

2023 Annual Geotechnical Inspection Mining Related Earth Structures



PRESENTED TO

Alexco Keno Hill Mining Corporation, dba Hecla Yukon

NOVEMBER 16, 2023

ISSUED FOR USE

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LIMITATIONS OF REPORT

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

1.0 INTRODUCTION

1.1 Background

Tetra Tech Canada Inc. (Tetra Tech), NELPCo's exclusive engineering service provider, was retained by Alexco Keno Hill Mining Corporation (AKHM), doing business as Hecla Yukon, to complete the 2023 annual physical geotechnical inspection of earth structures associated with the development of the Bellekeno, Flame and Moth, and Bermingham Mines, located near Keno City, Yukon.

Annual physical inspections and reporting are required under Quartz Mining License QML-0009 issued by the Yukon Government, Energy, Mines and Resources (Yukon Government 2019), and Type A Quartz Mining Water License QZ18-044 issued by the Yukon Water Board (Yukon Water Board 2020). Tetra Tech has been completing the annual physical inspection of these earth structures for several years, the most recent in 2022 (Tetra Tech 2023). This report summarizes the 2023 annual physical inspection and is intended to supplement AKHM's annual reporting requirements.

Authorization to complete this work was provided by way of Purchase Order PO08683.

1.2 Scope of Work

Tetra Tech's scope of services for this work included:

- Complete a visual inspection of the following structures, identified by AKHM:
 - Bellekeno Potentially Acid Generating (PAG) waste storage facility;
 - Bellekeno Road waste rock pile;
 - Bellekeno 625 water treatment ponds and discharge line;
 - Lightning Creek bridge abutments;
 - Mill water storage ponds;
 - Dry stacked tailings facility (DSTF);
 - Flame and Moth PAG waste storage facility;
 - Bermingham Non-Acid and/or Metal Leaching (NAML) waste dump;
 - Bermingham sludge containment facility;
 - Bermingham storage pond; and
 - Bermingham PAG waste storage facility.
- Collect readings of active instrumentation installed within and around the DSTF footprint.
- Provide an inspection report that summarizes:
 - Documentation of the inspection locations and methodologies;

- The results of the inspection;
- All problems identified such as physical instability, erosion, or water ponding;
- Remedial measures recommended;
- The status of any remedial measures recommended in the previous year’s report with an explanation regarding any recommendation not implemented; and
- Actions taken to planned in response to any identified issues and/or to prevent recurrence.

2.0 SITE VISIT

The 2023 annual inspection was completed between July 20 and July 22, 2023. Tetra Tech’s representatives included Mr. Richard Trimble, P.Eng., and Mr. Ian MacIntyre, P.Eng., who were accompanied by several AKHM and ERDC representatives including Baoyao Tang (Chief Mine Engineer), Moctar Diallo (Senior Geotechnical Engineer), and Cameron Robertson (Project Engineer).

Figure 1 below shows a track collected by a GPS worn by Mr. MacIntyre. Note there were areas visited under separate scopes of work.

