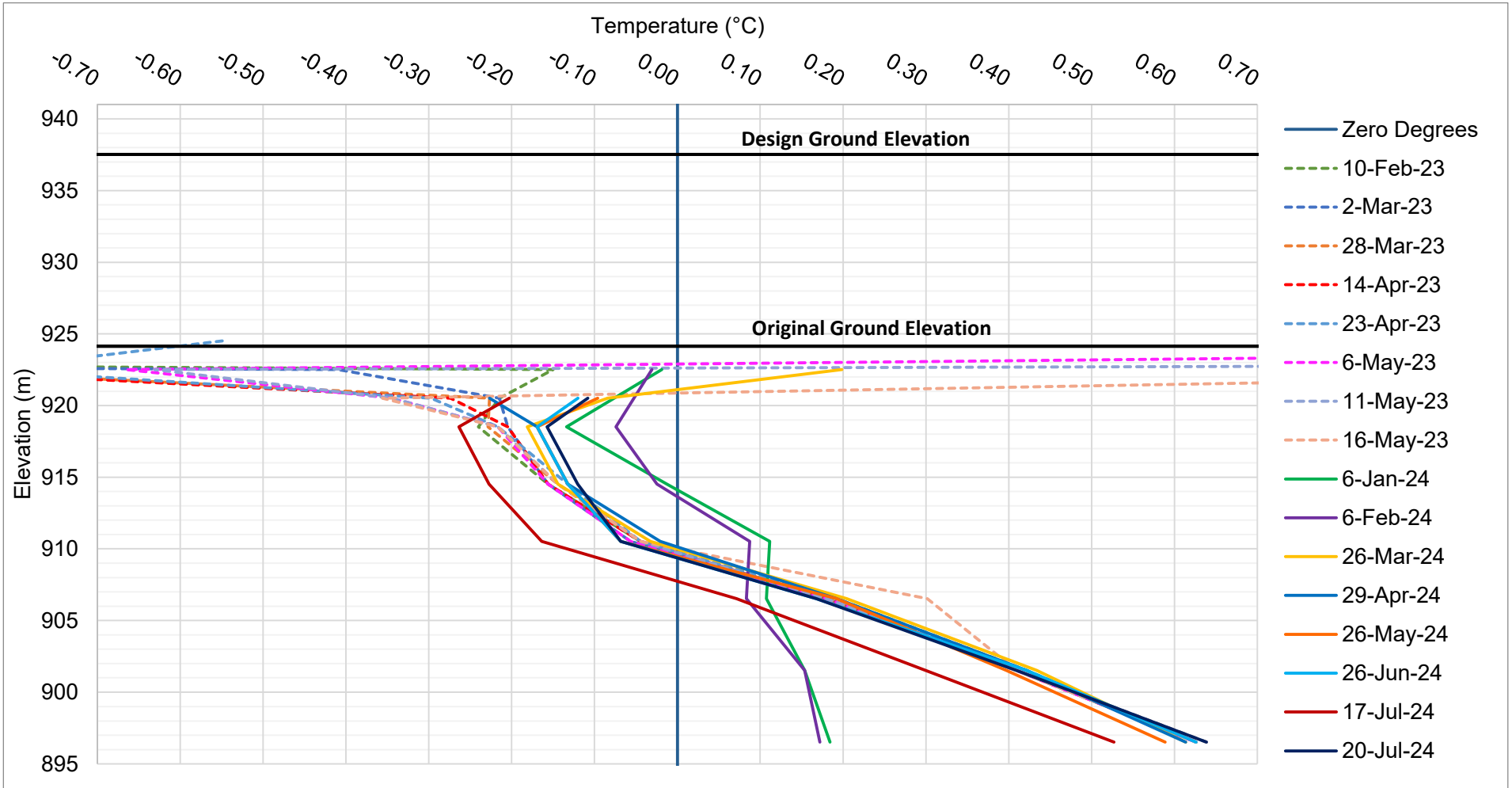
Instrument ID: BH22-07
Cable ID: 2822



Ground Temperature Readings

Project: AKHM DSTF Phase II Detailed Design
 Project No: 704-ENG.WARC04307-01
 Client: Hecla

ISSUED FOR USE
 Ground Temperature Data (2023 to 2024)



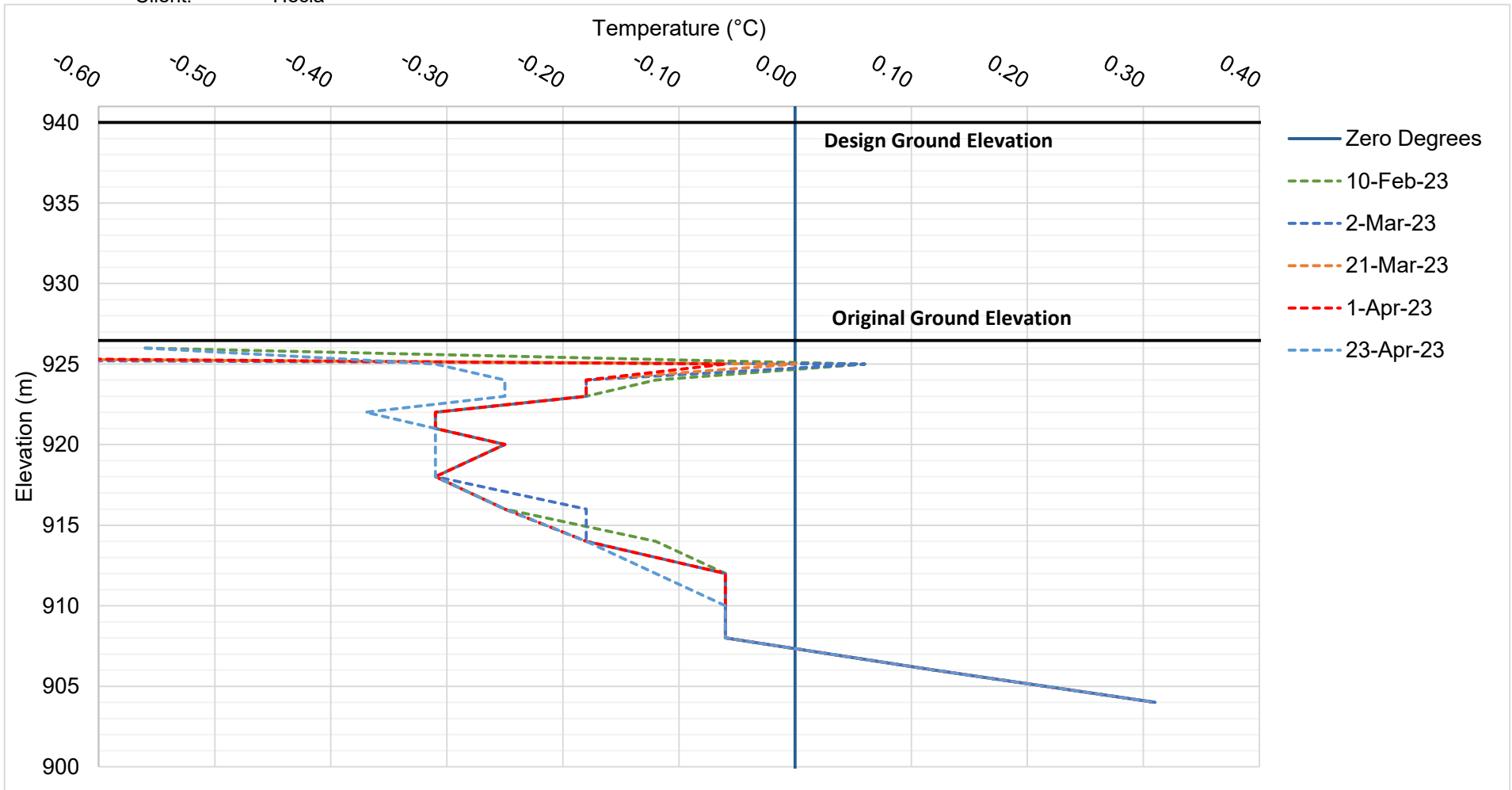
Instrument ID: BH22-09
 Cable ID: 2823



Ground Temperature Readings

Project: AKHM DSTF Phase II Detailed Design
Project No: 704-ENG.WARC04307-01
Client: Hecla

ISSUED FOR USE
Ground Temperature Data (2023 to 2024)



Instrument ID: BH22-08
Cable ID: 4473
Logger ID: D6050215

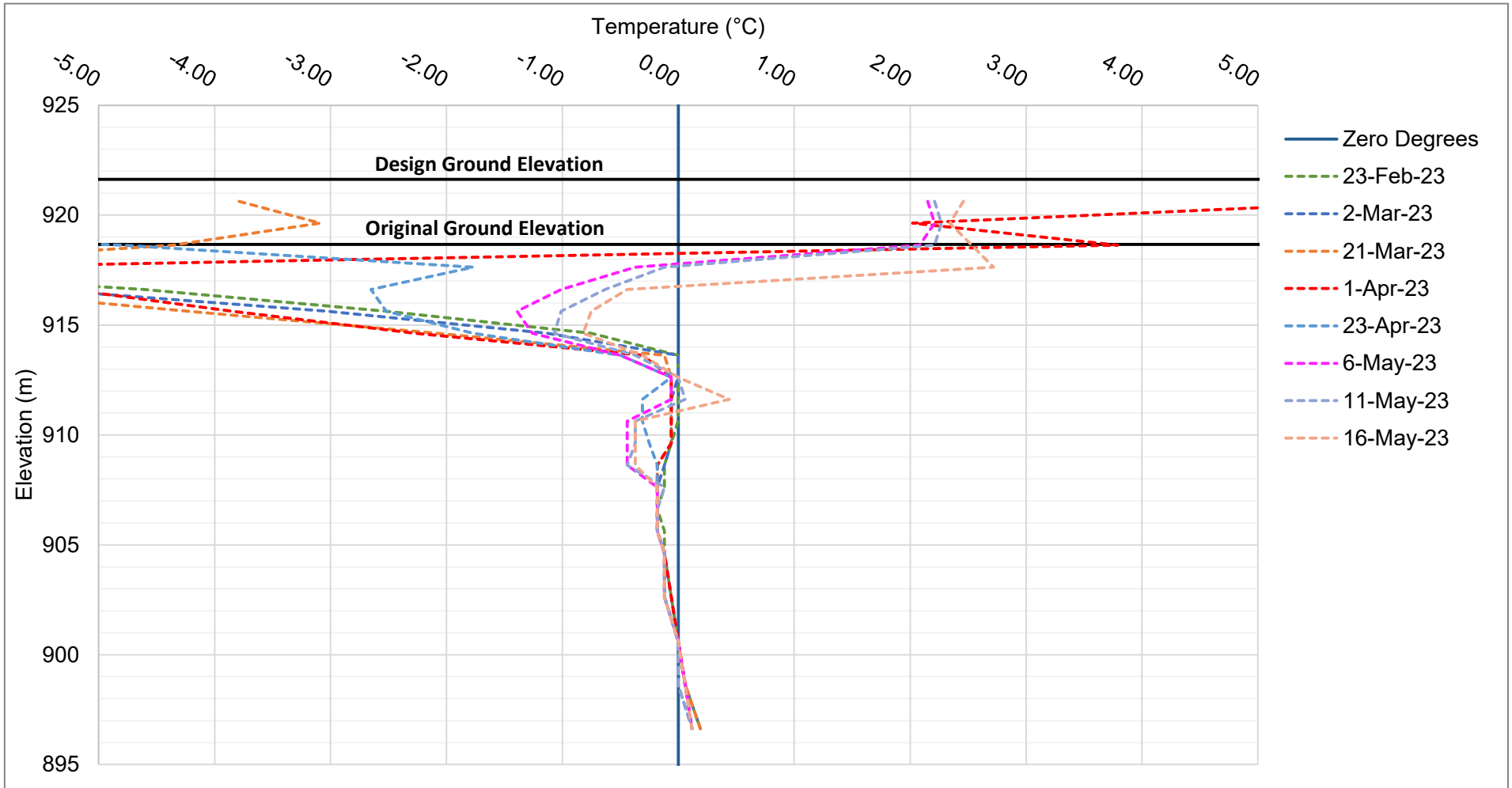
Note: Ground temperature data readings for BH22-08 is not available in 2024.



Ground Temperature Readings

Project: AKHM DSTF Phase II Detailed Design
Project No: 704-ENG.WARC04307-01
Client: Hecla

ISSUED FOR USE
Ground Temperature Data (2023 to 2024)



Instrument ID: BH22-10
Cable ID: 4474
Logger ID: D6050221

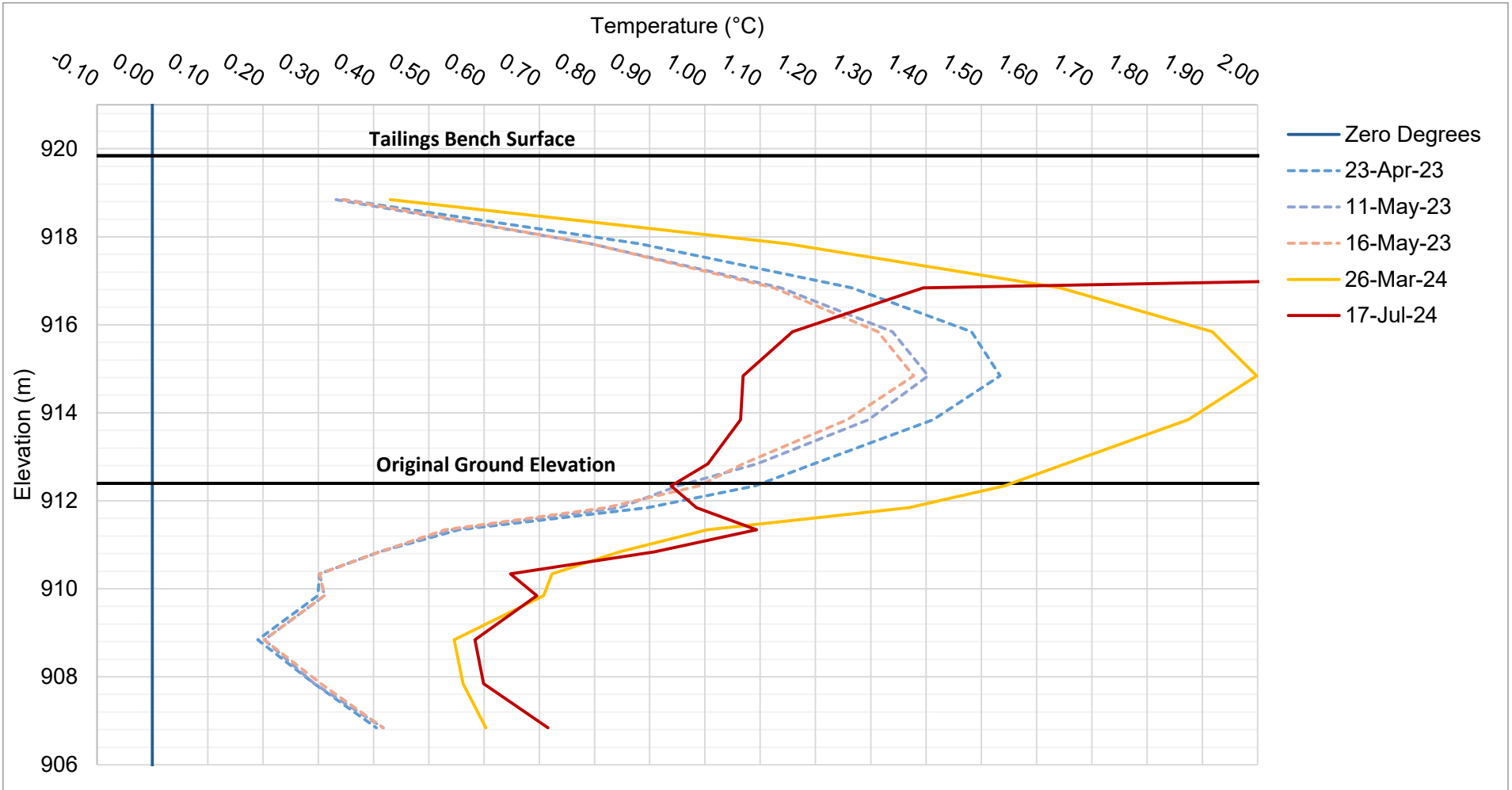
Note: Ground temperature data readings for BH22-10 is not available in 2024.



Ground Temperature Readings

Project: AKHM DSTF Phase II Detailed Design
Project No: 704-ENG.WARC04307-01
Client: Hecla

ISSUED FOR USE
Ground Temperature Data (2023 to 2024)



Instrument ID: BH22-40B
Cable ID: 2824



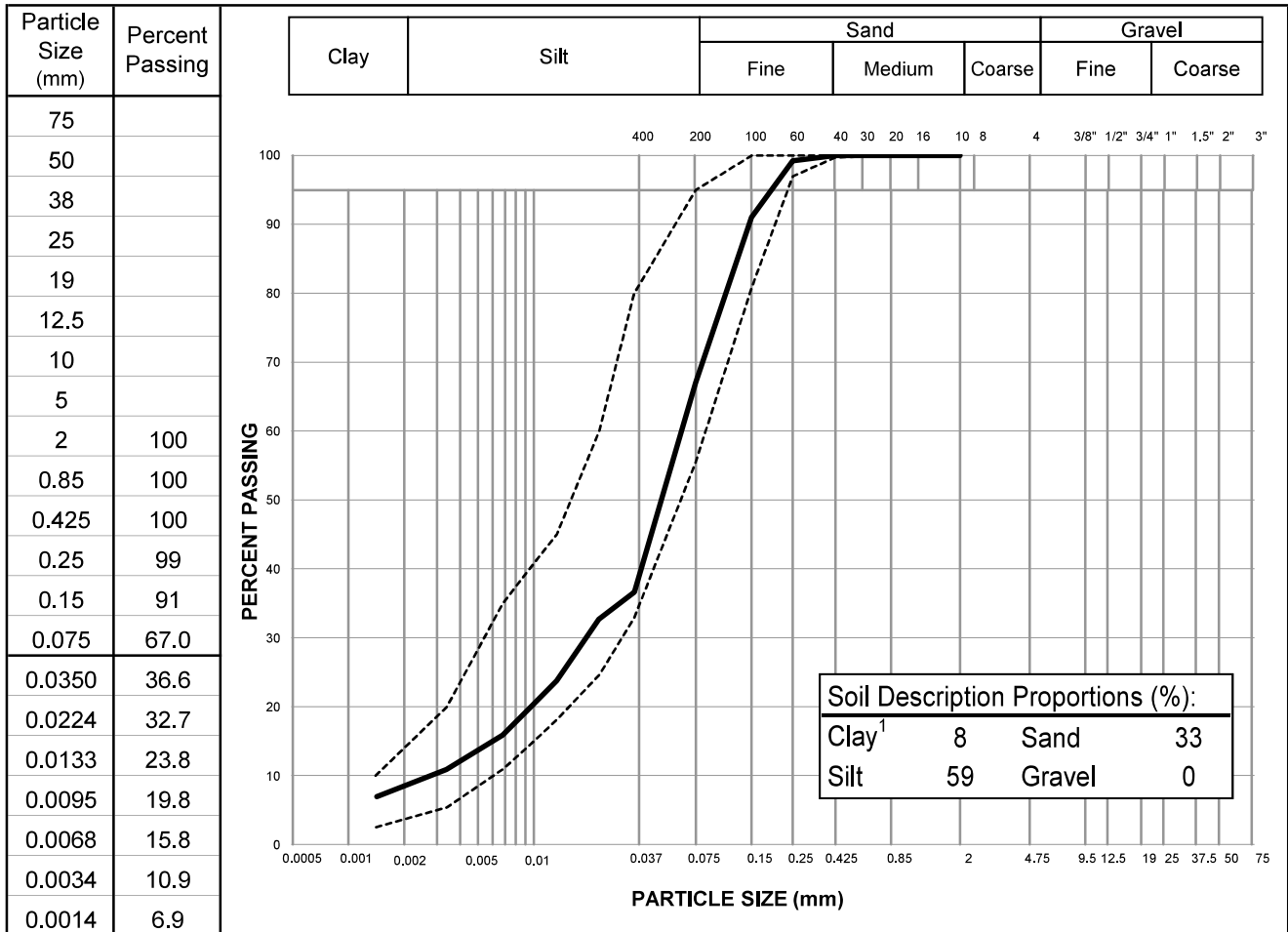
APPENDIX D

TAILINGS AND INTERFACE DIRECT SHEAR LABORATORY TEST DATA

PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Keno Hill Tailings	Sample No.: SA01
Project No.: ENG.WARC04415-07	Material Type: Tailings
Site: Keno Hill	Sample Loc.: -
Client: NELPCo	Sample Depth: -
Client Rep.: -	Sampling Method: Grab
Date Tested: February 1, 2024 By: BW	Date Sampled: December 1, 2023
Soil Description ² : SILT - sandy, trace clay	Sampled By: Client
	USC Classification: ML Cu: 22.4
	Cc: 2.0
Moisture Content: 18.8%	



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.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.

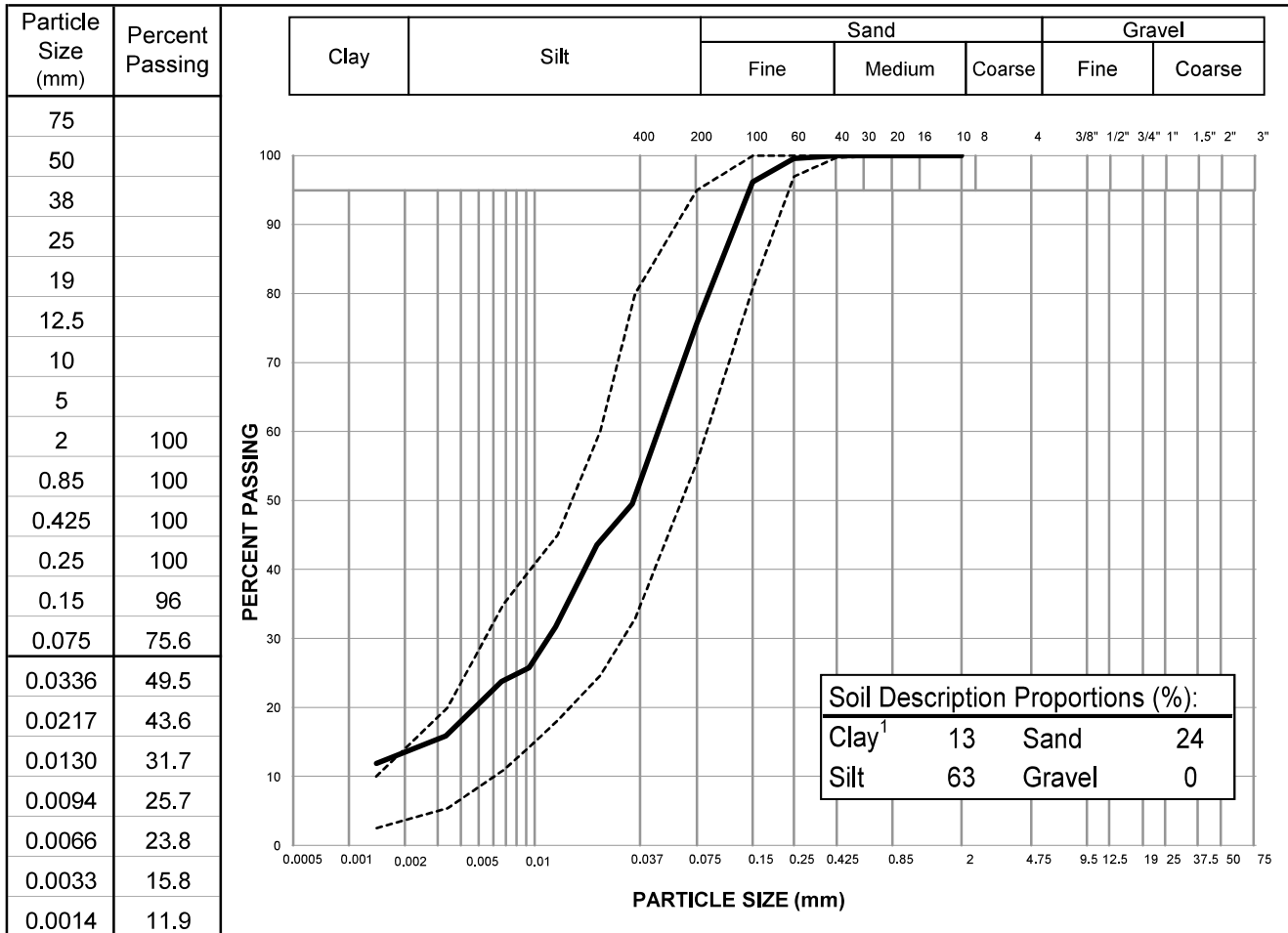


PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project: Keno Hill Tailings	Sample No.: SA02
Project No.: ENG.WARC04415-07	Material Type: Tailings
Site: Keno Hill	Sample Loc.: "Final Tailings"
Client: NELPCo	Sample Depth: -
Client Rep.: -	Sampling Method: Grab
Date Tested: February 1, 2024 By: BW	Date Sampled: January 1, 2024
Soil Description ² : SILT - sandy, trace clay	Sampled By: Client
	USC Classification: ML Cu: #N/A
	Cc: #N/A

Moisture Content: 19.9%



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.Eng.

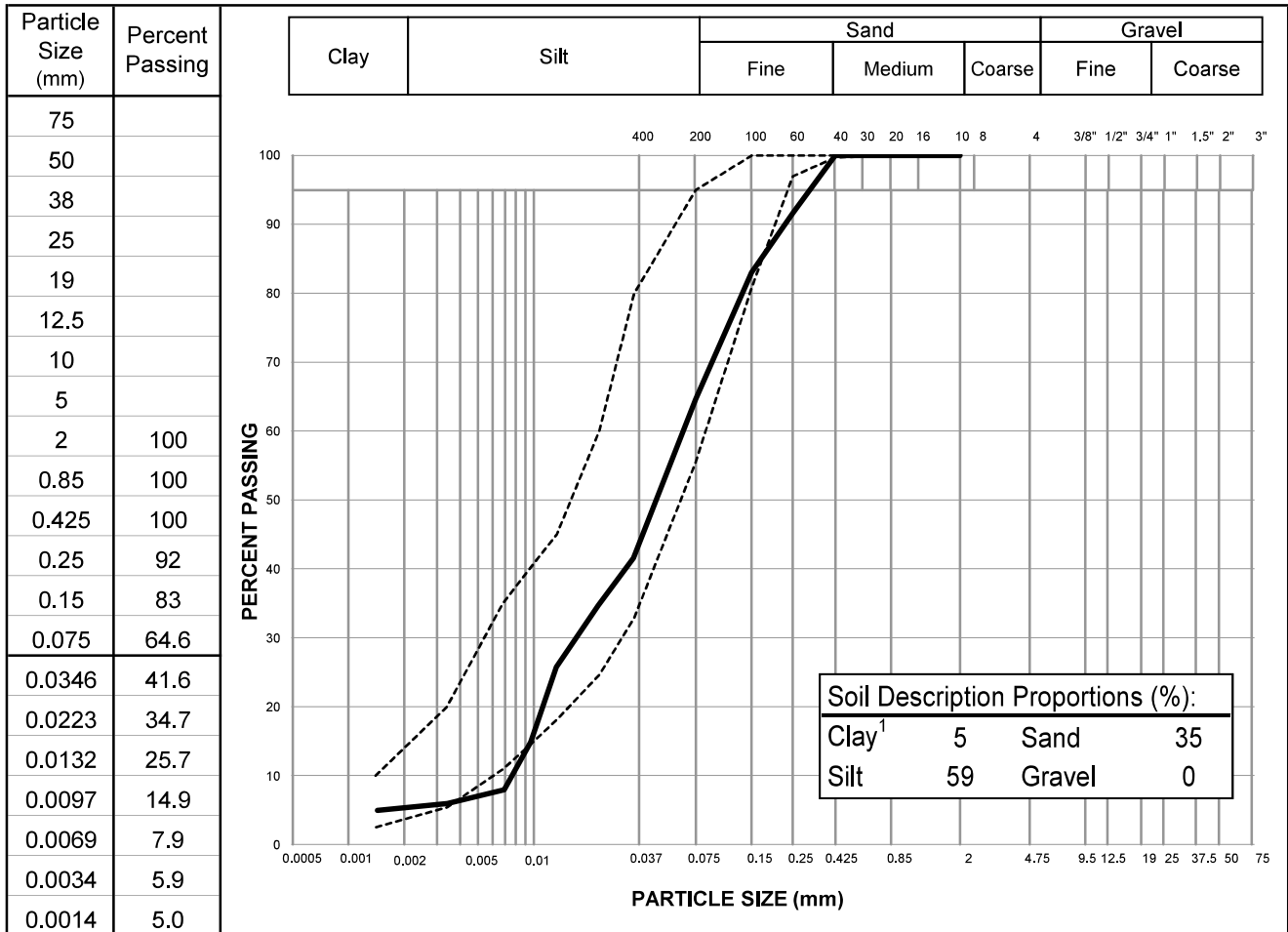
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	Keno Hill Tailings	Sample No.:	SA03
Project No.:	ENG.WARC04415-07	Material Type:	Tailings
Site:	Keno Hill	Sample Loc.:	-
Client:	NELPCo	Sample Depth:	-
Client Rep.:	-	Sampling Method:	Grab
Date Tested:	February 7, 2024	By:	BW
Date Tested:	February 7, 2024	Date Sampled:	January 29, 2024
Soil Description ² :	SILT - sandy, trace clay	Sampled By:	Client
		USC Classification:	ML Cu: 8.6
Moisture Content:	18.0%		Cc: 0.6



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.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



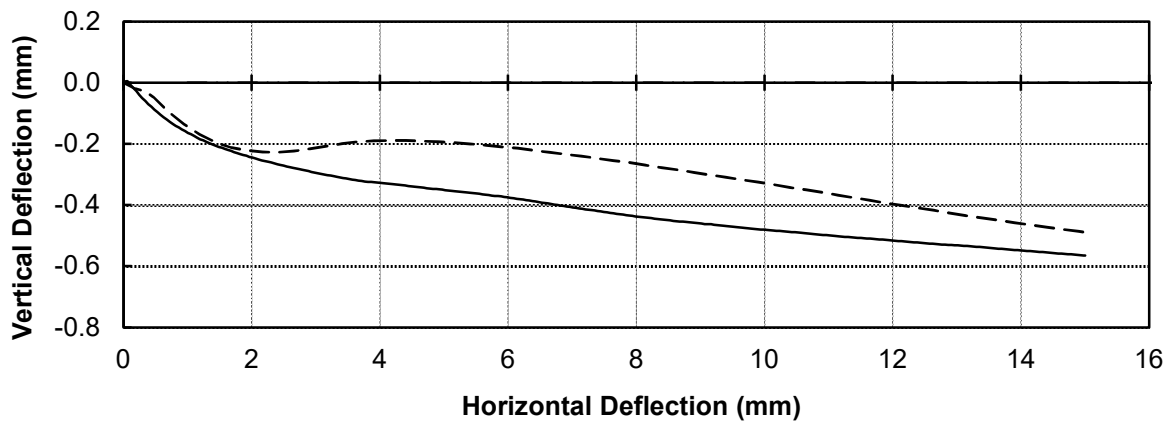
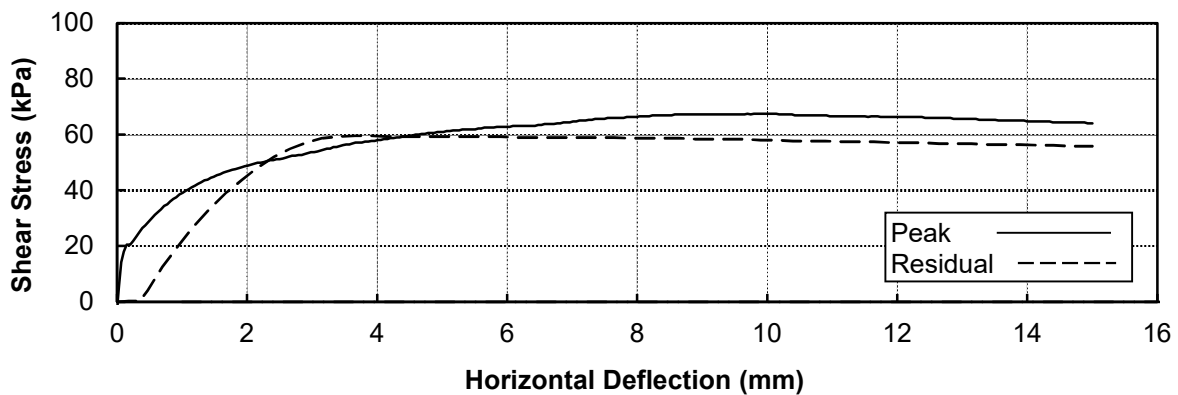
DIRECT SHEAR TEST

ASTM D3080

Project: Keno Mine Tailings
Project No.: ENG.WARC04415-07
Client: NELPCo.
Date Tested: October 26, 2023
Description: Filtered Tailings

Source: Flame & Moth Mill
Location: Tailings Discharge
Test No.: DS-1
Machine: 4
Preparation: Remolded

Normal Stress (kPa) =	100	Moisture Content (%)	13.2
Peak Stress (kPa) =	67	Wet Density (Mg/m ³)	1.881
Residual Stress (kPa) =	56	Dry Density (Mg/m ³)	1.662



Remarks: Remolded to 90%

Reviewed By: IPR P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.

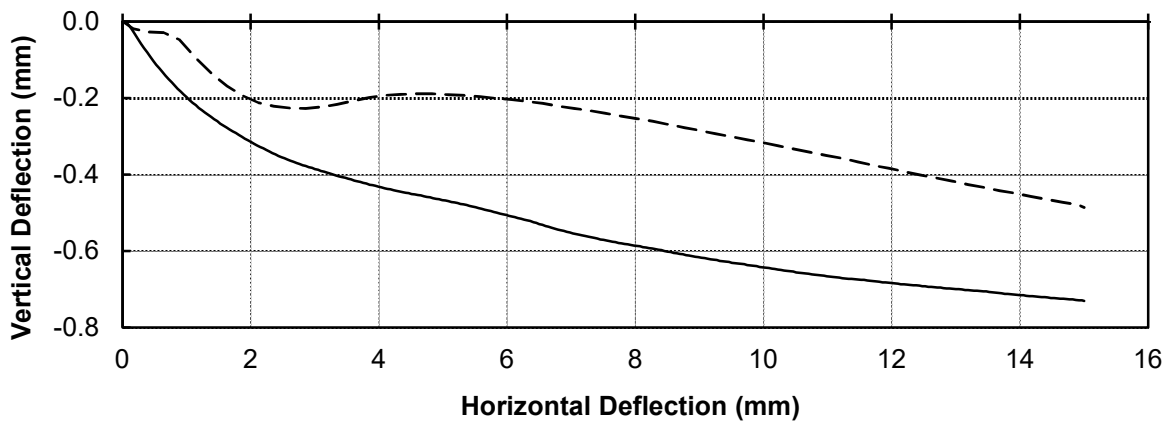
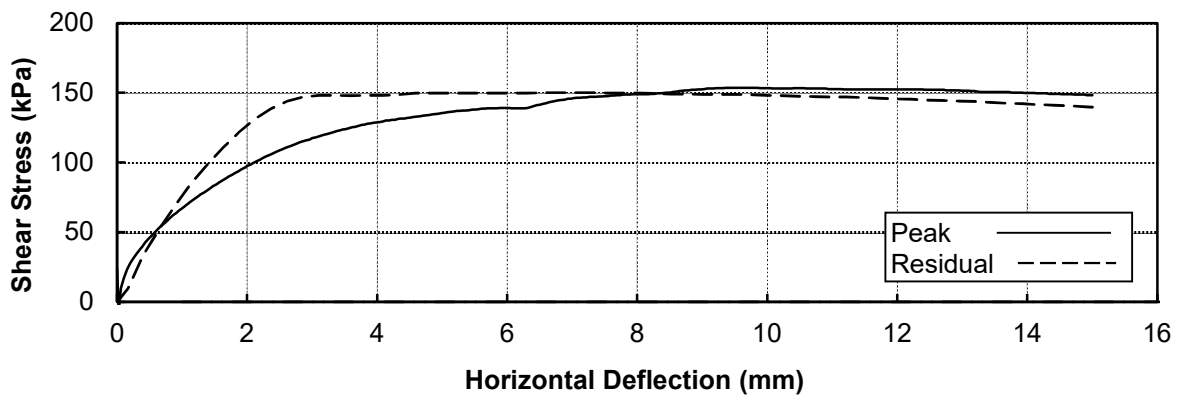
DIRECT SHEAR TEST

ASTM D3080

Project: Keno Mine Tailings
Project No.: ENG.WARC04415-07
Client: NELPCo.
Date Tested: October 26, 2023
Description: Filtered Tailings

Source: Flame & Moth Mill
Location: Tailings Discharge
Test No.: DS-2
Machine: 5
Preparation: Remolded

Normal Stress (kPa) =	200	Moisture Content (%)	18.3
Peak Stress (kPa) =	154	Wet Density (Mg/m ³)	1.881
Residual Stress (kPa) =	140	Dry Density (Mg/m ³)	1.590



Remarks: Remolded to 90%

Reviewed By: IPR P.Eng.

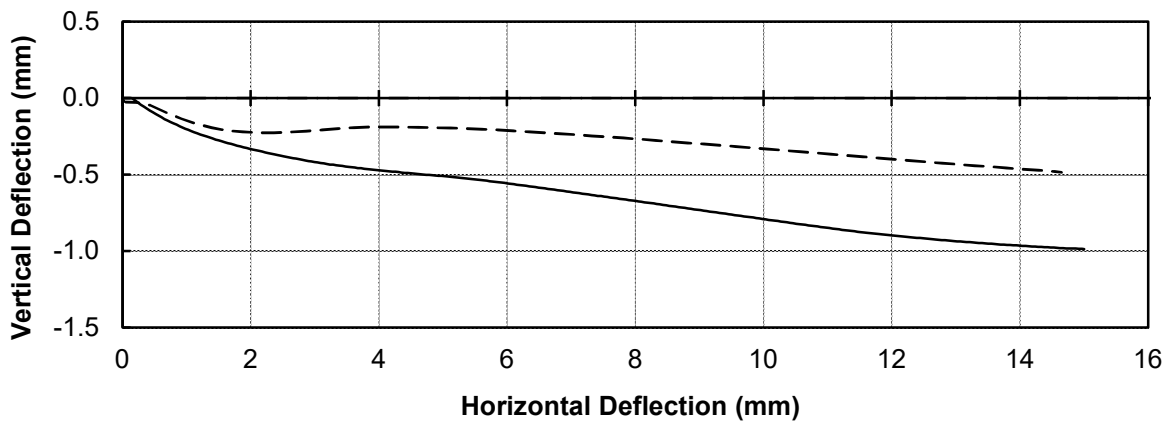
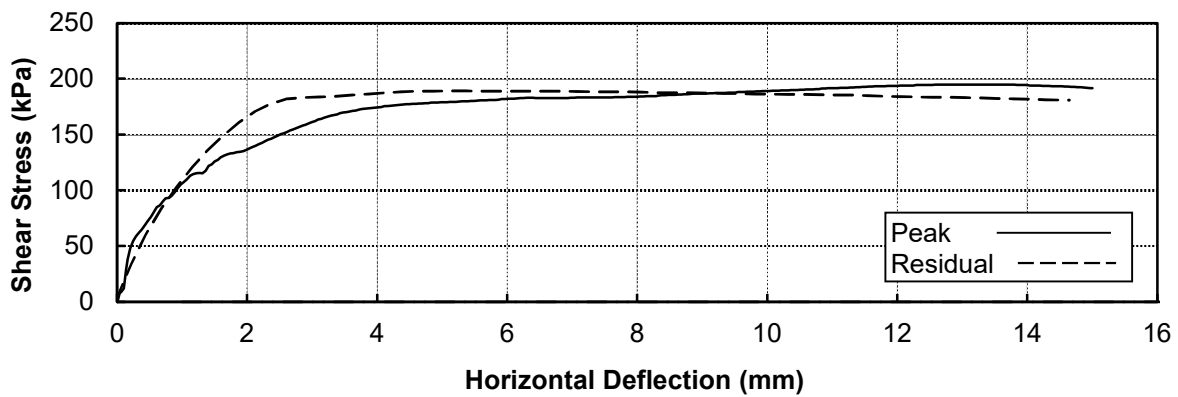
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.

DIRECT SHEAR TEST

ASTM D3080

Project:	Keno Mine Tailings	Source:	Flame & Moth Mill
Project No.:	ENG.WARC04415-07	Location:	Tailings Discharge
Client:	NELPCo.	Test No.:	DS-3
Date Tested:	October 26, 2023	Machine:	6
Description:	Filtered Tailings	Preparation:	Remolded

Normal Stress (kPa) =	300	Moisture Content (%)	13.3
Peak Stress (kPa) =	195	Wet Density (Mg/m ³)	1.881
Residual Stress (kPa) =	181	Dry Density (Mg/m ³)	1.661



Remarks: Remolded to 90%

Reviewed By: IPR P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.

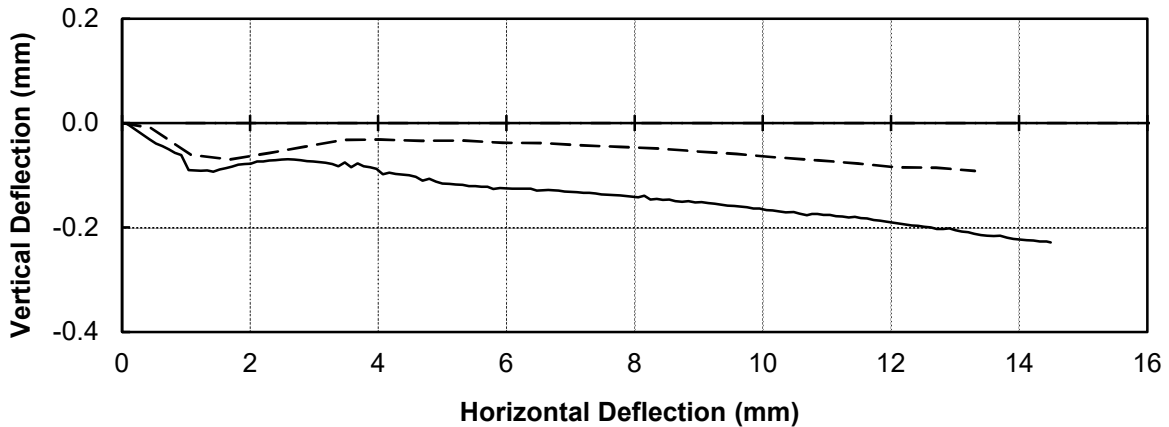
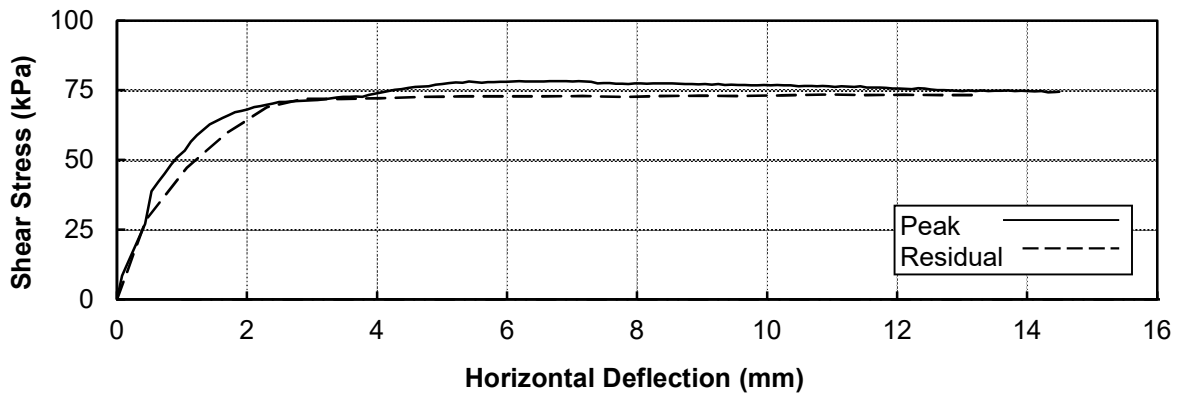
DIRECT SHEAR TEST

ASTM D3080

Project: Keno Hill Tailings
Project No.: ENG.WARC04415-07
Client: NELPCo.
Date Tested: October 26, 2023
Description: Filtered Tailings

Source: Flame & Moth Mill
Location: Tailings Discharge
Test No.: DS-4
Machine: 1
Preparation: Remolded

Normal Stress (kPa) =	100	Moisture Content (%)	Initial 13.1
Peak Stress (kPa) =	78	Wet Density (Mg/m ³)	1.986
Residual Stress (kPa) =	73	Dry Density (Mg/m ³)	1.756



Remarks: Remolded to 95%

Reviewed By: IPR P.Eng.

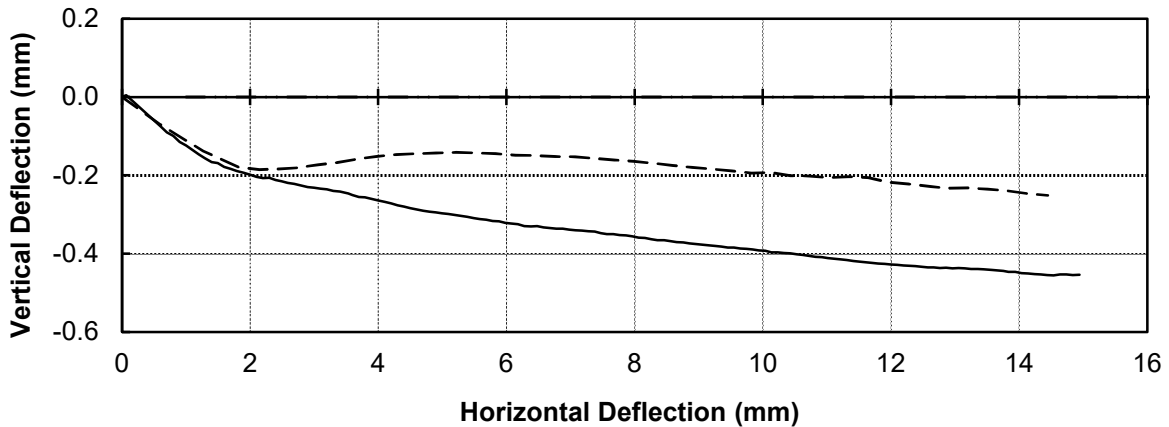
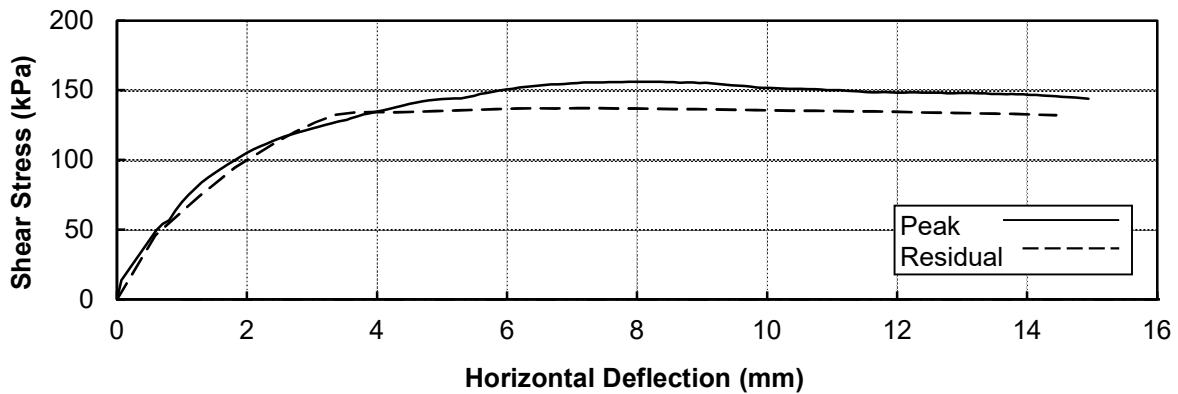
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.