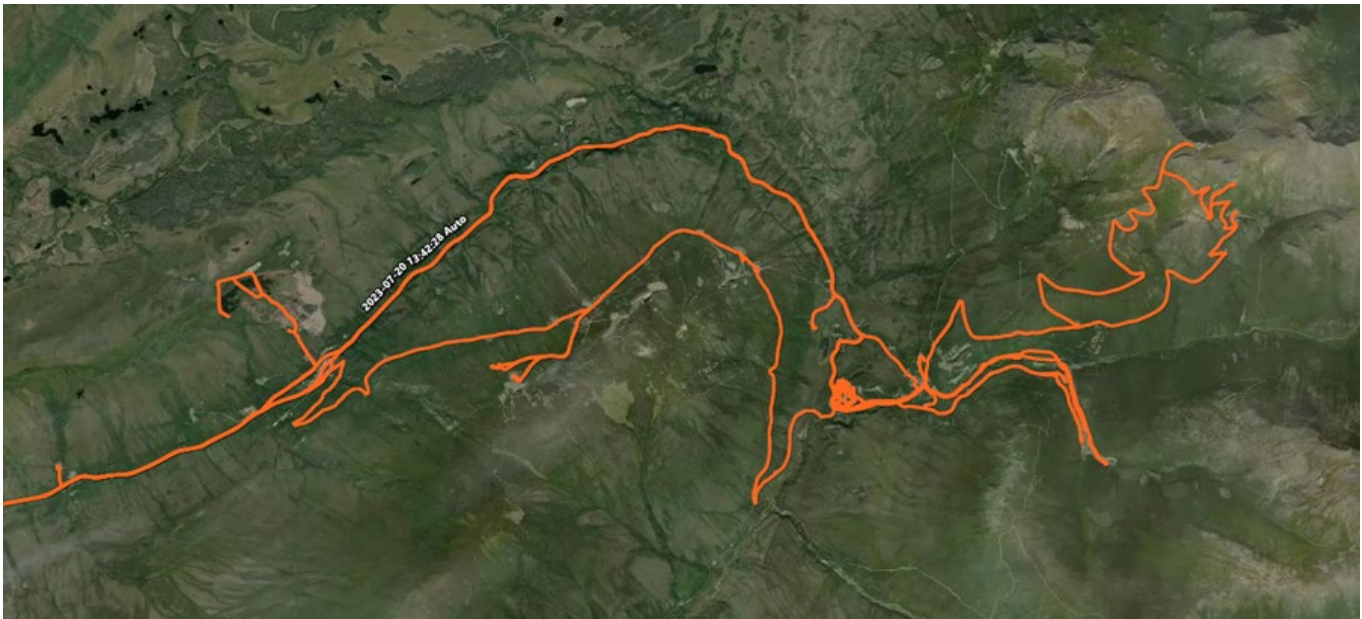


Figure 1: GPS tracklog of Mr. MacIntyre between July 20 and July 22, 2023.

3.0 OBSERSVATIONS AND RECOMMENDATIONS

3.1 General

The following sections summarize observations made during the site visit for each structure and describe remedial actions recommended to improve stability, if required. In Section 4, these recommended remedial actions have

been summarized and separated into geotechnical stability concerns, and ongoing facility maintenance to assist in the prioritization of efforts and allocation of resources.

Select photographs taken during the inspection have been included.

3.2 Bellekeno PAG Waste Facility

The PAG waste storage facility is located south of the Bellekeno portal. Tetra Tech understands it has not been used since 2013, but currently stores some waste rock.

The facility condition appeared unchanged from the previous year’s inspection. The remaining perimeter berms appeared intact with no visible signs of instability or distress. A drainage relief was excavated at the downstream end of the facility to minimize water ponding.

No remedial actions related to geotechnical performance are recommended at this time. Tetra Tech recommends the requirement to inspect this facility be reviewed and updated as necessary, particularly if it is not being operated.



Photo 1: Bellekeno PAG Storage Facility, facing north (I. MacIntyre, July 20, 2023)

3.3 Bellekeno Waste Rock Pile

The Bellekeno waste rock pile forms a portion of the Bellekeno Haul Road north of the Bellekeno portal.

At the time of the inspection, the waste rock pile crest, slopes, and toe showed no signs of deep-seated instabilities, significant movement, distress, sloughing or bulging. The condition of the facility appears generally unchanged from previous inspections.

No remedial actions related to geotechnical performance are recommended at this time.



Photo 2: Bellekeno Road Waste Rock Pile, facing southwest (I. MacIntyre, July 20, 2023)

3.4 Bellekeno 625 Water Treatment Ponds

The Bellekeno 625 water treatment ponds are located north of the Bellekeno 625 portal. The facility consists of two water treatment ponds. Treated water is discharged through a HDPE pipe onto the hillside above Lightning Creek.

The primary treatment pond was operating at its discharge elevation with a freeboard of approximately 0.8 m below the perimeter berm. The secondary treatment pond was discharging through its outlet with a freeboard of approximately 0.6 m below the perimeter berm. No signs of instability or movement were noted within the perimeter berms.

The outlet structure was noted to have been modified (it was not discharging during the 2022 inspection). The liner around the outlet was unsupported and may be at risk for failing or overtopping. The flume structure was noted to be supported by a large rock. Tetra Tech recommends the outlet structure be upgraded including anchoring and supporting the liner and flume. Use of granular fill may be required.