DIRECT SHEAR TEST

ASTM D3080

Project:	Keno Hill Tailings	Source:	Flame & Moth Mill
Project No.:	ENG.WARC04415-07	Location:	Tailings Discharge
Client:	NELPCo.	Test No.:	DS-5
Date Tested:	October 26, 2023	Machine:	2
Description:	Filtered Tailings	Preparation:	Remolded

Normal Stress (kPa) =	200	Moisture Content (%)	Initial 13.1
Peak Stress (kPa) =	156	Wet Density (Mg/m ³)	1.986
Residual Stress (kPa) =	132	Dry Density (Mg/m ³)	1.756



Remarks: Remolded to 95%

Reviewed By: IPR P.Eng.

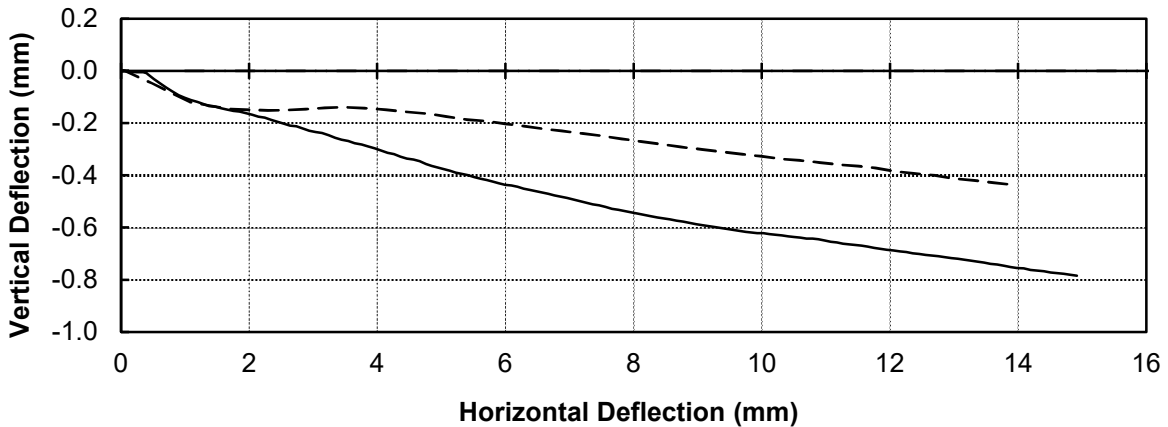
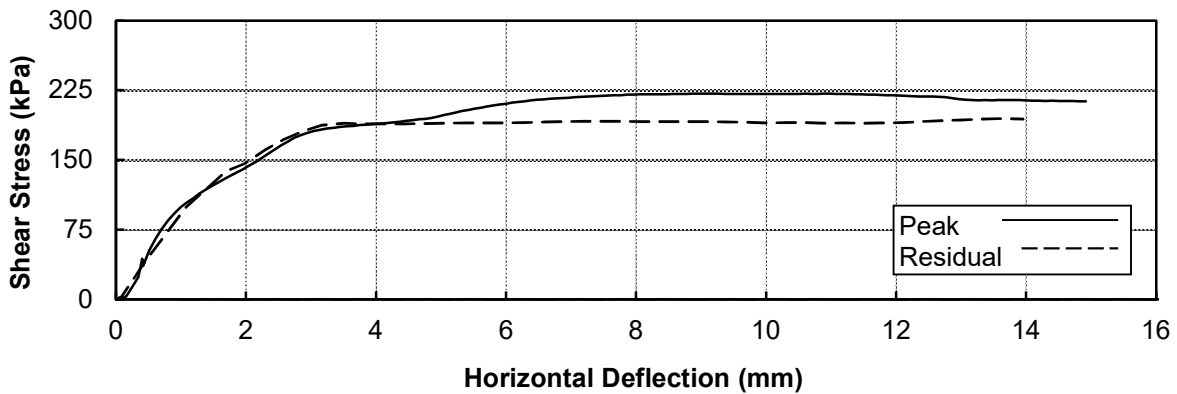
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.

DIRECT SHEAR TEST

ASTM D3080

Project:	Keno Hill Tailings	Source:	Flame & Moth Mill
Project No.:	ENG.WARC04415-07	Location:	Tailings Discharge
Client:	NELPCo.	Test No.:	DS-6
Date Tested:	October 26, 2023	Machine:	3
Description:	Filtered Tailings	Preparation:	Remolded

Normal Stress (kPa) =	300	Moisture Content (%)	Initial 13.2
Peak Stress (kPa) =	221	Wet Density (Mg/m ³)	1.986
Residual Stress (kPa) =	189	Dry Density (Mg/m ³)	1.754



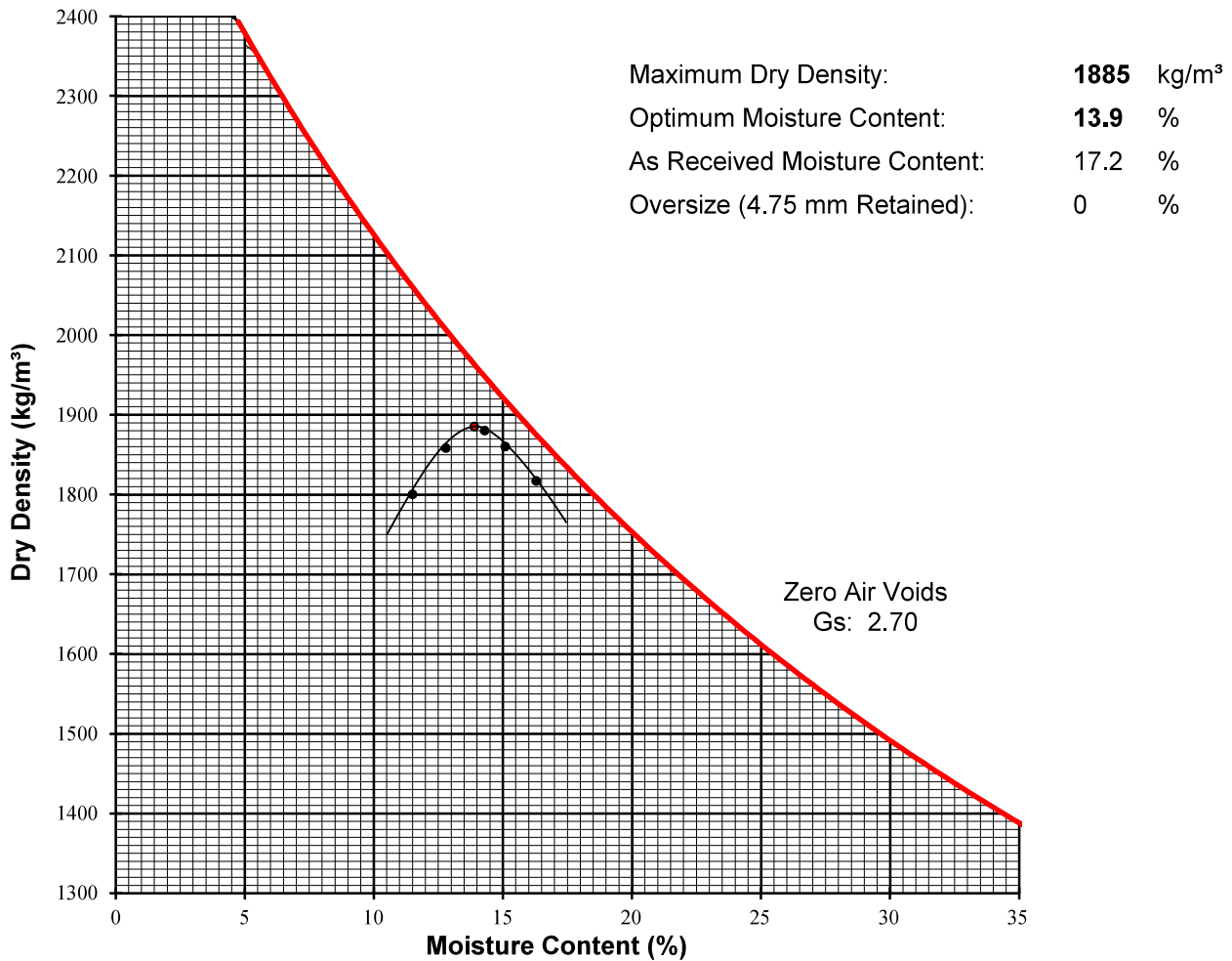
Remarks: Remolded to 95%

Reviewed By: IPR P.Eng.

MOISTURE-DENSITY RELATIONSHIP (Proctor) REPORT

ASTM D698 (Standard Proctor)

Project:	2022 Keno DSTF Tailings Characterization	Sample No.:	1948
Project No.:	ENG.WARC04181-01	Sampled By:	AKHM
Client:	Alexco Keno Mining Corp.	Date Received:	Apr 7, 2022
Attention:	Peter Johnson	Test Date:	Apr 11, 2022
E-mail:		Test By:	MA
Source:	Mill	Test Method:	A (Manual)
Sample Location:	Dry Stack Tailings Facility		
Sample Description:	SILT, sandy, trace clay, grey		



Remarks: _____

Reviewed By: IPR P.Eng.

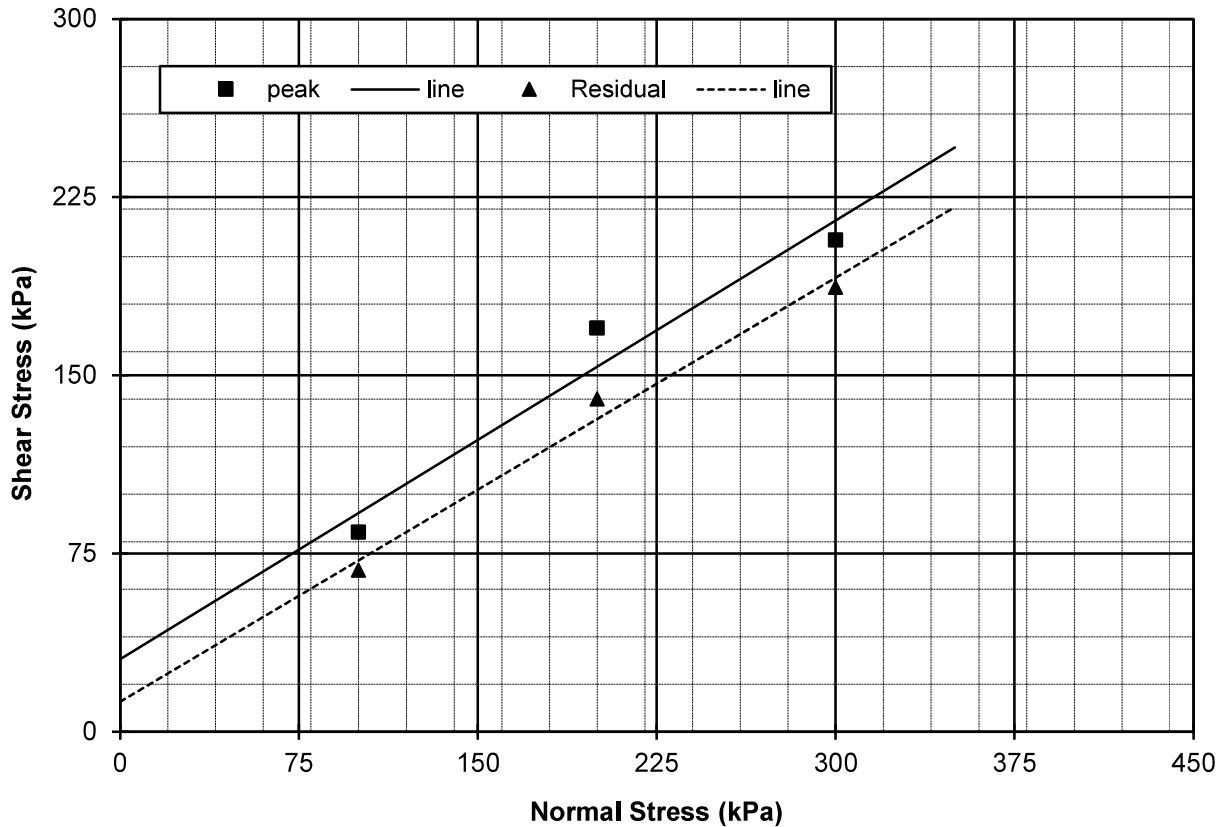
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project: <u>2022 Keno DSTF Tailings Characterization</u>	Sample No.: <u>1948</u>
Project No.: <u>ENG.WARC04181-01</u>	Location: <u>Dry Stack Tailings Facility</u>
Client: <u>Alexco Keno Mining Corp.</u>	Date: <u>Apr 21, 2022</u>
Attention: <u>Peter Johnson</u>	Tested By: <u>TD</u>
Email: _____	Office: <u>Edmonton</u>



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	30.7	31.6
Residual Strength:	12.7	30.8

Reviewed By: IPR P.Eng.

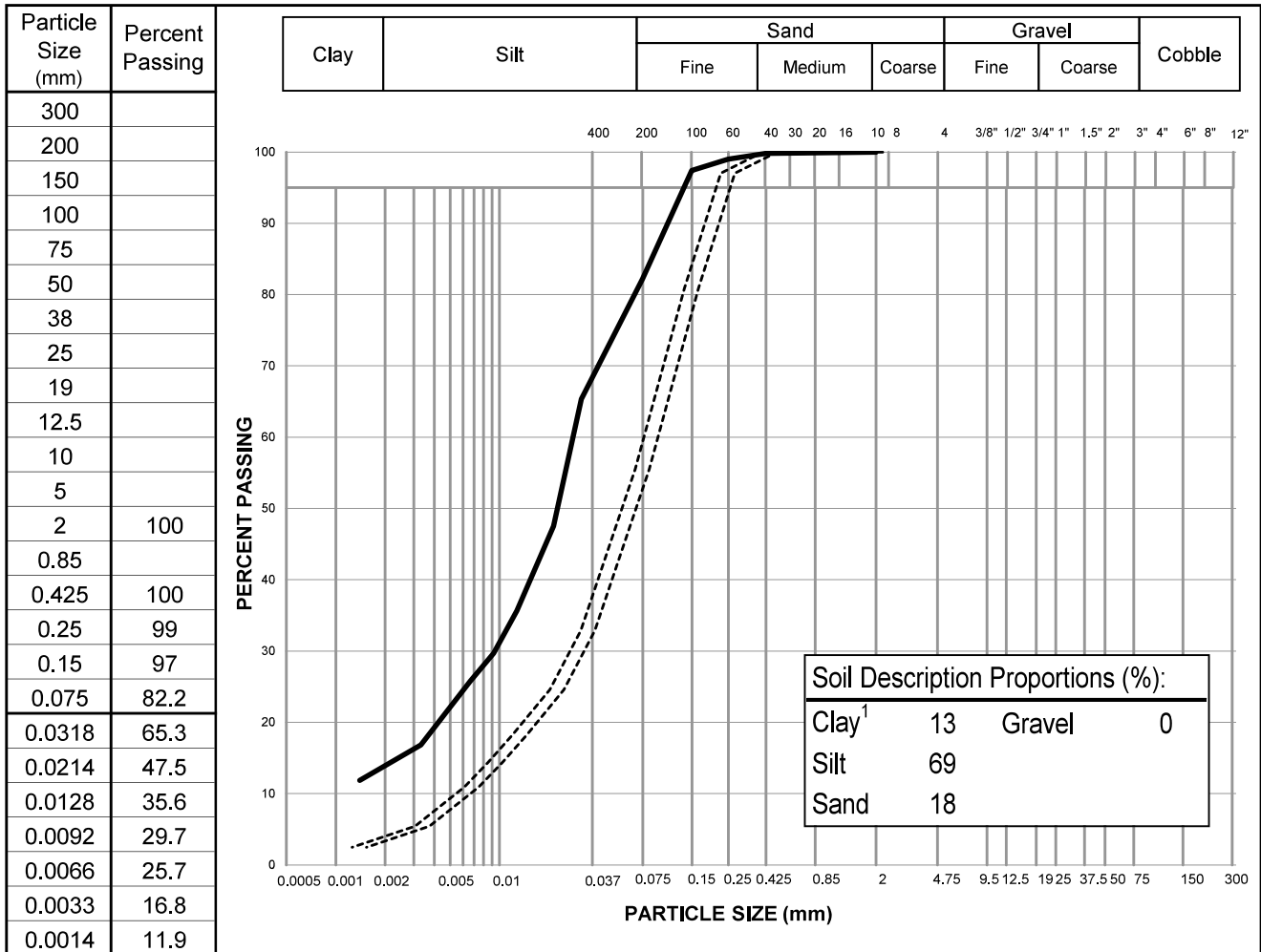
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	2022 Keno DSTF Tailings	Sample No.:	SA01
Project No.:	ENG.WARC04181-01	Material Type:	Tailings
Site:	Alexco Keno Mine	Sample Loc.:	-
Client:	Alexco Keno Hill Mining Corp.	Sample Depth:	-
Client Rep.:	Peter Johncon	Sampling Method:	Grab
Date Tested:	March 22, 2022	By:	BW
Soil Description ² :	SILT - some sand, some clay	Date Sampled:	December 1, 2021
		Sampled By:	Client
		USC Classification:	ML Cu: #N/A
Moisture Content:	20.5%		Cc: #N/A



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

Specification: _____

Remarks: December 08-14, 2021

Reviewed By: P.Eng.

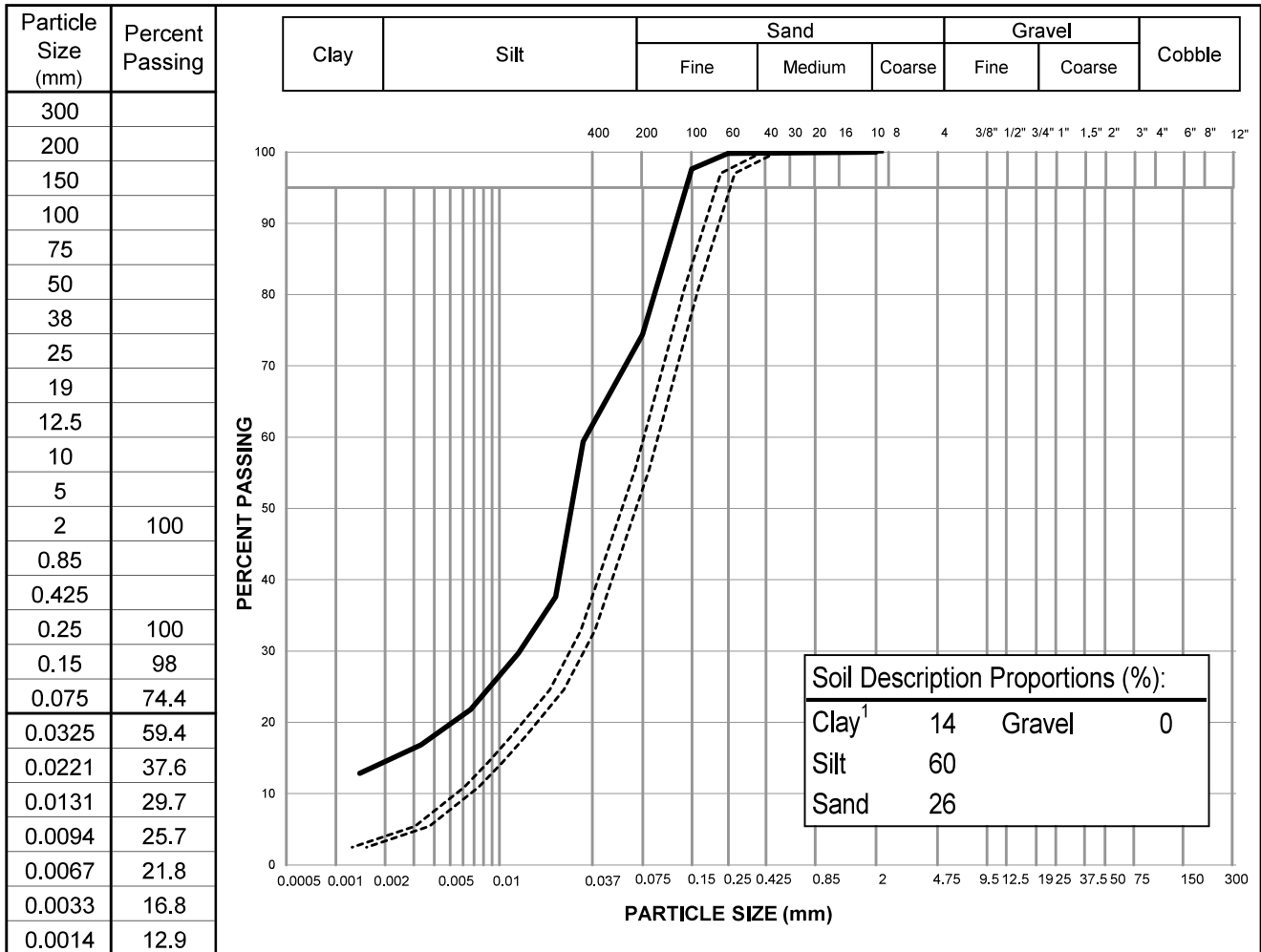
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	2022 Keno DSTF Tailings	Sample No.:	SA03
Project No.:	ENG.WARC04181-01	Material Type:	Tailings
Site:	Alexco Keno Mine	Sample Loc.:	-
Client:	Alexco Keno Hill Mining Corp.	Sample Depth:	-
Client Rep.:	Peter Johncon	Sampling Method:	Grab
Date Tested:	March 22, 2022	By:	BW
Soil Description ² :	SILT - sandy, some clay	Date Sampled:	December 1, 2021
		Sampled By:	Client
		USC Classification:	ML Cu: #N/A
Moisture Content:	20.9%		Cc: #N/A



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

Specification: _____

Remarks: March 08-14, 2022

Reviewed By: P.Eng.

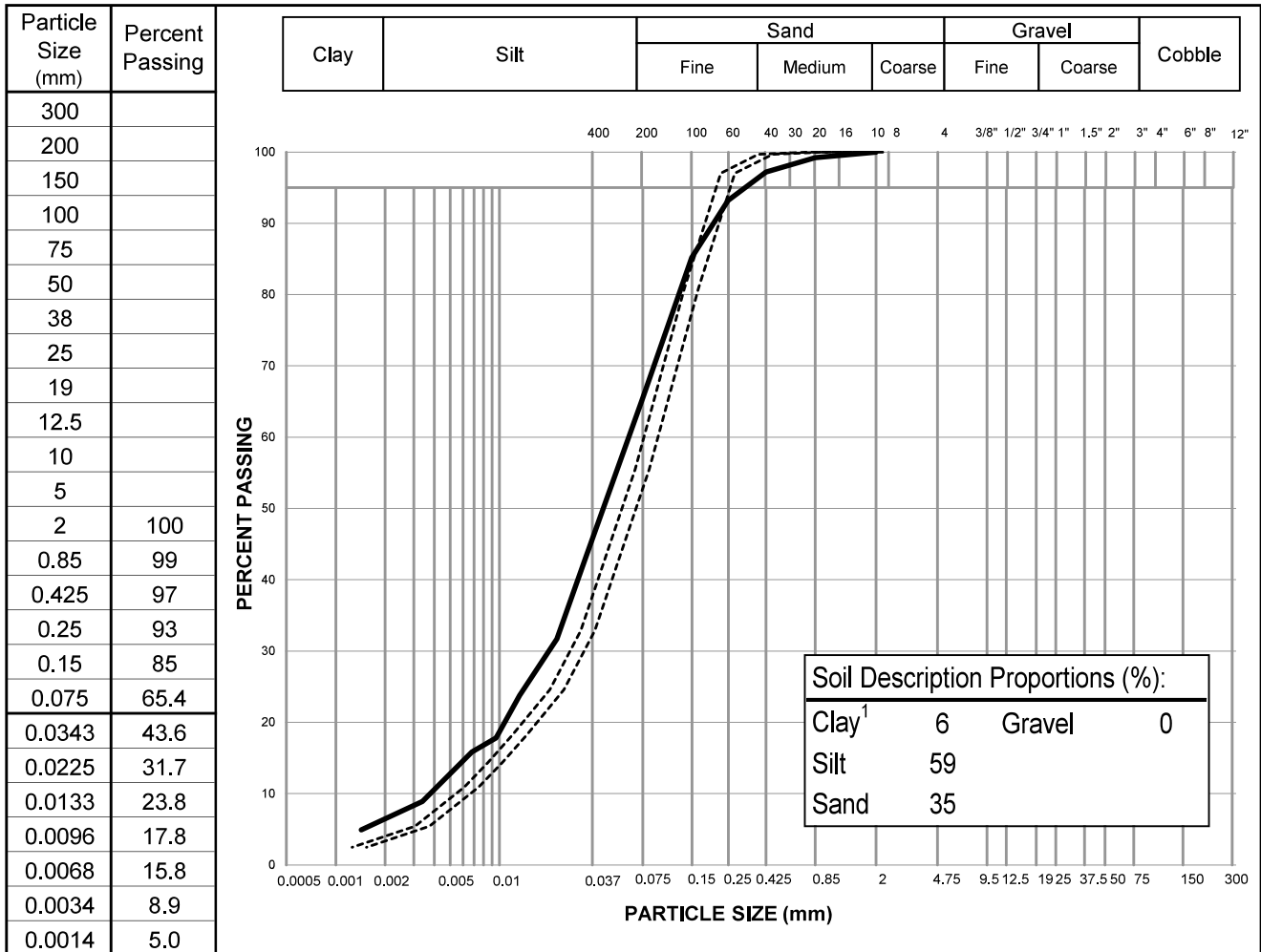
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	2022 Keno DSTF Tailings	Sample No.:	SA04
Project No.:	ENG.WARC04181-01	Material Type:	Tailings
Site:	Alexco Keno Mine	Sample Loc.:	-
Client:	Alexco Keno Hill Mining Corp.	Sample Depth:	-
Client Rep.:	Peter Johncon	Sampling Method:	Grab
Date Tested:	April 5, 2022	By:	BW
Soil Description ² :	SILT - sandy, trace clay	Date Sampled:	March 29, 2022
		Sampled By:	Client
		USC Classification:	ML Cu: 16.5
Moisture Content:	17.5%		Cc: 1.7



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

Specification: _____

Remarks: March 29th, 2022

Reviewed By: P.Eng.

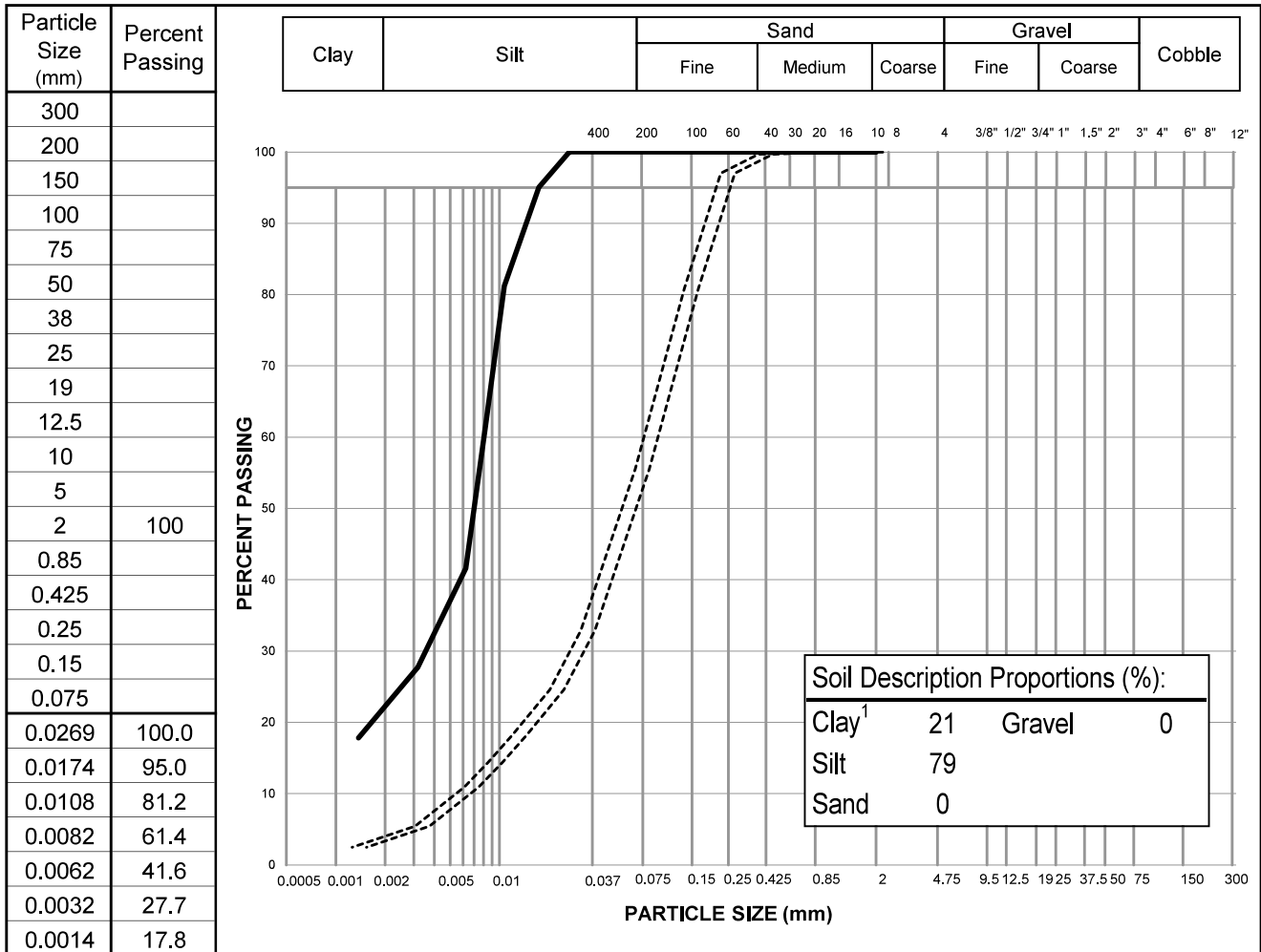
Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



PARTICLE SIZE ANALYSIS REPORT

ASTM D7928 & C136

Project:	2022 Keno DSTF Tailings	Sample No.:	SA13
Project No.:	ENG.WARC04181-01	Material Type:	F and M Sludge
Site:	Alexco Keno Mine	Sample Loc.:	-
Client:	Alexco Keno Hill Mining Corp.	Sample Depth:	-
Client Rep.:	Peter Johnson	Sampling Method:	Grab
Date Tested:	June 13, 2022	By:	CP
Soil Description ² :	SILT and SAND - some clay	Date Sampled:	-
		Sampled By:	Client
		USC Classification:	ML Cu: #N/A
Moisture Content:	124.2%		Cc: #N/A



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

Specification: _____

Remarks: _____

Reviewed By: P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.

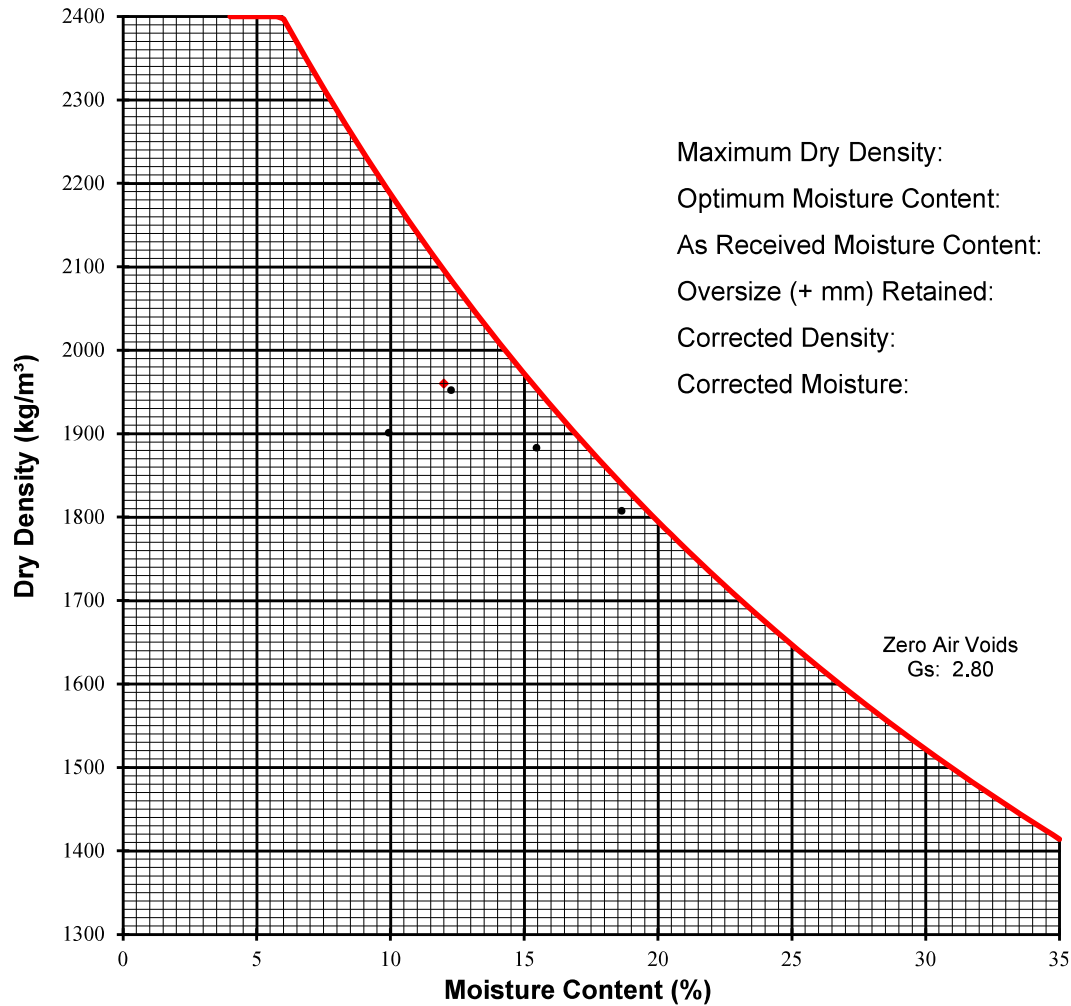


MOISTURE-DENSITY RELATIONSHIP (Proctor) REPORT

ASTM D698 Standard

Project: 2022 Keno DSTF Tailings
Client: Alexco Keno Hill Mining
Attention: Peter Johnson
Project No.: ENG.WARC04181-01
Description: SILT and SAND - some clay
Source: Dry Stack Tailings Facility

Sample No.: SA15
Sampled By: Client
Sample Date: May 31, 2022
Test Date: June 10, 2022
Preparation: Moist
Compaction: Manual



Remarks: -

Reviewed By:  P.Eng.

Data presented hereon is for the sole use of the stipulated client. Tetra Tech is not responsible, nor can be held liable, for use made of this report by any other party, with or without the knowledge of Tetra Tech. The testing services reported herein have been performed to recognized industry standards, unless noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance or material suitability. Should engineering interpretation be required, Tetra Tech will provide it upon written request.



ANALYSIS REPORT
SCC Accreditation No.: 403

Mr. Ian MacIntyre
Tetra Tech

Date: February 14, 2024
 Report: 6710-001S-1A-en

IDENTIFICATION: Interface test #1: Tailings Vs GTX Non-woven
 Project: 704-ENV.WARC 04415-09
 Tailings received on January 03, 2024
 Received: January 9, 2024

STANDARD:

TEST: Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear ASTM D5321/D5321M-21

TEST CONDITIONS: Shear surface 304 x 304 mm;
 Data acquisition period (seconds): 6.00
 Flat surfaces grips fixed with 4 bolts + rasp surface in lower box and upper box ;
 Normal load: Micro-Stepper Motor
 Rate of horizontal displacement(mm/min); 0.2
 Tested in machine direction ;
 Submerged interface ;
 Thickness: 5 measurements per specimen according to ASTM D5199 (Non-woven Geotextile);
 Mass per unit area: 1 measurement per specimen according to ASTM D5261 (Non-woven Geotextile);
 Testing configuration - Upper box / Lower box: Tailings / Non-woven Geotextile
 Date of test: between January 24 and February 6, 2024

RESULTS: Individual Data

Normal Compressive Pressure (kPa):	102.4	201.7	400.4
------------------------------------	-------	-------	-------

GEOTEXTILE PROPERTIES

Mass per unit area of the geosynthetic estimated basing on the weight of the specimen (g/m²):	302	293	279
---	-----	-----	-----

Specimen thickness (mils):	76	70	70
----------------------------	----	----	----

PROPERTIES OF THE SOIL

Water content of compaction (%):	15.5	15.1	15.3
----------------------------------	------	------	------

Dry unit weight after compaction (kg/m³):	1860	1880	1870
---	------	------	------

Duration of the consolidation (hours):	16	16	16
--	----	----	----

TEST RESULTS

Peak shear stress (kPa):	84.4	150.7	308.2
--------------------------	------	-------	-------

Prepared by:

 Marlon Bustos, M.Eng.
 Technician

Approved by:

 Omar Kamla, Eng.
 Project Leader

Date: February 14, 2024

**** Any question regarding this report or its authenticity? Please contact Omar Kamla ****

The reports are identified by an alphanumeric code, the letter preceding "en" refers to the revision number, emitted in ascending order. The electronic copy sent by CTT Group is the official report. The reported identification is based on what was observed on the received sample and/or information provided by the customer. The samples in relation to this report are retained for a period of 30 days following transmission of the report. The above reported results refer exclusively to the samples submitted for evaluation. This analysis report cannot be partly used or reproduced, unless in whole, without CTT Group prior written consent. The ISO IEC 17025 Scope of Accreditation of CTT Group is available at www.gcttg.com. In this report, the tests which number is followed by the symbol are not covered by this accreditation. For customer's complete address, please refer to the email

ANALYSIS REPORT
SCC Accreditation No.: 40†

Mr. Ian MacIntyre
Tetra Tech

Date: February 14, 2024
 Report: 6710-001S-1A-en

IDENTIFICATION: Interface test #1: Tailings Vs GTX Non-woven
 Project: 704-ENV.WARC 04415-09
 Tailings received on January 03, 2024
 Received: January 9, 2024

STANDARD:

TEST: Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear ASTM D5321/D5321M-21


RESULTS (CONT):	Individual Data		
	Shear stress at large displacement (kPa):	64.1	108.7
Estimated peak angle of friction (°):	37		
Estimated peak adhesion (kPa):	3.4		
Estimated angle of friction at large displacement (°):	30		
Estimated adhesion at large displacement (kPa):	0.0		


REMARKS: -The thickness of the soil layer was reduced to 40 mm to facilitate consolidation and minimize experimental problems.

Consolidation:

- 100kPa: 1 hour at 10kPa, 1 hour at 50kPa, 16 hours at 100kPa.
- 200kPa: 1 hour at 10kPa, 1 hour at 50kPa, 1 hour at 100kPa, 16 hours at 200kPa.
- 400kPa: 1 hour at 10kPa, 1 hour at 50kPa, 1 hour at 100kPa, 1 hour at 200kPa, 16 hours at 400kPa.

- See graphs and pictures in appendix.

Prepared by: 
 Marlon Bustos, M.Eng.
 Technician

Approved by: 
 Omar Kamla, Eng.
 Project Leader

Date: February 14, 2024

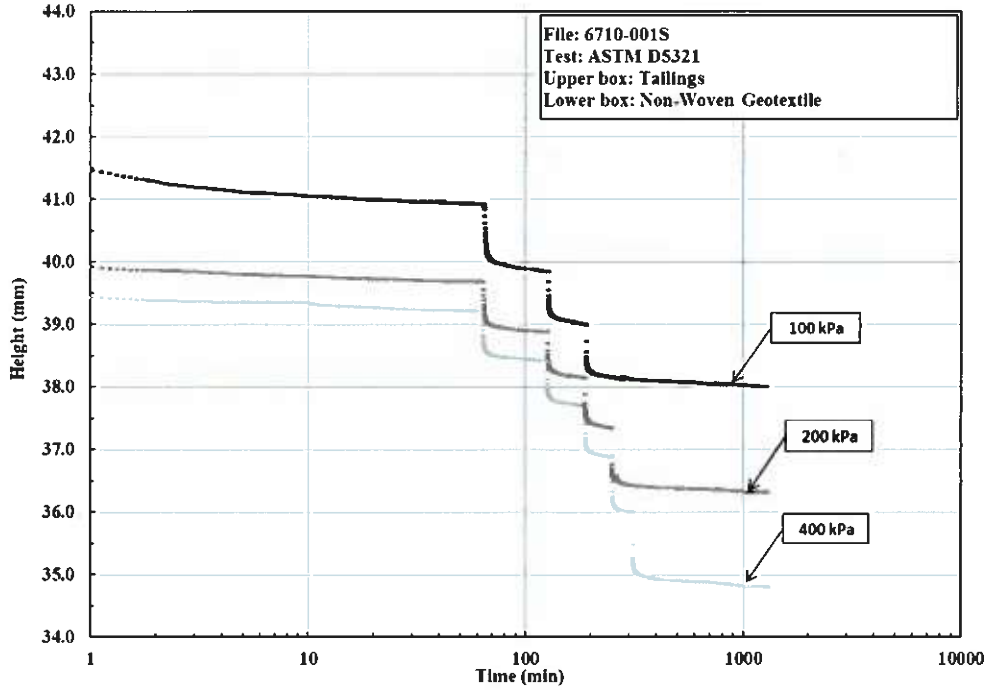
**** Any question regarding this report or its authenticity? Please contact Omar Kamla ****

The reports are identified by an alphanumeric code, the letter preceding "-en" refers to the revision number, emitted in ascending order. The electronic copy sent by CTT Group is the official report. The reported identification is based on what was observed on the received sample and/or information provided by the customer. The samples in relation to this report are retained for a period of 30 days following transmission of the report. The above reported results refer exclusively to the samples submitted for evaluation. This analysis report cannot be partly used or reproduced, unless in whole, without CTT Group prior written consent. † The ISO/IEC 17025 Scope of Accreditation of CTT Group is available at www.gcttg.com. In this report, the tests which number is followed by the symbol † are not covered by this accreditation. For customer's complete address, please refer to the email.

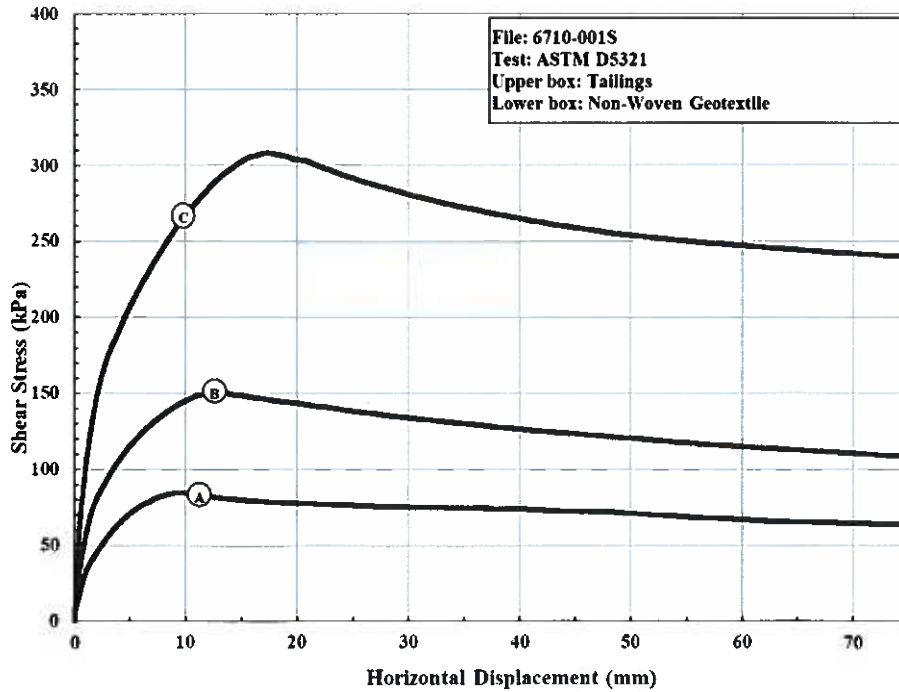




APPENDIX
Graphs

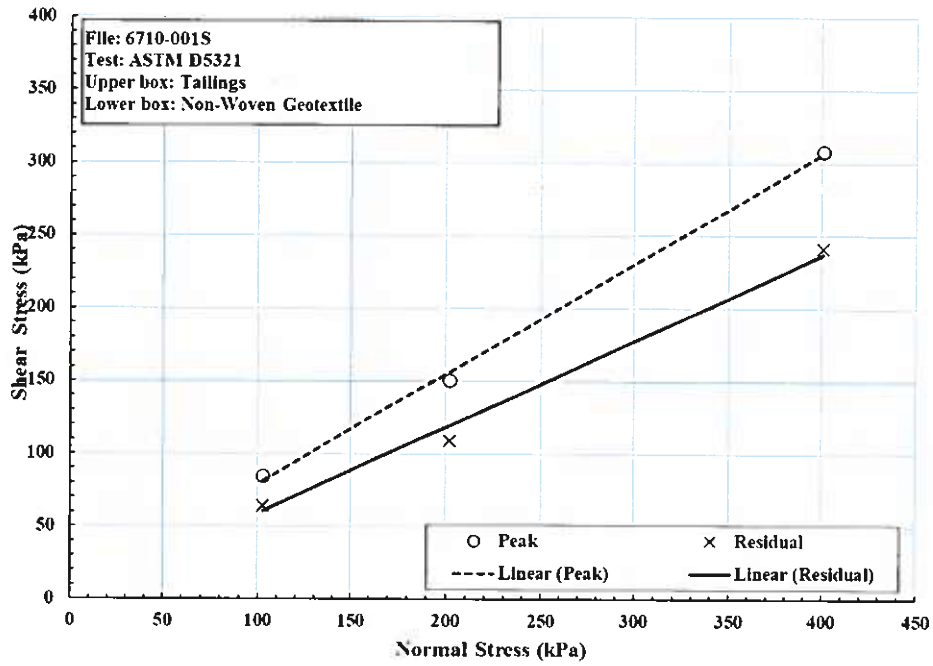


Consolidation curve



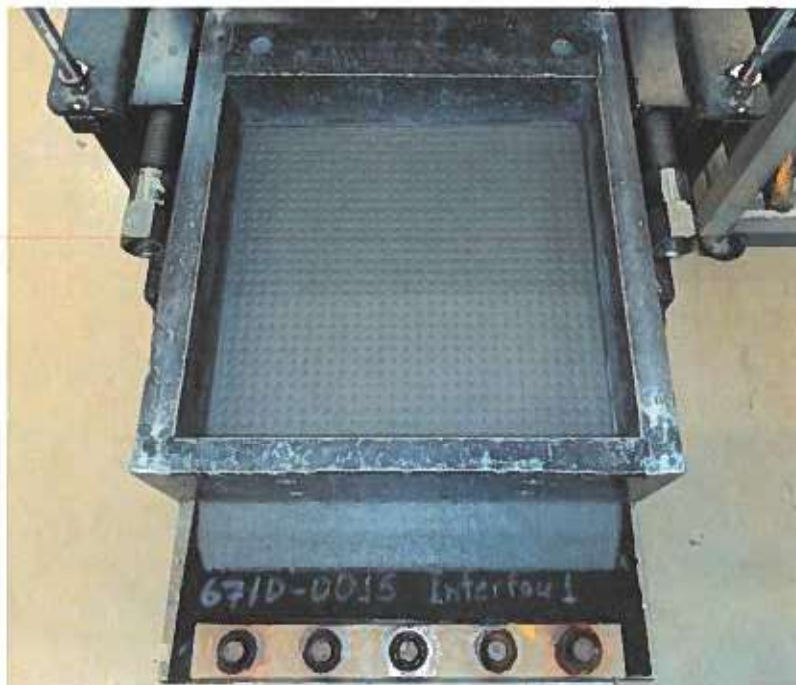
Shear Stress vs Horizontal Displacement



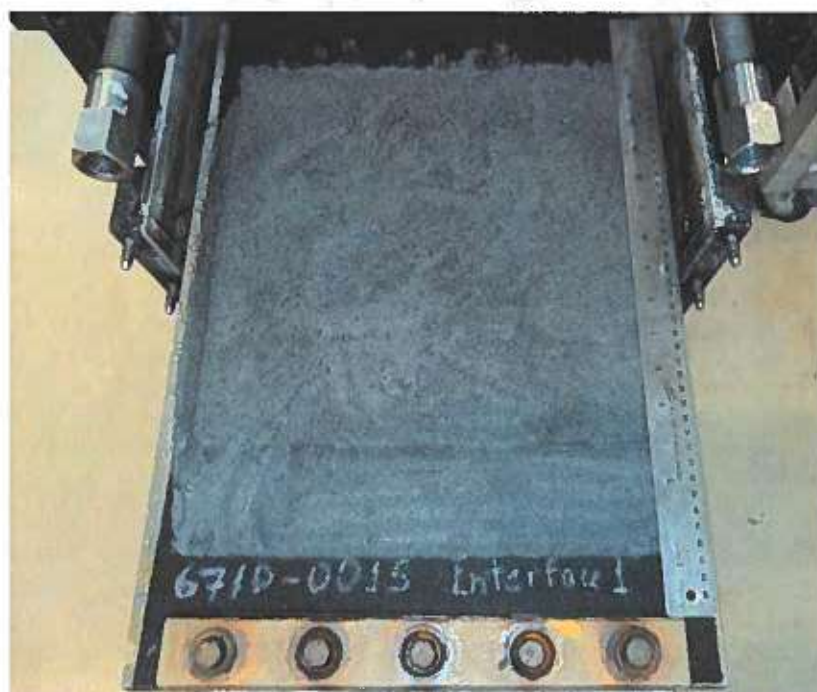


Shear Stress vs Normal Stress





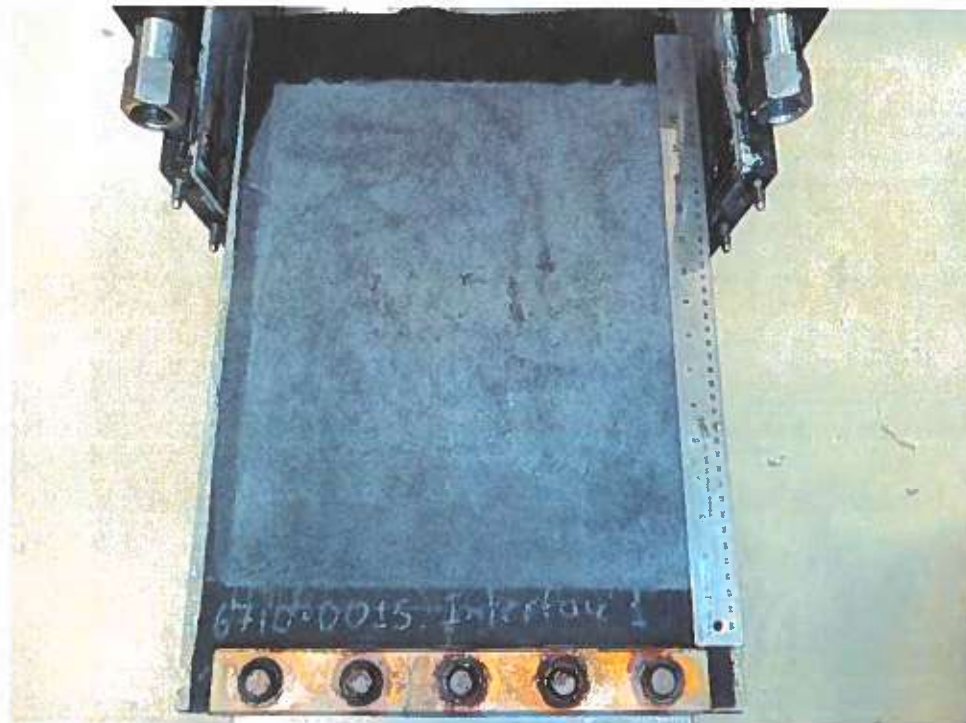
Interface #1 - Test at 100kPa



Non-woven Geotextile after the test - Test at 100kPa

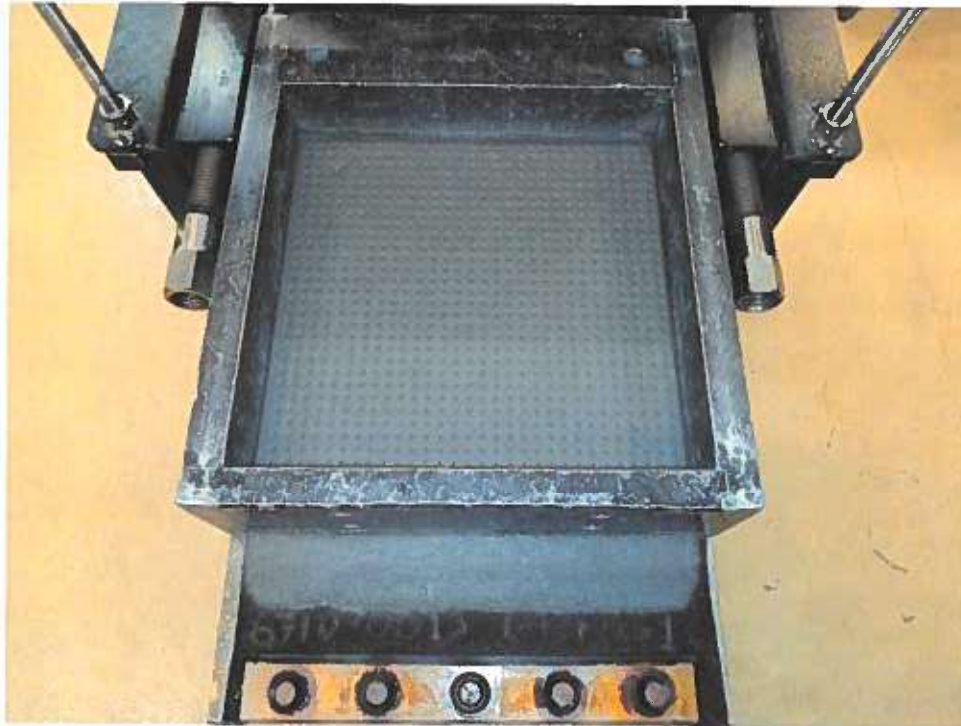


Interface #1 - Test at 200kPa

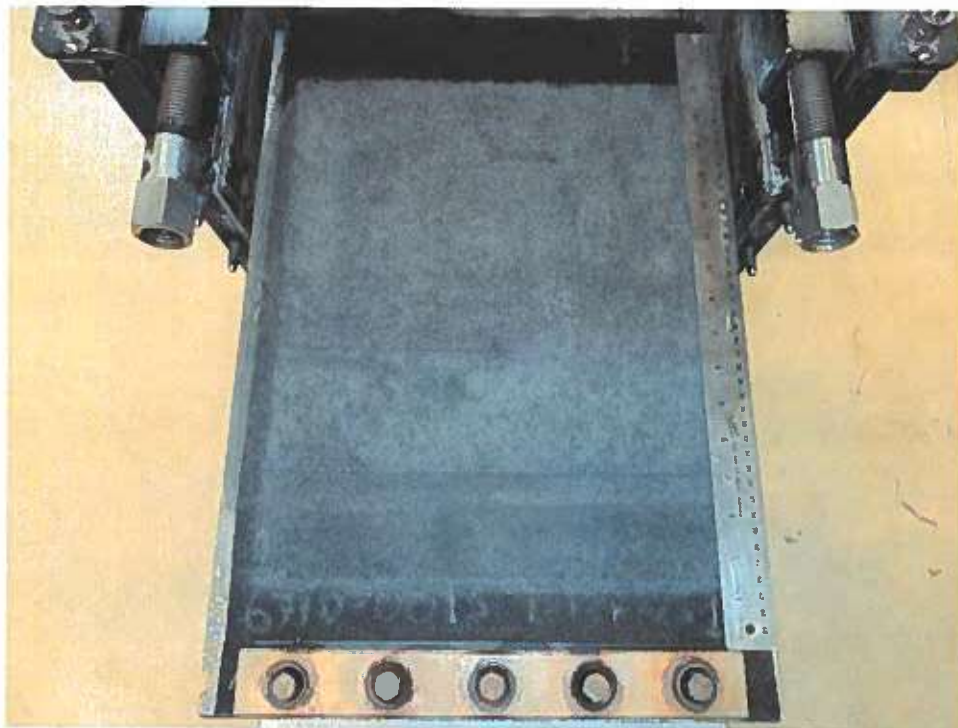


Non-woven Geotextile after the test - Test at 200kPa





Interface #1 - Test at 400kPa



Non-woven Geotextile after the test - Test at 400kPa



ANALYSIS REPORT
SCC Accreditation No.: 40†

Mr. Ian MacIntyre
Tetra Tech

Date: February 14, 2024
 Report: 6710-001S-2A-en

IDENTIFICATION: Interface test #2: GTX Non-woven Vs Geonet Hydranet 220 # GN000131
 Project: 704-ENV.WARC 04415-09
 Received: January 9, 2024

STANDARD:

TEST: Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear ASTM D5321/D5321M-21

TEST CONDITIONS: Shear surface 304 x 304 mm;
 Data acquisition period (seconds): 0.24
 Flat surfaces grips fixed with 4 bolts + rasp surface in lower box and upper box ;
 Normal load: Micro-Stepper Motor
 Rate of horizontal displacement(mm/min): 5
 Tested in machine direction ;
 Submerged interface ;
 Thickness: 5 measurements per specimen according to ASTM D5199 (Non-woven Geotextile and Geonet);
 Mass per unit area: 1 measurement per specimen according to ASTM D5261 (Non-woven Geotextile);
 Testing configuration - Upper box / Lower box: Non-woven Geotextile / Geonet
 Date of test: January 19, 2024

RESULTS: Individual Data
 Normal Compressive Pressure (kPa): 101.9 198.9 397.6

GEOTEXTILE PROPERTIES :

Mass per unit area of the geosynthetic estimated basing on the weight of the specimen (g/m²): 261 293 301

Specimen thickness (mils): 71 73 74

GEONET PROPERTIES :

Specimen thickness (mils): 197 196 195


Duration of the consolidation (hours): 1 1 1

TEST RESULTS :

Peak shear stress (kPa): 31.2 65.3 154.6

Shear stress at large displacement (kPa): 23.5 49.8 92.1

Prepared by: 
 Marlon Bustos, M.Eng.
 Technician

Approved by: 
 Omar Kamla, Eng.
 Project Leader

Date: February 14, 2024

**** Any question regarding this report or its authenticity? Please contact Omar Kamla ****

The reports are identified by an alphanumeric code, the letter preceding "-en" refers to the revision number, emitted in ascending order. The electronic copy sent by CTT Group is the official report. The reported identification is based on what was observed on the received sample and/or information provided by the customer. The samples in relation to this report are retained for a period of 30 days following transmission of the report. The above reported results refer exclusively to the samples submitted for evaluation. This analysis report cannot be partly used or reproduced, unless in whole, without CTT Group prior written consent. † The ISO/IEC 17025 Scope of Accreditation of CTT Group is available at www.gcttg.com. In this report, the tests which number is followed by the symbol † are not covered by this accreditation. For customer's complete address, please refer to the email.



ANALYSIS REPORT
SCC Accreditation No.: 40‡

Mr. Ian MacIntyre
 Tetra Tech

Date: February 14, 2024
 Report: 6710-001S-2A-en

IDENTIFICATION: Interface test #2: GTX Non-woven Vs Geonet Hydranet 220 # GN000131
 Project: 704-ENV.WARC 04415-09
 Received: January 9, 2024

STANDARD:

TEST: Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear ASTM D5321/D5321M-21

RESULTS (CONT):	Individual Data	
Estimated peak angle of friction (°):	20	
Estimated peak adhesion (kPa):	0.0	
Estimated angle of friction at large displacement (°):	12	
Estimated adhesion at large displacement (kPa):	1.8	

REMARKS: - See graphs and pictures in Appendix.

Prepared by:

Marlon Bustos
 Marlon Bustos, M.Eng.
 Technician

Approved by:

Omar Kamla
 Omar Kamla, Eng
 Project Leader

Date: February 14, 2024

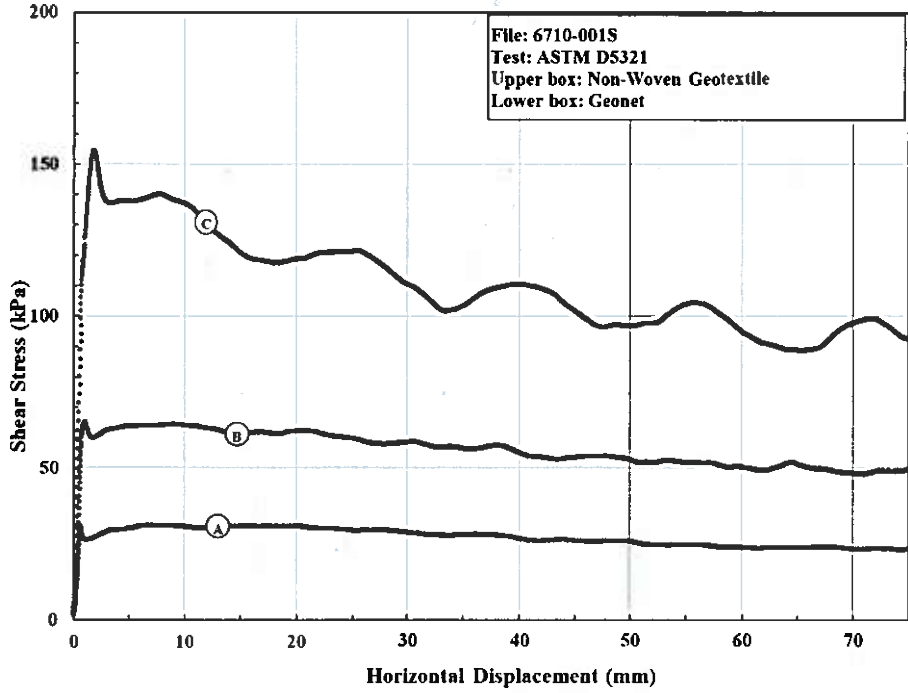
**** Any question regarding this report or its authenticity? Please contact Omar Kamla ****

The reports are identified by an alphanumeric code, the letter preceding "-en" refers to the revision number, emitted in ascending order. The electronic copy sent by CTT Group is the official report. The reported identification is based on what was observed on the received sample and/or information provided by the customer. The samples in relation to this report are retained for a period of 30 days following transmission of the report. The above reported results refer exclusively to the samples submitted for evaluation. This analysis report cannot be partly used or reproduced, unless in whole, without CTT Group prior written consent. ‡ The ISO/IEC 17025 Scope of Accreditation of CTT Group is available at www.gcttg.com. In this report, the tests which number is followed by the symbol ‡ are not covered by this accreditation. For customer's complete address, please refer to the email.

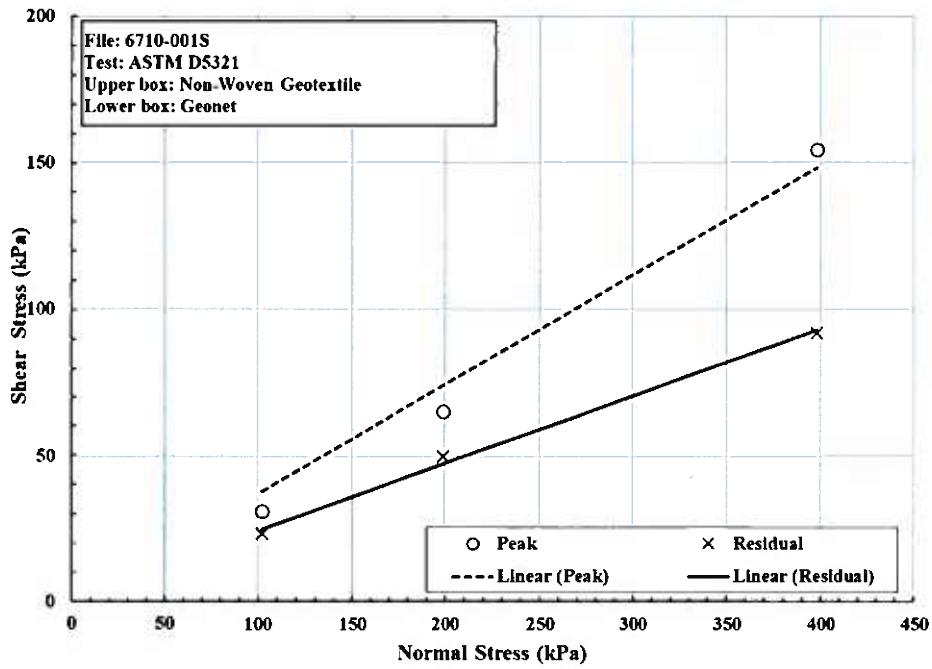




Graphs



Shear Stress vs Horizontal Displacement



Shear Stress vs Normal Stress



Pictures



Non-woven Geotextile after the test – Test at 100kPa



Geonet after the test – Test at 100kPa





Non-woven Geotextile after the test – Test at 200kPa

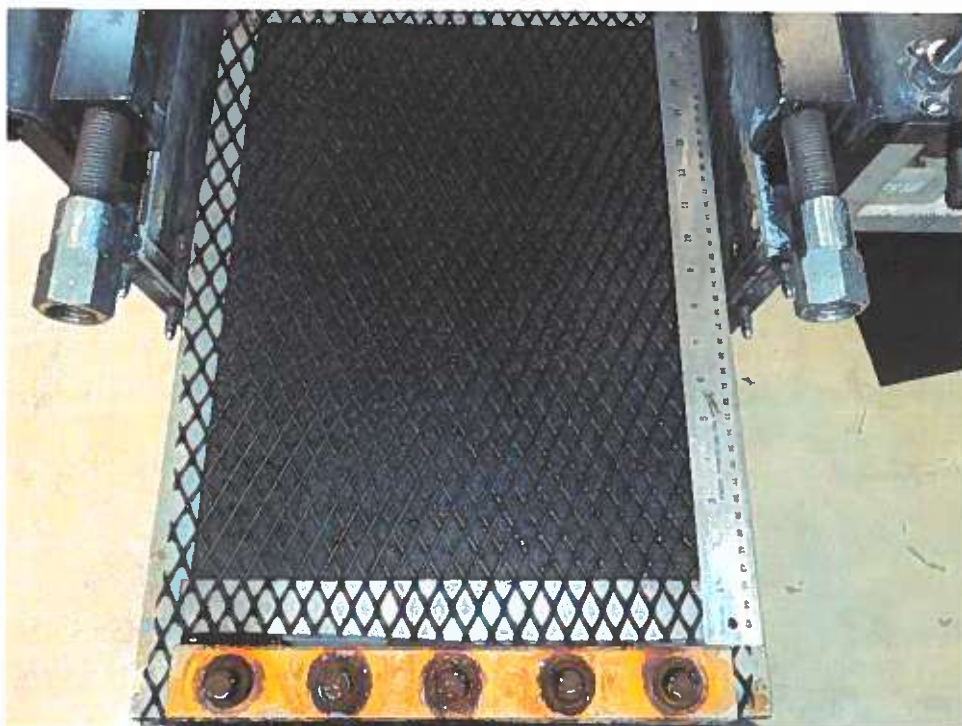


Geonet after the test – Test at 200kPa





Non-woven Geotextile after the test – Test at 400kPa



Geonet after the test – Test at 400kPa



ANALYSIS REPORT
SCC Accreditation No.: 40‡

Mr. Ian MacIntyre
Tetra Tech

Date: February 14, 2024
 Report: 6710-001S-3A-en

IDENTIFICATION: Interface test #3: Geonet Hydranet 220 # GN000131 Vs GCL Bentomat ST #10
 Project: 704-ENV.WARC 04415-09
 Geonet received on January 09, 2024
 Received: January 19, 2024

STANDARD:

TEST: Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method ASTM D6243/D6243M-20 Proc. B

TEST CONDITIONS: Shear surface 304 x 304 mm;
 Data acquisition period (seconds): 1.20
 Hydration of the GCL: 24 hours under 10 kPa, prior to consolidation ;
 Flat surfaces grips fixed with 4 bolts + rasp surface in lower box and upper box ;
 Normal load: Micro-stepper motor
 Rate of horizontal displacement(mm/min): 1
 Tested in machine direction ;
 Submerged interface ;
 Testing configuration - Upper box / Lower box: Geonet Hydranet 220 / GCL Bentomat ST#10 (Non-woven side)
 Date of test: from February 7 to 13, 2024

RESULTS:	Individual Data			Avg.	S.D.	% CV
Normal Compressive Pressure (kPa):	101.5	200.8	399.5			
TESTS RESULTS	:					
Maximum Shear Stress (kPa):	41.9	77.0	180.5			
Residual Shear Stress (kPa):	39.9	72.9	137.0			
Estimated Maximum angle of friction (°):	23					
Estimated Maximum adhesion (kPa):	0.0					
Estimated Residual angle of friction (°):	18					
Estimated Residual adhesion (kPa):	7.1					

REMARKS: - See graphs and pictures in Appendix.

Prepared by:

Marlon Bustos
 Marlon Bustos, M.Eng.
 Technician

Approved by:

Omar Kamla
 Omar Kamla, Eng.
 Project Leader

Date: February 14, 2024

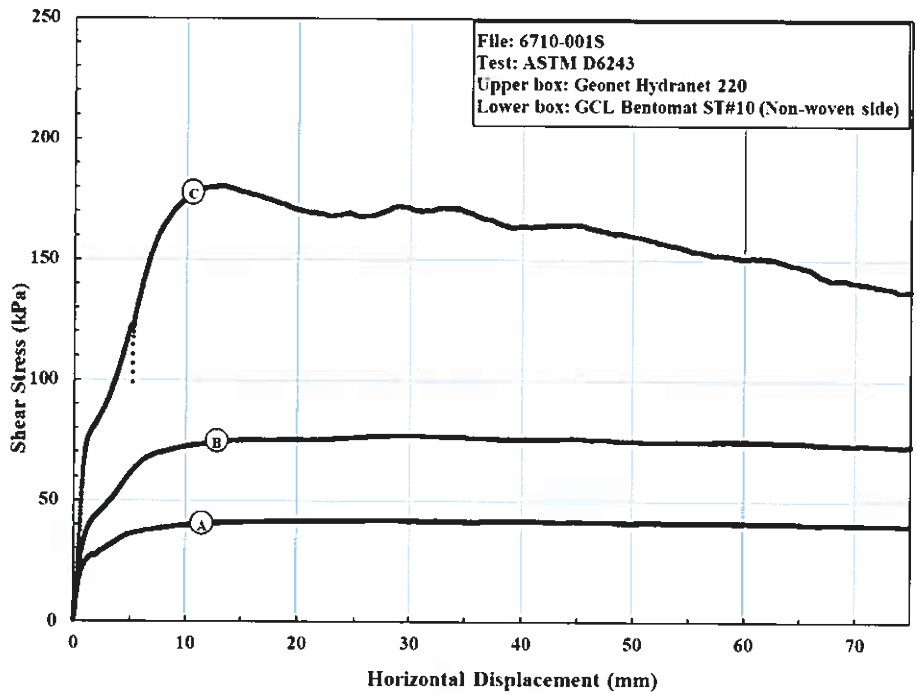
**** Any question regarding this report or its authenticity? Please contact Omar Kamla ****

The reports are identified by an alphanumeric code, the letter preceding "-en" refers to the revision number, emitted in ascending order. The electronic copy sent by CTT Group is the official report. The reported identification is based on what was observed on the received sample and/or information provided by the customer. The samples in relation to this report are retained for a period of 30 days following transmission of the report. The above reported results refer exclusively to the samples submitted for evaluation. This analysis report cannot be partly used or reproduced, unless in whole, without CTT Group prior written consent. ‡ The ISO/IEC 17025 Scope of Accreditation of CTT Group is available at www.gcttg.com. In this report, the tests which number is followed by the symbol □ are not covered by this accreditation. For customer's complete address, please refer to the email.

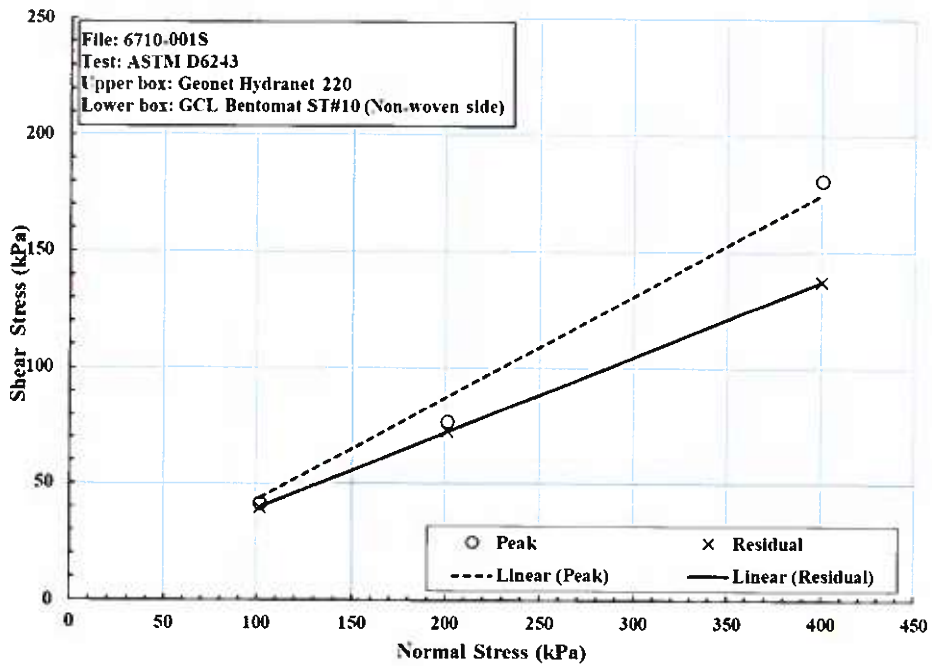




APPENDIX
Graphs



Shear Stress vs Horizontal Displacement



Shear Stress vs Normal Stress



Geonet Hydranet 220 after the test - Test at 100kPa



GCL Bentomat ST#10 (non-woven side) after the test – Test at 100kPa





Geonet Hydranet 220 after the test - Test at 200kPa



GCL Bentomat ST#10 (non-woven side) after the test – Test at 200kPa





Geonet Hydranet 220 after the test - Test at 400kPa



GCL Bentomat ST#10 (non-woven side) after the test – Test at 400kPa



ANALYSIS REPORT
SCC Accreditation No.: 40‡

Mr. Ian MacIntyre
Tetra Tech

Date: February 19, 2024
 Report: 6710-001S-4A-en

IDENTIFICATION: Interface test #4: GCL Bentomat ST #10 Vs Drainage blanket (Gravel, coarse soil "Dmax 16mm")
 Project: 704-ENV.WARC 04415-09
 Gravel received on January 03, 2024
 Received: January 19, 2024


STANDARD:

TEST: Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method ASTM D6243/D6243M-20 Proc. C

TEST CONDITIONS: Shear surface 304 x 304 mm;
 Data acquisition period (seconds): 1.20
 Hydration of the GCL: 24 hours under 10 kPa, prior to consolidation ;
 Flat surfaces grips fixed with 4 bolts + rasp surface in lower box and upper box ;
 Normal load: Micro-Stepper Motor
 Rate of horizontal displacement(mm/min): 1
 Tested in machine direction ;
 Submerged interface ;
 Testing configuration - Upper box / Lower box: Drainage Blanket (Gravel) / GCL Bentomat ST #10 (woven side)
 Date of test: from February 14 to 16, 2024

RESULTS:	Individual Data			Avg.	S.D.	% CV
Normal Compressive Pressure (kPa):	102.5	203.7	402.3			
PROPERTIES OF THE SOIL						
Water content of compaction (%):	6.3	6.5	6.2			
Dry unit weight after compaction (kg/m ³):	2050	2060	2050			
Duration of the consolidation (hours):	4	4	4			
TESTS RESULTS						
Maximum Shear Stress (kPa):	58.5	131.8	212.0			
Residual Shear Stress (kPa):	23.7	34.8	45.1			
Estimated Maximum angle of friction (°):	26					
Estimated Maximum adhesion (kPa):	16.7					
Estimated Residual angle of friction (°):	3					
Estimated Residual adhesion (kPa):	18.3					

Prepared by: 
 Marlon Bustos, M.Eng.
 Technician

Approved by: 
 Omar Kamla, Eng.
 Project Leader

Date: February 19, 2024

**** Any question regarding this report or its authenticity? Please contact Omar Kamla ****

The reports are identified by an alphanumeric code, the letter preceding "-en" refers to the revision number, emitted in ascending order. The electronic copy sent by CTT Group is the official report. The reported identification is based on what was observed on the received sample and/or information provided by the customer. The samples in relation to this report are retained for a period of 30 days following transmission of the report. The above reported results refer exclusively to the samples submitted for evaluation. This analysis report cannot be partly used or reproduced, unless in whole, without CTT Group prior written consent. ‡ The ISO/IEC 17025 Scope of Accreditation of CTT Group is available at www.gcttg.com. In this report, the tests which number is followed by the symbol □ are not covered by this accreditation. For customer's complete address, please refer to the email.

ANALYSIS REPORT
SCC Accreditation No.: 40‡

Mr. Ian MacIntyre
Tetra Tech

Date: February 19, 2024
Report: 6710-001S-4A-en


REMARKS: - See graphs and pictures in Appendix.

- Consolidation:
100 kPa: 1 hour at 50 kPa, 4 hours at 100 kPa
200 kPa: 1 hour at 50 kPa, 1 hour at 100 kPa, 4 hours at 200 kPa.
400 kPa: 1 hour at 50 kPa, 1 hour at 100 kPa, 1 hour at 200 kPa, 4 hours at 400 kPa.

Prepared by:


Marlon Bustos, M.Eng.
Technician

Approved by:


Omar Kamla, Eng.
Project Leader

Date: February 19, 2024

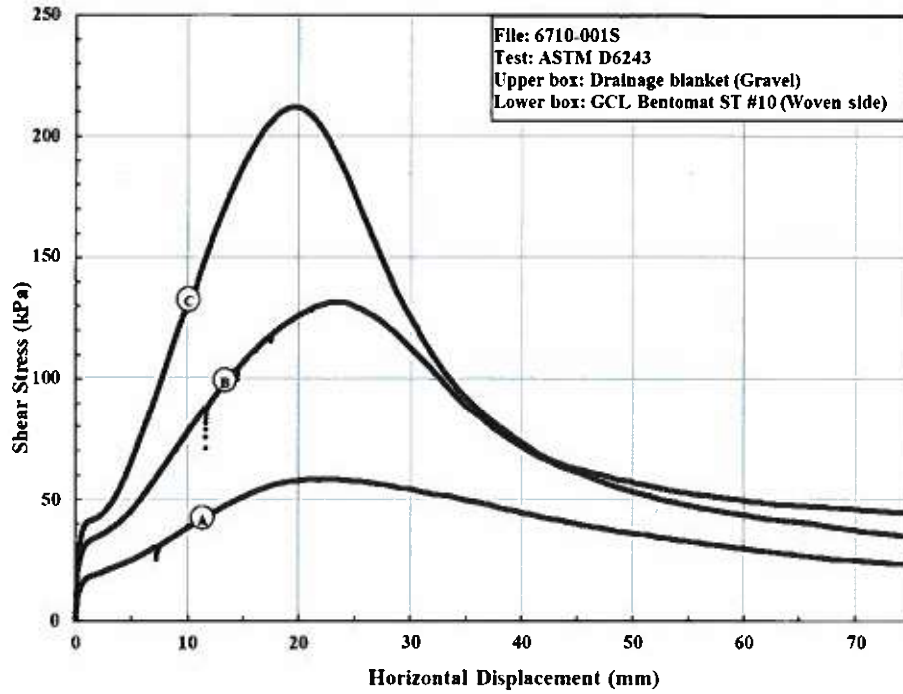
**** Any question regarding this report or its authenticity? Please contact Omar Kamla ****

The reports are identified by an alphanumeric code, the letter preceding "en" refers to the revision number, emitted in ascending order. The electronic copy sent by CTT Group is the official report. The reported identification is based on what was observed on the received sample and/or information provided by the customer. The samples in relation to this report are retained for a period of 30 days following transmission of the report. The above reported results refer exclusively to the samples submitted for evaluation. This analysis report cannot be partly used or reproduced, unless in whole, without CTT Group prior written consent. ‡ The ISO IEC 17025 Scope of Accreditation of CTT Group is available at www.gcttg.com. In this report, the tests which number is followed by the symbol # are not covered by this accreditation. For customer's complete address, please refer to the email.

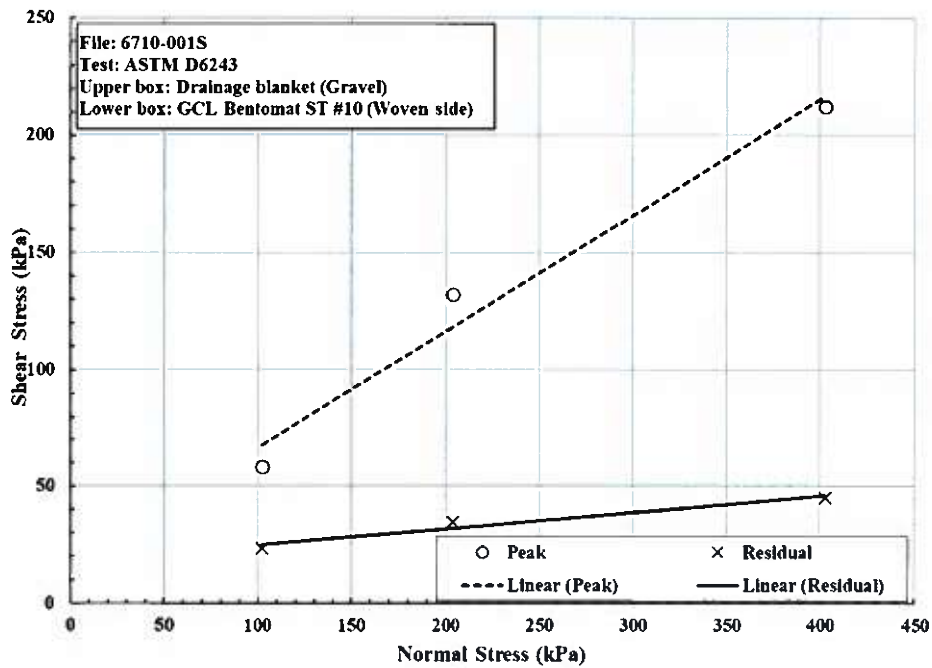




APPENDIX
Graphs



Shear Stress vs Horizontal Displacement



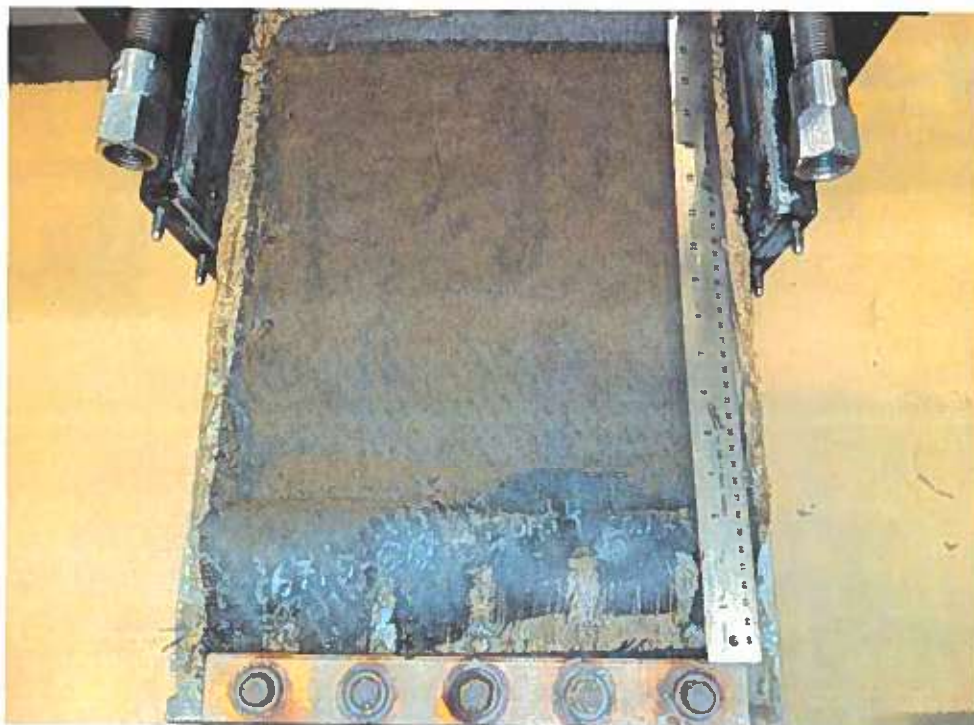
Shear Stress vs Normal Stress



Pictures

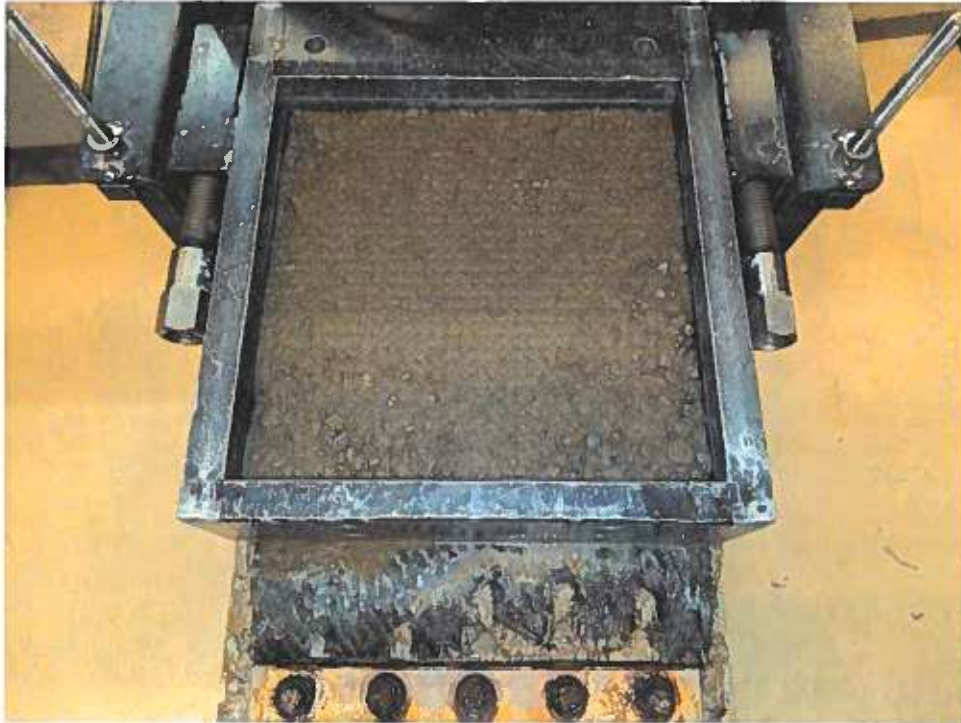


Interface #4 - Test at 100kPa



GCL Bentomat ST#10 (woven side) after the test – Test at 100kPa





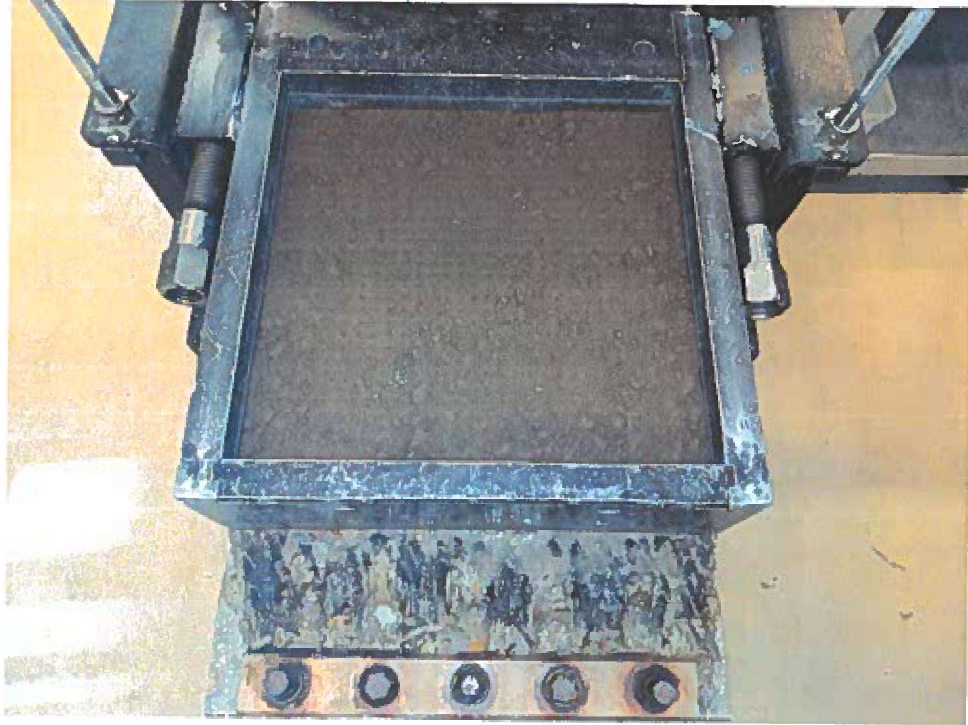
Interface #4 - Test at 200kPa



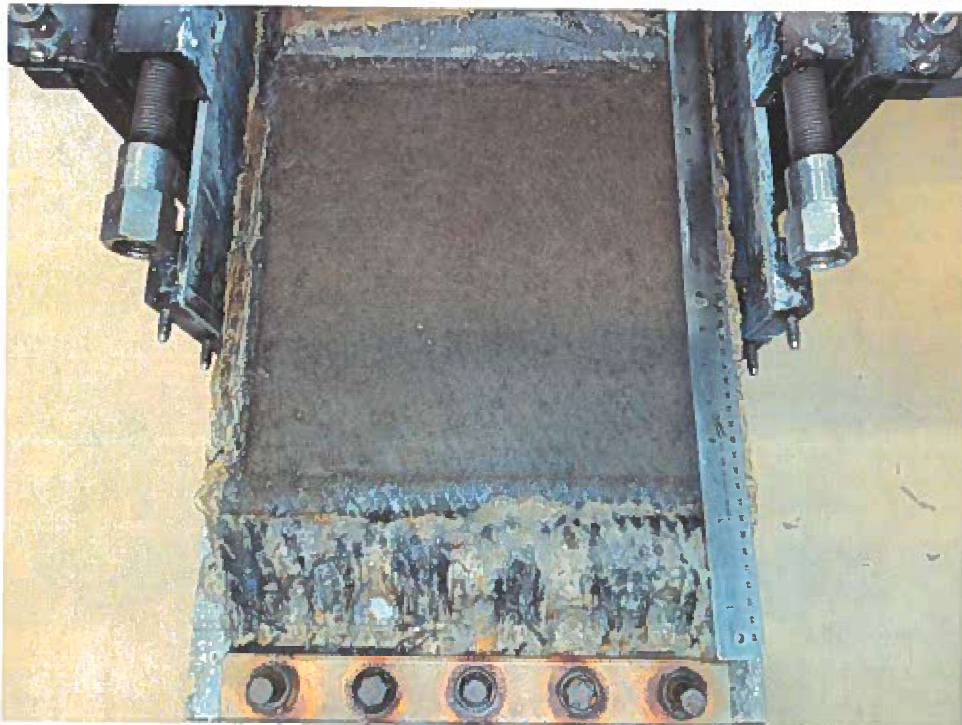
GCL Bentomat ST#10 (woven side) after the test – Test at 200kPa

Groupe CTT Inc.