The rip in the liner near the end of the secondary pond noted in 2021 was still evident and does not appear to have increased in size. Any rips or tears in the liner should be repaired.

The conditions at the discharge do not appear to have changed, except for continued vegetation growth. Flow is discharged directly onto the natural slope. While the slope is vegetated, some erosion is visible immediately around the discharge. While minor for now, the erosion may increase in severity, and options should be evaluated to provide some armoring around the discharge point.



Photo 3: Bellekeno 625 Water Treatment Ponds, facing southwest (I. MacIntyre, July 20, 2023)



Photo 4: Bellekeno 625 Water Treatment Ponds, facing northwest (I. MacIntyre, July 20, 2023)



**Photo 5: Bellekeno 625 Water Treatment Ponds, outlet structure. Note unsupported liner and flume.
(I. MacIntyre, July 20, 2023)**

3.5 Lightning Creek Bridge Abutments (Bellekeno Haul Road)

The Lightning Creek bridge is located on the Bellekeno Haul Road, southwest of Keno City.

The bridge consists of a single span steel structure with a wooden deck and is founded on earth filled timber crib abutments. At the time of the inspection the bridge abutments appeared stable and sufficiently protected from erosion by riprap armoring. As has been documented in previous inspections, some erosion was noted along the road edge.

The erosion gully should be backfilled using coarse grained material as required, and positive drainage established to minimize erosion.

The bridge guardrail was damaged. It should be repaired, and markers installed at each end to increase visibility.



Photo 6: Lightning Creek Bridge – Bellekeno Haul Road (I. MacIntyre, July 30, 2023)



Photo 7: Lightning Creek Bridge – Bellekeno Haul Road, erosion along abutment (I. MacIntyre, July 20, 2023)

3.6 Lightning Creek Bridge Abutments (Onek Road)

The Lightning Creek bridge crossing on the Onek Road is located east of Keno City, as shown on Figure 1. The bridge consists of a single span steel structure founded on earth-filled cribbing abutments. Access across the bridge is currently blocked, as has been the case for several years.

At the time of the inspection the bridge abutments appeared stable and sufficiently protected from erosion by riprap armoring. No remedial actions related to geotechnical performance are recommended at this time.



Photo 8: Lightning Creek Bridge – Onek Road (I. MacIntyre, July 20, 2023)

3.7 Mill and Fill Water Storage Ponds

Two water storage ponds, the Mill Water Storage Pond and the Fill Water Treatment Plant Pond are located near the mill site, west of Keno City, as shown on Figure 1.

At the time of the inspection, the freeboards in the Fill Water and Mill Water ponds were approximately 0.8 m and 2.5 m, respectively.

The liners and berms of each pond appeared to be in generally good condition. Vegetation continues to grow along berm and liner edge. This growth may impact liner and berm stability and impair visual inspections and should be cleared/removed.

As noted in previous inspections, there is ongoing erosion located in the area above the Fill Water pond near its southeast corner. This location appears to drain runoff from around the crusher area. While the erosion has not yet impacted the pond, it should be monitored and repaired/backfilled as necessary and armored with coarse rock. AKHM should consider establishing proper drainage prevent future issues. Surface water must be prevented from flowing directly into the pond. Maintenance may be required after heavy precipitation events.



Photo 9: Fill and Mill Water Treatment Plant ponds, background and foreground, respectively. – aerial view facing north (I. MacIntyre, July 20, 2023)



Photo 10: Fill Water Storage pond – facing south (I. MacIntyre, July 20, 2023)



Photo 11: Fill Water Storage pond, erosion gully – facing northeast (I. MacIntyre, July 20, 2023)



Photo 12: Mill water storage pond, erosion gully – facing south (I. MacIntyre, July 20, 2023)

3.8 Dry Stacked Tailings Facility

The dry stacked tailings facility (DSTF) is located near the mill site, west of Keno City, as shown on Figure 1 and 2. Production and tailings placement appeared to have been ongoing recently, but no tailings placement was observed during the site visit.

Several areas or conditions were observed that required attention:

- Sinkholes and erosion gullies noted along south facing slope of lower bench, similar to those noted in 2022.