3000, avenue Boullé, St-Hyacinthe, QC, Canada, J2S 1H9
T.:(+1) 877 288-8378



Interface #4 - Test at 400kPa



GCL Bentomat ST#10 (woven side) after the test - Test at 400kPa

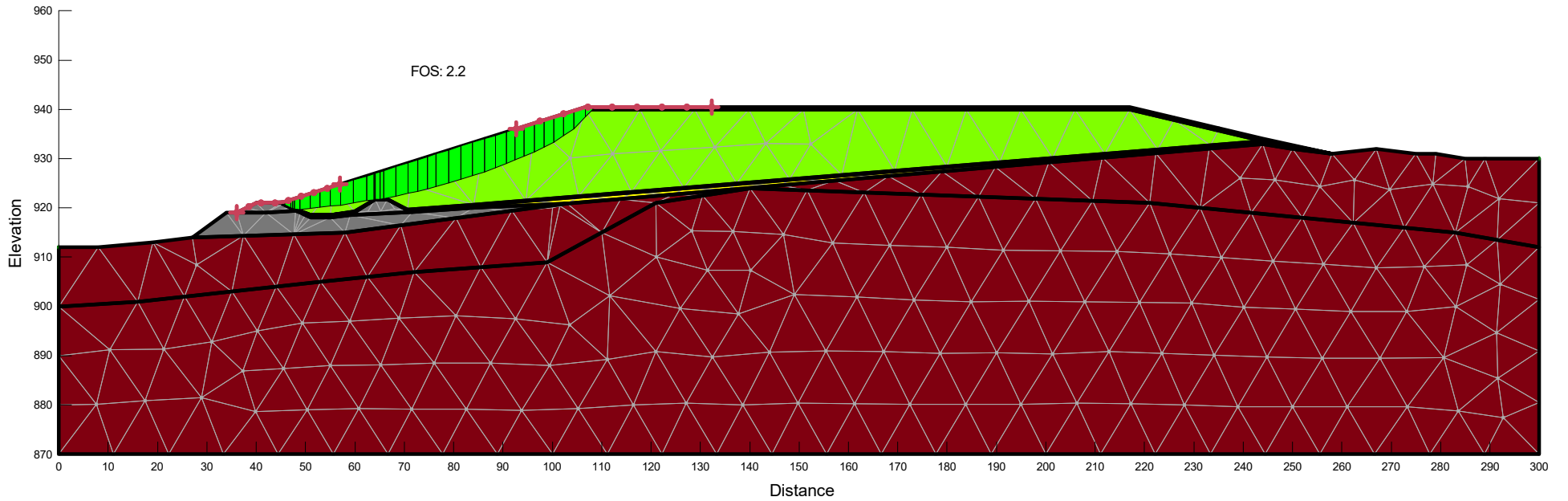


APPENDIX E

STABILITY ANALYSIS RESULTS

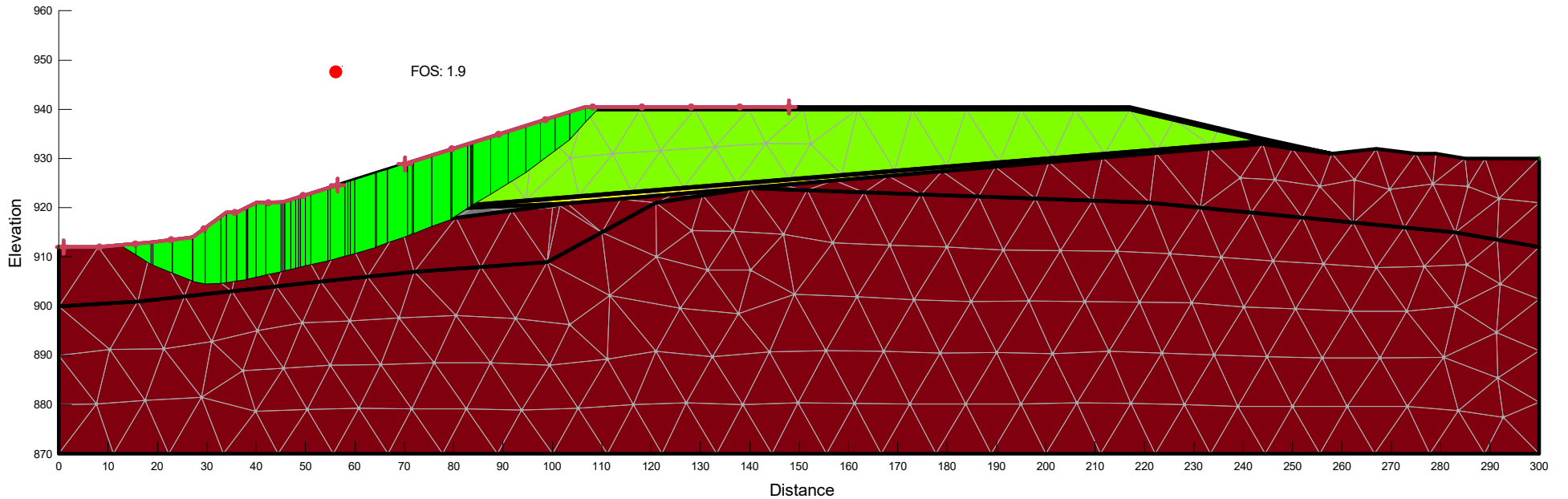
Name: A01 - Fully Frozen - Static Shallow
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



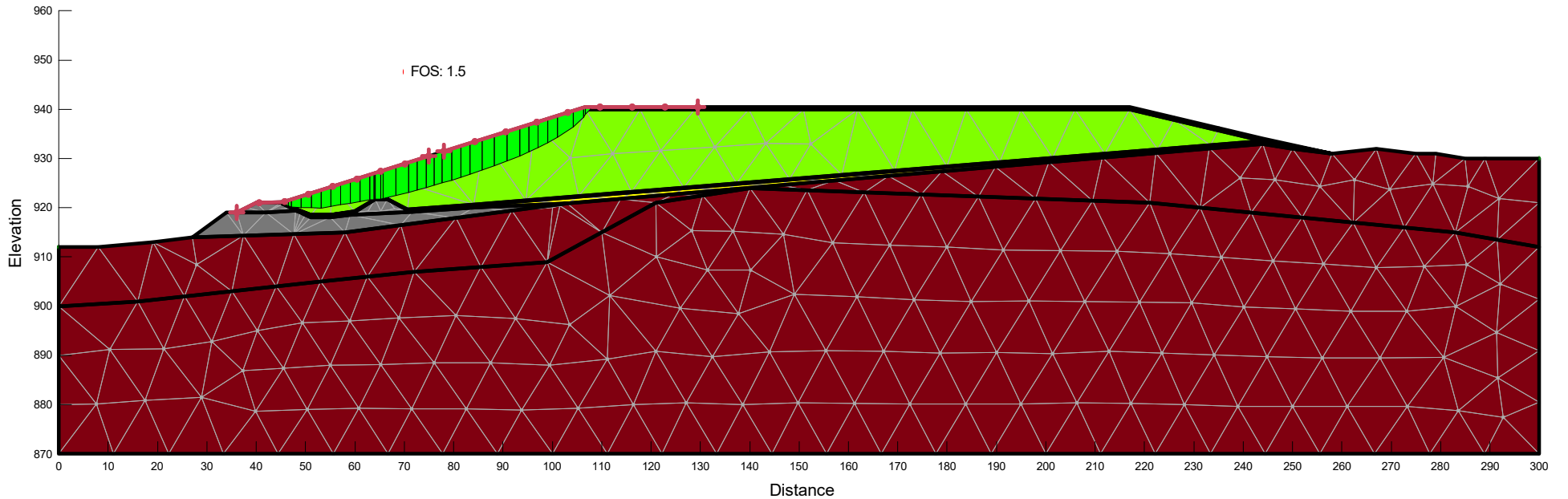
Name: A02 - Fully Frozen - Static Deep
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 </tr		



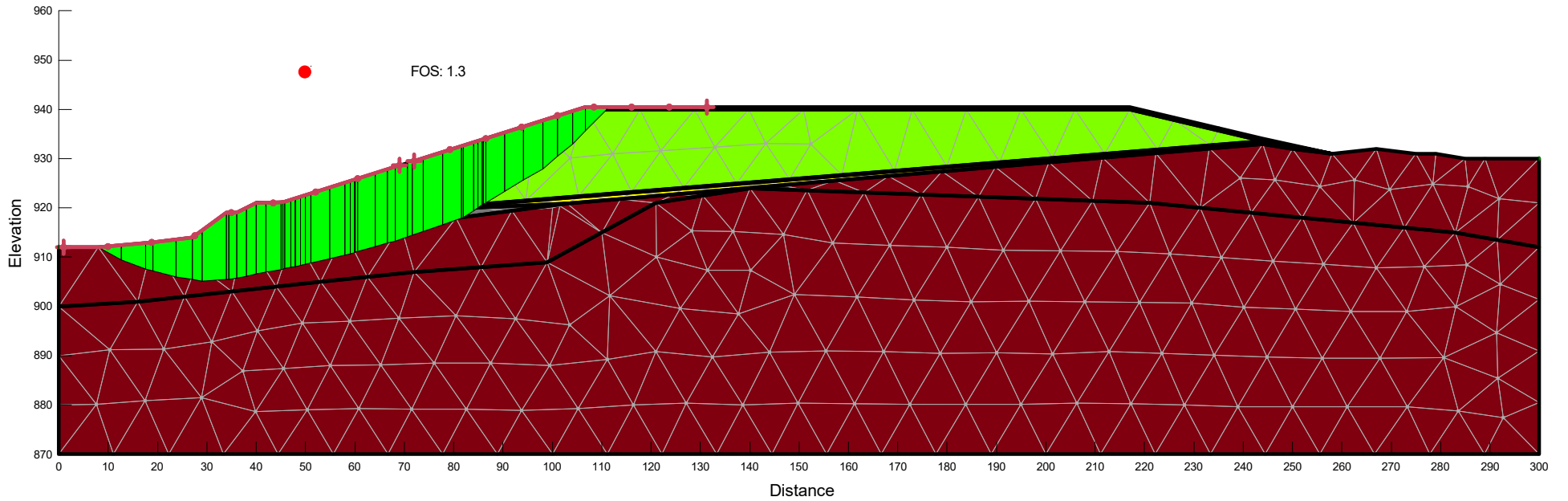
Name: A03 - Fully Frozen - Pseudostatic Shallow
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



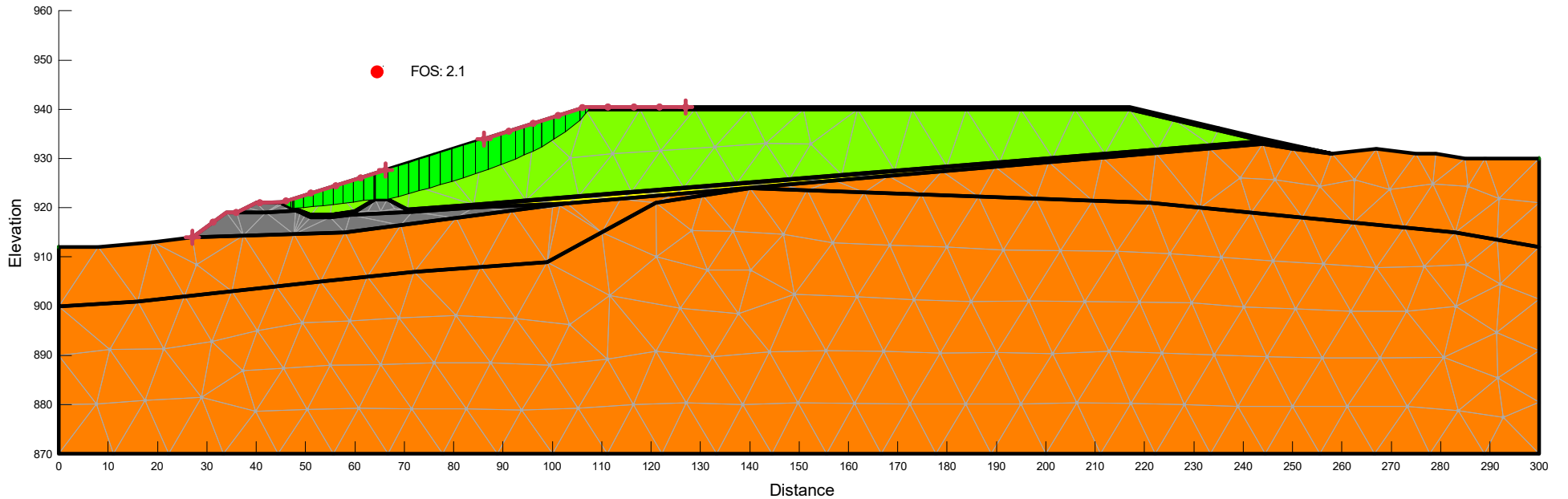
Name: A04 - Fully Frozen - Pseudostatic Deep
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



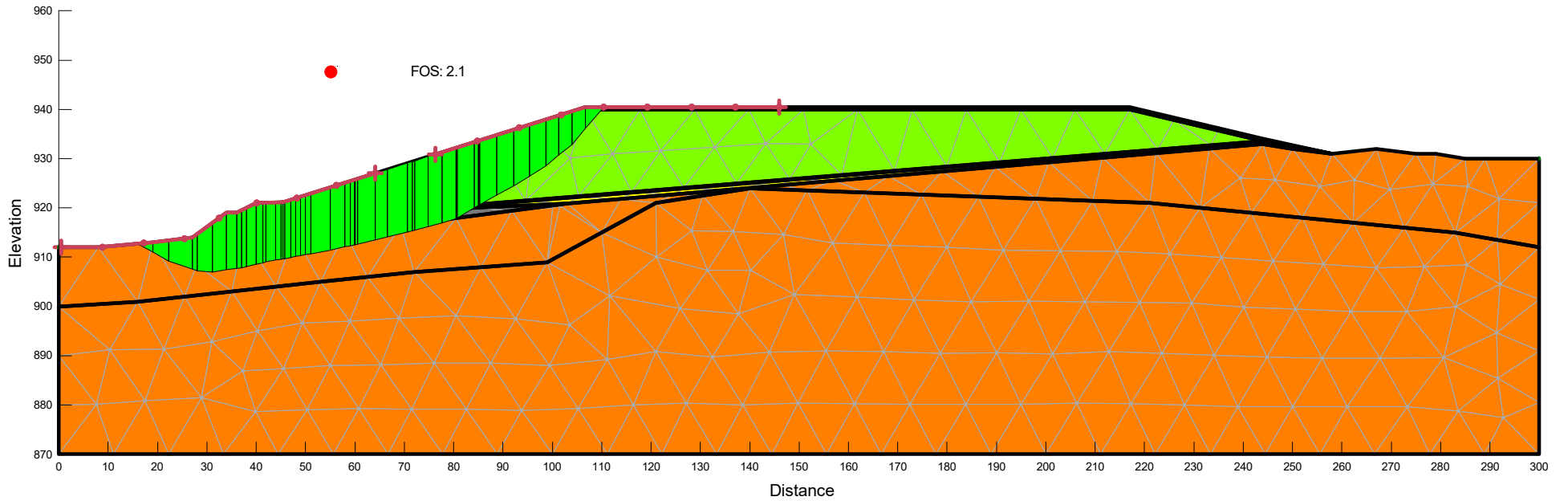
Name: A05 - Fully Thawed - Static Shallow
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



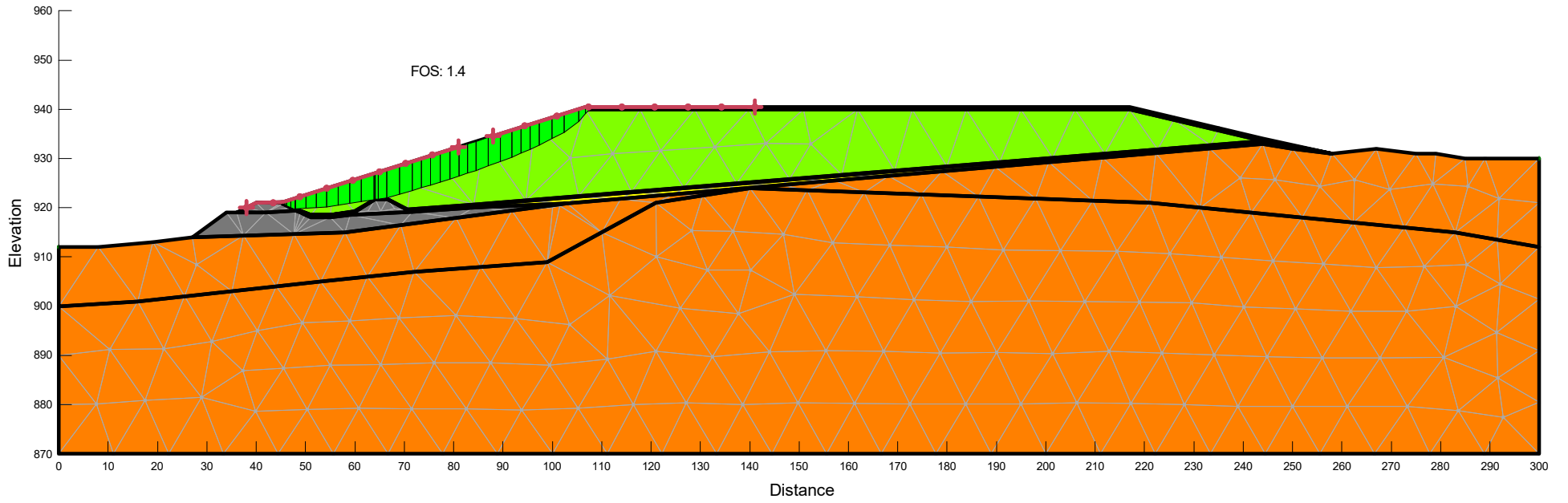
Name: A06 - Fully Thawed - Static Deep
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



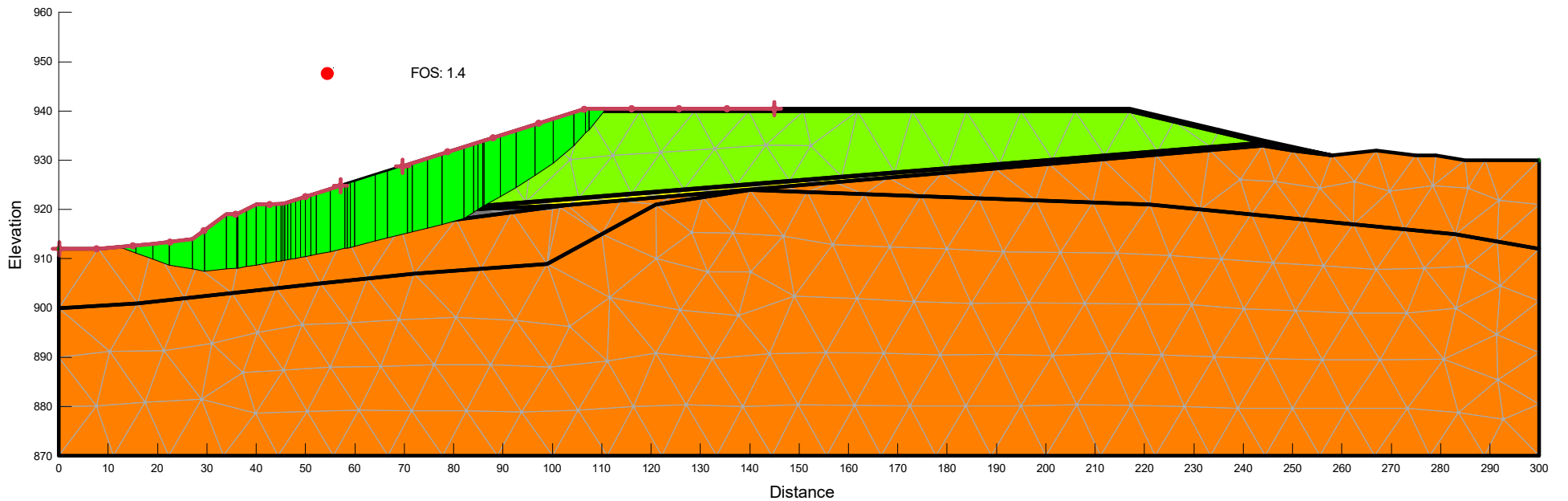
Name: A07 - Fully Thawed - Pseudostatic Shallow
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



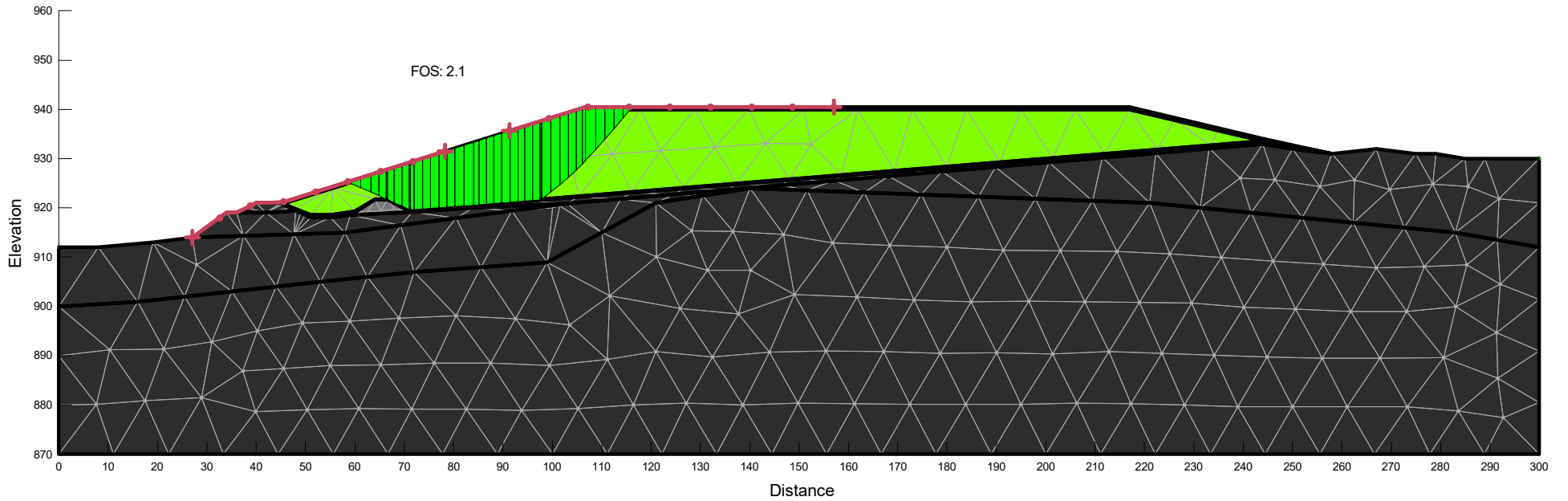
Name: A08 - Fully Thawed - Pseudostatic Deep
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



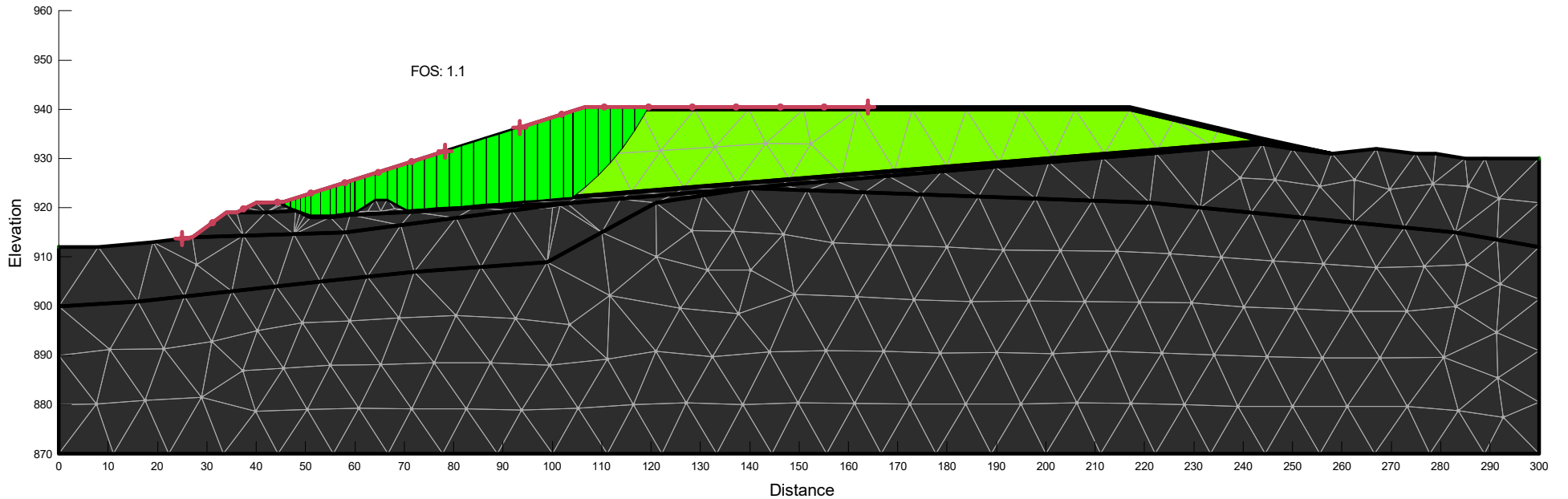
Name: A09 - Foundation Analysis - Static Deep
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 10 m
 Horz Seismic Coef.:
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



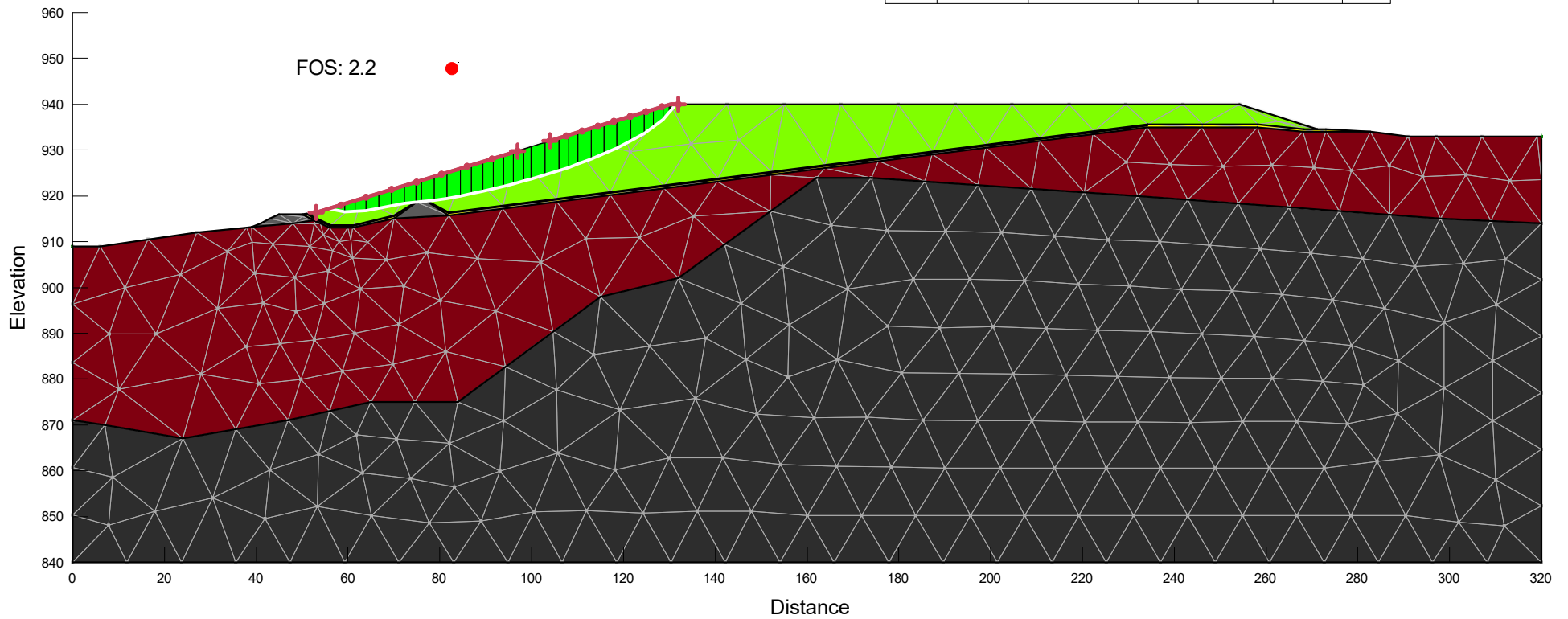
Name: A10 - Foundation Analysis - Pseudostatic Deep
 File Name: WARC04307-02_Section A_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 10 m
 Horz Seismic Coef.: 0.139
 Scale: 1:1,231

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0



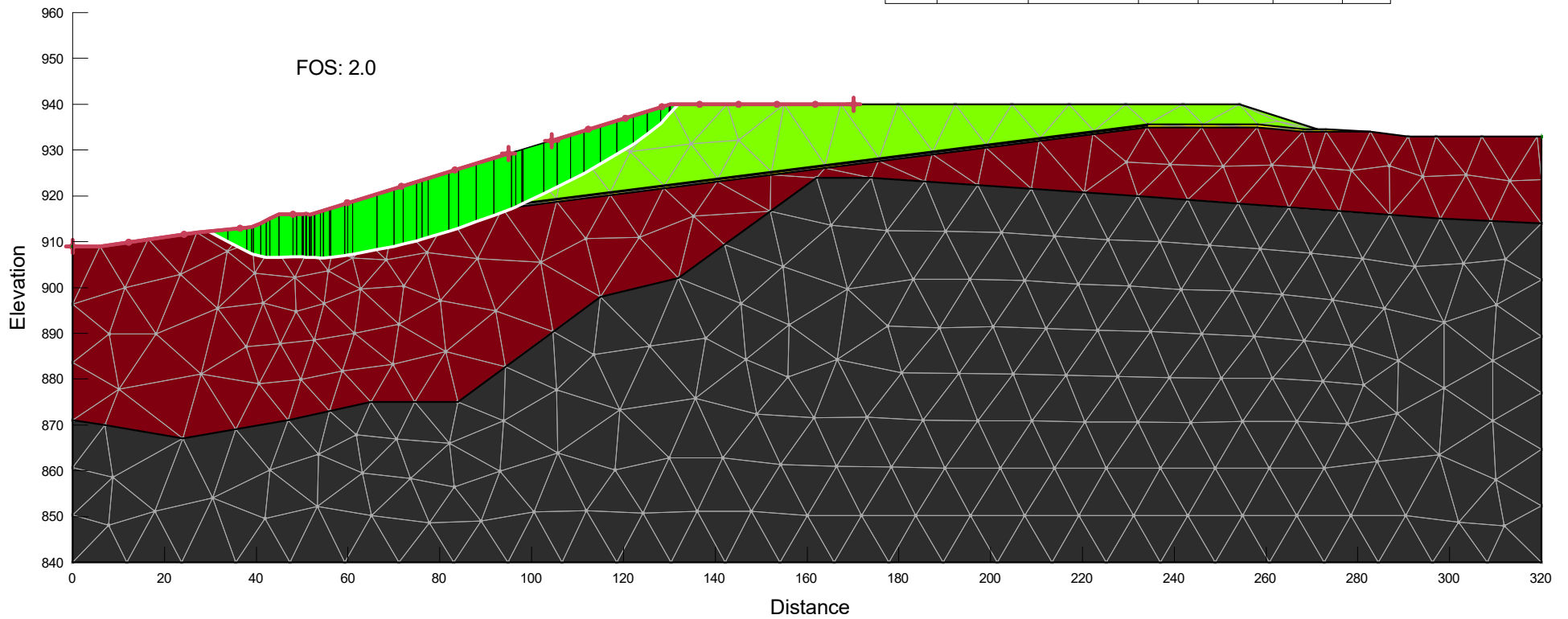
Name: B01 - Fully Frozen - Static Shallow
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



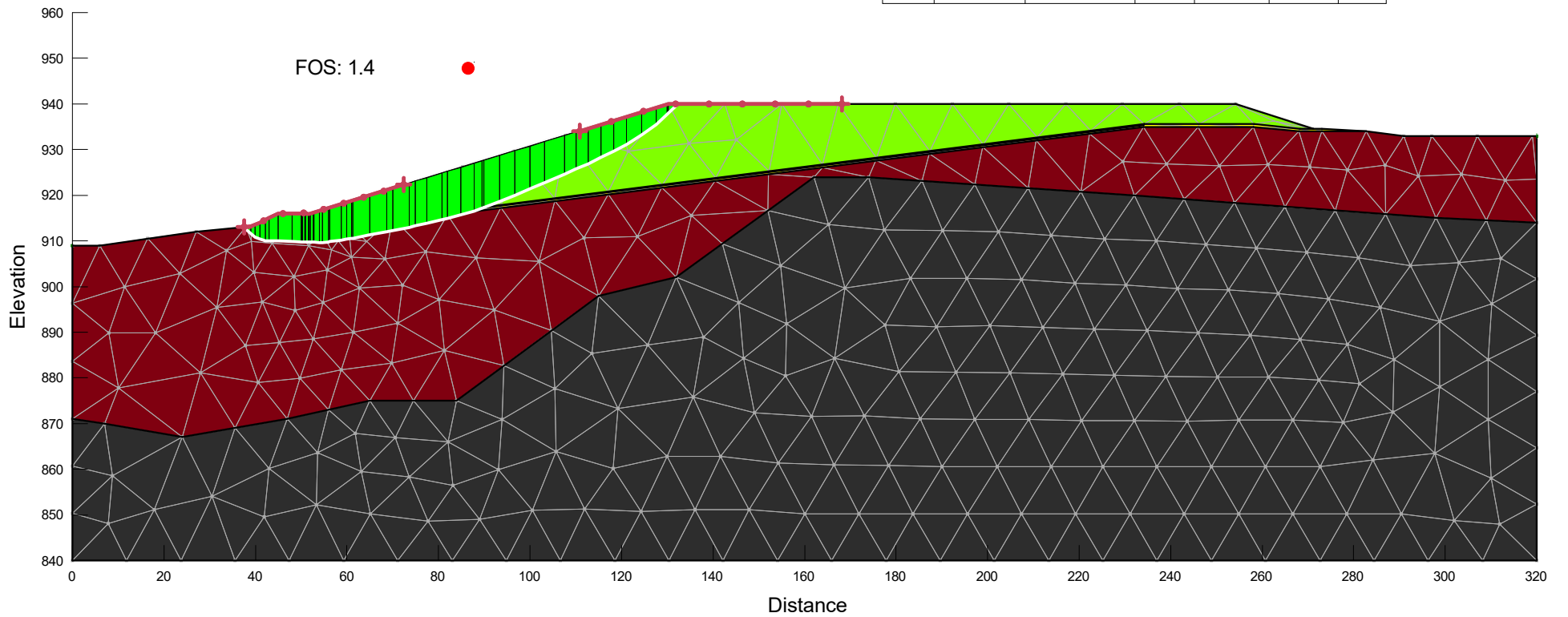
Name: B02 - Fully Frozen - Static Deep
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



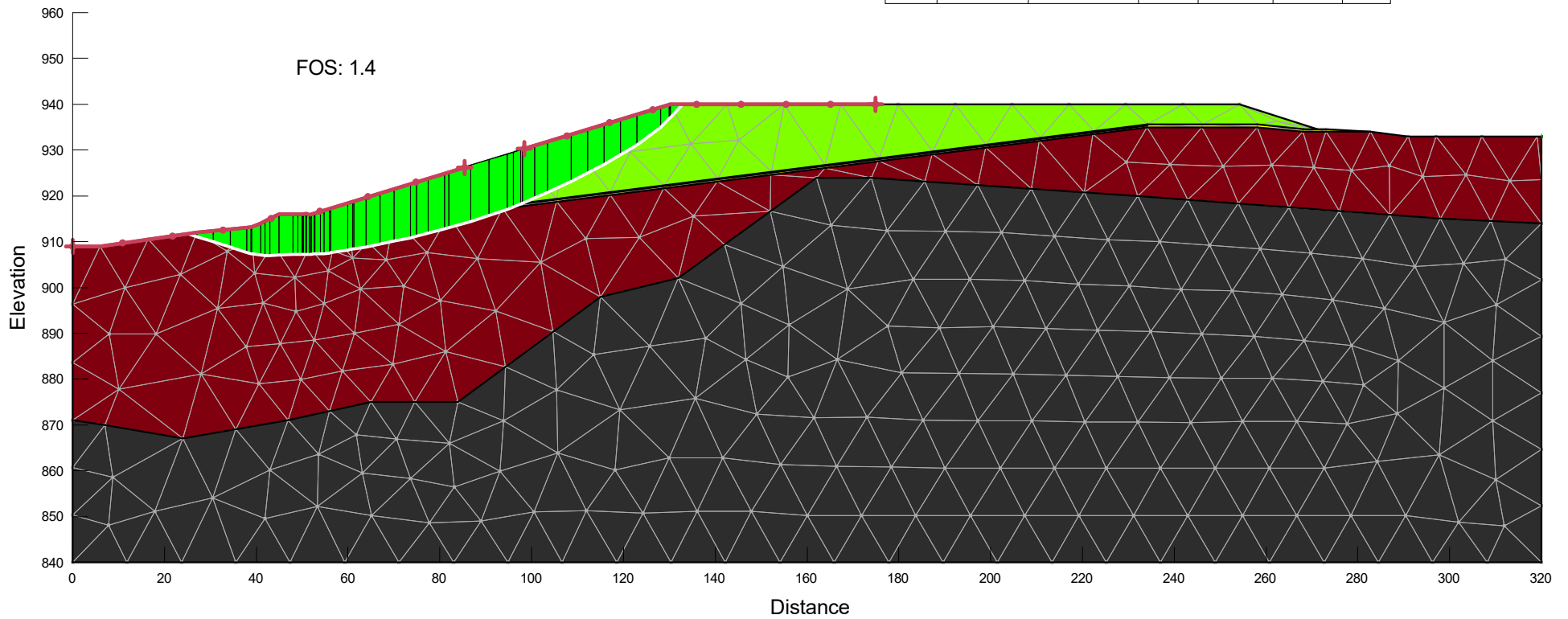
Name: B03 - Fully Frozen - Pseudostatic Shallow
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



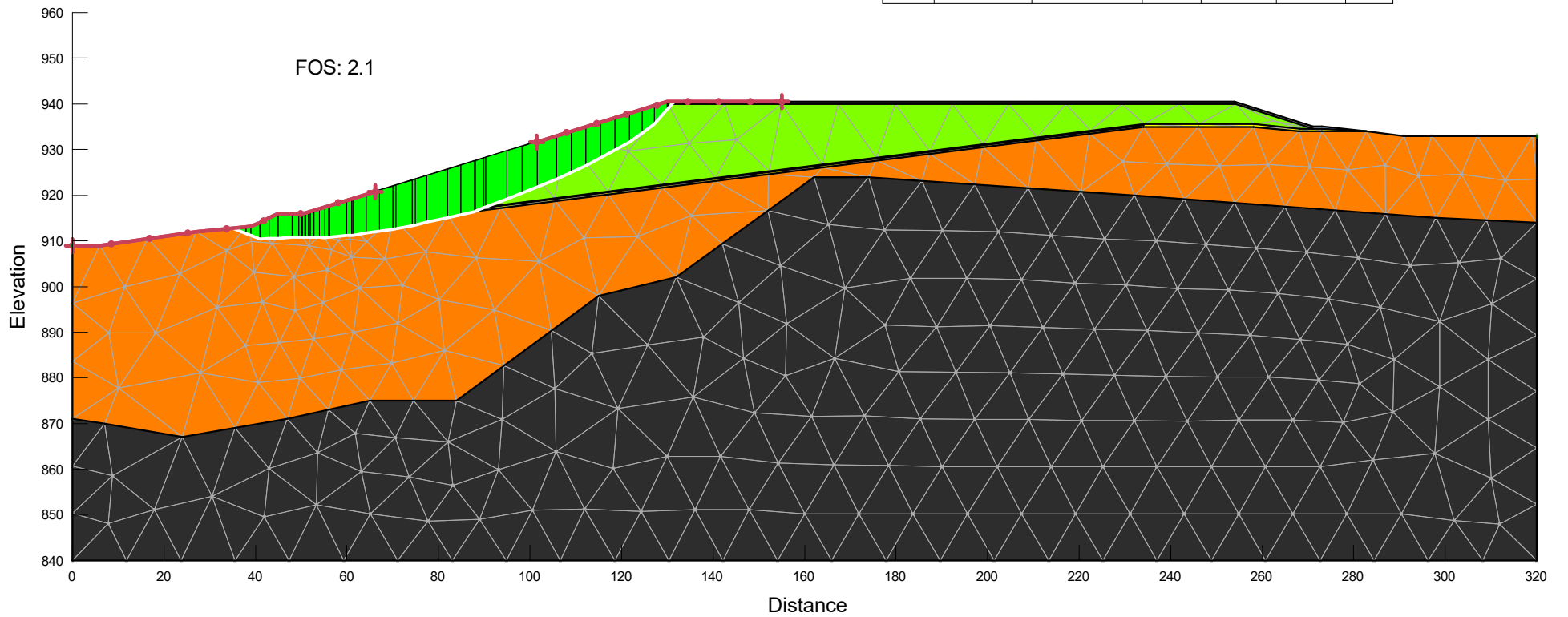
Name: B04 - Fully Frozen - Pseudostatic Deep
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



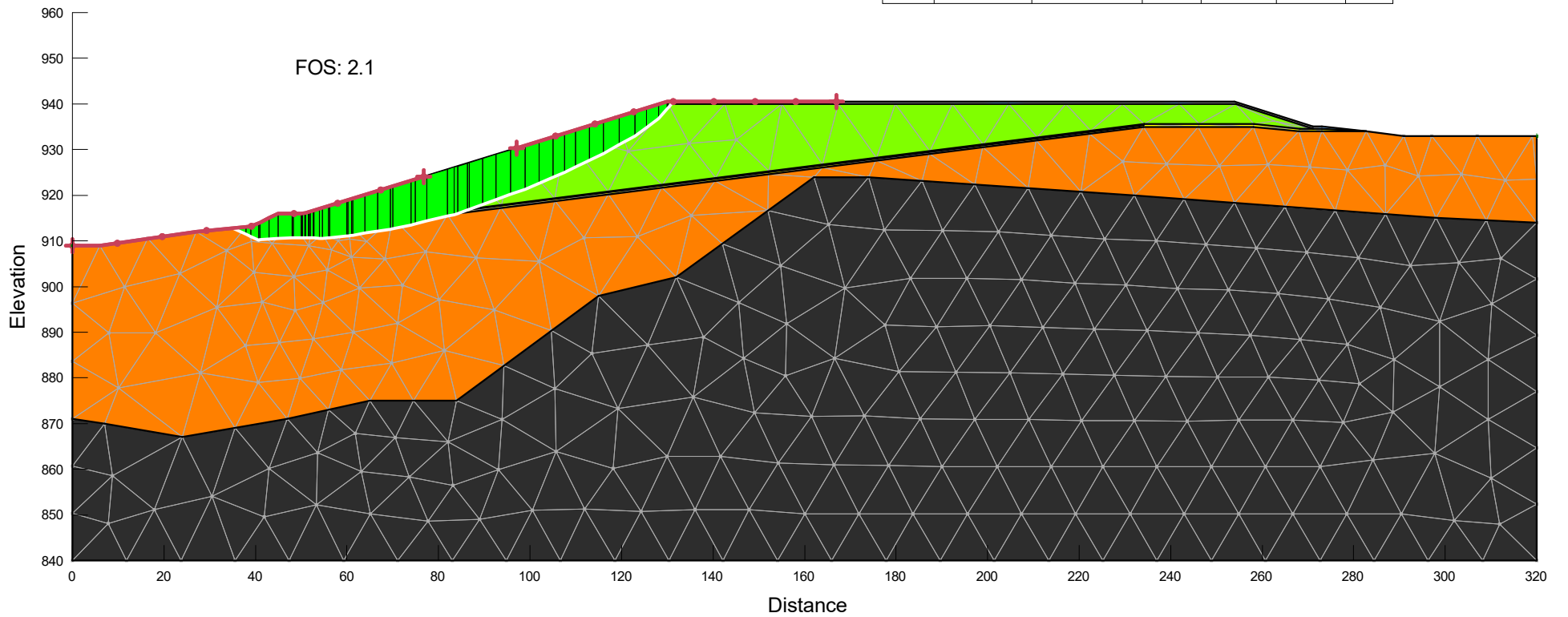
Name: B05 - Fully Thawed - Static Shallow
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



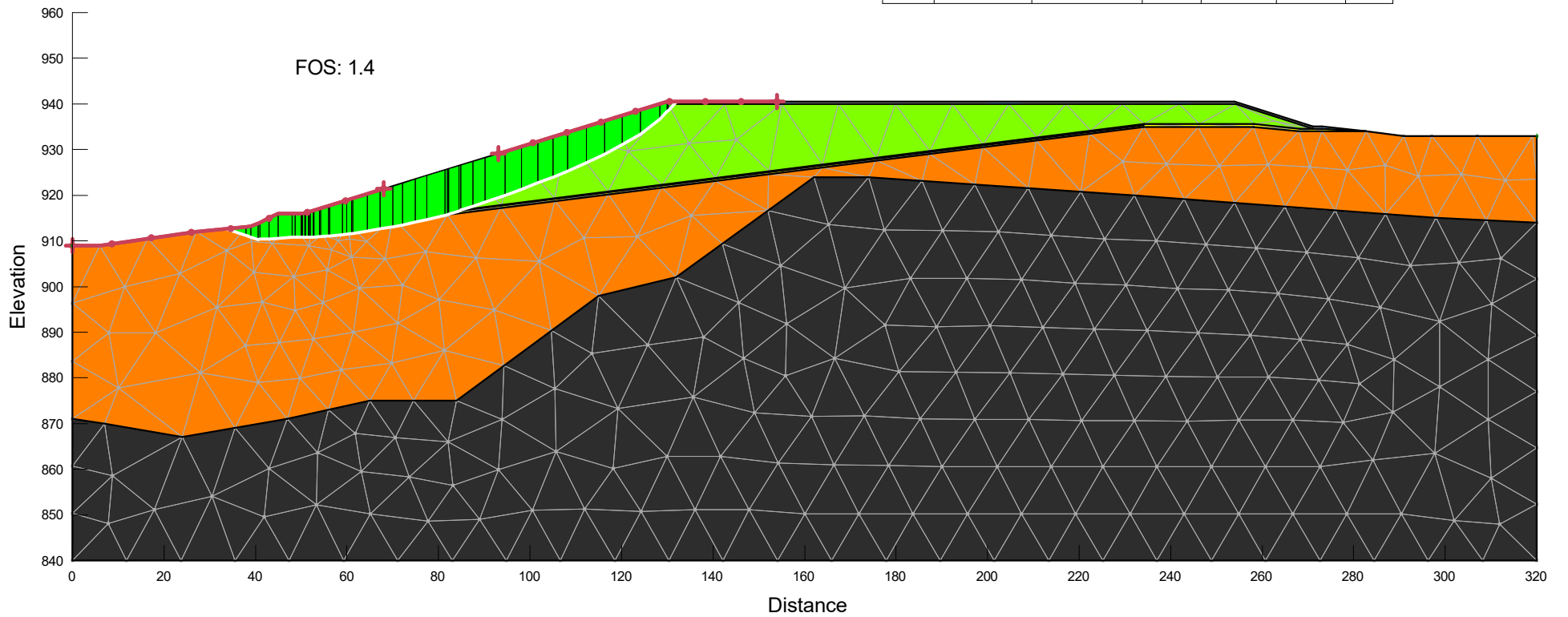
Name: B06 - Fully Thawed - Static Deep
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



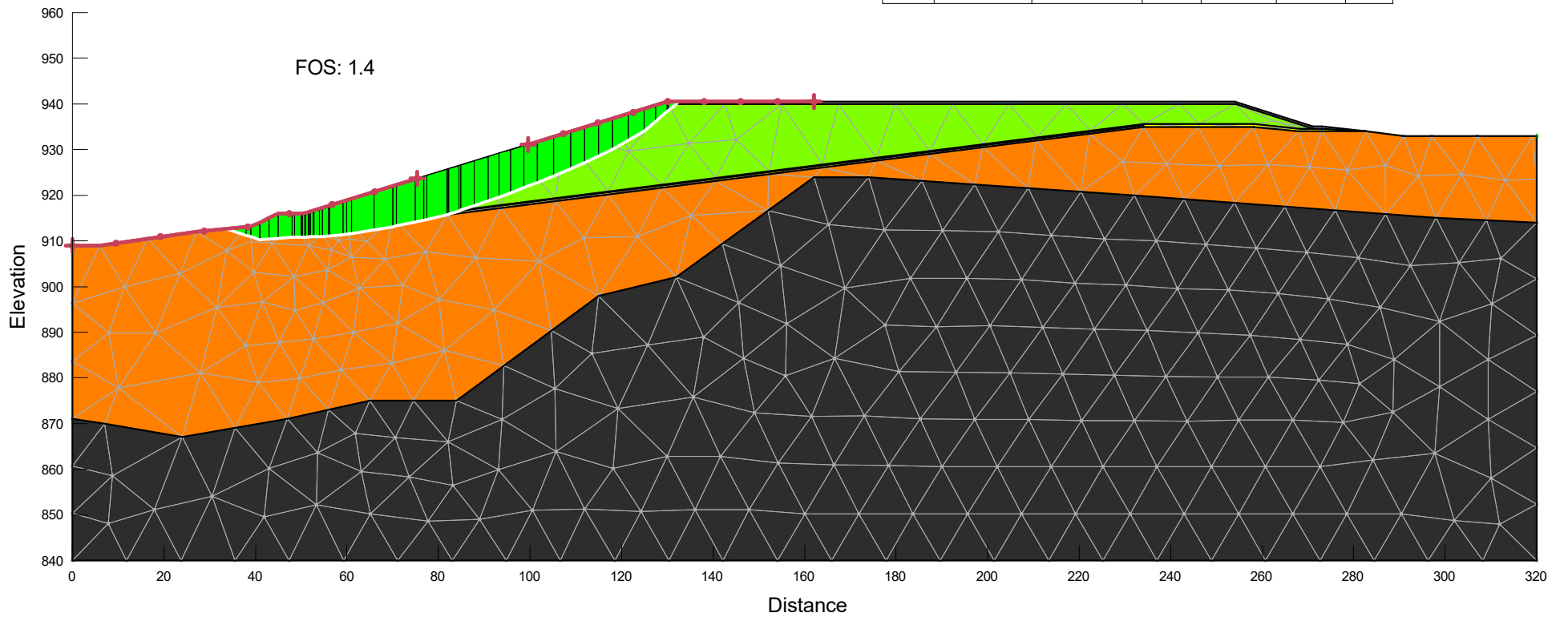
Name: B07 - Fully Thawed - Pseudostatic Shallow
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



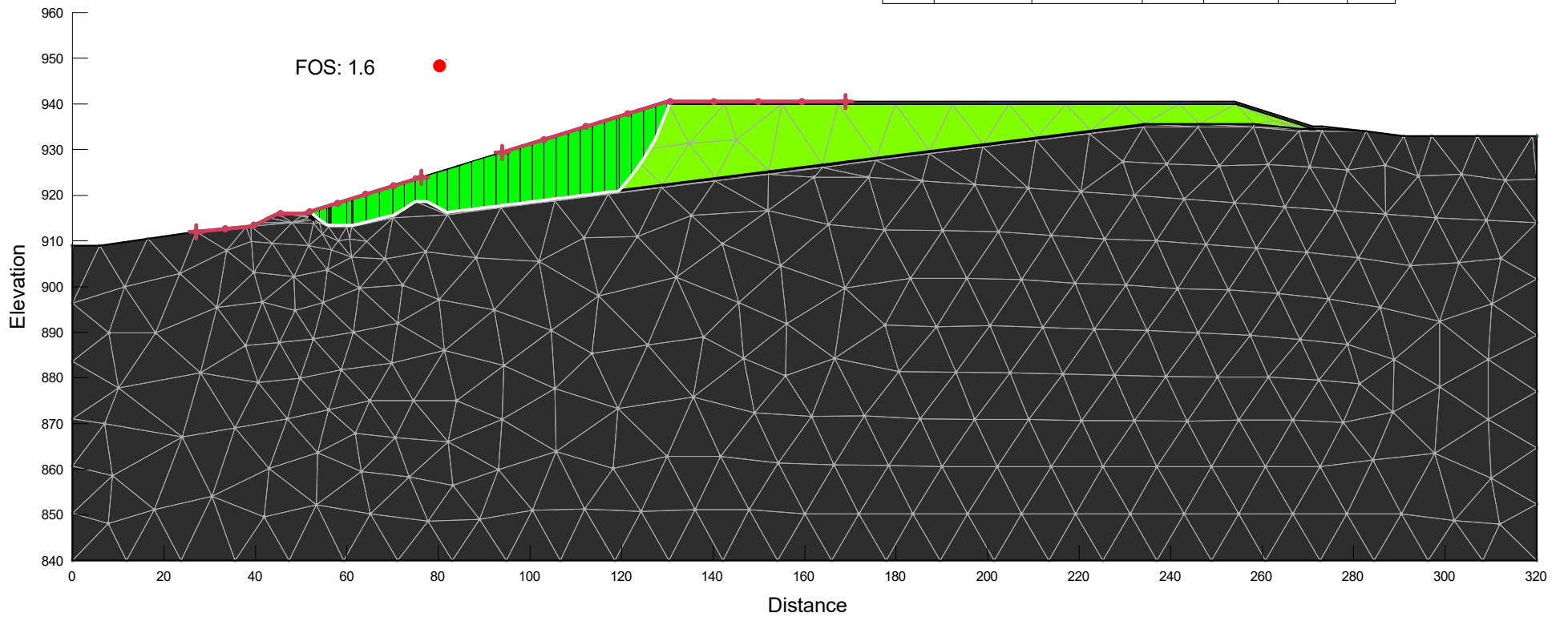
Name: B08 - Fully Thawed - Pseudostatic Deep
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



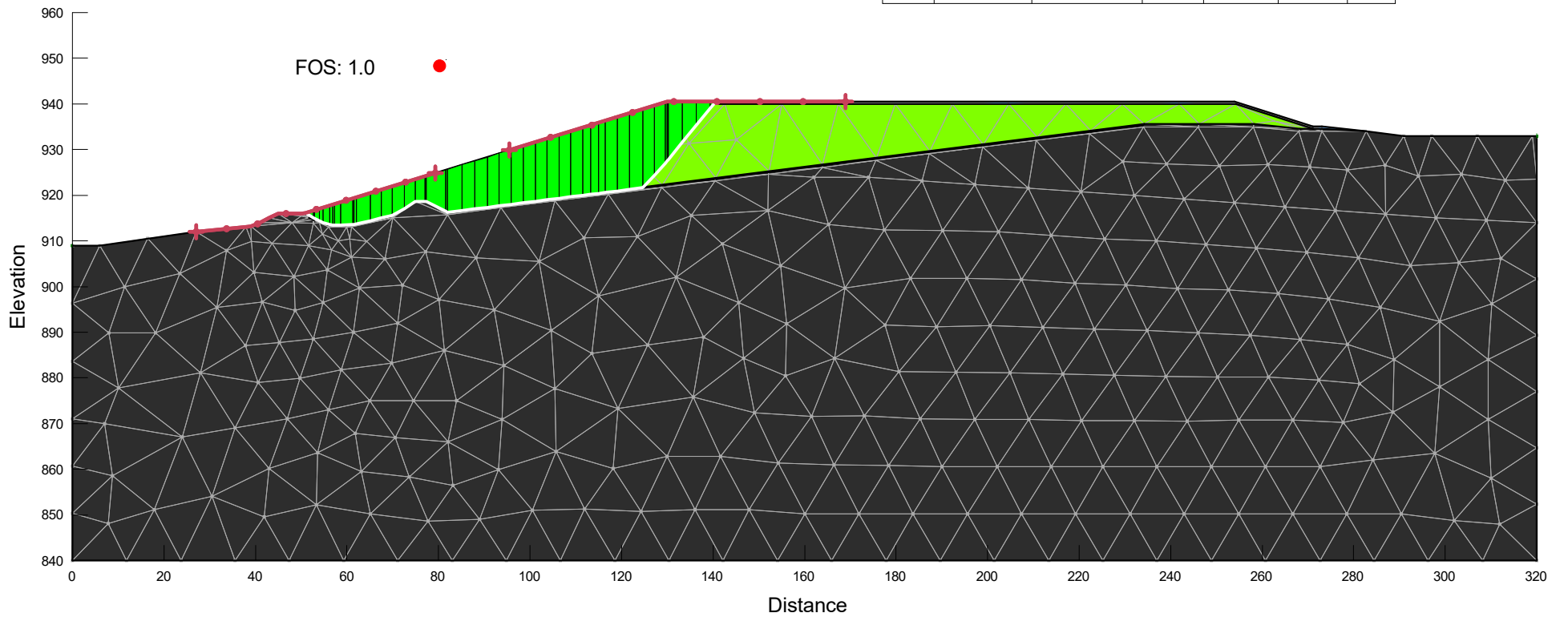
Name: B09 - Foundation Analysis - Static Deep
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 10 m
 Horz Seismic Coef.:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0



Name: B10 - Foundation Analysis - Pseudostatic Deep
 File Name: WARC04307-02_Section B_3.25-1Tails_Interior Berm_SG4-1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 10 m
 Horz Seismic Coef.: 0.139

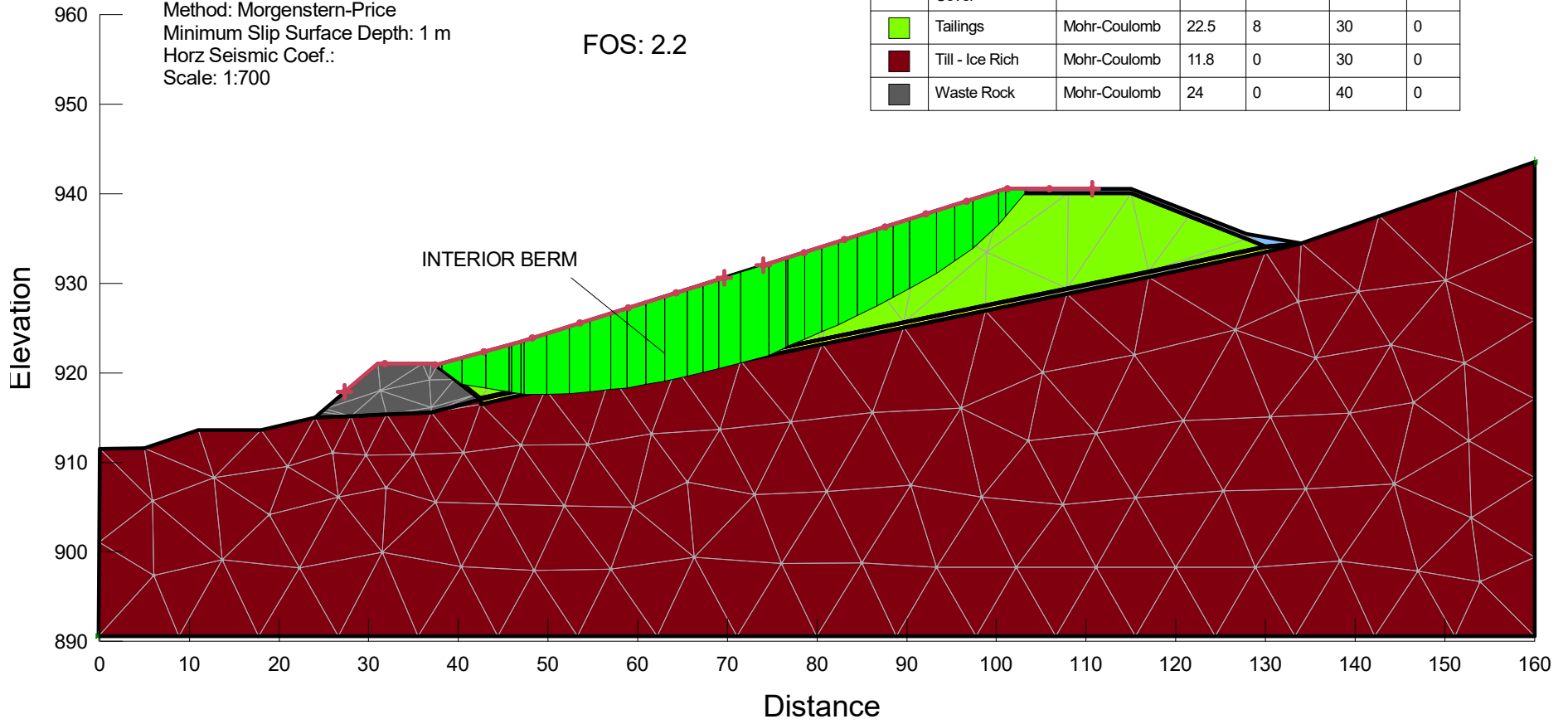
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0



Name: C01 - Fully Frozen - Static Shallow
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:
 Scale: 1:700

FOS: 2.2

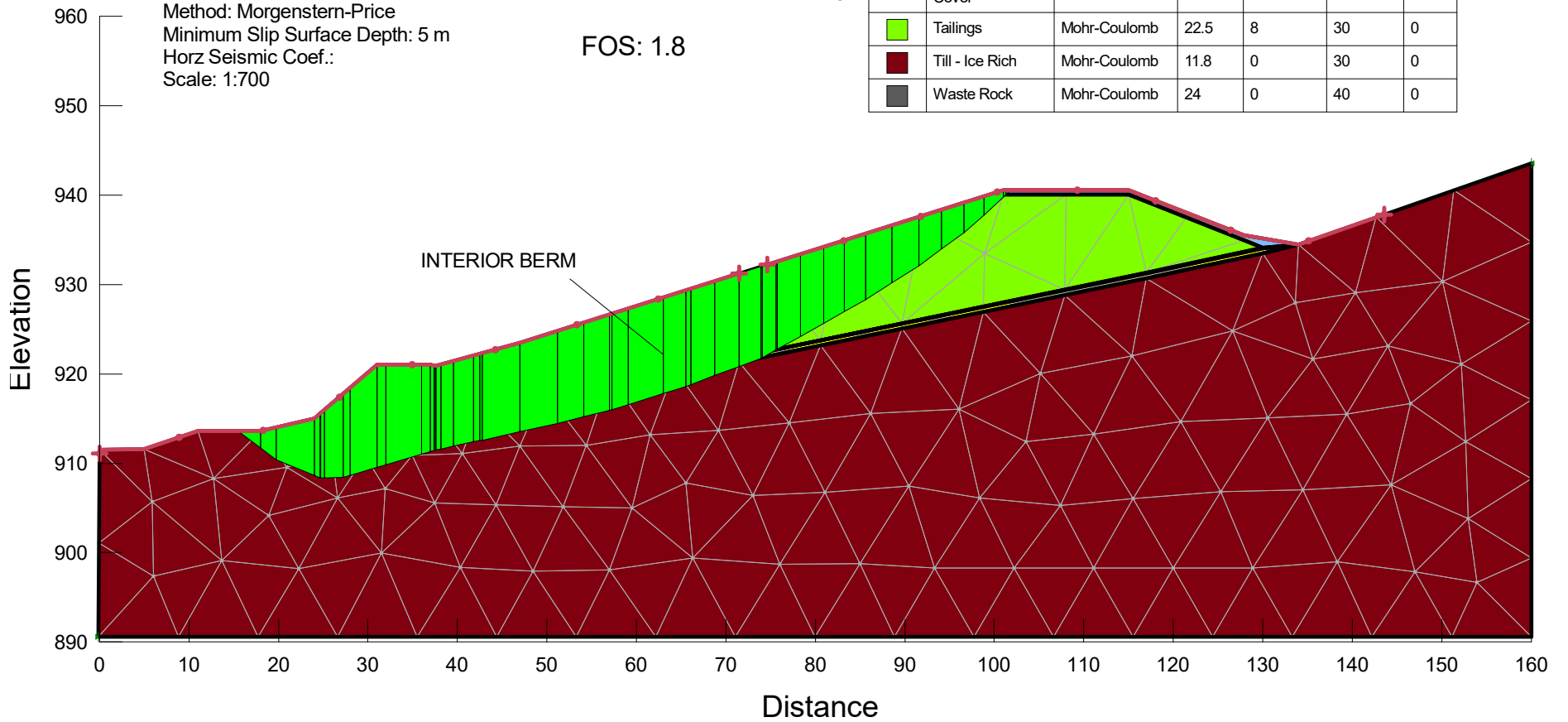
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	24	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	40	0	



Name: C02 - Fully Frozen - Static Deep
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:
 Scale: 1:700

FOS: 1.8

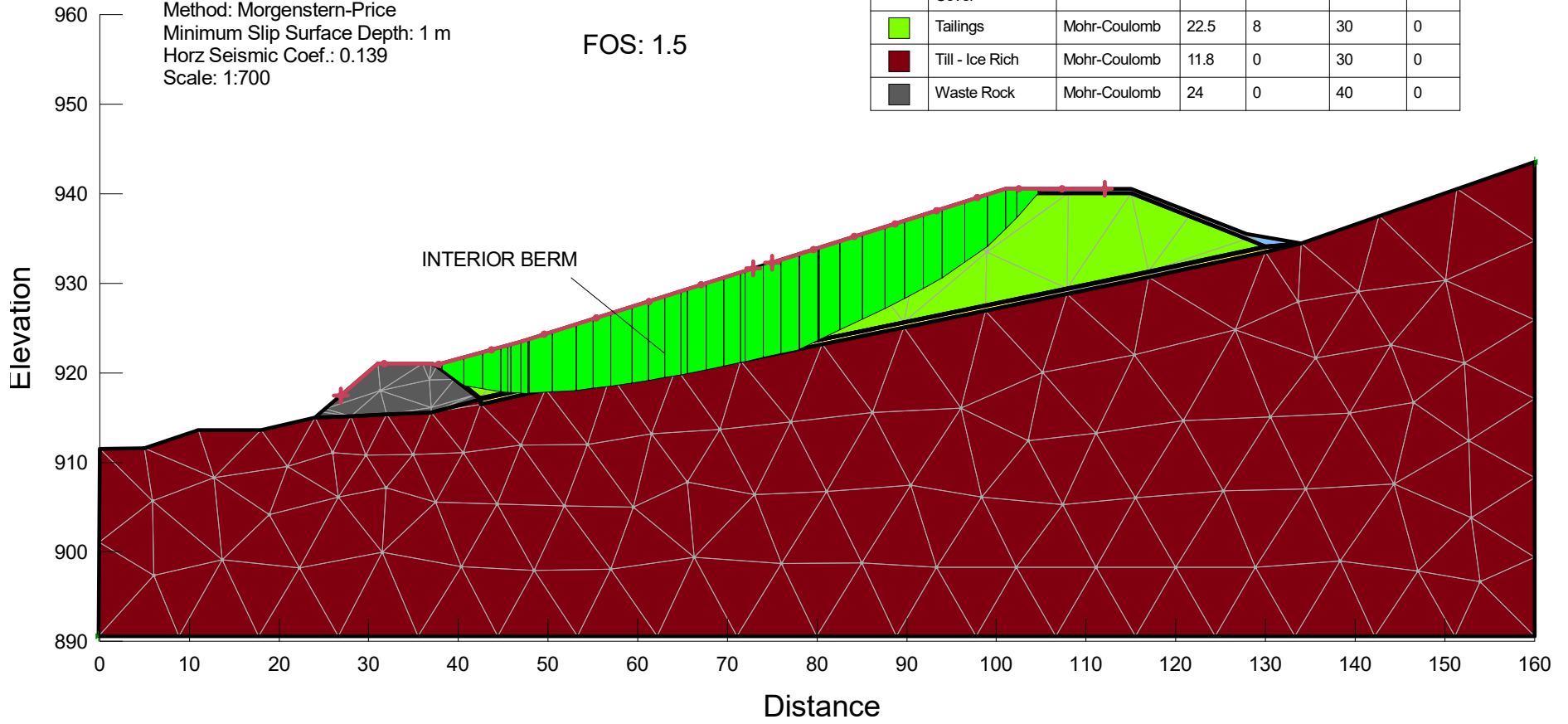
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	24	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	40	0	



Name: C03 - Fully Frozen - Pseudostatic Shallow
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139
 Scale: 1:700

FOS: 1.5

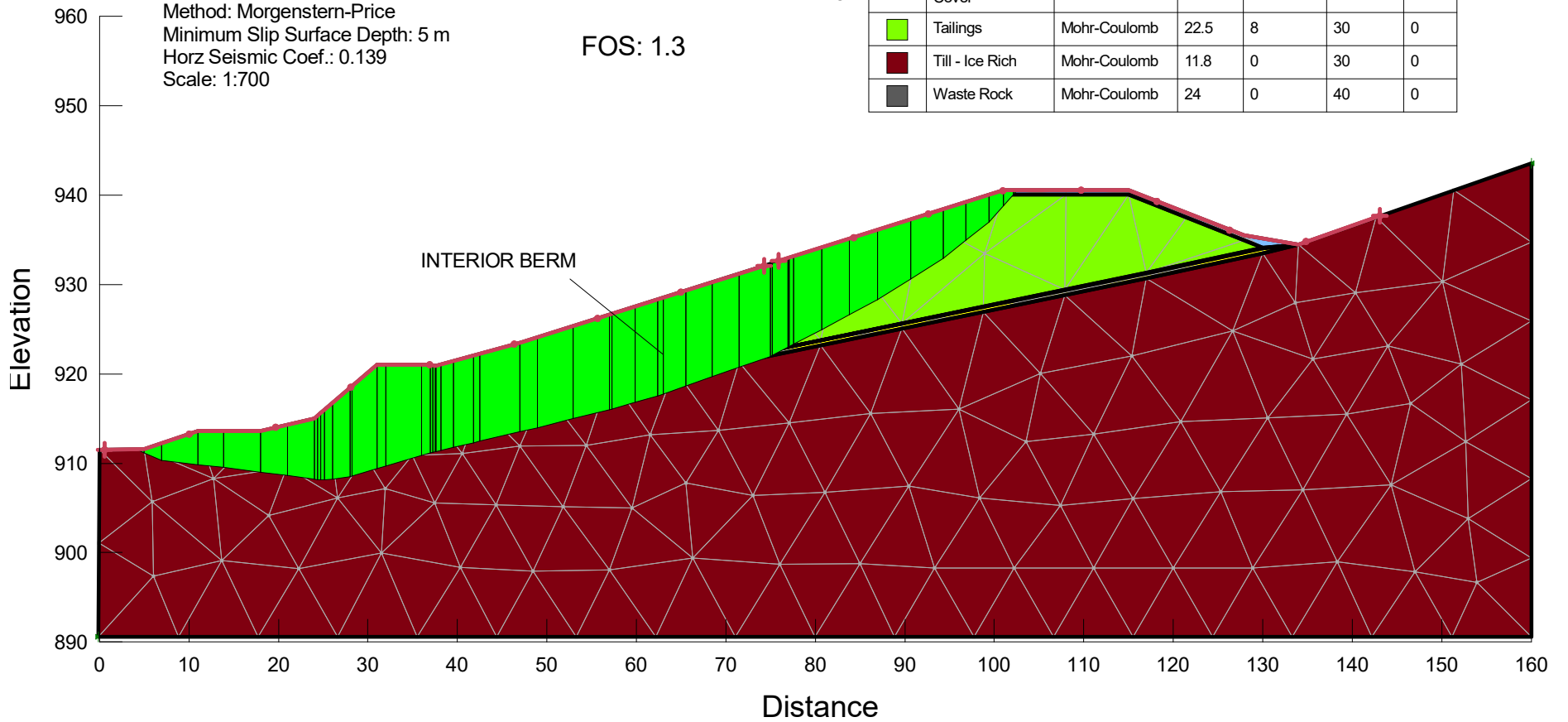
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	24	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	40	0	



Name: C04 - Fully Frozen - Pseudostatic Deep
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139
 Scale: 1:700

FOS: 1.3

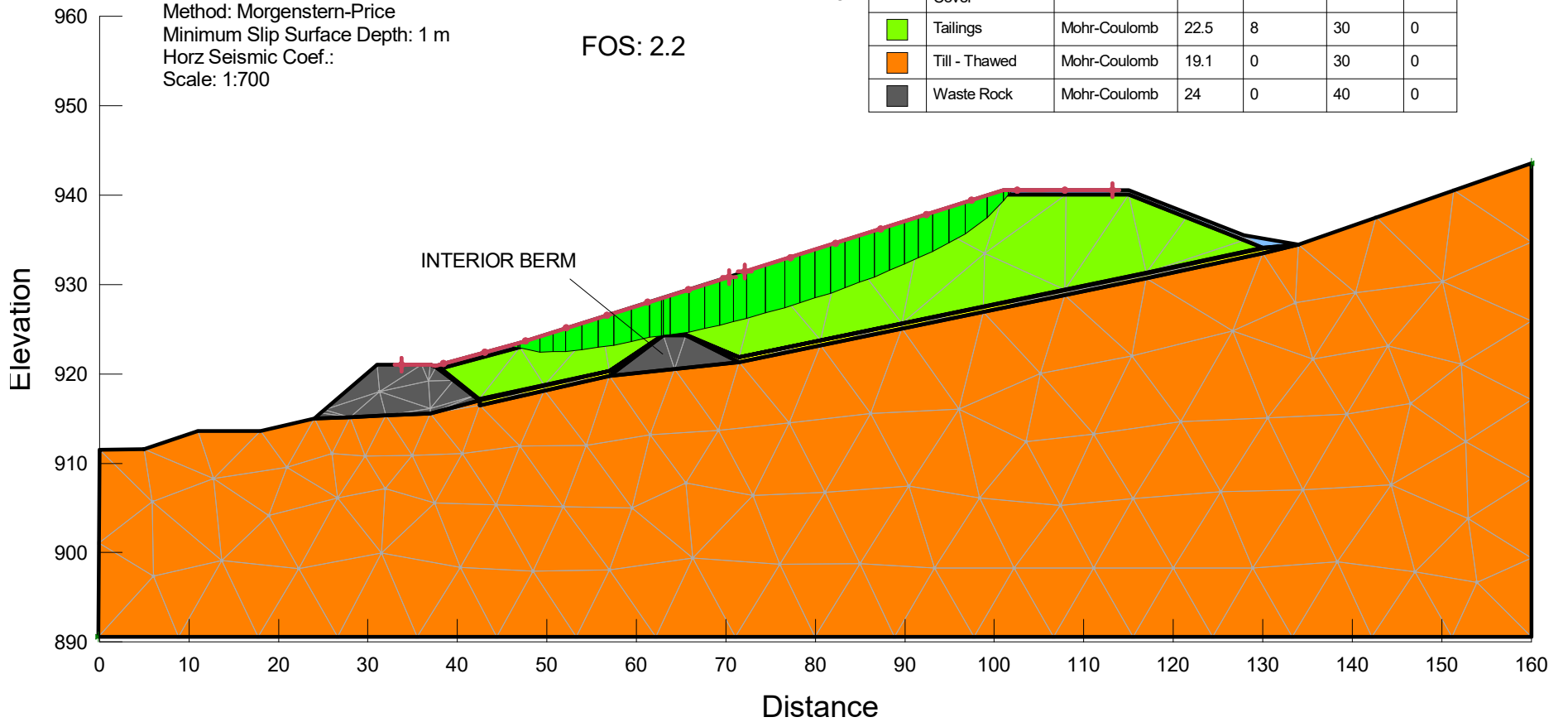
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	24	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	40	0	



Name: C05 - Fully Thawed - Static Shallow
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:
 Scale: 1:700

FOS: 2.2

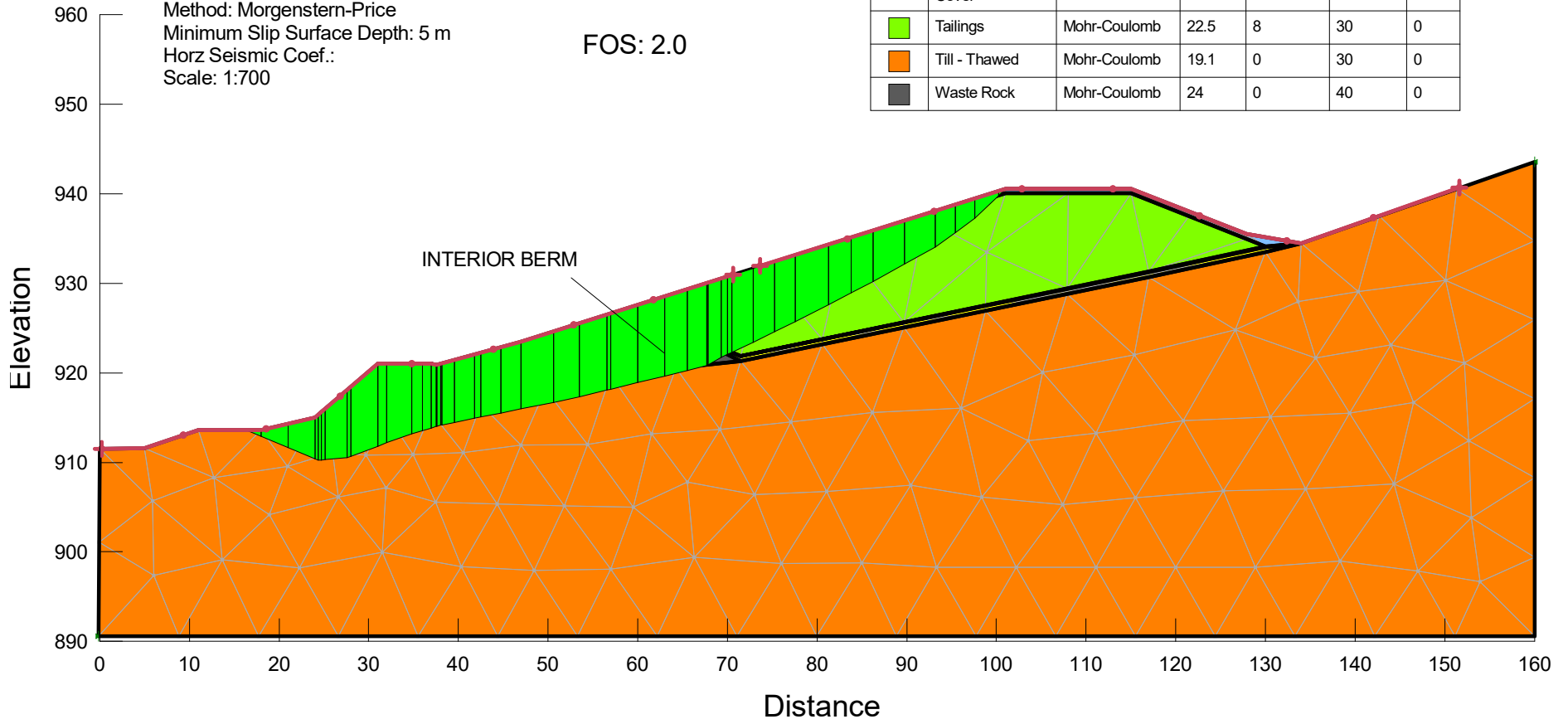
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	24	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



Name: C06 - Fully Thawed - Static Deep
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:
 Scale: 1:700

FOS: 2.0

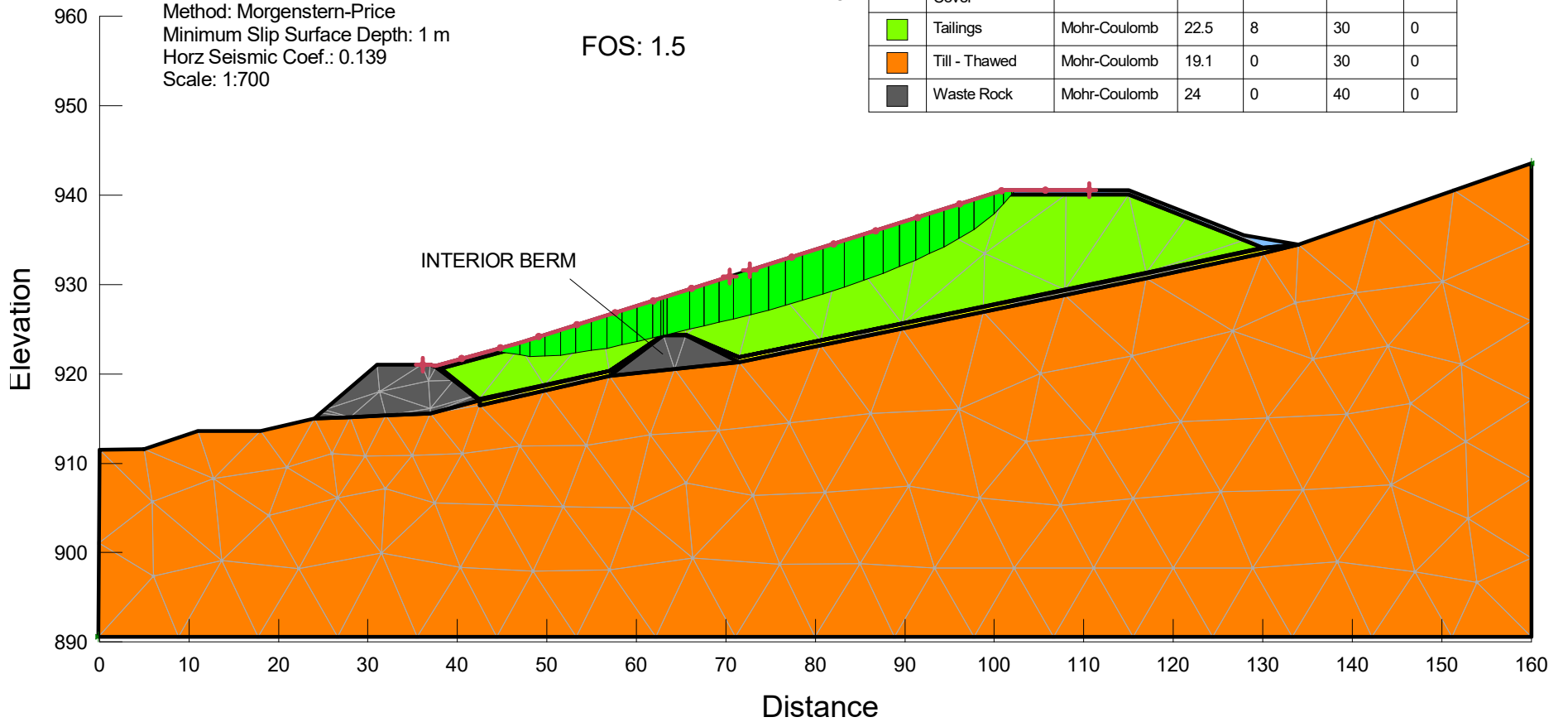
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	24	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



Name: C07 - Fully Thawed - Pseudostatic Shallow
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139
 Scale: 1:700

FOS: 1.5

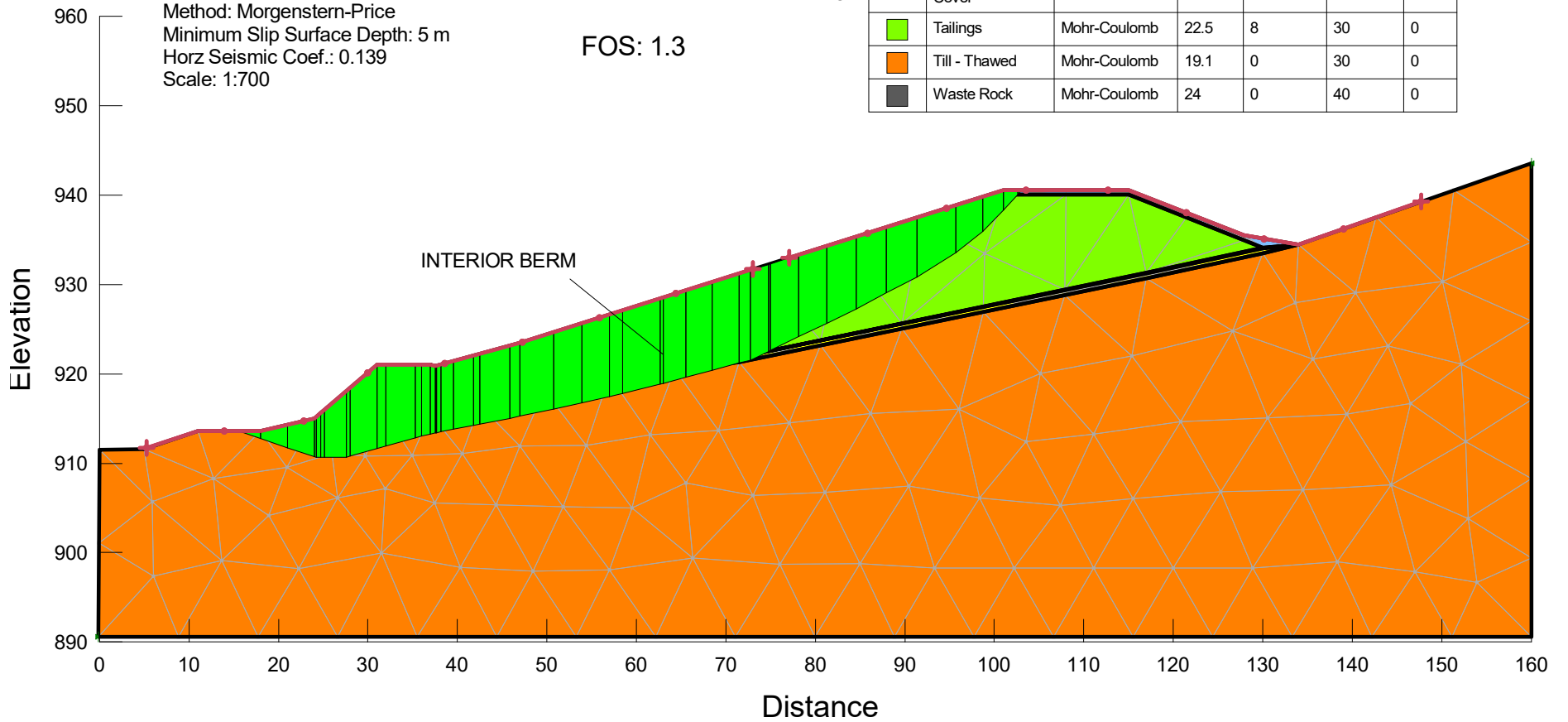
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	24	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



Name: C08 - Fully Thawed - Pseudostatic Deep
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139
 Scale: 1:700

FOS: 1.3

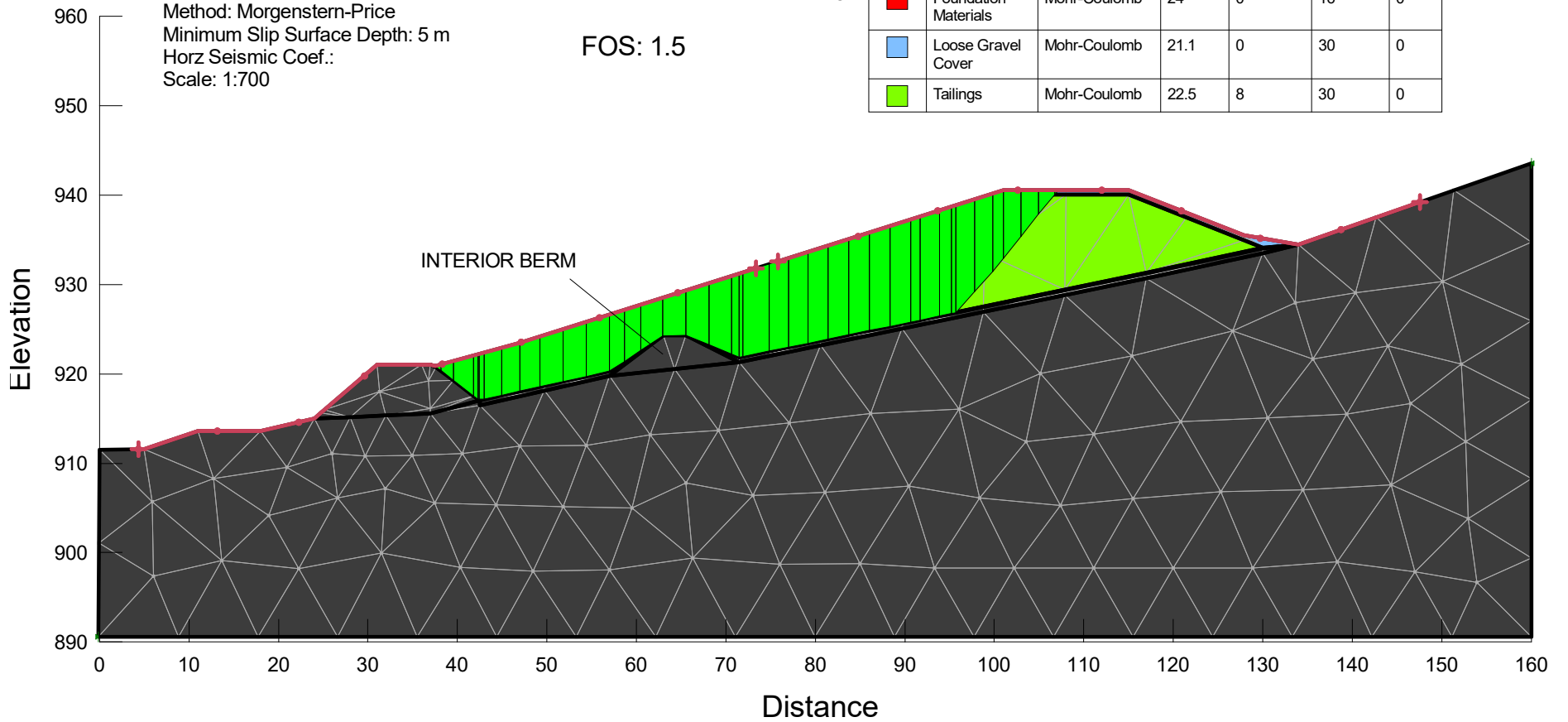
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Red	Foundation Materials	Mohr-Coulomb	24	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	40	0	



Name: C09 - Foundation Analysis - Static Deep
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:
 Scale: 1:700

FOS: 1.5

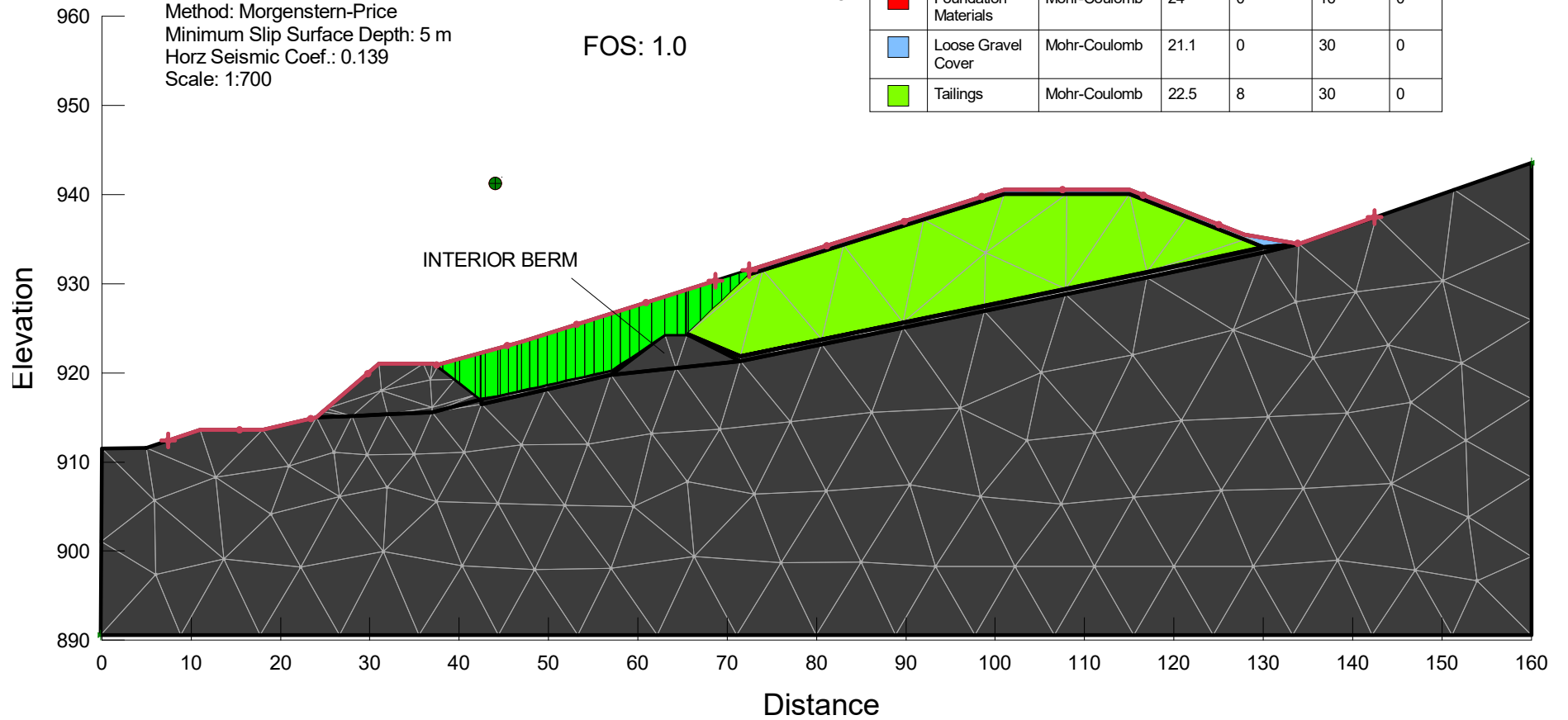
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	24	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0



Name: C10 - Foundation Analysis - Pseudostatic Deep
 File Name: WARC04307-02_Section C_3.25-1Tails_Interior Berm_SG4-1-final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139
 Scale: 1:700

FOS: 1.0

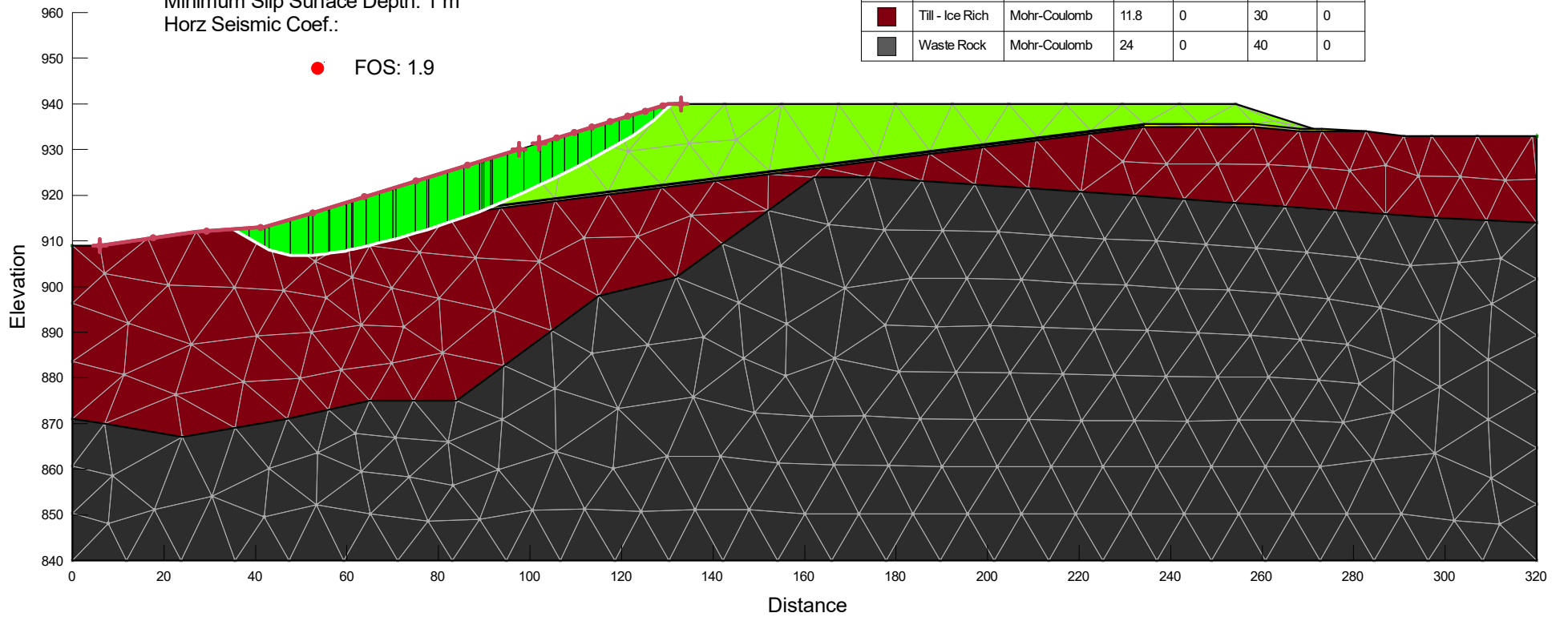
Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	24	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0



Name: D01 - Fully Frozen - Static Shallow
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:

● FOS: 1.9

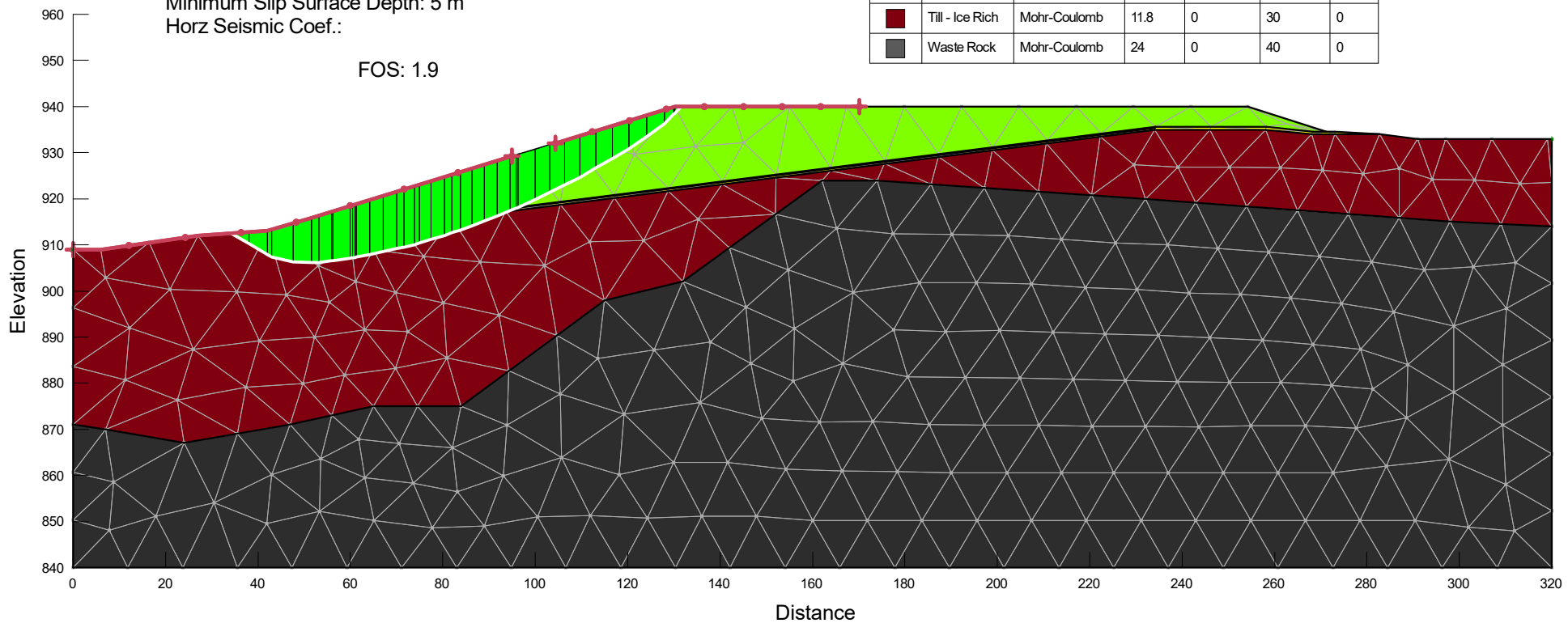
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0 </td <td>40</td> <td>0</td>	40	0