- One sinkhole was noted to be approximately 0.5 m deep and at least 1.5 m in width.
- Sinkholes and eroded areas should be excavated to competent/compact material, replace and compact with tailings / cover material as appropriate to design, photos should be taken during process and provided to Tetra Tech.
- May be attributed to ponding of water along lower bench, releasing through cover material. Minimal cover material was also observed in this area, as thin as 150 mm. During repair works 0.5 m of cover should be established as per design.
- As recommended in 2021, any of these occurrences (i.e., sinkholes, blow outs, tension cracks, etc.) should be surveyed and reported to Tetra Tech along with photos immediately when they are observed.
- The lower bench has been observed to pond water during freshet. The ponded area may be up to 1 m in depth, estimated visually. This water ponding, and possible release through a thin cover material may be contributing to the erosion issues noted above. Based on readings collected from the GTC installed in BH22-40b on the bench (replacing BH40, damaged in 2013), Tetra Tech anticipates at least some of this ponding is attributed to settlement caused by the gradual thaw of localized ice rich permafrost. As discussed with AKHM, this lower bench should be stripped of cover material, regraded using tailings, placed per the Operations, Maintenance, and Surveillance Manual (OMS, 2023), and recovered with cover material (0.5 m thick per design) to ensure positive drainage to the west slope.
- Tailings recently deposited on upper bench were estimated visually to have moisture contents higher than 15% (estimated visually at >20%). AKHM should ensure pressing procedure is completed to maintain moisture content of tailings to 15% or lower (by mass) - this is crucial for DSTF stability and performance.
- Recent tailings placement near the crest of Phase 1 were estimated visually to be exceeding 2.5H:1V slopes. These areas should be surveyed and if necessary, cut back to the design slope.
- Runoff Collection System:
 - Tailings were noted to encroach on the eastern limits of Phase 1 and beyond the collection ditch - AKHM was cleaning this area out at the time of the inspection. Runoff collection ditching must be reestablished here per design.
 - The runoff collection ditching along the north and west perimeters consists of exposed and unanchored liner. It must be reestablished per design.
 - Erosion gullies noted through tailings slope on upper bench. Once an area has been constructed to design, cover material should be placed to minimize erosion of tailings.
 - The toe collection ditch along the southern facing slope of Phase 1 lower bench is absent. This must be constructed per design.
 - Collection sump at toe of Phase 1 appeared full of sediment, this should be cleared out and re-established per design.
 - Tetra Tech is aware this has been completed as of October 2023.
- Phase 1B liner placement was noted to be continuing along southern edge of Phase 1 upper bench – appears generally consistent with design.

- OMS and Inspections

- OMS has been updated by Tetra Tech (July 2023). All site staff working on the DSTF should review and become familiar with its contents, including weekly inspection checklist and trigger action response plan (TARP).
- As the DSTF is progressing into Phase 1B, and in light of recent surficial instabilities and placement of tailings at moisture contents exceeding those permitted in the design, Tetra Tech recommends more frequent inspections of the DSTF by the engineer - ideally at least every four months.



**Photo 13: DSTF Phase 1 – aerial view facing northeast. Areas of erosion visible in foreground slope.
(I. MacIntyre, July 22, 2023)**



Photo 14: Photo 13: DSTF Phase 1 – aerial view facing east. (I. MacIntyre, July 22, 2023)



Photo 15: Photo 13: DSTF Phase 1 – aerial view facing southwest. Over steepened areas of recent placement visible in foreground. (I. MacIntyre, July 22, 2023)



Photo 16: DSTF Phase 1A area, southwest slope. Small sink hole indicating migration of materials. Extends below cover into tailings. Erosion gully visible in background (I. MacIntyre, July 20, 2023)



Photo 17: DSTF Phase 1 collection sump after cleaning of sediment build up. Liner was later installed. Facing southwest. (I. MacIntyre, July 22, 2023)



Photo 18: DSTF Phase 1 south west runoff collection ditching, Facing North. Typical, showing exposed an unanchored liner and buildup of sediment. (I. MacIntyre, July 20, 2023)



Photo 19: DSTF Phase 1 north perimeter runoff collection ditching, Facing North. Typical, showing exposed an unanchored liner and buildup of sediment. (I. MacIntyre, July 22, 2023)



Photo 20: DSTF Phase 1 lower bench south slope. No runoff collection ditching present, possible buildup of debris along toe. Facing North. (I. MacIntyre, July 20, 2023)

3.8.1 Instrumentation

Ground Temperature Cables

During DSTF Phase 1 design and construction seven ground temperature cables (GTC’s) were installed. Through years of operations, several of these have been damaged beyond repair or are no longer functioning.