Name: D02 - Fully Frozen - Static Deep
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:

FOS: 1.9

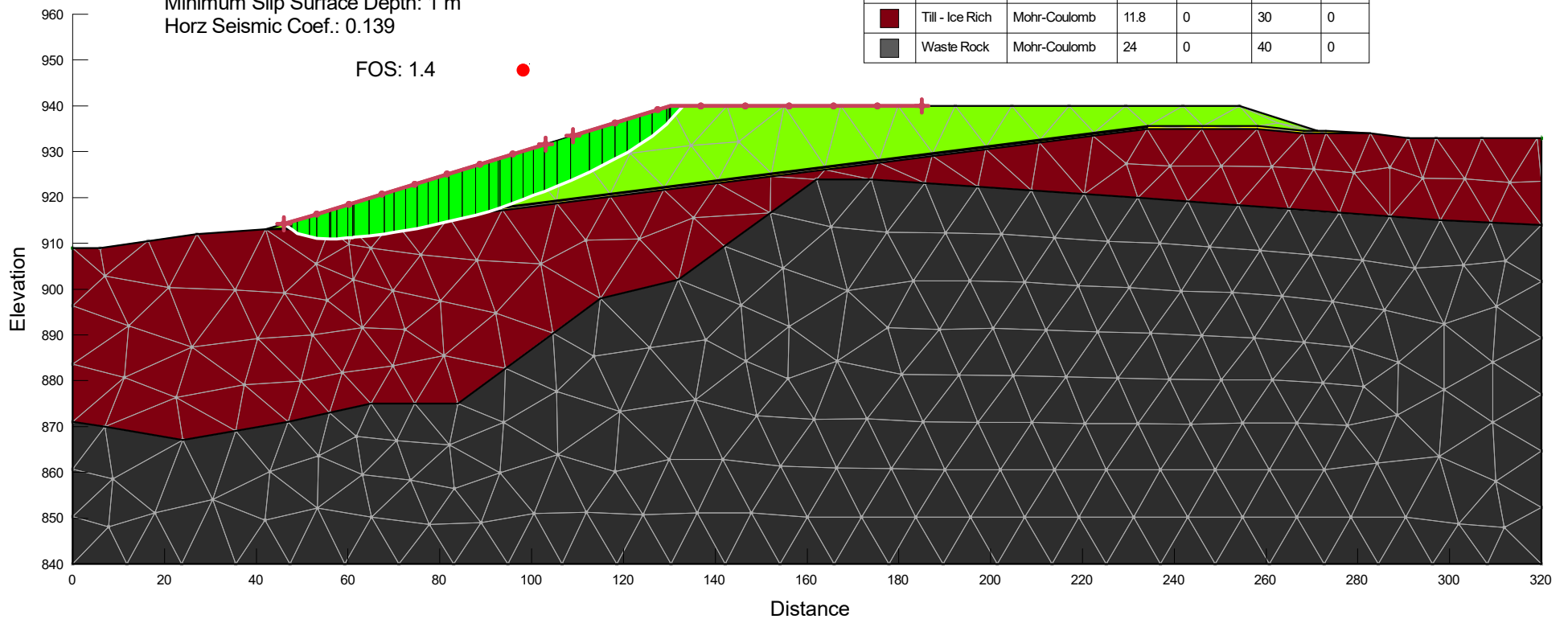
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



Name: D03 - Fully Frozen - Pseudostatic Shallow
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139

FOS: 1.4

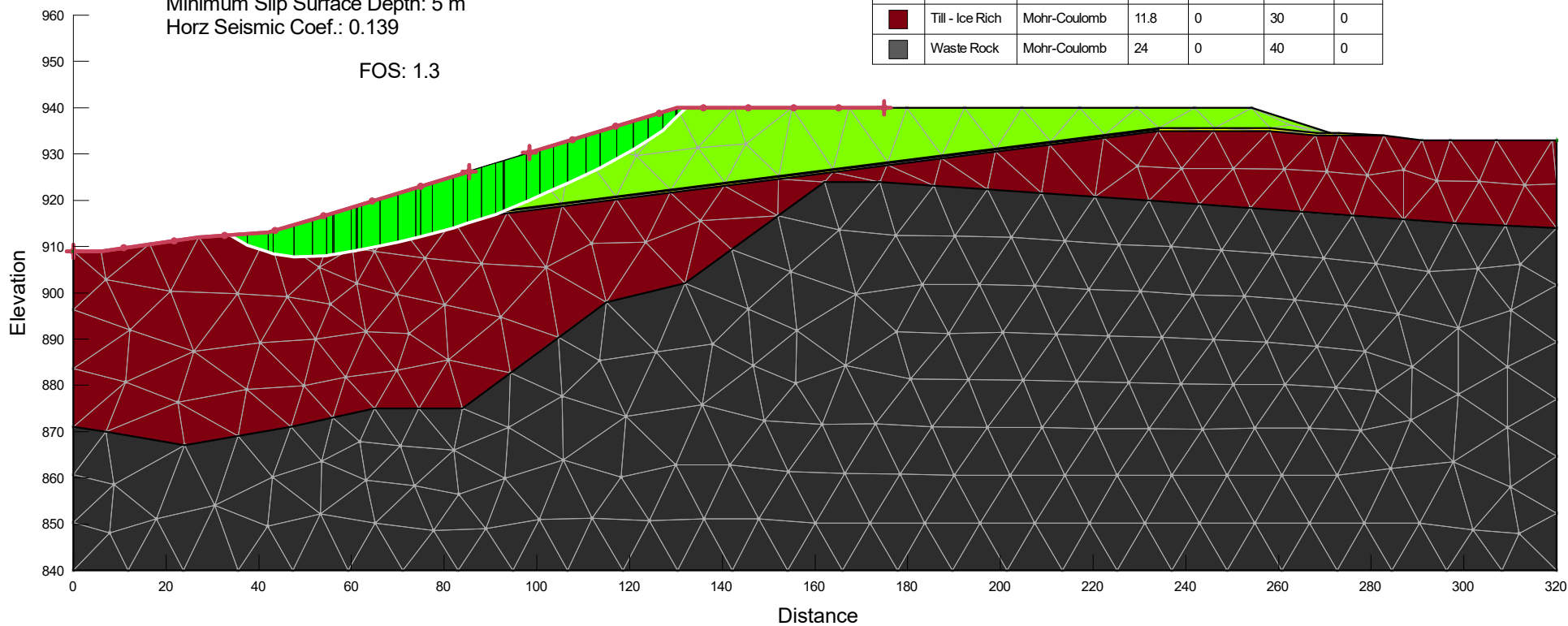
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0 <td>40</td> <td>0</td>	40	0



Name: D04 - Fully Frozen - Pseudostatic Deep
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139

FOS: 1.3

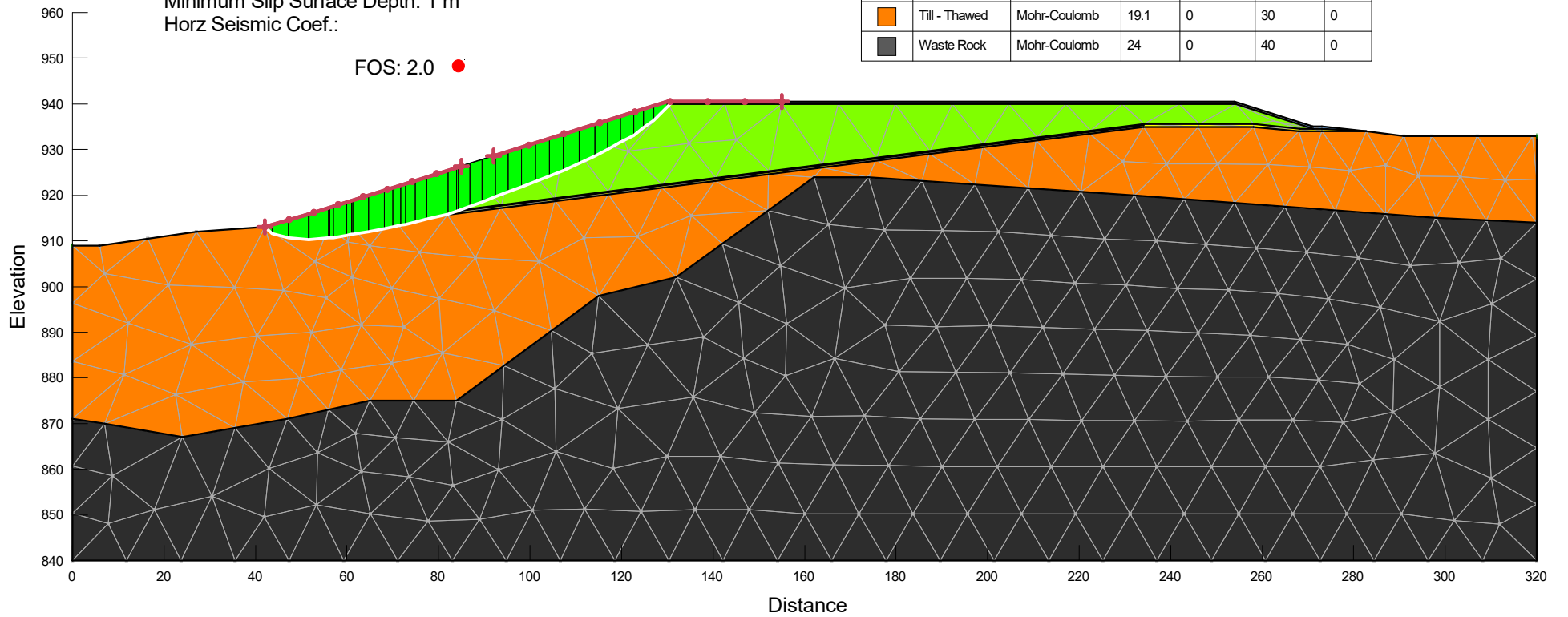
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0
Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



Name: D05 - Fully Thawed - Static Shallow
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:

FOS: 2.0 ●

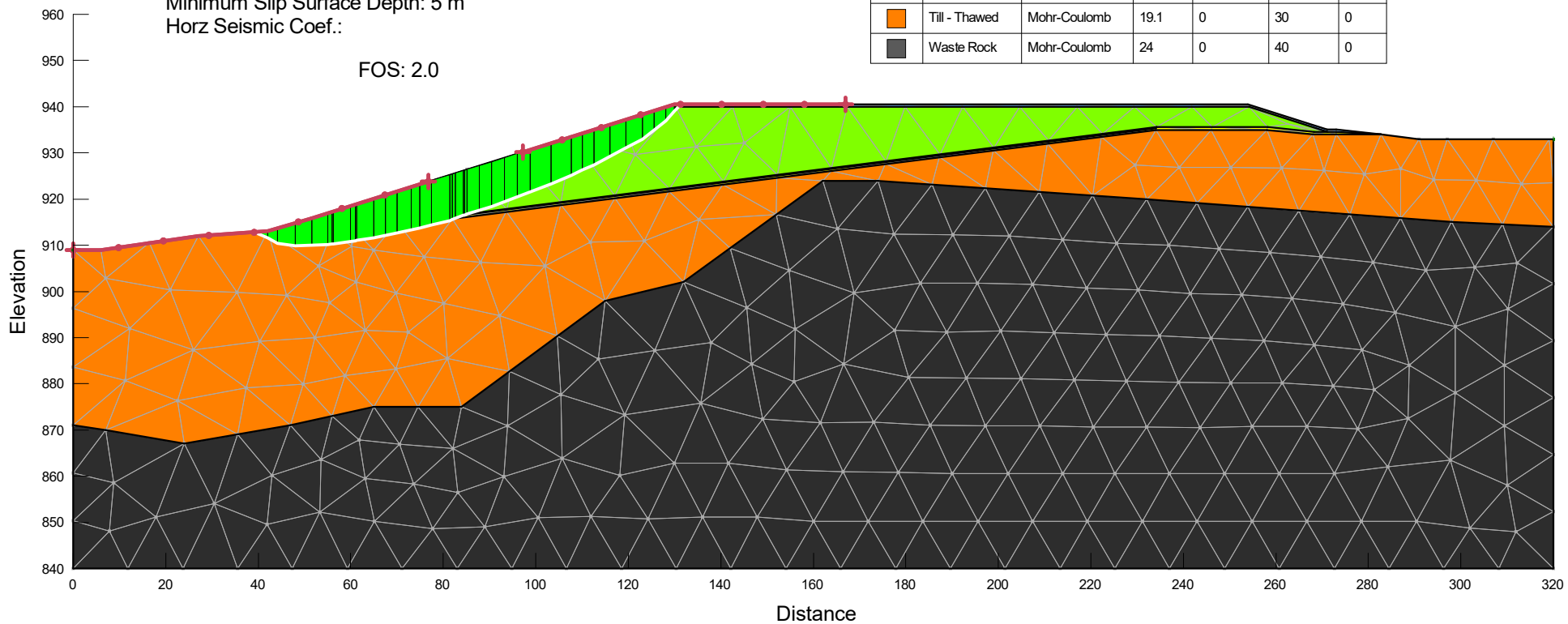
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



Name: D06 - Fully Thawed - Static Deep
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:

FOS: 2.0

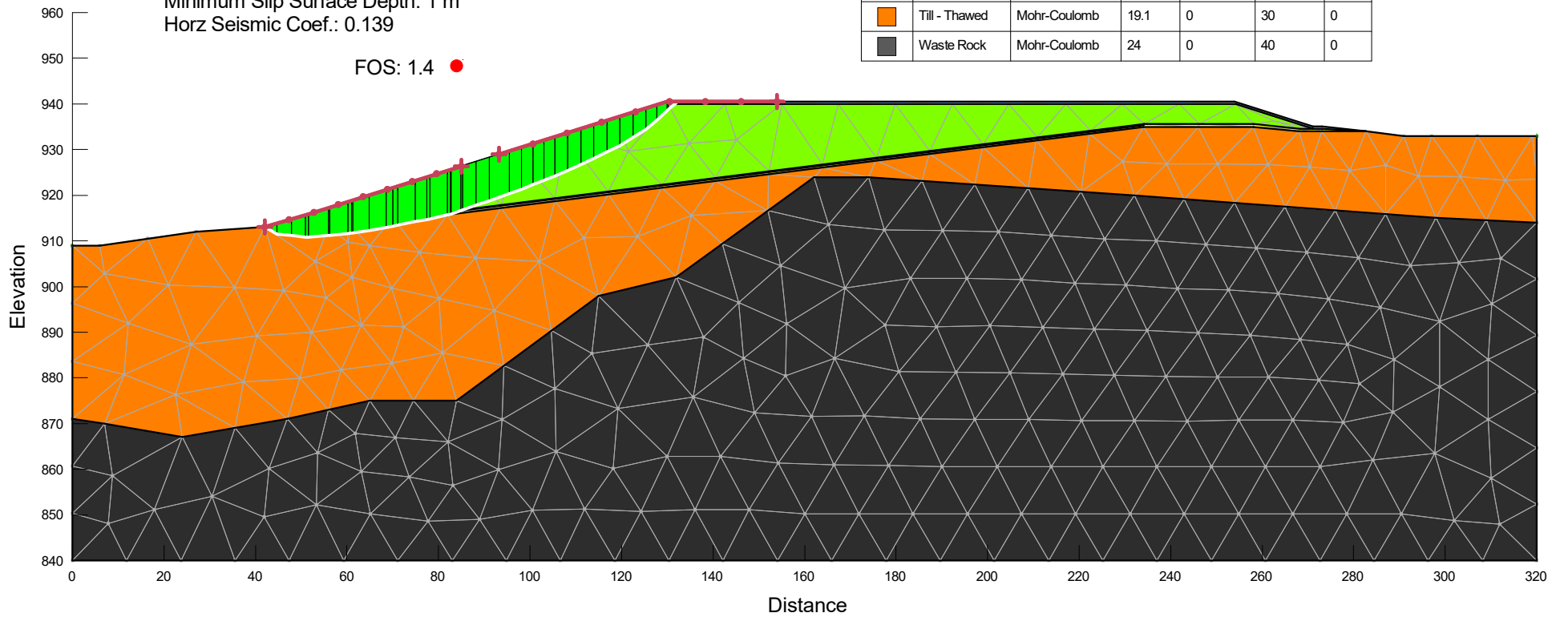
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



Name: D07 - Fully Thawed - Pseudostatic Shallow
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139

FOS: 1.4 ●

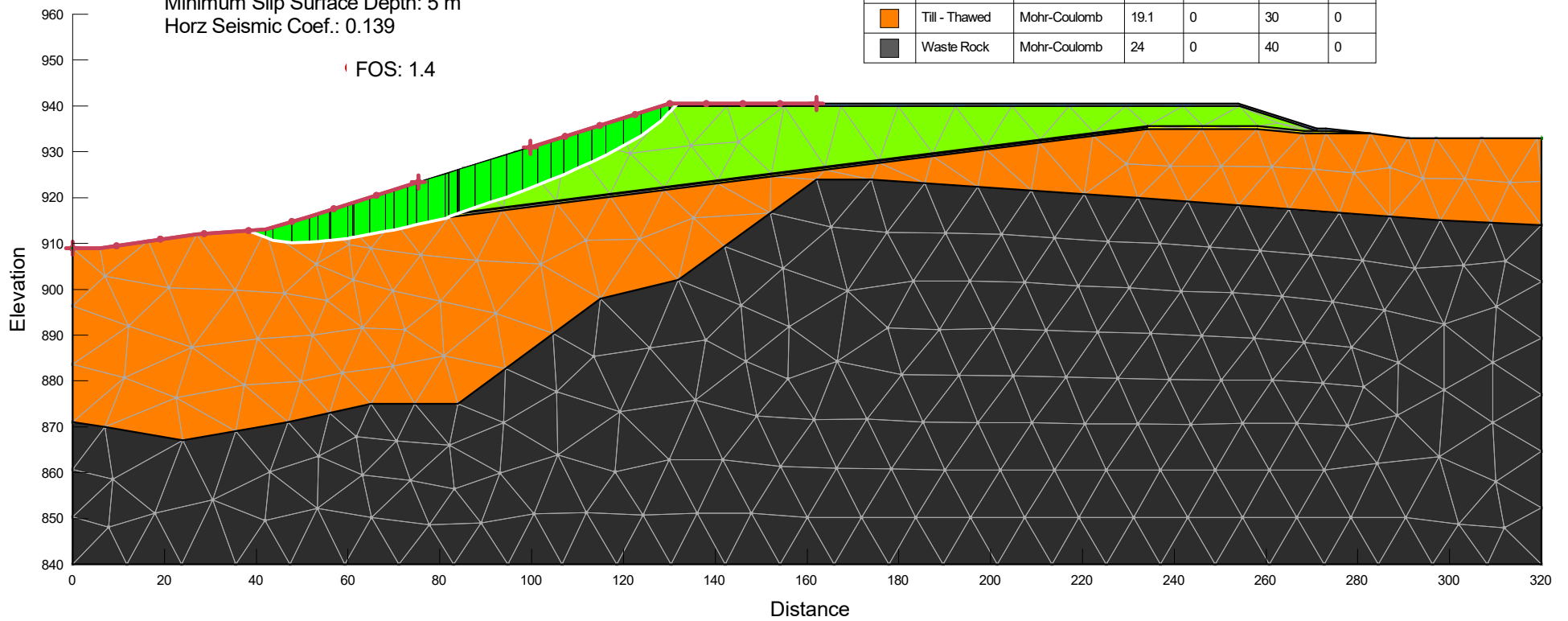
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0 </tr		



Name: D08 - Fully Thawed - Pseudostatic Deep
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139

FOS: 1.4

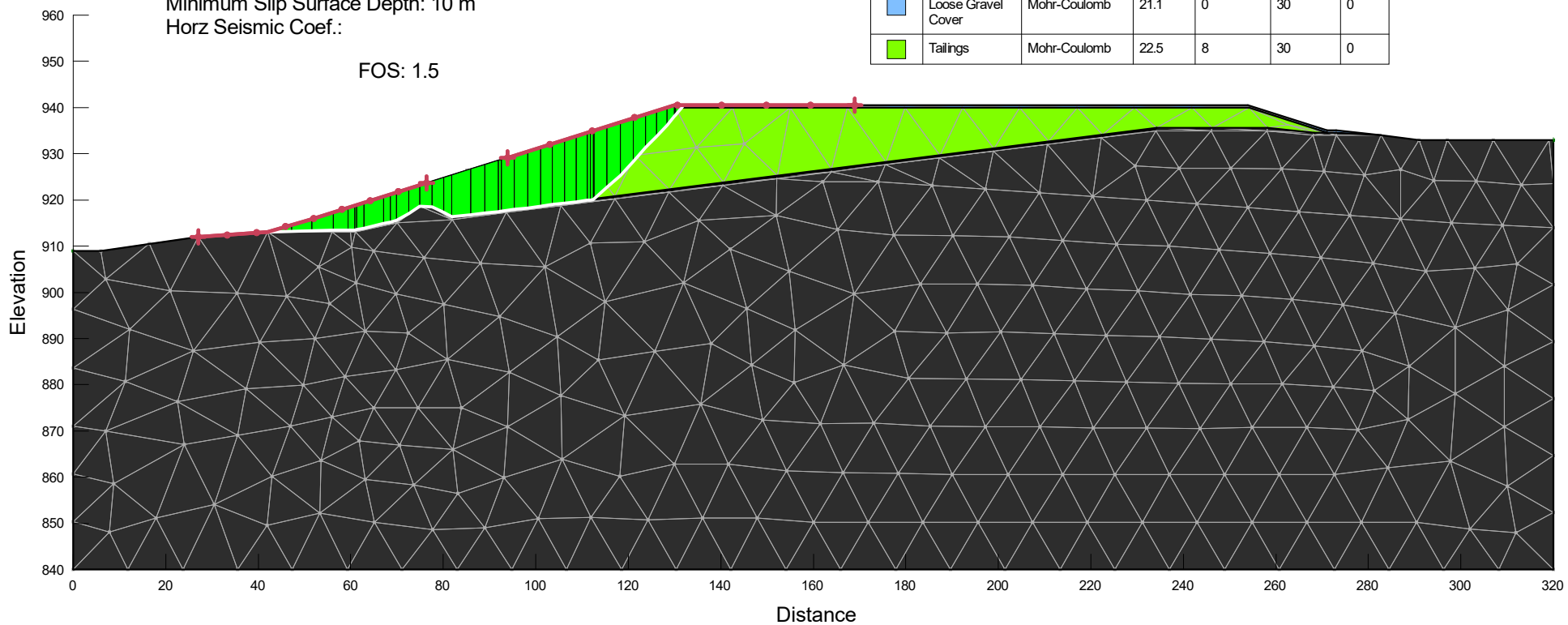
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Yellow	Gravel Drainage Blanket	Mohr-Coulomb	24	0	35	0
Light Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Light Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Orange	Till - Thawed	Mohr-Coulomb	19.1	0	30	0
Dark Grey	Waste Rock	Mohr-Coulomb	24	0	40	0



Name: D09 - Foundation Analysis - Static Deep
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 10 m
 Horz Seismic Coef.:

FOS: 1.5

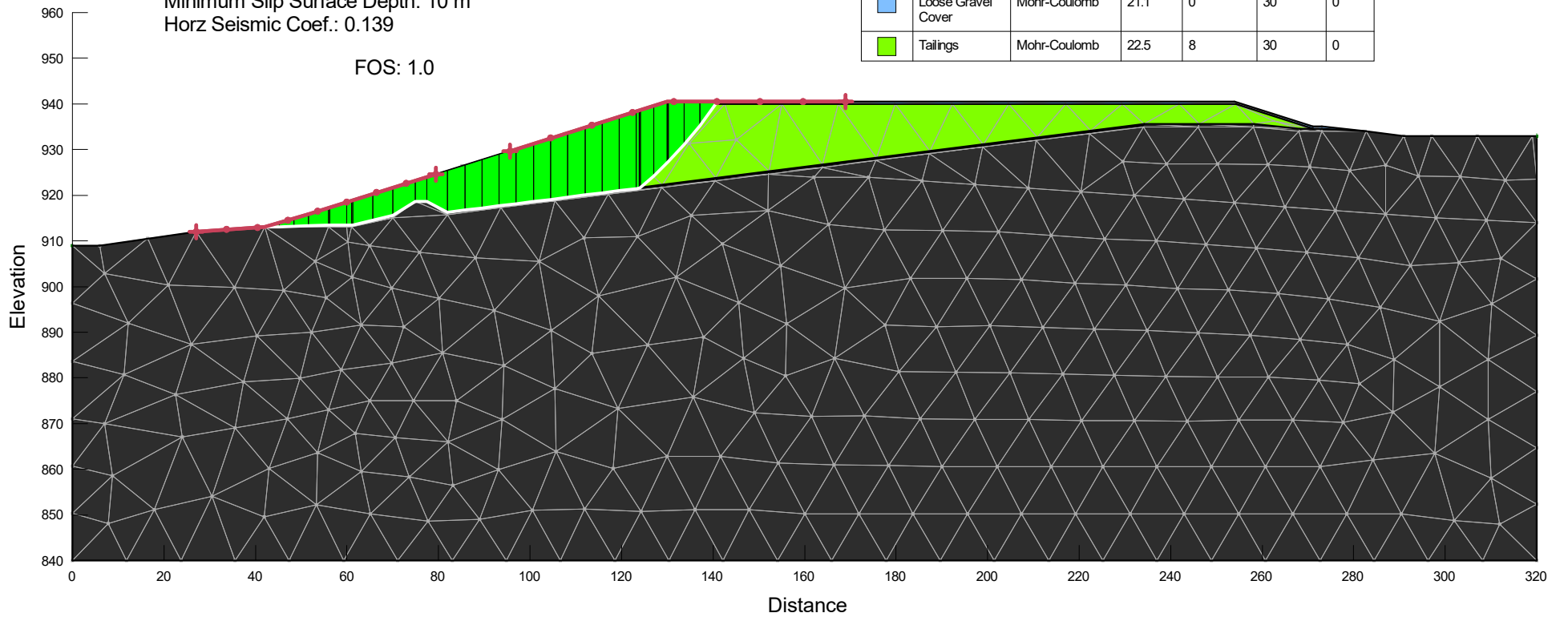
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0



Name: D10 - Foundation Analysis - Pseudostatic Deep
 File Name: WARC04307-02_Section D_3.25-1Tails_SG4-1_Final.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 10 m
 Horz Seismic Coef.: 0.139

FOS: 1.0

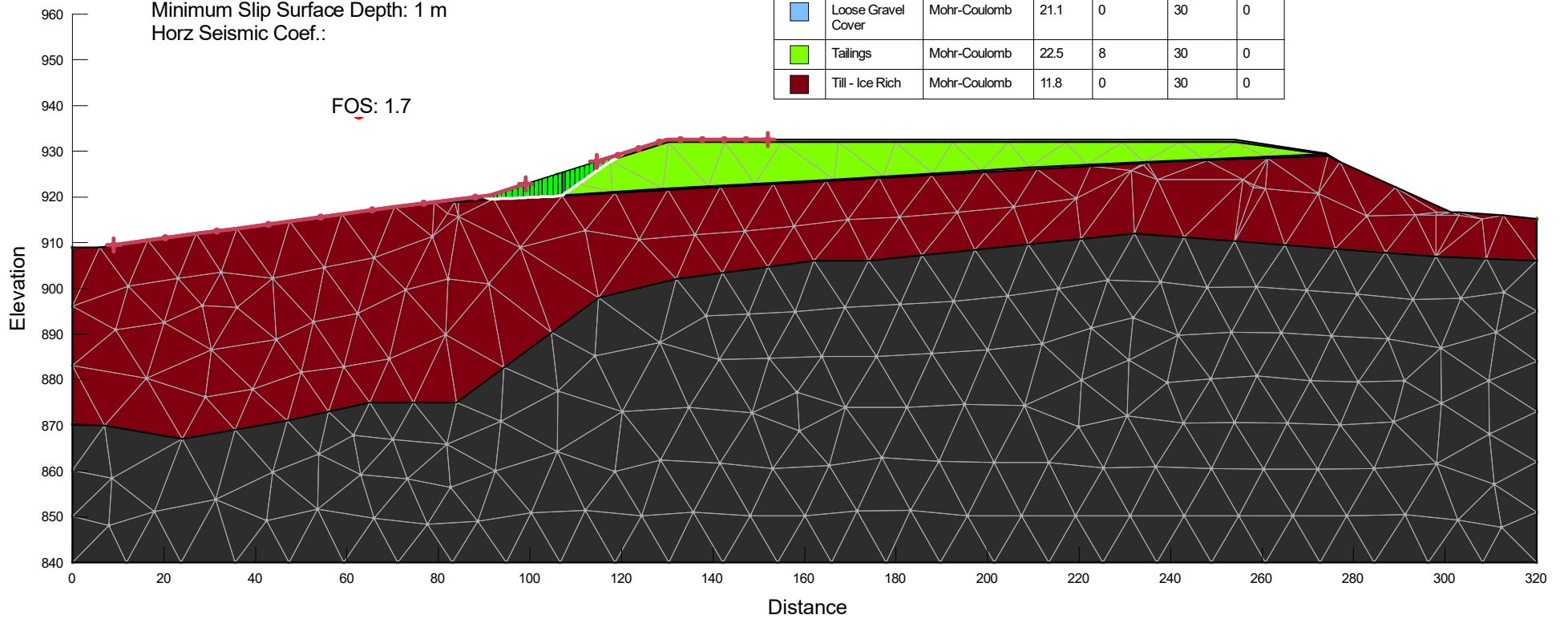
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0



Name: E01 - Fully Frozen - Static Shallow
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:

FOS: 1.7

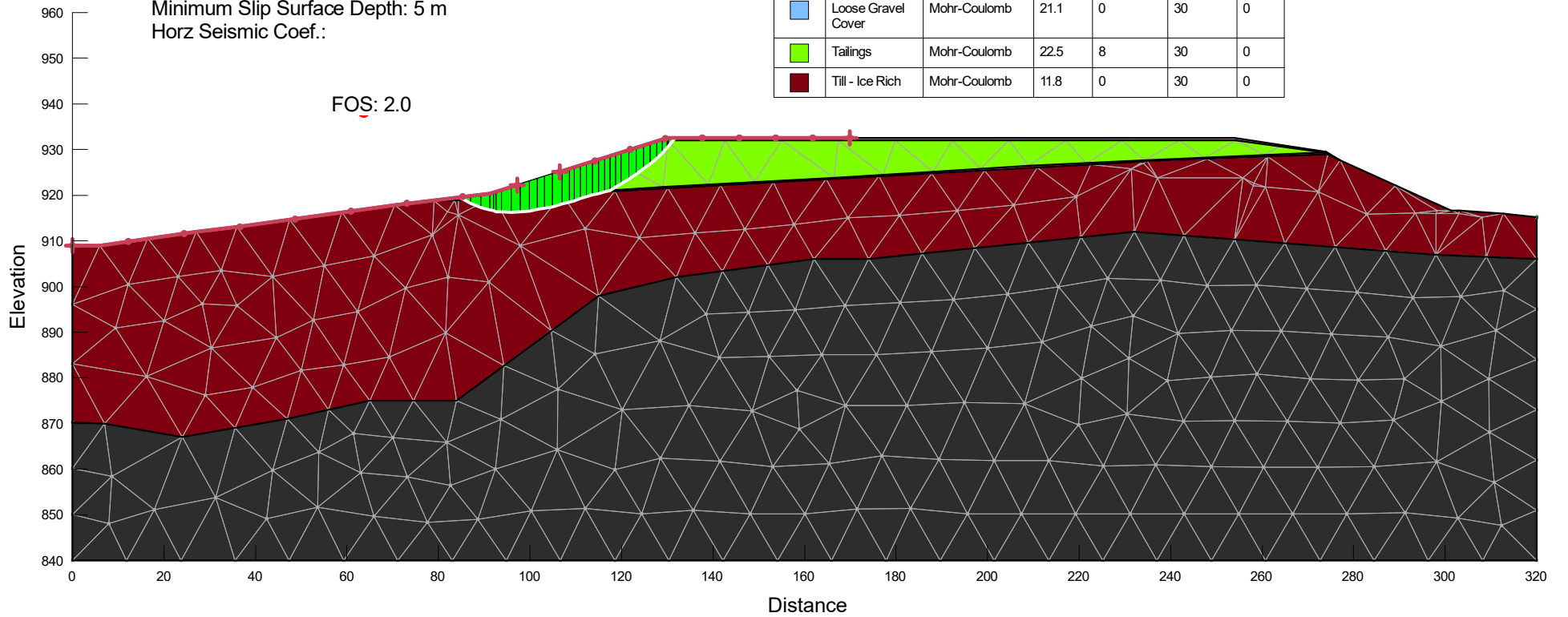
Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0



Name: E02 - Fully Frozen - Static Deep
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:

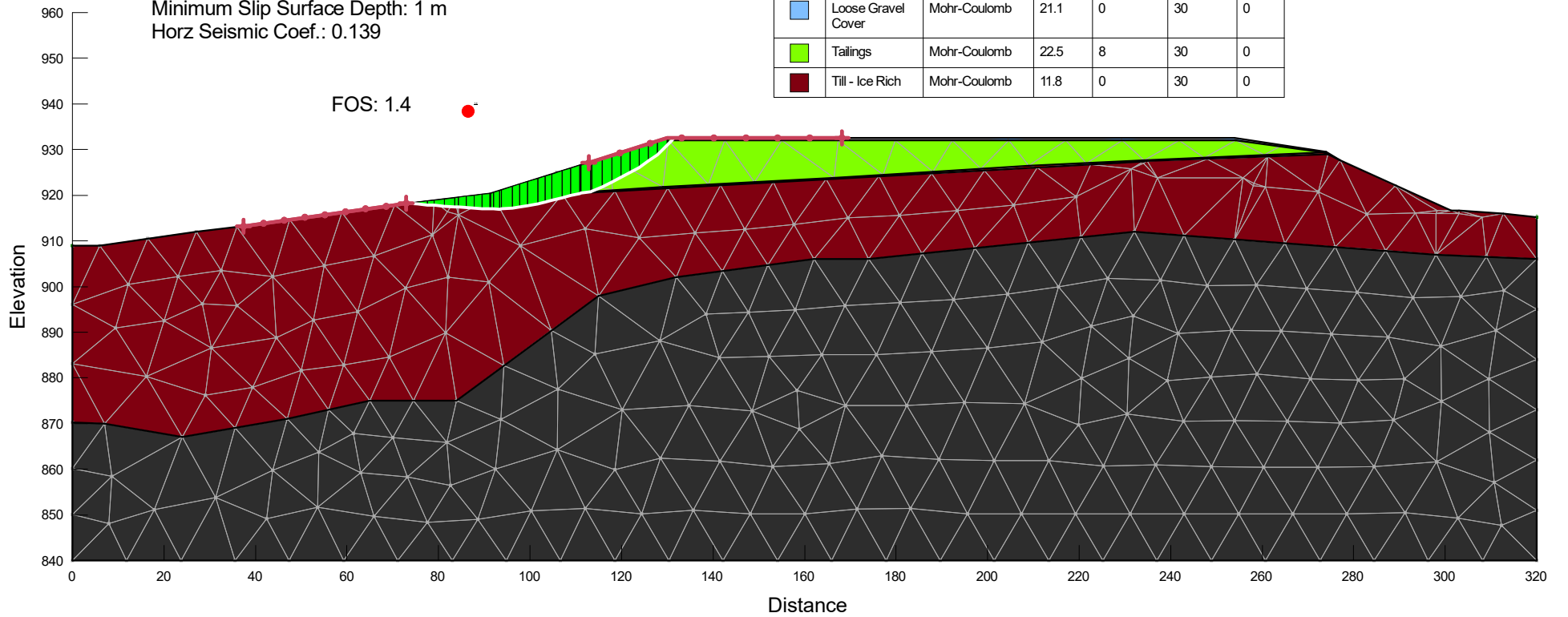
FOS: 2.0

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0
■	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0



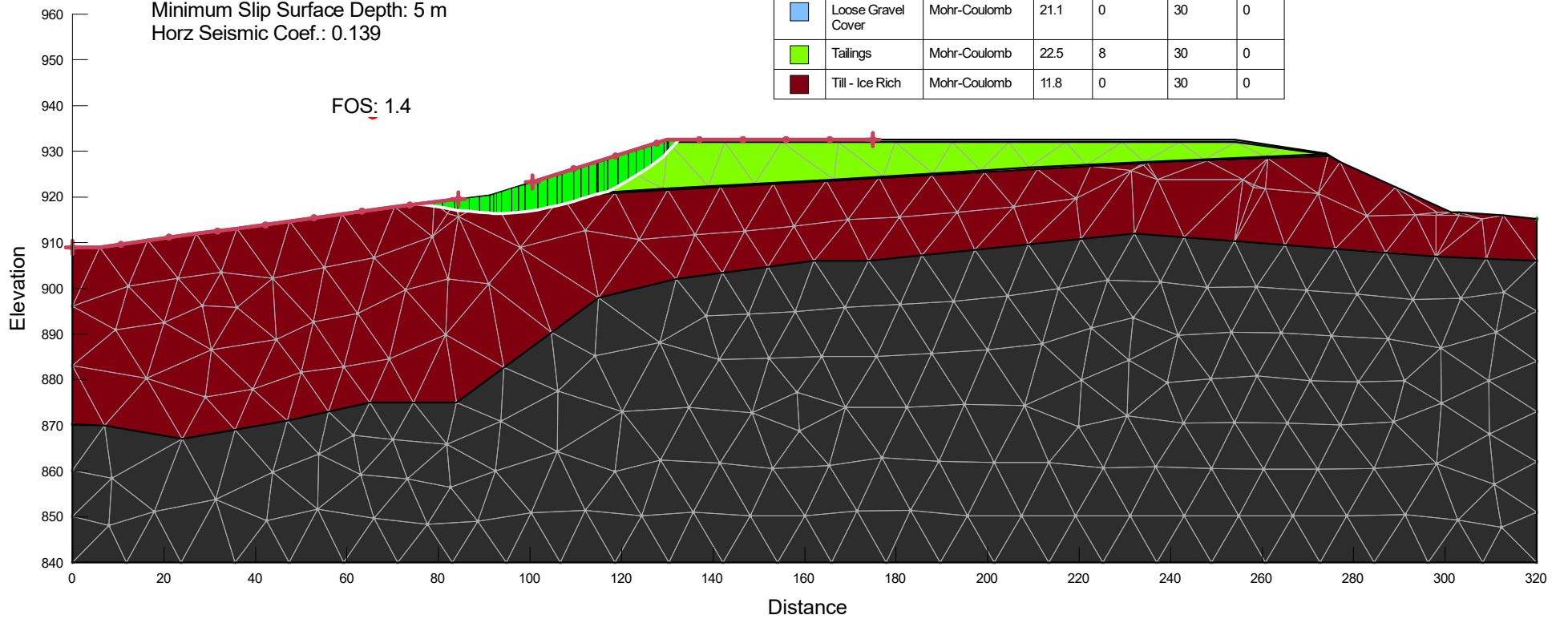
Name: E03 - Fully Frozen - Pseudostatic Shallow
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0
■	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0



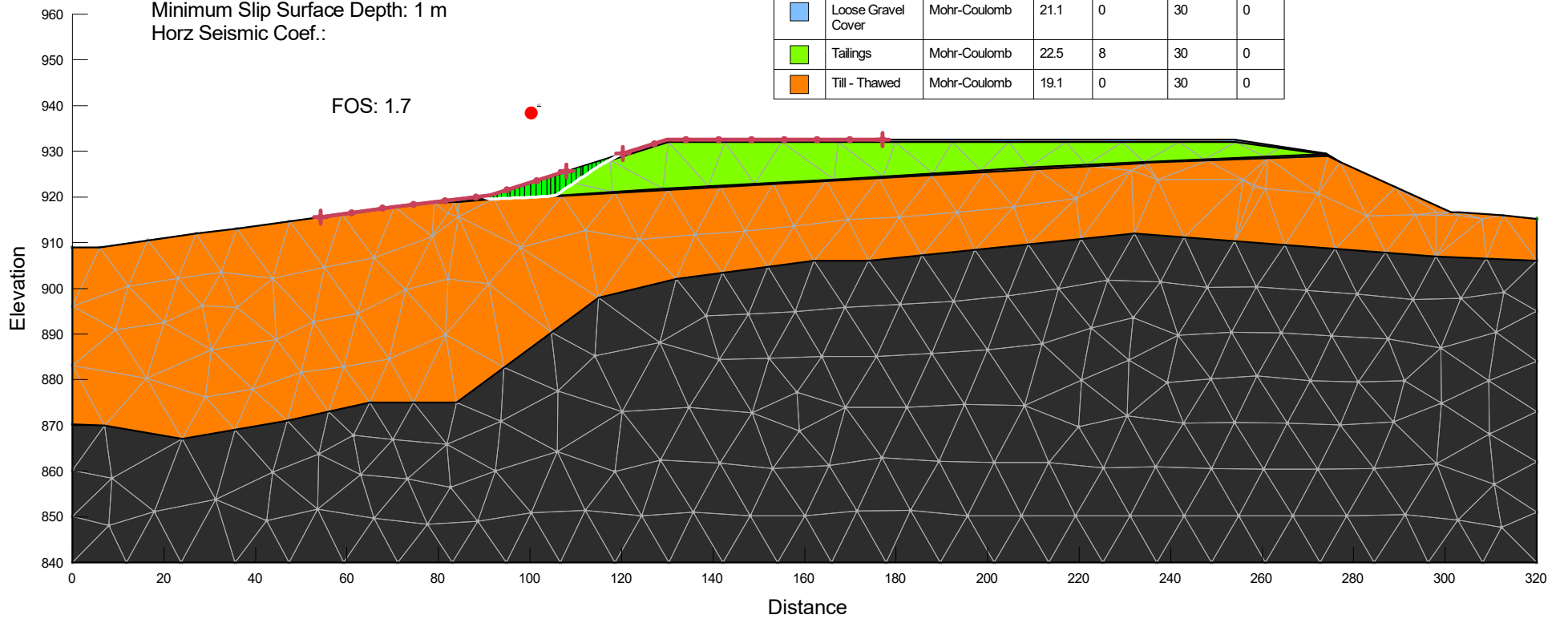
Name: E04 - Fully Frozen - Pseudostatic Deep
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
Black	Bedrock	Bedrock (Impenetrable)				
Red	Foundation Materials	Mohr-Coulomb	20	0	16	0
Blue	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
Green	Tailings	Mohr-Coulomb	22.5	8	30	0
Dark Red	Till - Ice Rich	Mohr-Coulomb	11.8	0	30	0



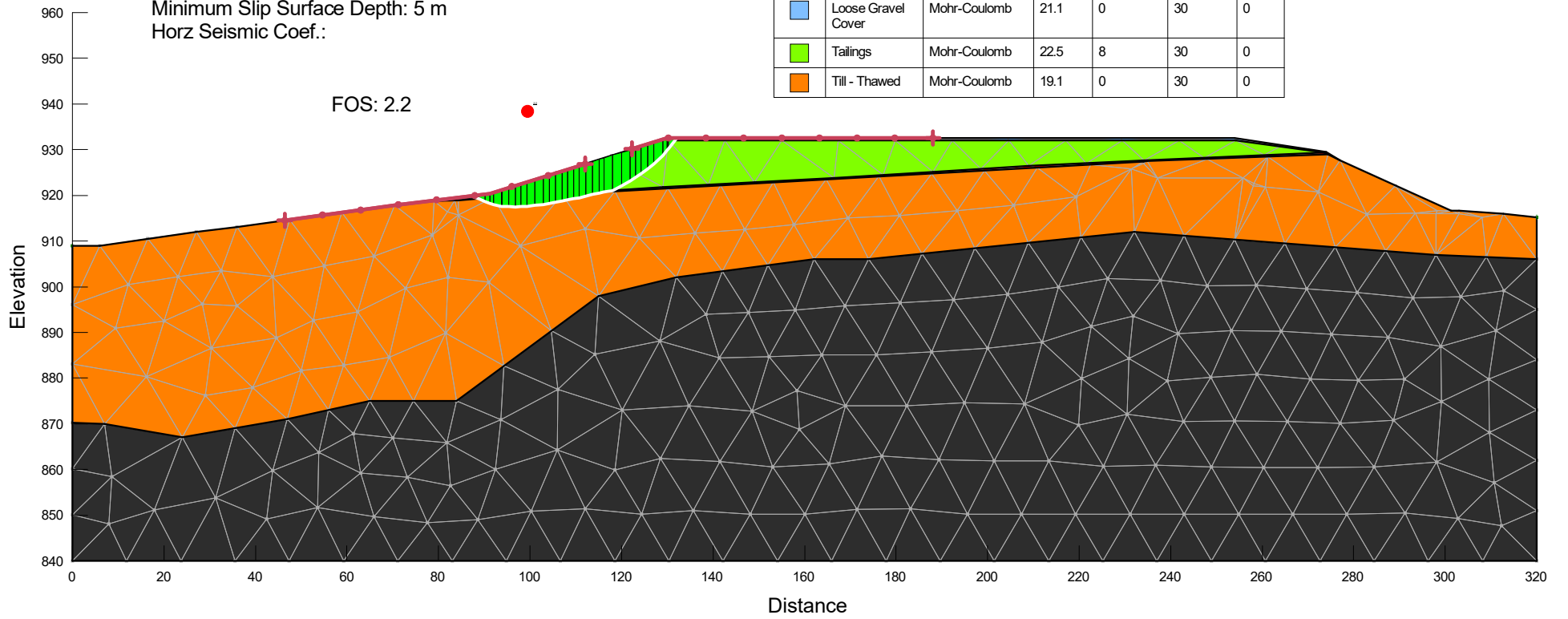
Name: E05 - Fully Thawed - Static Shallow
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30 </td <td>0</td>	0
■	Till - Thawed	Mohr-Coulomb	19.1	0	30	0



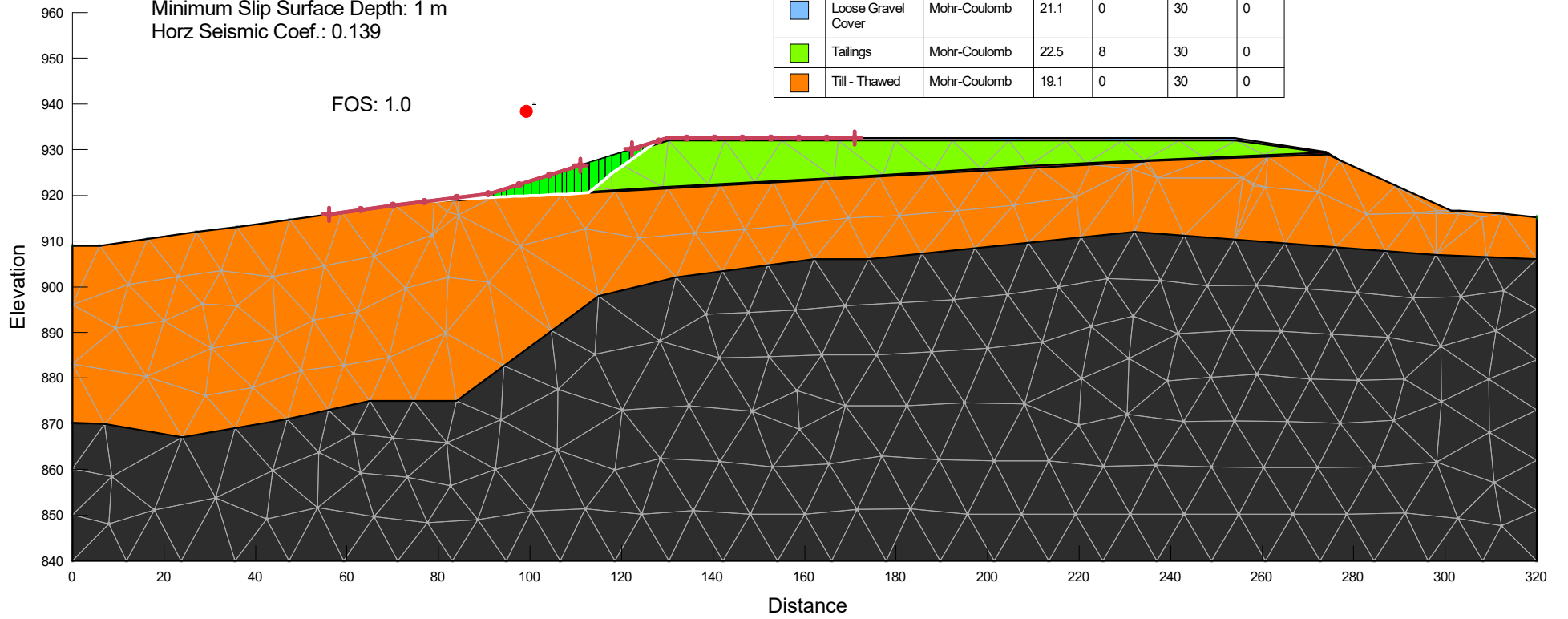
Name: E06 - Fully Thawed - Static Deep
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0 </td
■	Till - Thawed	Mohr-Coulomb	19.1	0	30	0