Updated ground temperature readings were collected from accessible and functioning cables, and are presented in Appendix B. A summary of the cables is provided below:

Table 1 – GTC Instrumentation Status and Comments

Cable ID	Status	Additional Comments
BH15	Functioning.	Possible erroneous readings at depth.
BH17	Cable not accessible due to damaged casing. Functionality not known.	NA
BH18	Appears to have been padded over for warehouse expansion. Assumed destroyed.	NA
BH23	Not located – Assumed destroyed.	Previous erroneous readings at depth.
BH31	Functioning.	Possible erroneous readings at depth.
BH32	Not functioning, lead damaged, assumed by frost heave.	NA
BH22-40B	Functioning.	Replacement of BH40.

In general, the data collected continues to indicate typical ranges of near surface temperatures. Several cables continue to show sufficiently low temperatures (i.e., less than -3°C) that it may indicate individual thermistor beads have been compromised or are malfunctioning.

Importantly, BH22-40B, which was installed to replace the GTC in BH40 which was damaged in 2013, indicates the warm permafrost previously observed and measured under the lower bench of Phase has thawed (last readings on BH40 were collected in 2013).

Slope Inclinometers

There are no longer any functioning SI’s within the DSTF area. Tetra Tech is working with AKHM to develop a long-term geotechnical instrumentation plan.

Tetra Tech recommends a long-term geotechnical instrumentation monitoring plan be developed and implemented.

3.9 OMS Manual update – Dry Stacked Tailings Facility

The OMS manual was updated in July 2023. All AKHM staff involved in the DSTF should be familiar with its content, including weekly visual inspection and TARP requirements. This document should be reviewed and updated as necessary.

3.10 Flame and Moth PAG Waste Storage Facility

The Flame and Moth PAG waste storage facility is located south of the mill.

At the time of the inspection the facility conditions appeared similar to the previous inspection. The perimeter berms appeared intact with no visible signs of instability or distress. However, placement of PAG along the south end of facility was beginning to encroach on berm extents. These areas should be cleaned out, the berm clearly

reestablished, and liner anchored properly per design (Tetra Tech, 2018 and Tetra Tech EBA, 2014). Note this includes a 2 m crest of “Zone B” material.

Additionally, a sump culvert for sampling / pumping was not observed. This requirement should be reviewed and addressed as appropriate.



Photo 21: Flame and Moth PAG waste storage facility, aerial view facing west. (I. MacIntyre, July 20, 2023)

3.11 Birmingham NAML Waste Dump

The Birmingham NAML waste dump is located to the northwest of the Birmingham portal and was designed by Tetra Tech. At the time of the inspection, it appeared placement of waste material was ongoing.

Localized sections of slopes near the crest were estimated to be steeper than the 2H:1V recommended in the design (Tetra Tech 2021). No sign of deep seated or global instability, on-going movement, or distress were observed. However, a previously sloughed volume of material was noted. This sloughed material appeared to consist of a finer gradation of waste rock, and higher moisture content than the typical NAML waste rock. No ongoing movement was apparent in this area, and the sloughage appeared very localized.

The upper portion of the dump should be regraded to the 2H:1V design slopes, and the dump surface graded to ensure positive drainage away from the facility.

Design recommended the installation of groundwater monitoring wells to monitor pore-water pressure within the dump. These have not yet been installed. AKHM and Tetra Tech should review this requirement.



Photo 22: Birmingham NAML waste dump, aerial view facing south. Sloughed material visible in lower left. (I. MacIntyre, July 20, 2023)

3.12 Birmingham Mine Sludge Containment Facility

Near the Birmingham water treatment plant, two lined enclosures were constructed to support sludge bags.

At the time of the inspection the facility condition appeared unchanged from 2022. Crest, slopes, and toe showed no signs of deep-seated instabilities, significant movement, distress, sloughing or bulging.