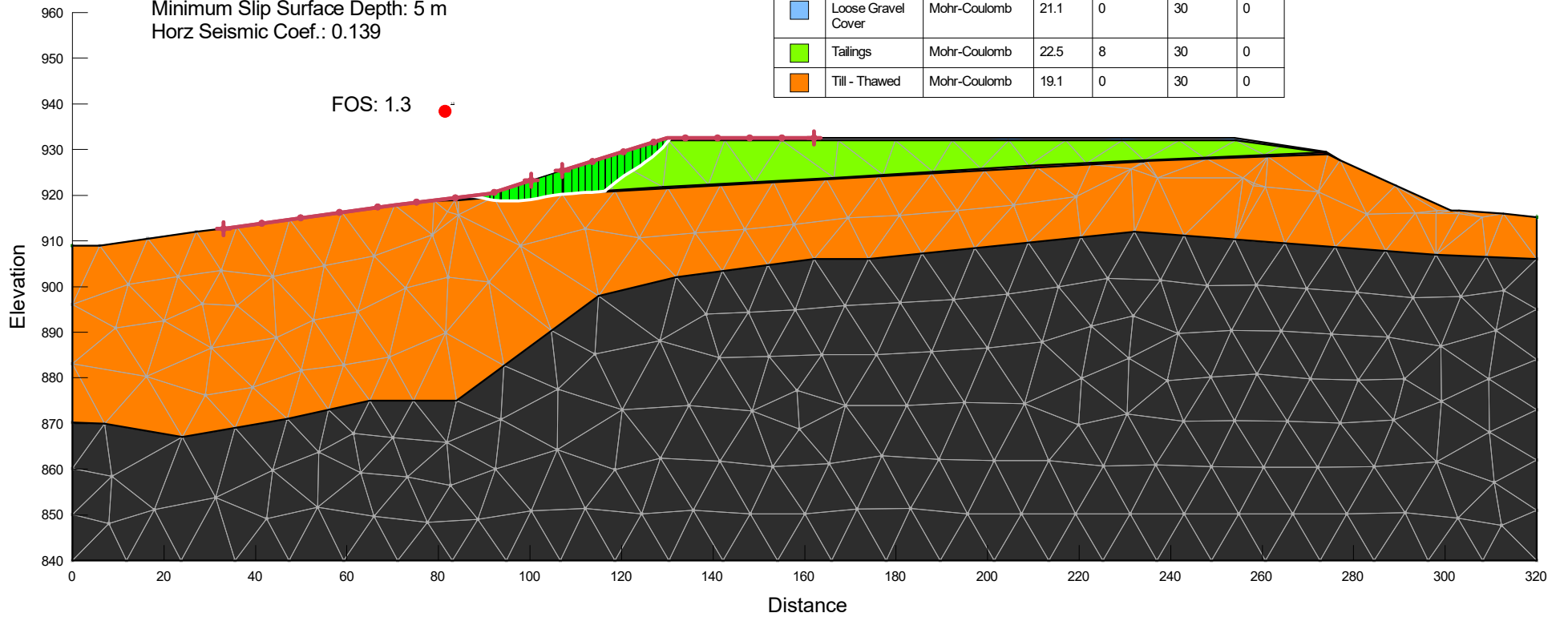
Name: E07 - Fully Thawed - Pseudostatic Shallow
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 1 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0
■	Till - Thawed	Mohr-Coulomb	19.1	0	30	0



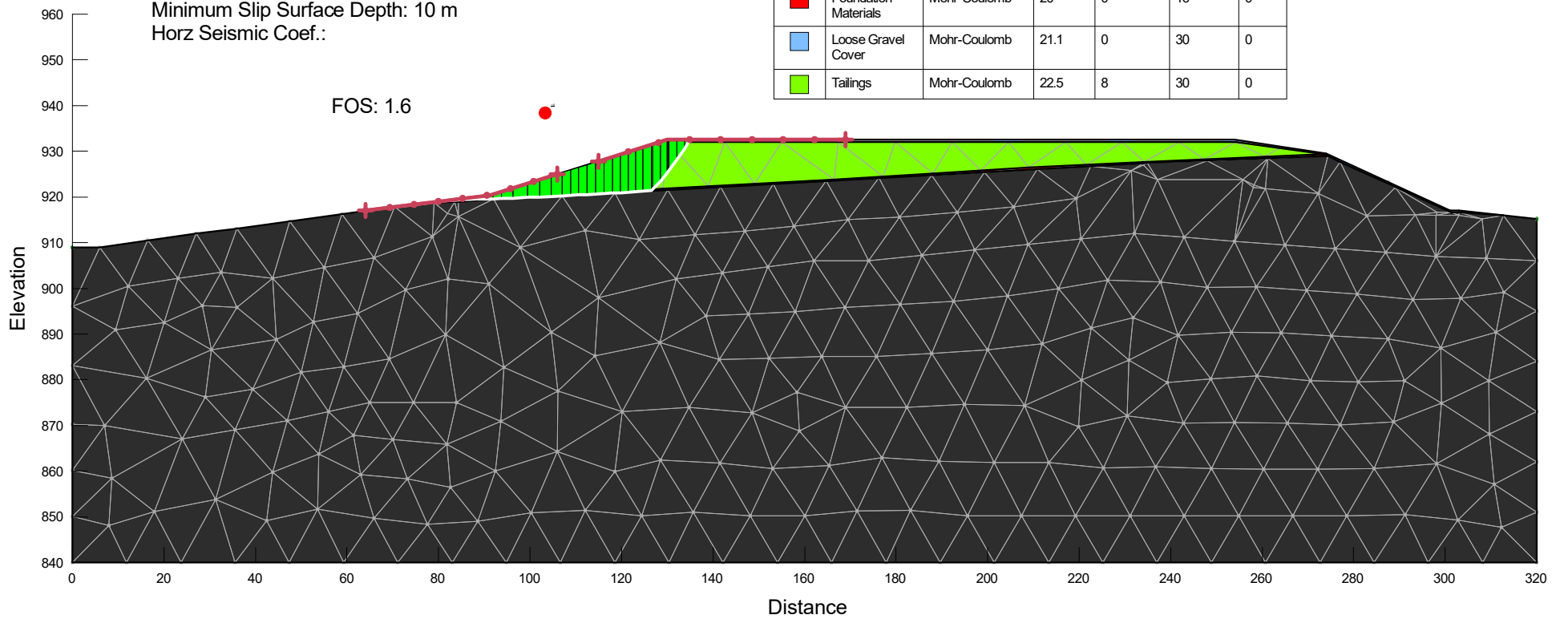
Name: E08 - Fully Thawed - Pseudostatic Deep
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 5 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0
■	Till - Thawed	Mohr-Coulomb	19.1	0	30	0



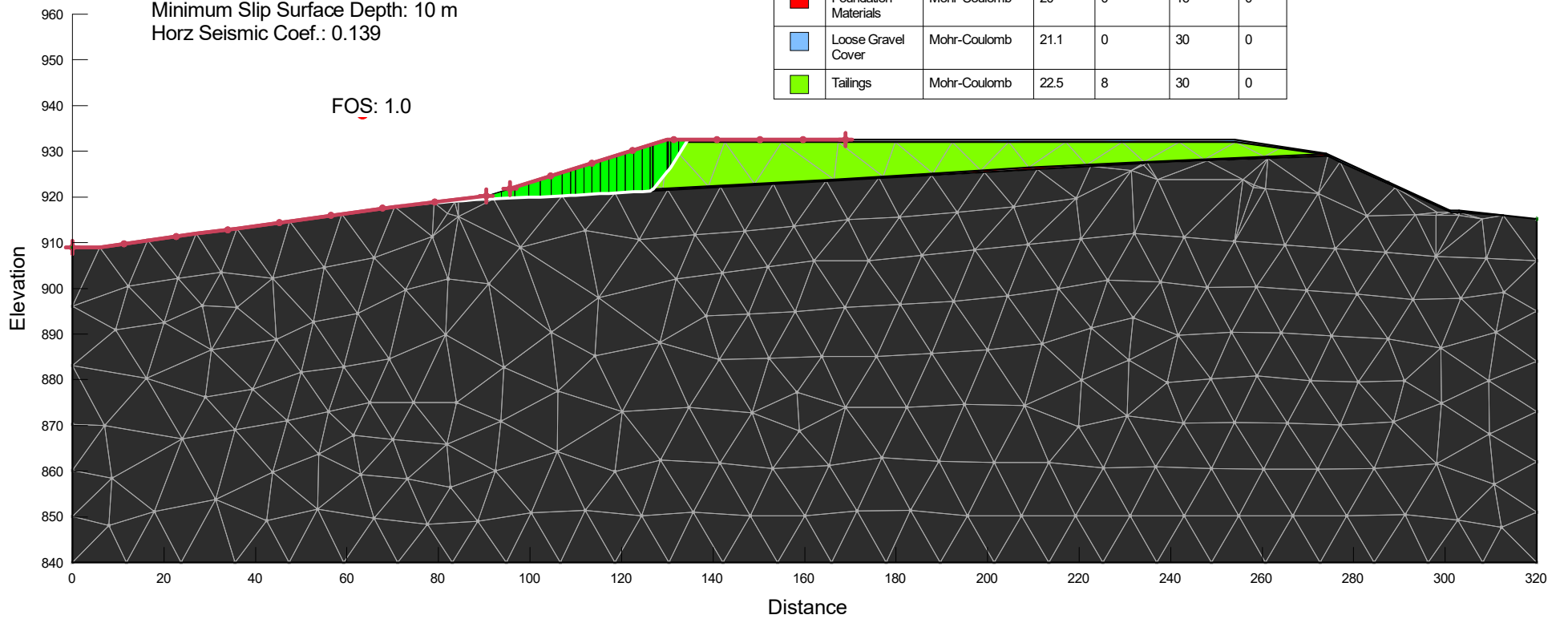
Name: E09 - Foundation Analysis - Static Deep
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 10 m
 Horz Seismic Coef.:

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0



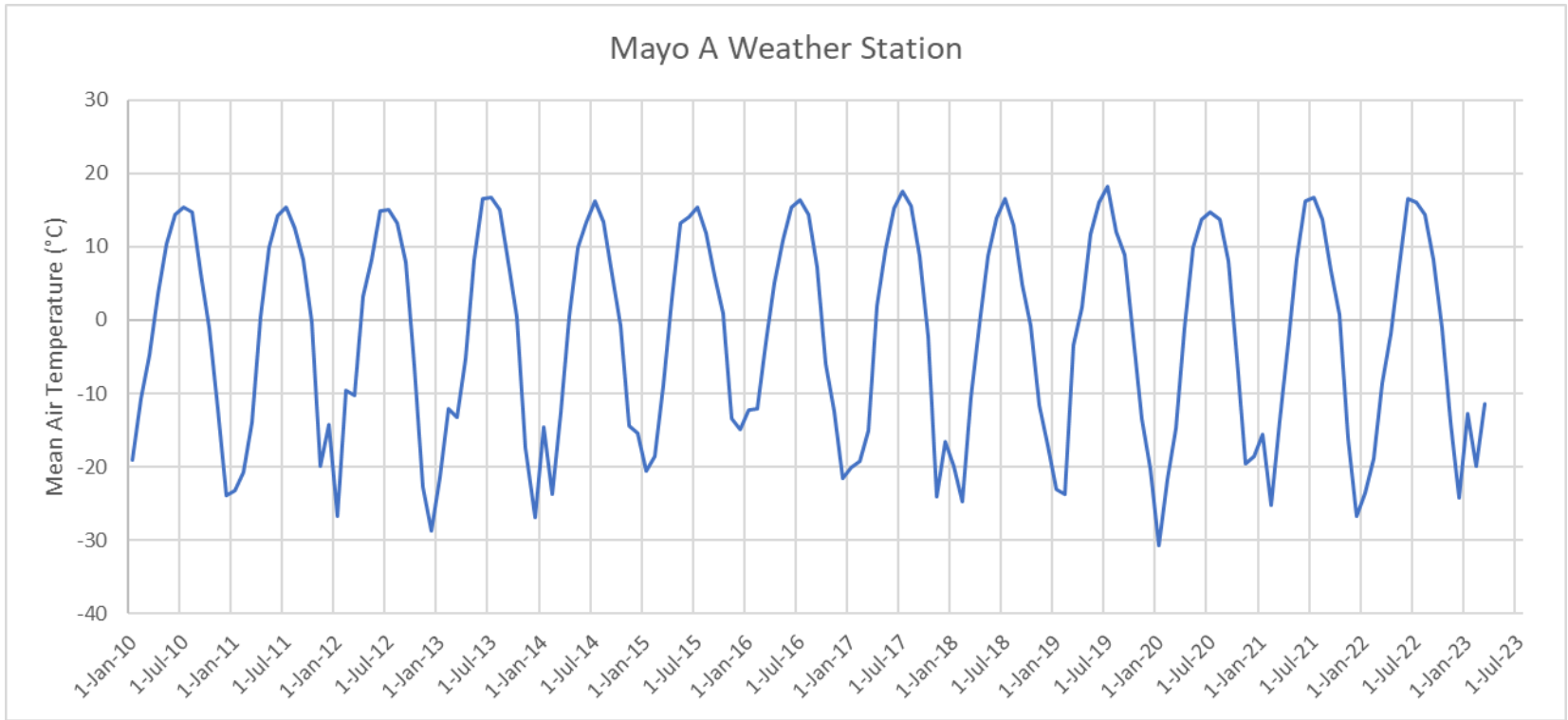
Name: E10 - Foundation Analysis - Pseudostatic Deep
 File Name: WARC04307-02_Section E_3.25-10m Tails R1.gsz
 Method: Morgenstern-Price
 Minimum Slip Surface Depth: 10 m
 Horz Seismic Coef.: 0.139

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Phi-B (°)
■	Bedrock	Bedrock (Impenetrable)				
■	Foundation Materials	Mohr-Coulomb	20	0	16	0
■	Loose Gravel Cover	Mohr-Coulomb	21.1	0	30	0
■	Tailings	Mohr-Coulomb	22.5	8	30	0



APPENDIX F

GEOHERMAL MODEL FIGURES



LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

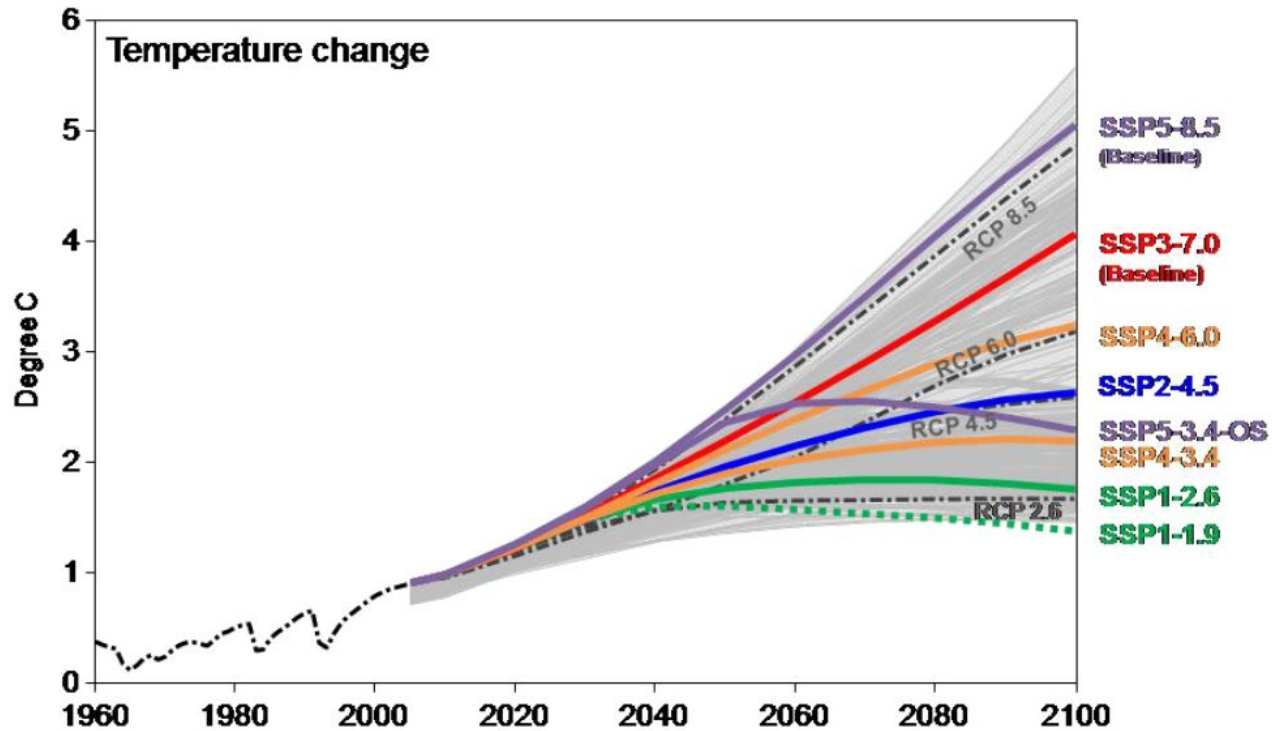
**Mean Monthly Air Temperatures from
Mayo A Weather Station
(January 2010 to April 2023)**

**STATUS
ISSUED FOR USE**



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-1



Source: Riahi et al, 2016

LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

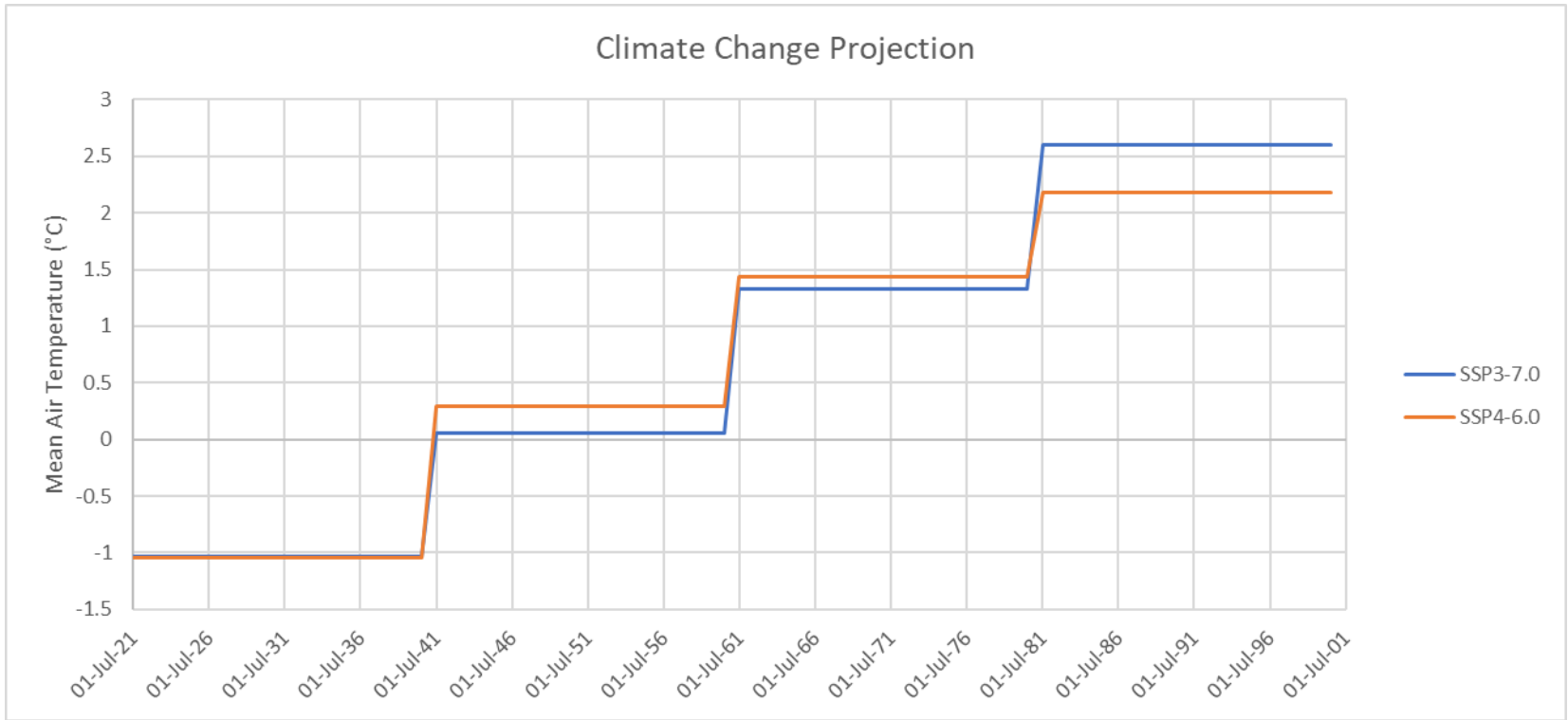
**Comparison of Temperature Change for
CMIP6 Climate Scenarios**



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-2

STATUS
ISSUED FOR USE



LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

**Mean Annual Temperature for SSP3-7.0
and SSP4-6.0**



PROJECT NO.
ENG.WARC04307-01

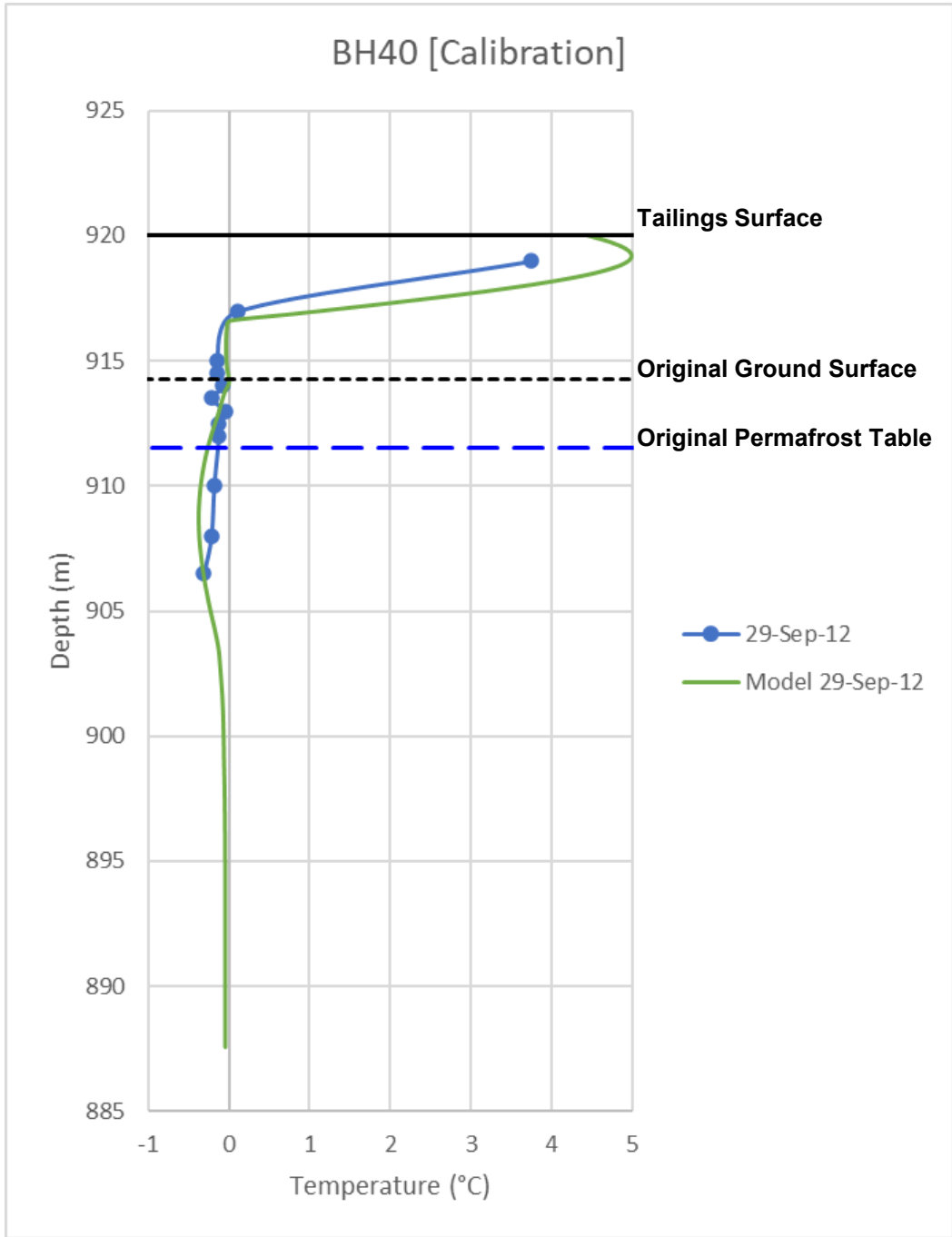
DWN	CKD	APVD	REV
EDG	IM	RT	A

OFFICE
WHITEHORSE

DATE
JUNE 2023

Figure F-3

STATUS
ISSUED FOR USE



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

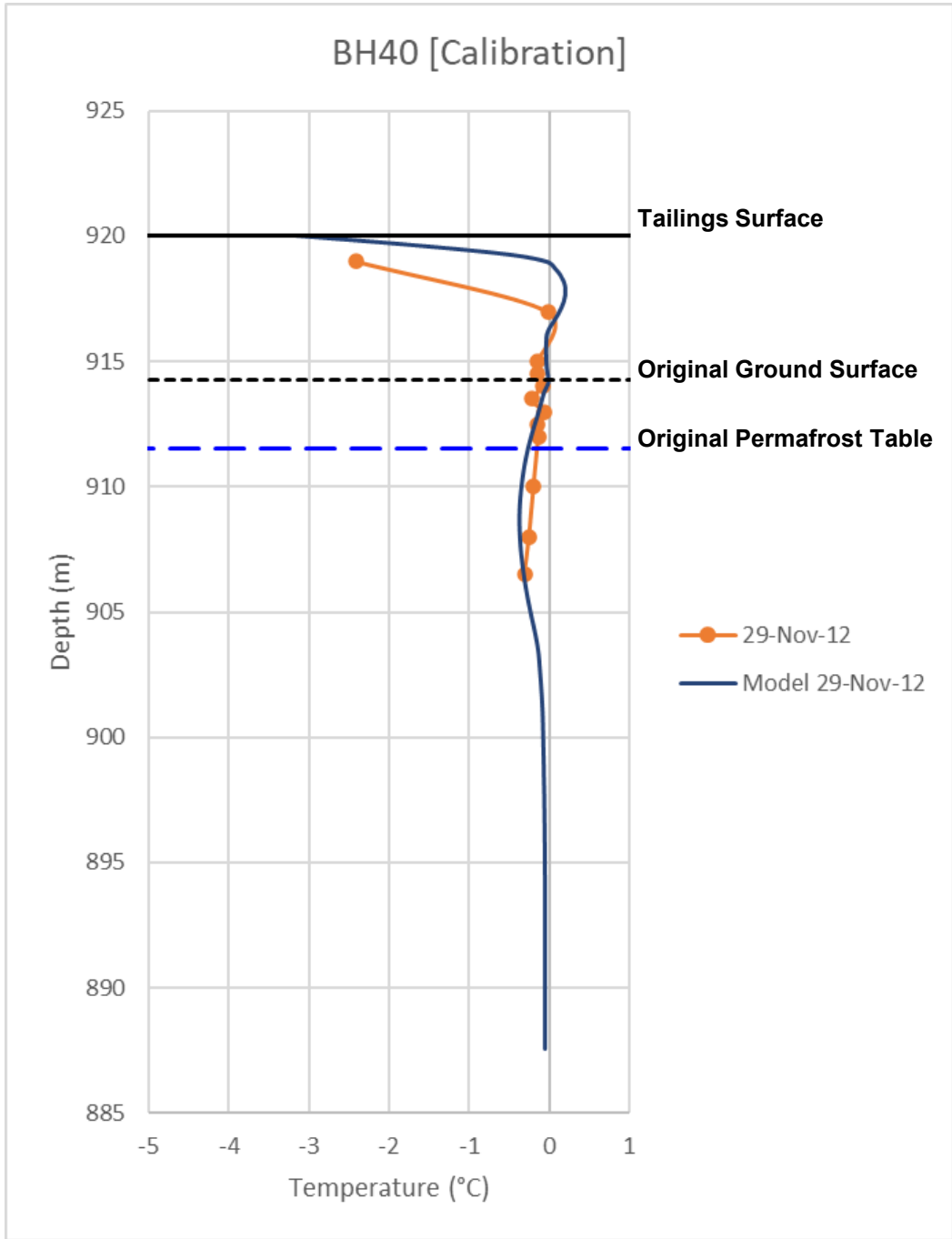
Model Calibration at BH-40: September 2012

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-4



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

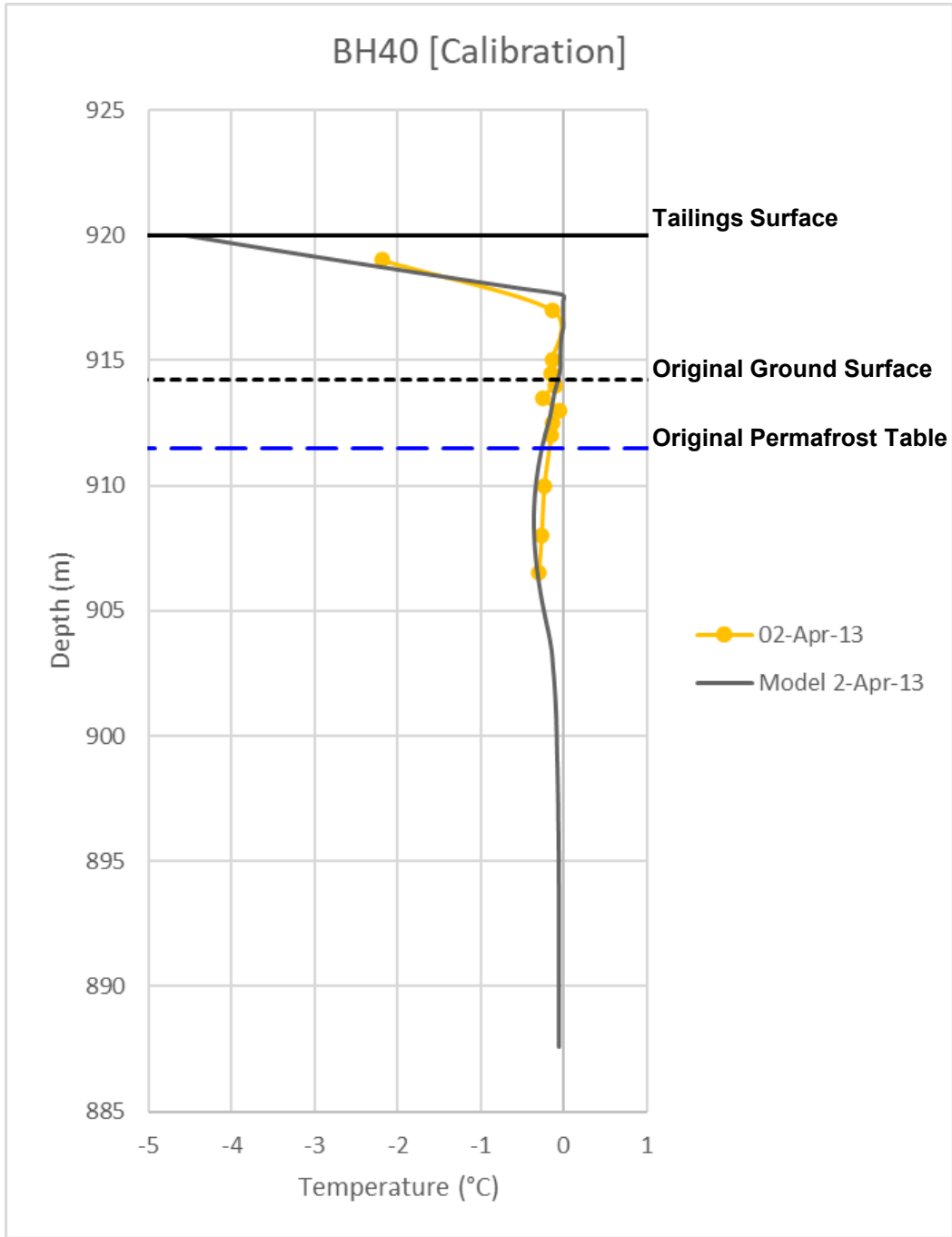
Model Calibration at BH-40: November 2012

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-5



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

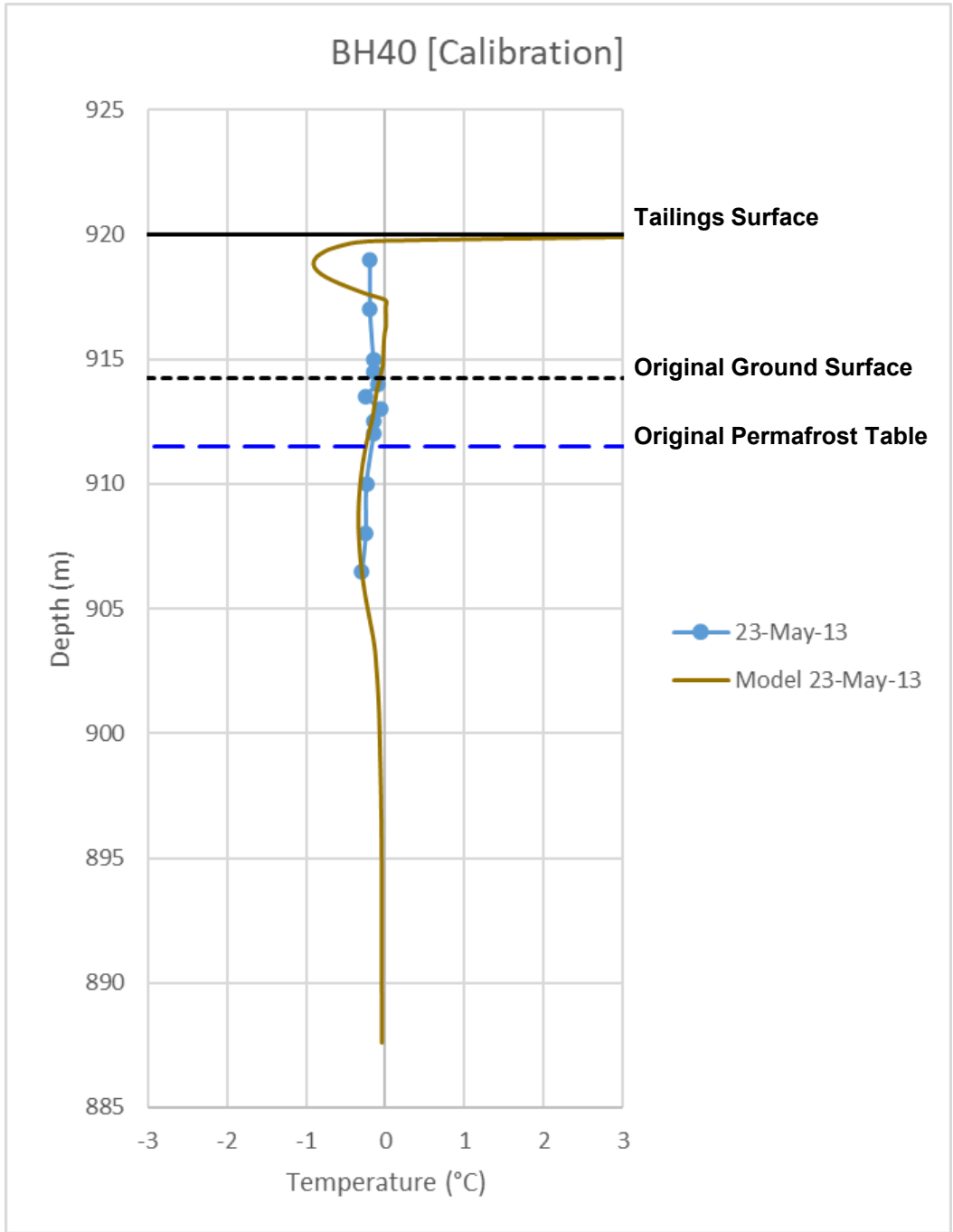
Model Calibration at BH-40: April 2013

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-6



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

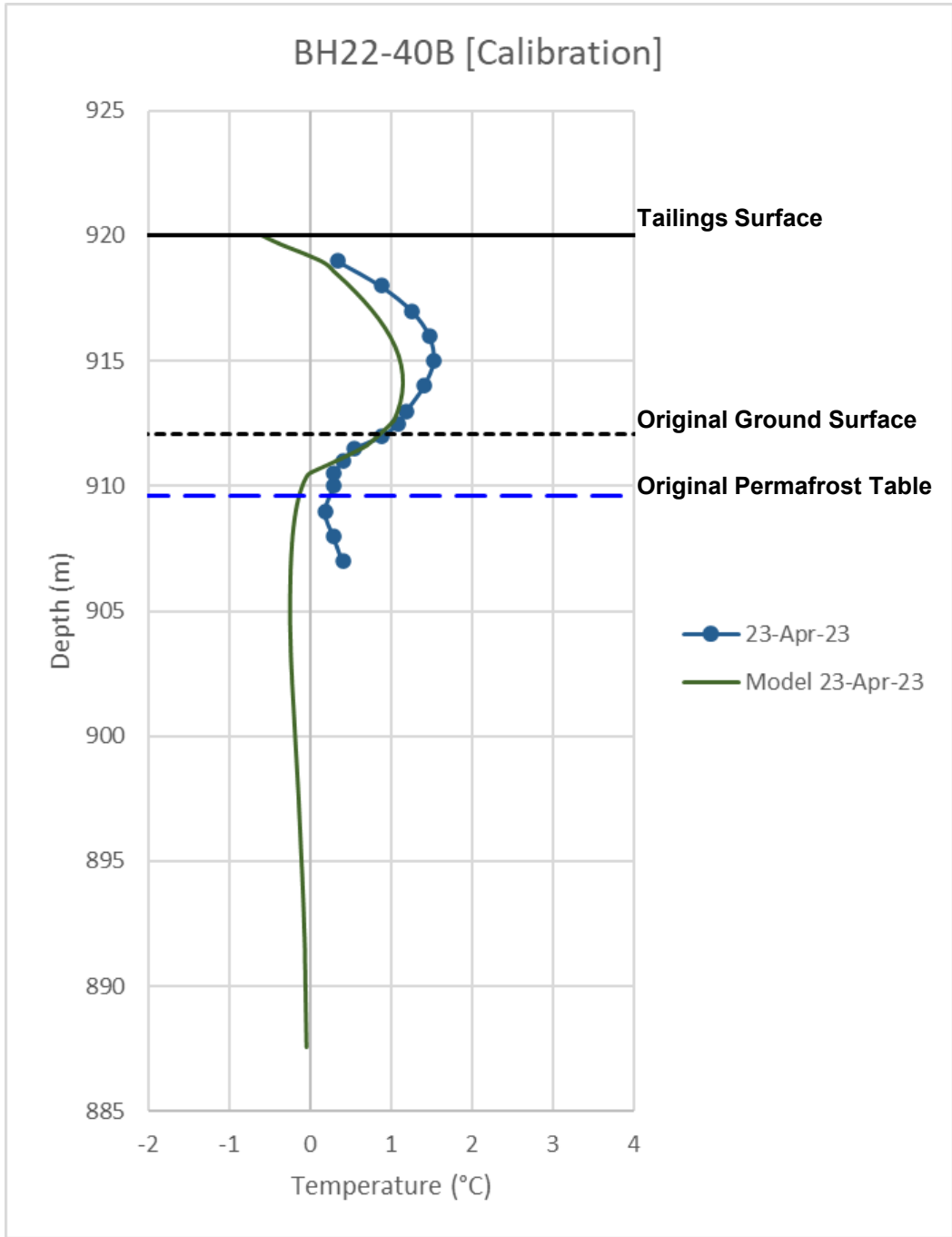
Model Calibration at BH-40: May 2013

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-7



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

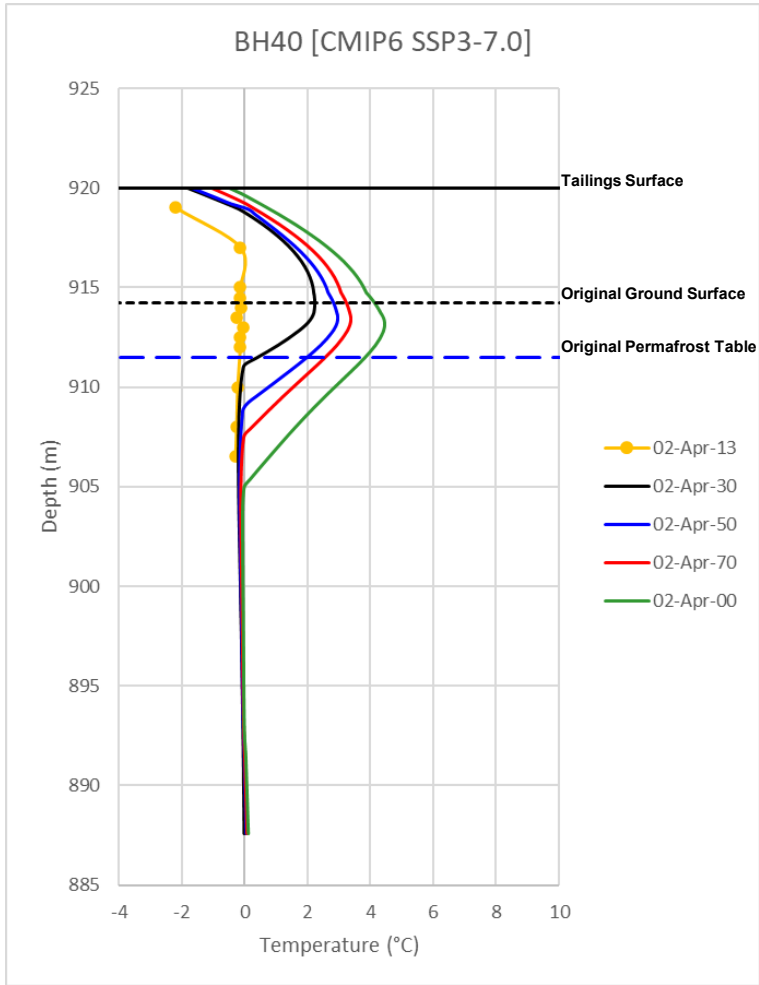
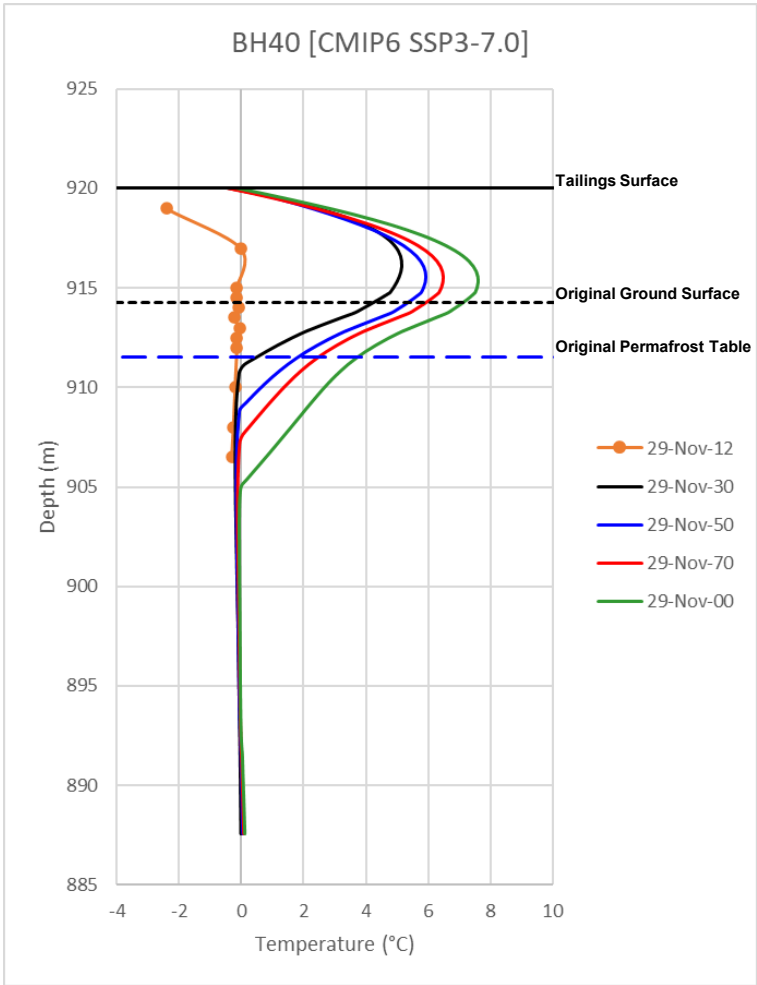
Model Calibration at BH22-40B: April 2023

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-8



LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

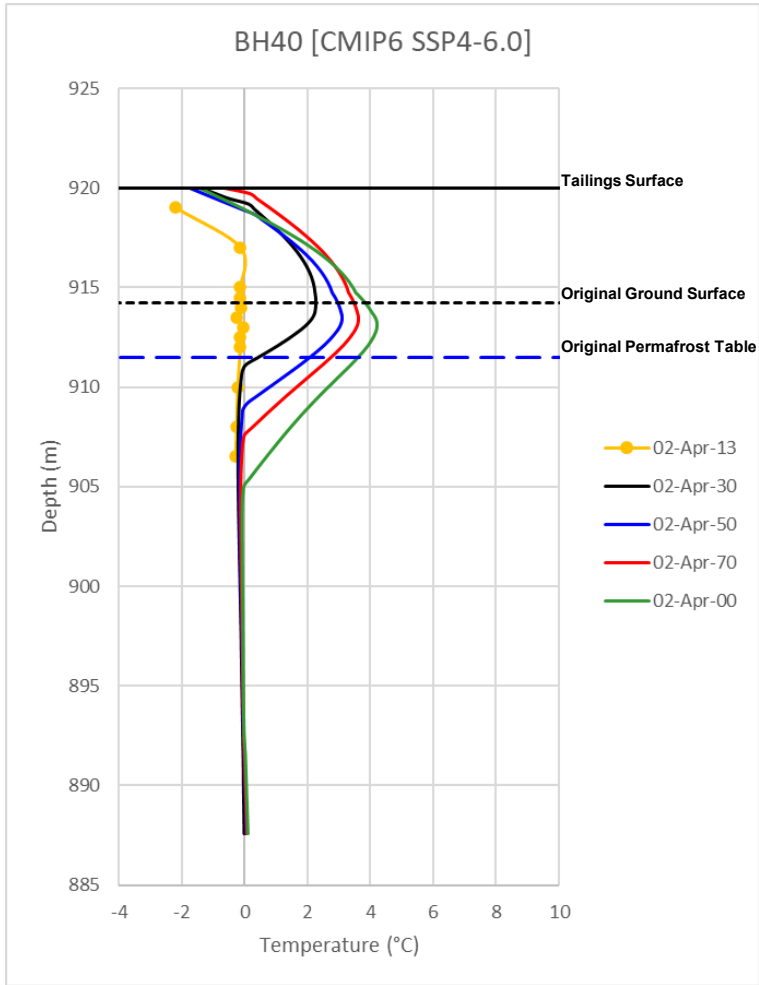
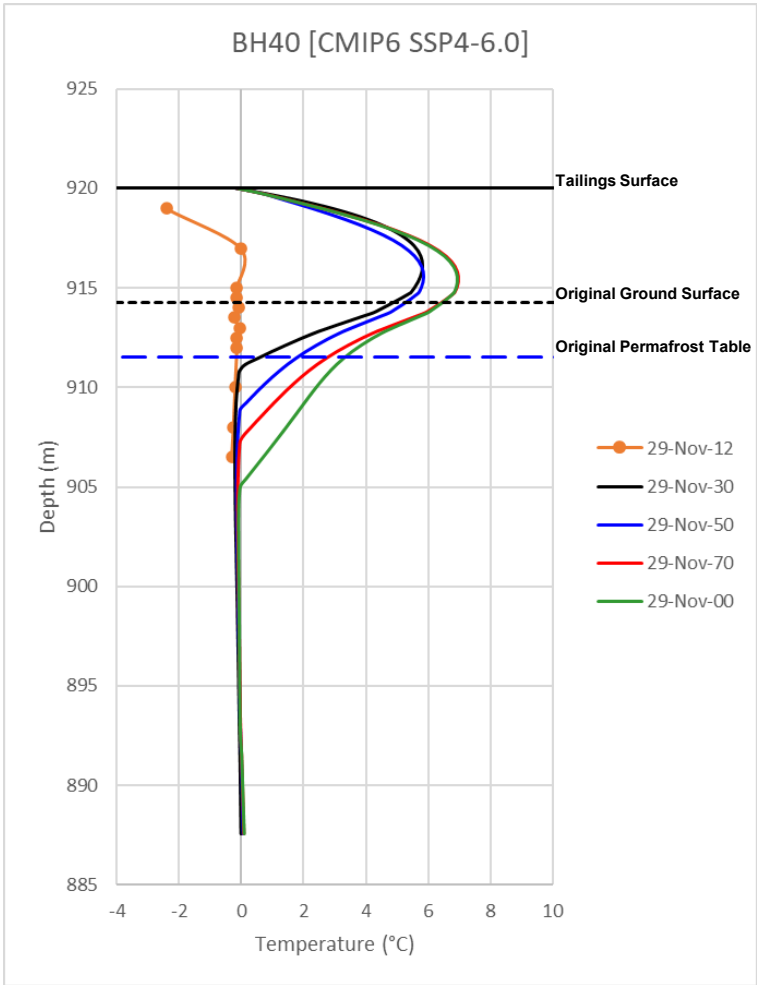
**Temperature Projection at BH40 under
SSP3-7.0 Climate Scenario**