However, as was noted in 2022, the newer portion of the facility appears to have been constructed without removing all organics within the footprint. AKHM noted they believe most organics were removed, while acknowledging some remaining along the facility toe. The facility should be monitored closely for movement, particularly during freshet, and the remaining organics should be removed and replaced with compacted granular fill.



Photo 23: Bermingham Mine Sludge Waste Containment Facility – buried organics and trees visible in foreground. (I. MacIntyre, July 20, 2023)

3.13 Bermingham Storage Pond

The Bermingham storage pond is located northeast of the Bermingham portal.

At the time of the inspection, facility appeared unchanged from 2022. The freeboard observed was approximately 1.0 m. The liners and berms appeared to be in generally good condition, no signs of instability, movement, distress, or seepage were noted.

No remedial actions are recommended at this time.



Photo 24: An aerial view of the Bermingham storage pond (I. MacIntyre, July 20, 2023)

3.14 Bermingham PAG Waste Storage Facility

The Bermingham PAG waste storage facility is located on the upper bench above the Bermingham portal.

At the time of the inspection the storage facility appeared generally unchanged from 2022, apart from the placement of some additional PAG material. Berms showed no signs of deep-seated instabilities, significant movement, distress, seepage, sloughing or bulging.

A sump culvert for sampling / pumping was not observed. This requirement should be reviewed and addressed as appropriate.

No remedial actions related to geotechnical performance are recommended at this time.



Photo 25: Bermingham PAG waste storage facility, aerial view (P. Johnson, August 30, 2022)

4.0 DISCUSSION AND SUMMARY OF RECOMMENDATIONS

In general, the structures inspected during the physical inspection appeared to be in good condition, and no significant risks associated with geotechnical stability were observed.

However, some areas and conditions require action. The remedial actions recommended in the previous sections are summarized in Table 2 below.

Table 2 – Summary of 2023 Recommendations

Structure / Facility	Stability Recommendation	Maintenance Recommendation
Bellekeno PAG Waste Facility	<ul style="list-style-type: none"> No remedial actions related to geotechnical performance are recommended at this time. Review requirement to inspect facility. 	
Bellekeno Road Waste Rock Pile	<ul style="list-style-type: none"> No remedial actions related to geotechnical performance are recommended at this time. 	
Bellekeno 625 Water Treatment Ponds	<ul style="list-style-type: none"> Consider riprap armor at discharge. The outlet structure be upgraded including anchoring and supporting the liner and flume. 	<ul style="list-style-type: none"> Repair tears in liner.
Lightning Creek Bridge Bellekeno Haul Road	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> The erosion gully should be backfilled using coarse grained material as required, and positive drainage established to minimize erosion. The bridge guardrail should be repaired, and markers installed at each end to increase visibility.
Lightning Creek Bridge Onek Road	<ul style="list-style-type: none"> No remedial actions related to geotechnical performance are recommended at this time. 	
Mill Water Storage Ponds	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Monitor erosion above Fill Pond, and repair as necessary i.e., backfill and armor with coarse rock. AKHM should consider establishing proper drainage prevent future issues. Maintenance may be required after heavy precipitation events. This growth may impact liner and berm stability and impair visual inspections and should be cleared/removed.
Dry Stacked Tailings Facility	<ul style="list-style-type: none"> Regrade lower bench as described in Section 3.8 Survey over steepened areas of tailings placement near crest and cut to design slope of 2.5H:1V if necessary. Ensure mill pressing procedure maintains moisture of tailings to 15% or lower (by mass). Tetra Tech recommends increasing DSTF engineer inspection frequency to at least once every 4 months. AKHM staff should review and be familiar with OMS, particularly weekly visual inspection, and TARP requirements. Develop and implement a long-term geotechnical instrumentation monitoring plan. 	<ul style="list-style-type: none"> Repair sinkholes. Establish cover per design. Reestablish and maintain all surface runoff collection ditching per design. Consider completing some proactive snow removal prior to freshet to minimize surface runoff erosion potential. Survey and photograph all indications of instabilities (sinkholes, cracks, etc.) and provide to Tetra Tech when observed.
Flame and Moth PAG Waste Storage Facility	<ul style="list-style-type: none"> Reestablish berm and liner properly per design (ENG.WARC03443-01, Tetra Tech, May 2018 - can be provided on request) Note this includes a 2 m crest of “Zone B” material. The requirement for a sump culvert for sampling / pumping, as shown in design, should be reviewed and addressed as appropriate. 	
Birmingham NAML Waste Dump	<ul style="list-style-type: none"> The upper portion of the dump should be regraded to design slopes (2H:1V), and the dump surface graded to ensure positive drainage away from the facility. Design recommended the installation of groundwater monitoring wells to monitor pore-water pressure within the dump. These have not yet been installed. AKHM and Tetra Tech should review this requirement. 	
Birmingham Sludge Containment Facility	<ul style="list-style-type: none"> Remove visible organics and trees and replace with compacted granular fill. Monitor performance during freshet. 	<ul style="list-style-type: none"> None
Birmingham Storage Pond	<ul style="list-style-type: none"> No remedial actions related to geotechnical performance are recommended at this time. 	
Birmingham PAG Waste Storage Facility	<ul style="list-style-type: none"> No remedial actions related to geotechnical performance are recommended at this time. The requirement for a sump culvert for sampling / pumping, as shown in design, should be reviewed and addressed as appropriate. 	