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-9



LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

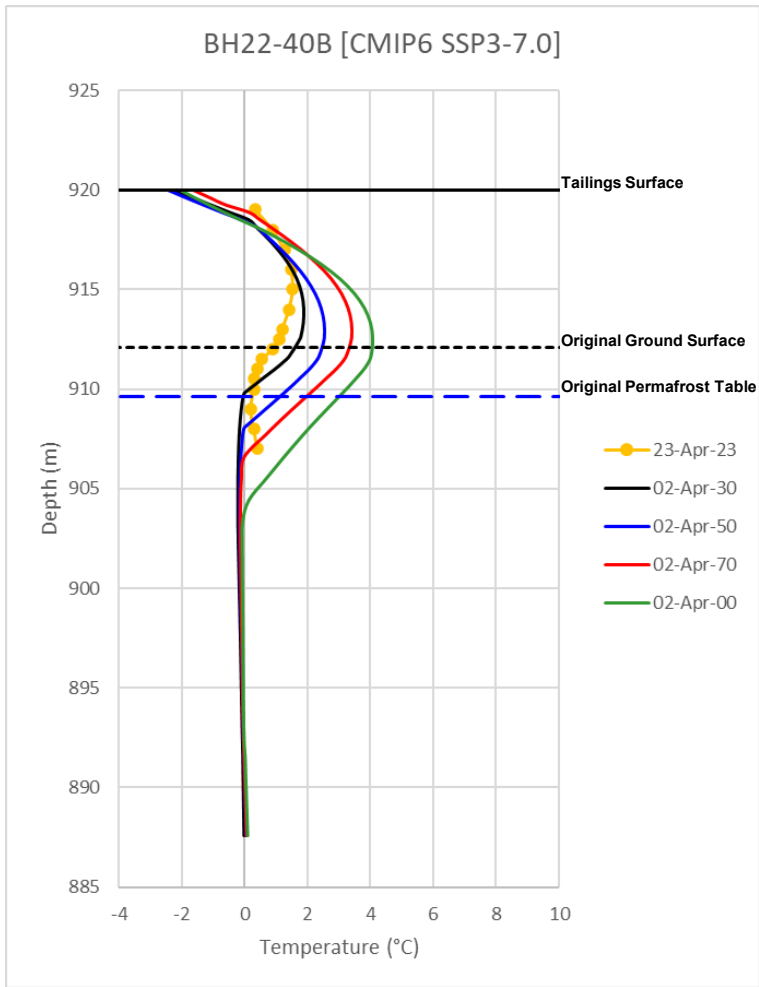
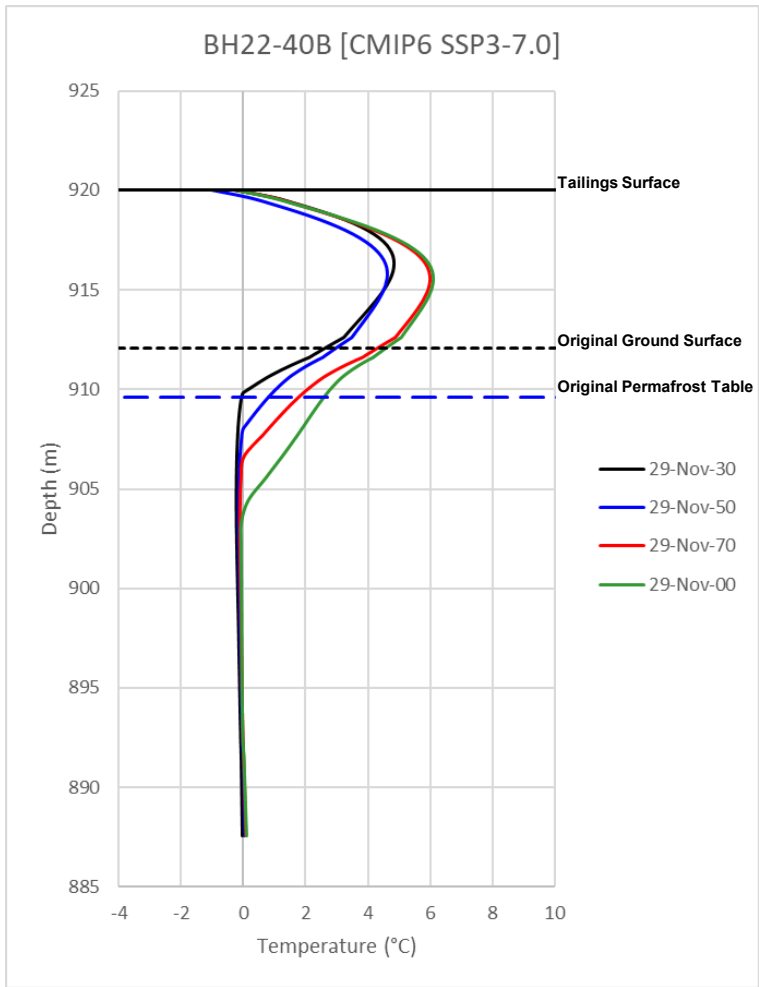
**Temperature Projection at BH40 under
SSP4-6.0 Climate Scenario**

**STATUS
ISSUED FOR USE**



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-10



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

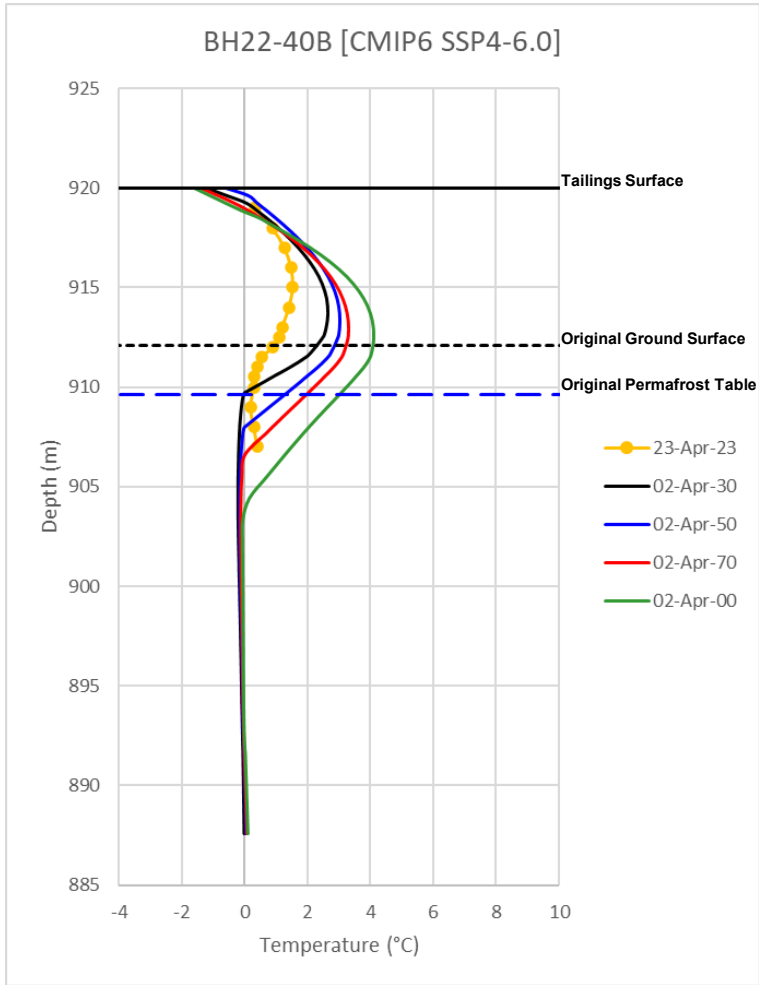
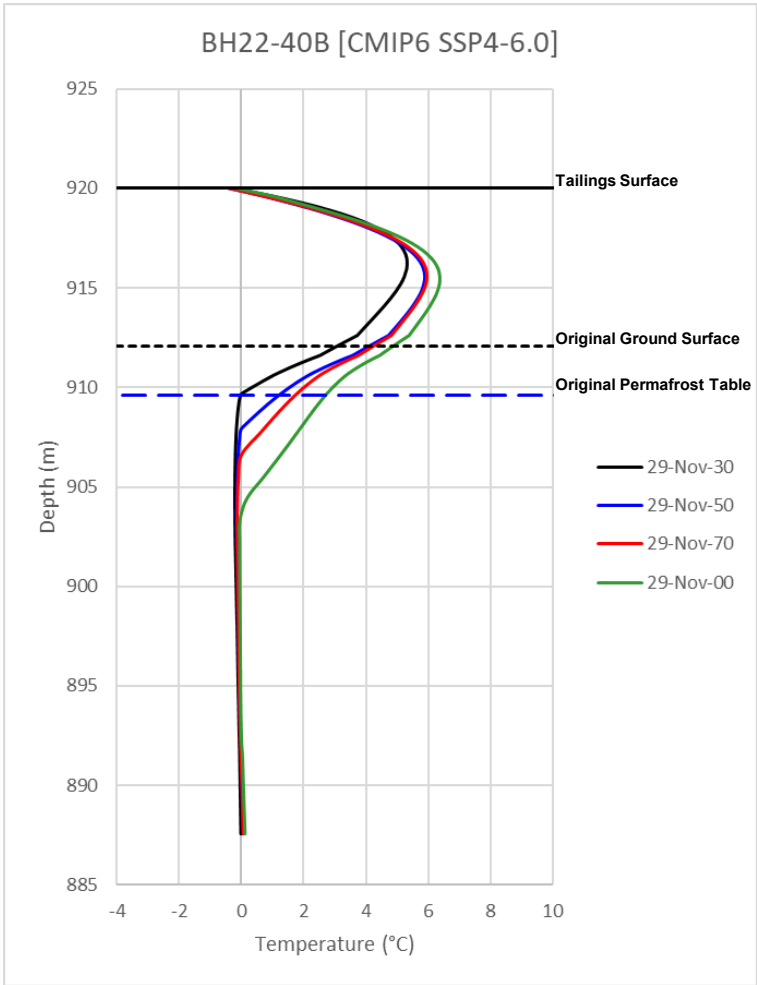
**Temperature Projection at BH22-40B under
SSP3-7.0 Climate Scenario**

PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-11

STATUS
ISSUED FOR USE





LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

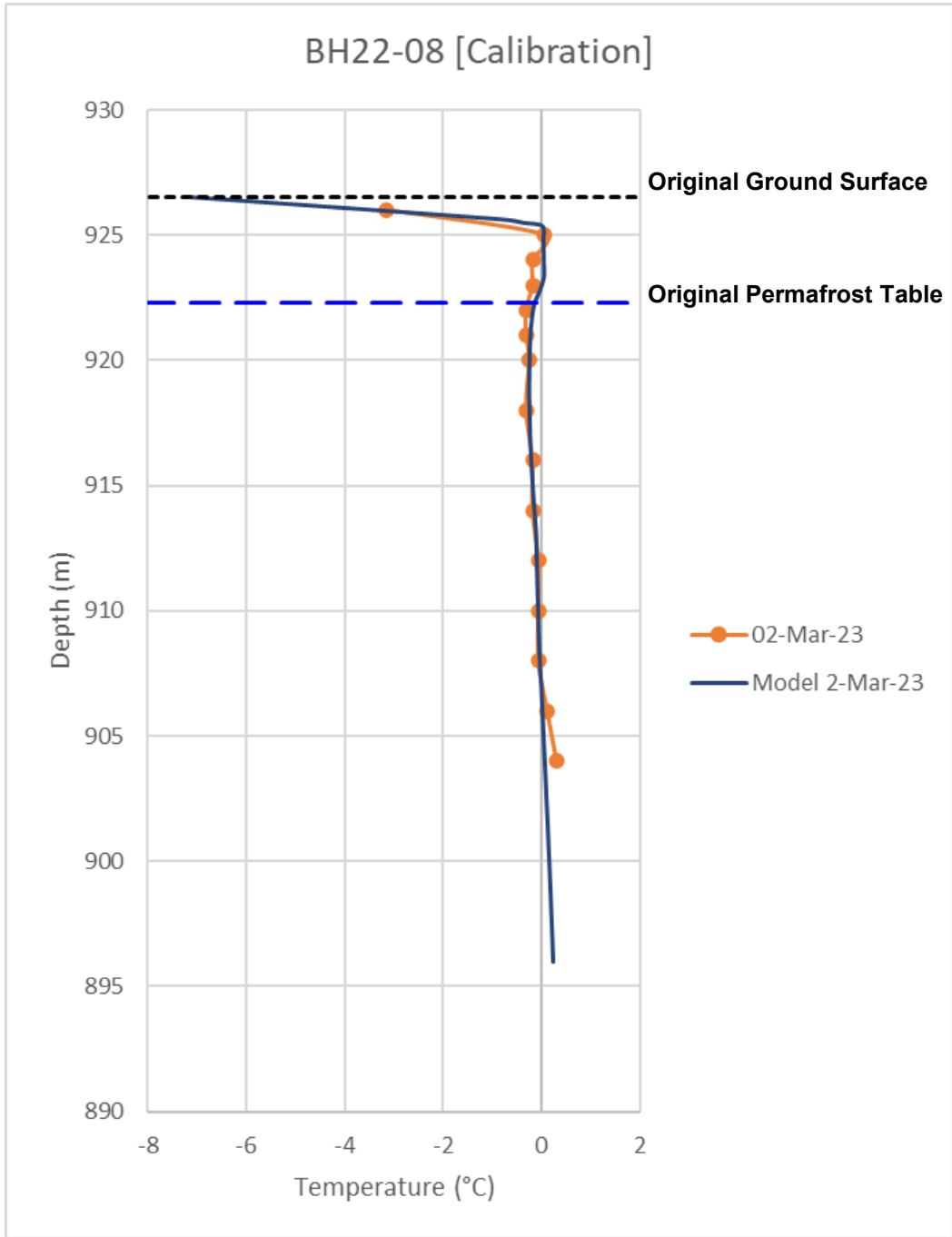
**Temperature Projection at BH22-40B under
SSP4-6.0 Climate Scenario**



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-12

STATUS
ISSUED FOR USE



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

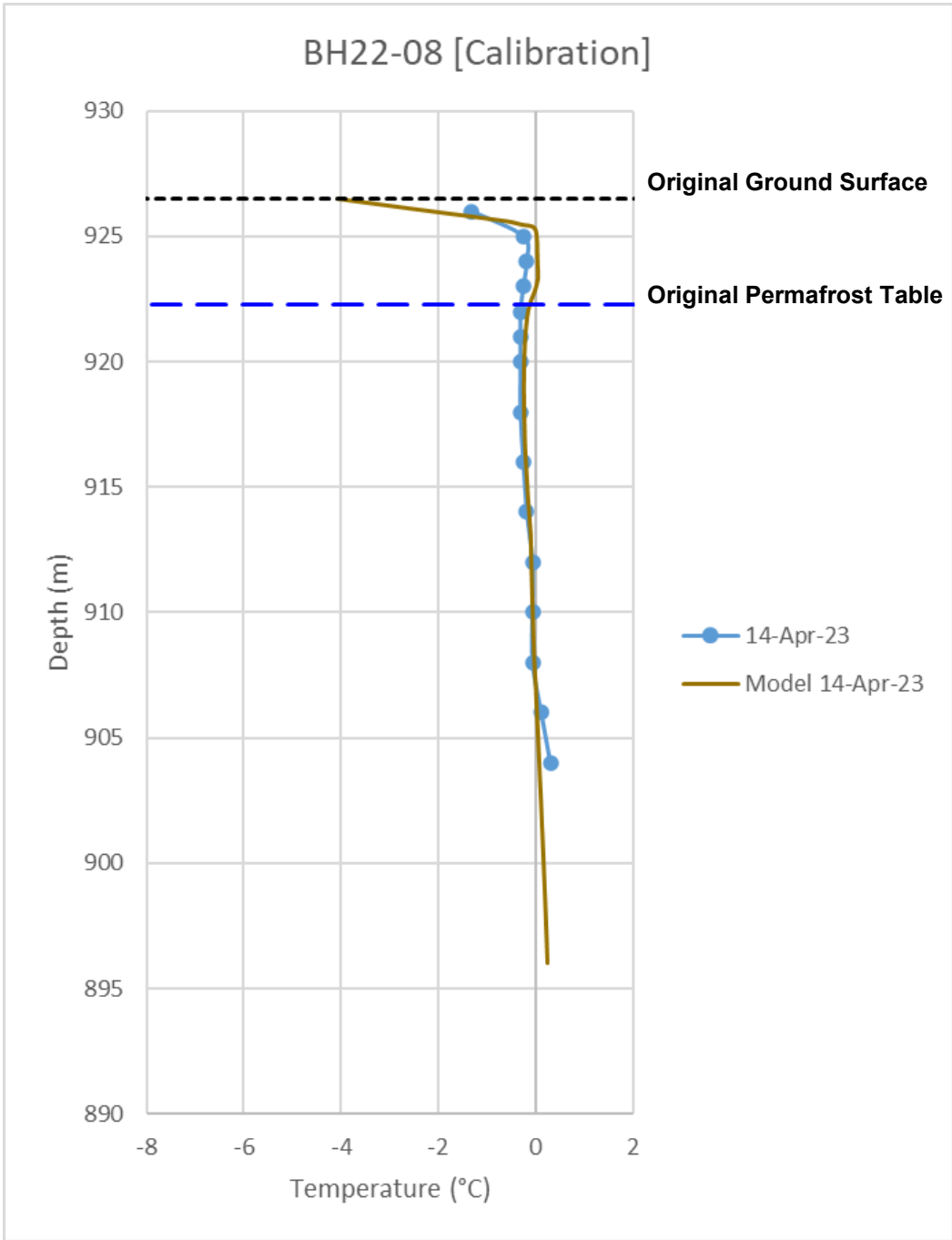
Model Calibration at BH22-08: March 2023

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-13



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

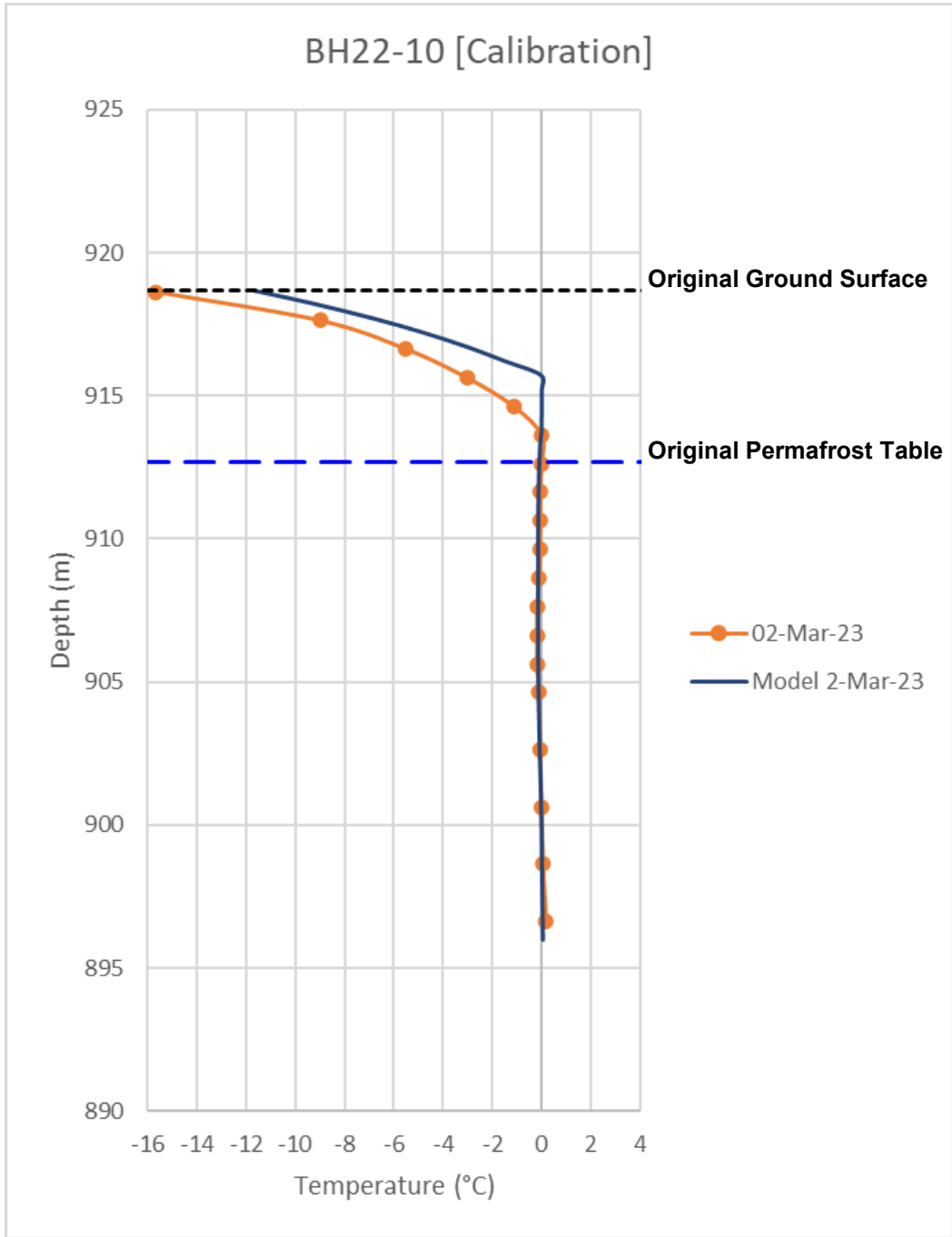
Model Calibration at BH22-08: April 2023

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-14



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

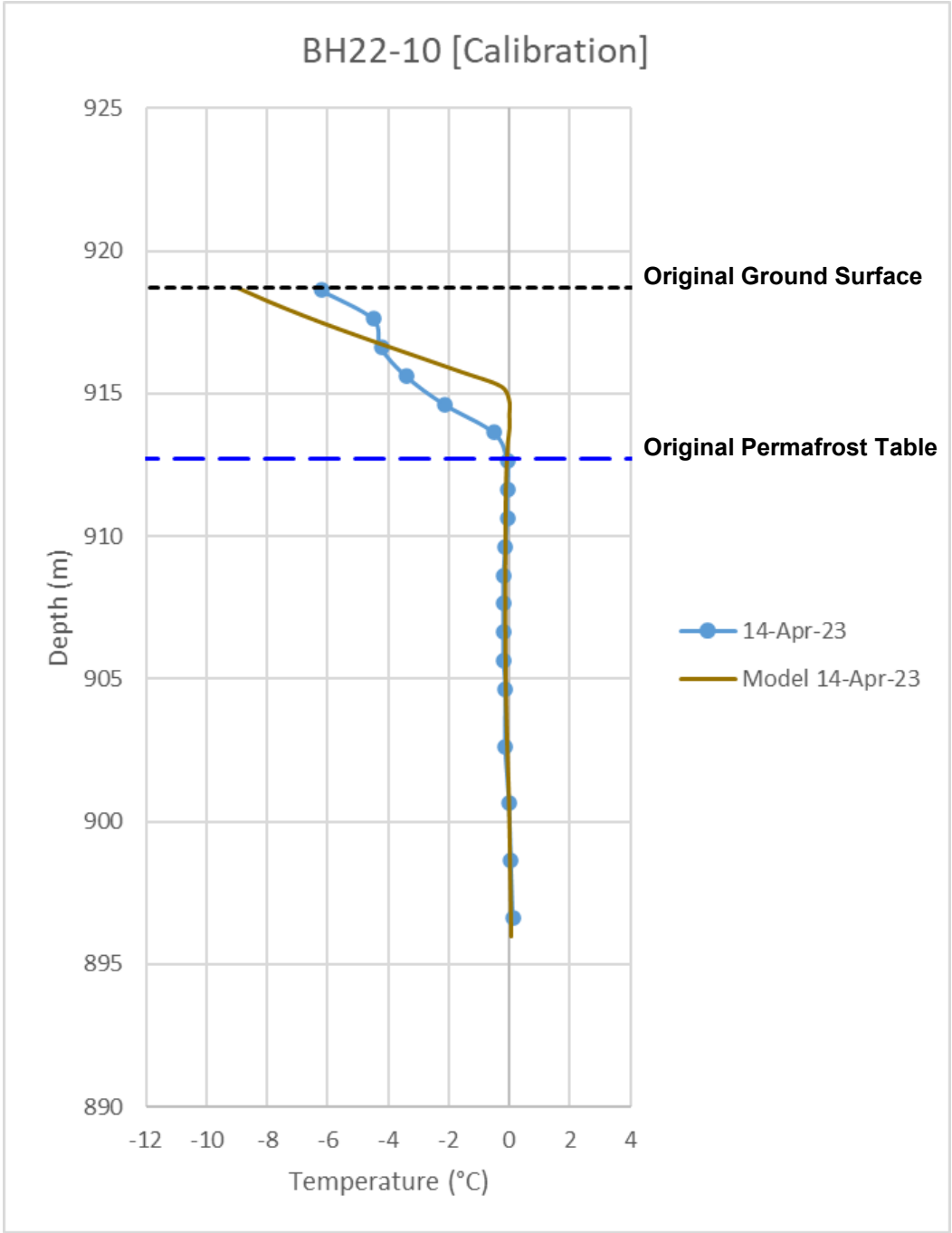
Model Calibration at BH22-10: March 2023

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-15



LEGEND

NOTES

CLIENT



DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON

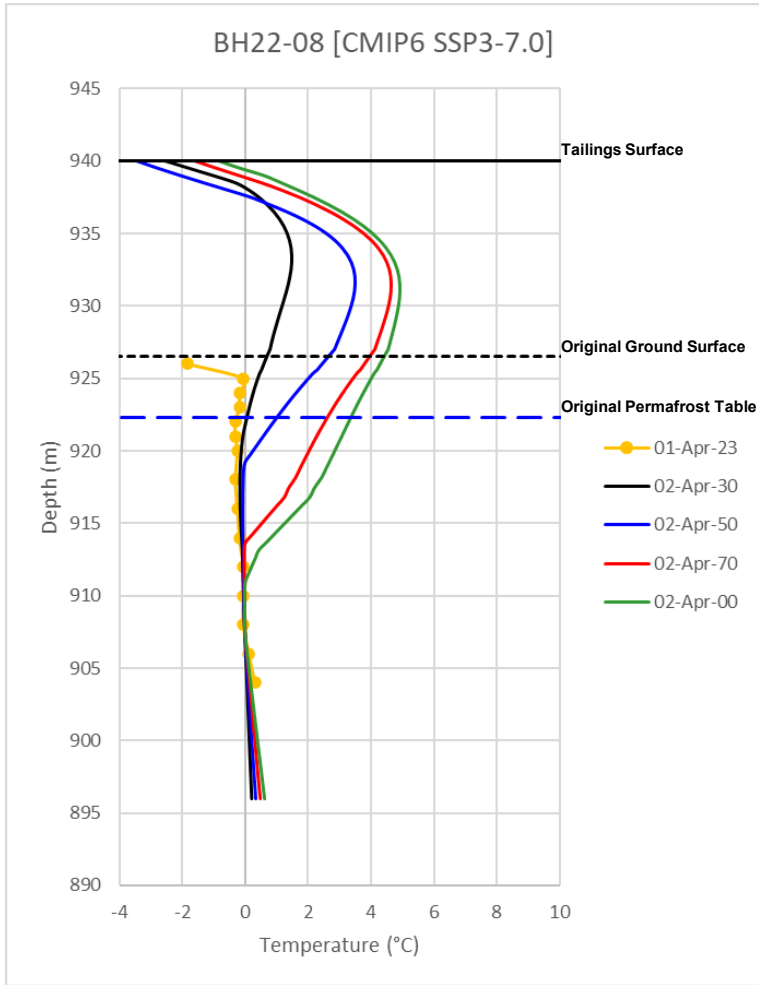
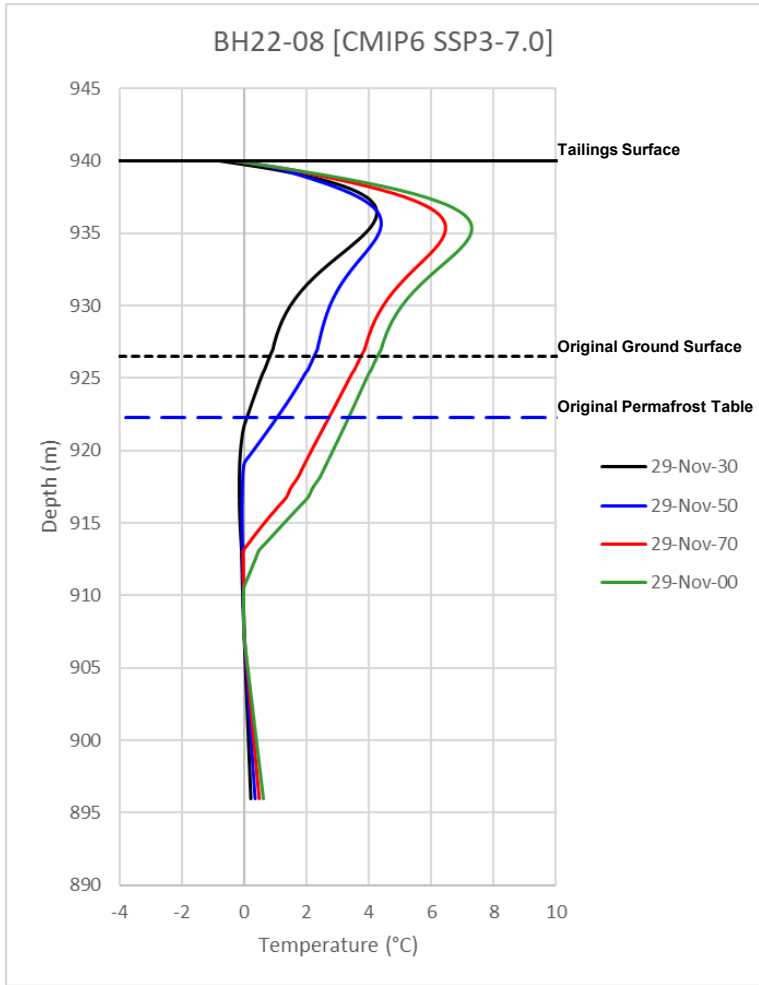
Model Calibration at BH22-10: April 2023

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-16



LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

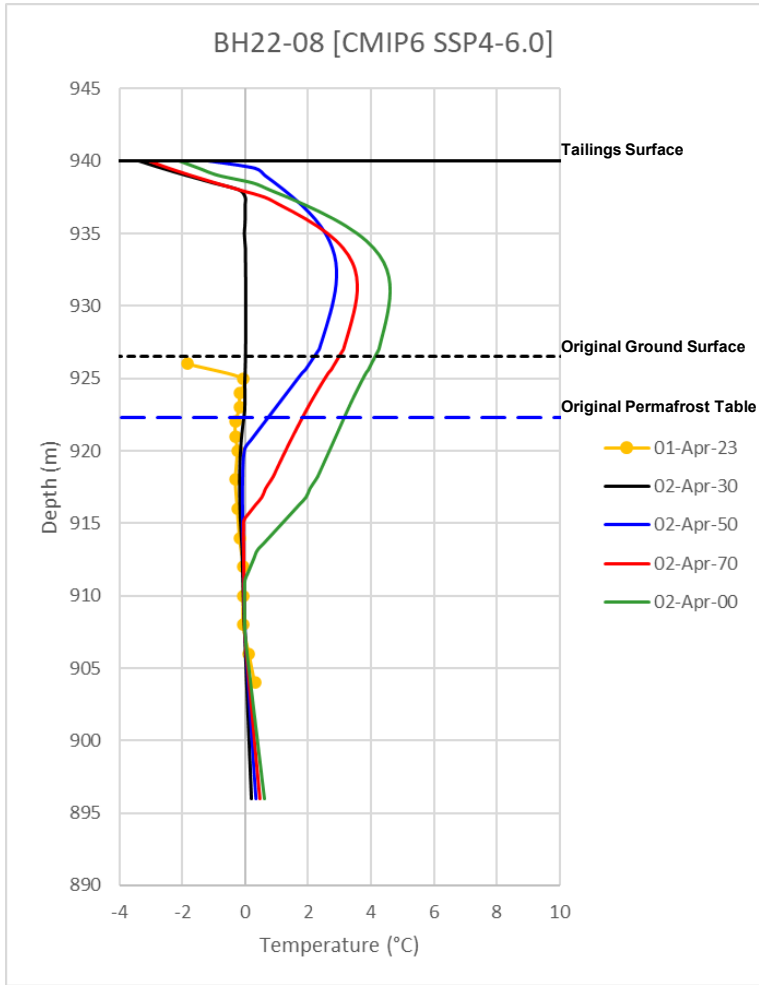
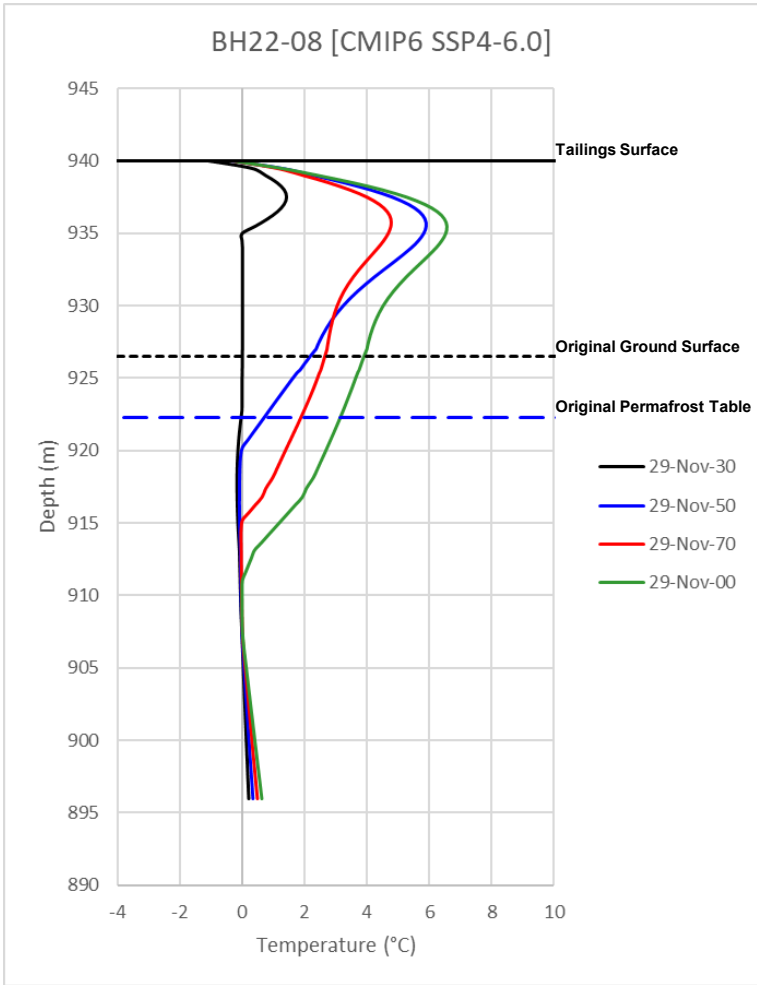
**Temperature Projection at BH22-08 under
SSP3-7.0 Climate Scenario**



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-17

STATUS
ISSUED FOR USE



LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

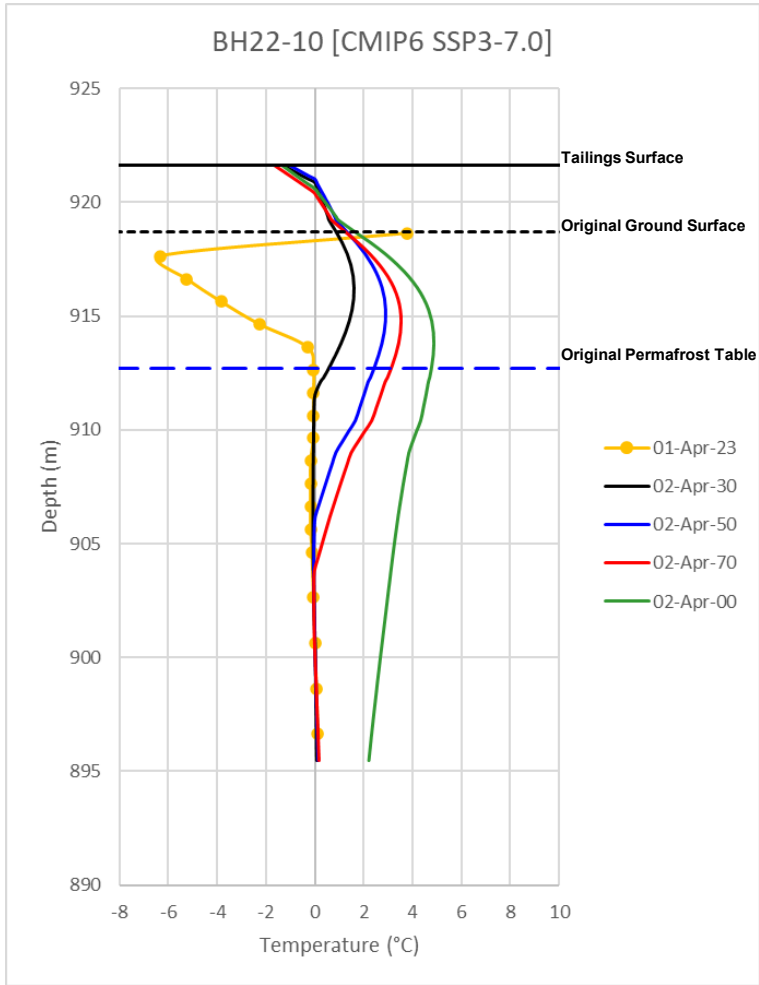
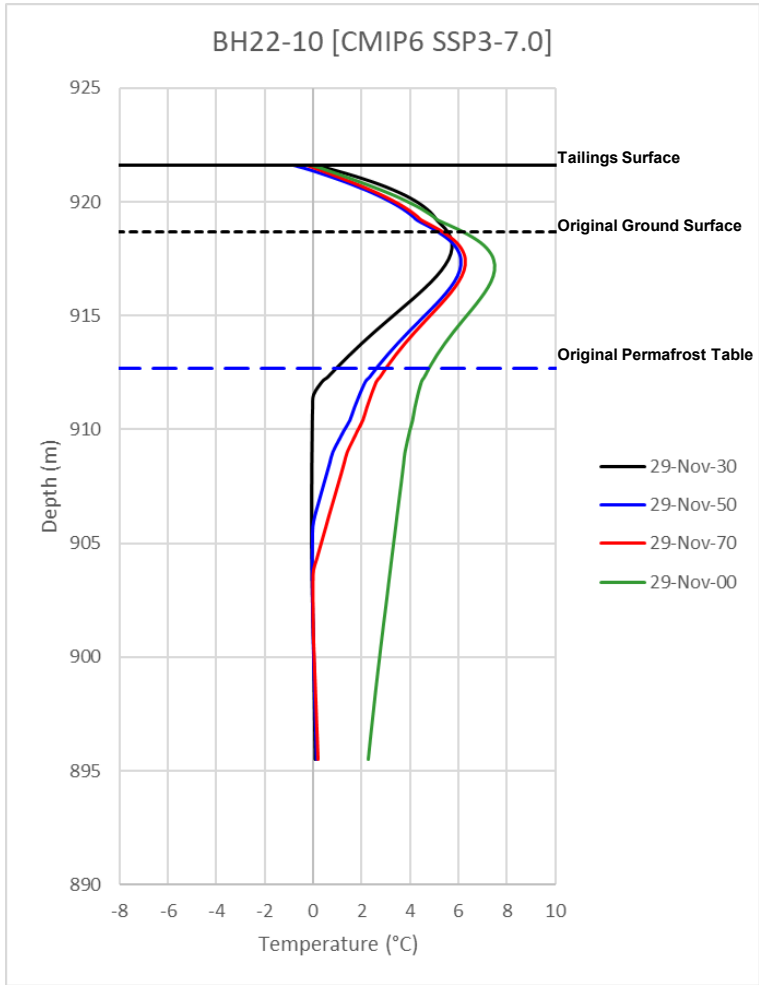
**Temperature Projection at BH22-08 under
SSP4-6.0 Climate Scenario**

**STATUS
ISSUED FOR USE**



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-18



LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

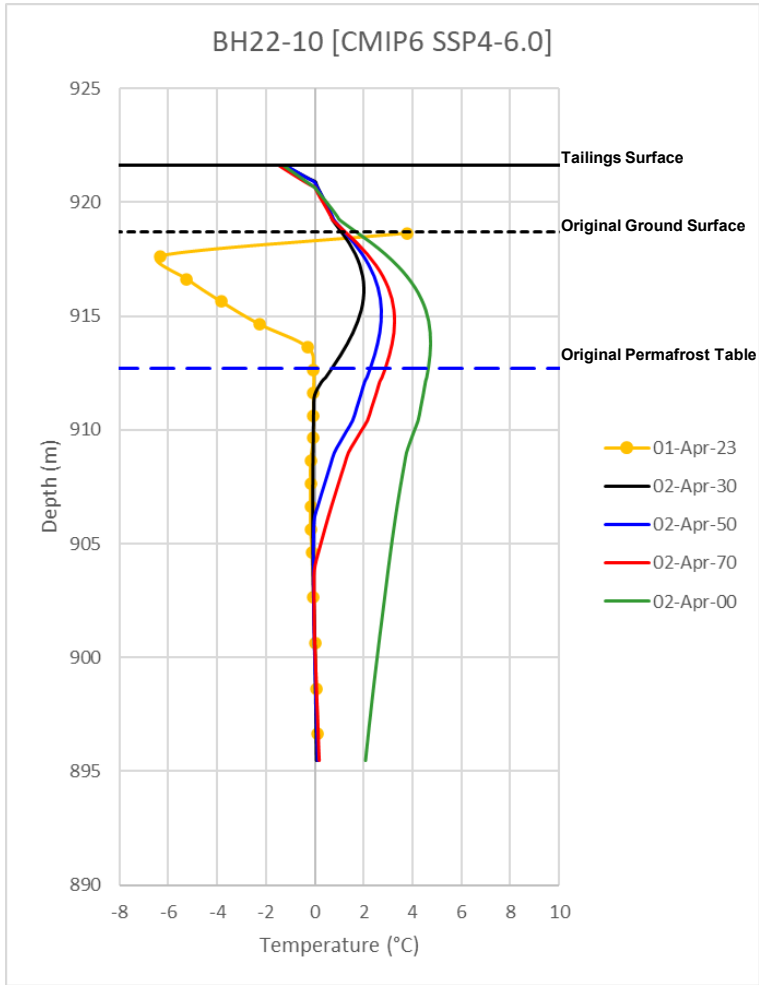
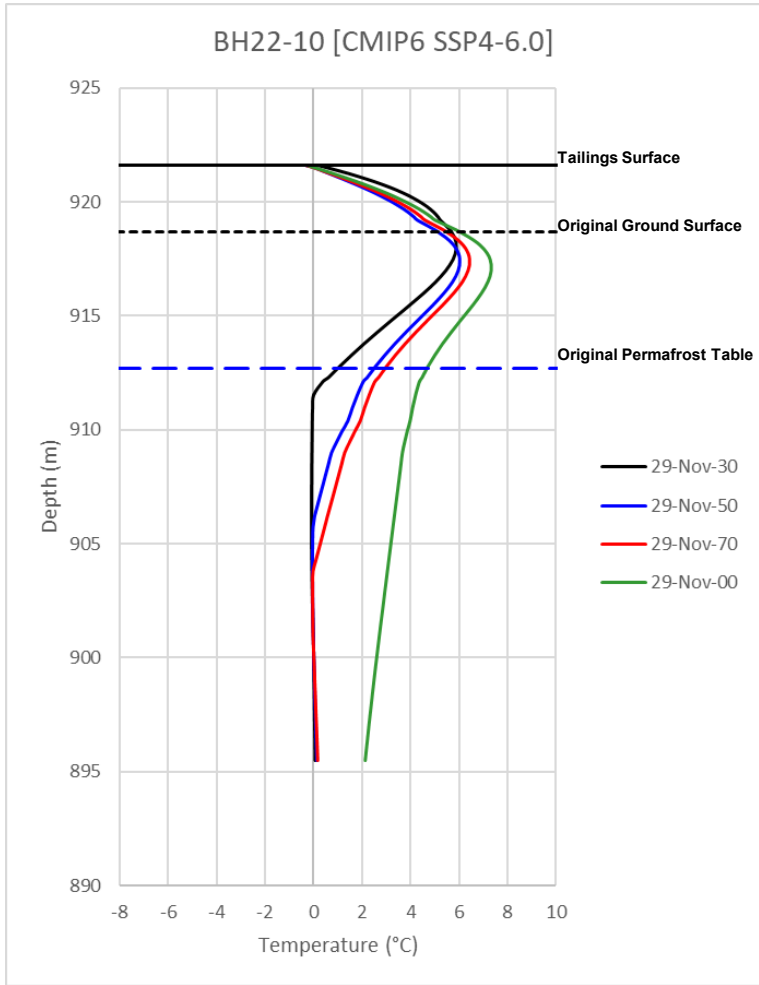
**Temperature Projection at BH22-10 under
SSP3-7.0 Climate Scenario**

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-19



LEGEND

NOTES

CLIENT



**DETAILED DESIGN – PHASE 2 DRY STACK TAILINGS FACILITY
KENO HILL DISTRICT MILL SITE, YUKON**

**Temperature Projection at BH22-10 under
SSP4-6.0 Climate Scenario**

STATUS
ISSUED FOR USE



PROJECT NO. ENG.WARC04307-01	DWN EDG	CKD IM	APVD RT	REV A
OFFICE WHITEHORSE	DATE JUNE 2023			

Figure F-20