5.0 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.



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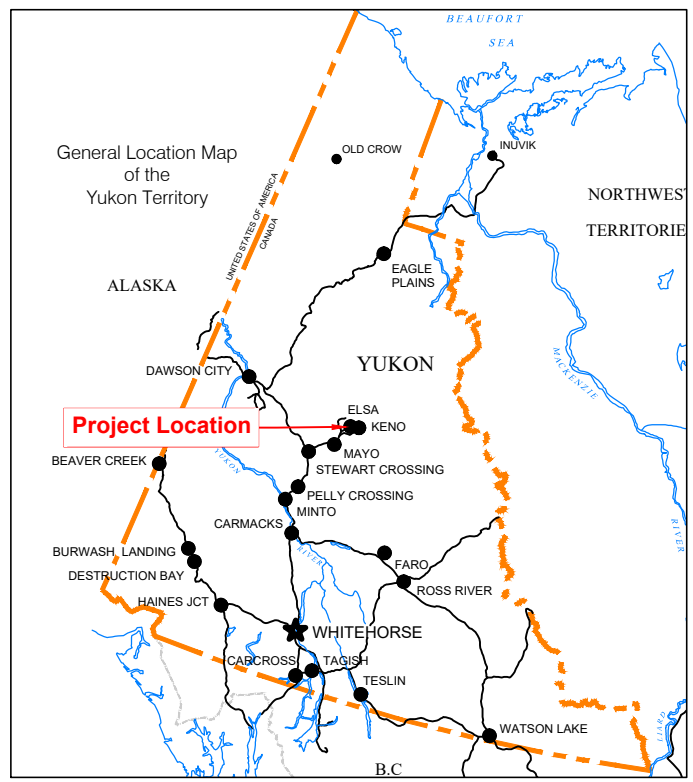
REFERENCES

- OMS 2023. *Operations, Maintenance, and Surveillance Manual- Rev 1, Dry Stack Tailings Facility, Keno Hill Silver District Mining Operations*. Prepared by Tetra Tech for Hecla Mining Company, dated July 2023.
- Tetra Tech EBA 2014. *Waste Storage Facility Design – Revision 1 IFU. Flame and Moth Property, Keno City, Yukon*. Prepared by Tetra Tech EBA and submitted to Alexco Resource Corp. October 2, 2014. File W14103485-01.
- Tetra Tech 2018. *Alexco Flame and Moth P-AML Waste Storage Facility Slope Stability Assessment Keno City, Yukon*. Submitted to Alexco Resource Corp May 30, 2018. File ENG.WARC03443-01
- Tetra Tech 2021. *NAML Waste Dump Design. Bermingham Mine near Keno City, Yukon*. Submitted to Alexco Resource Corp July 5, 2021. File 704-ENG.WARC03961-01.
- Tetra Tech 2023. *2022 Annual Geotechnical Inspection – Mining Related Earth Structures, Revision 1 IFU*. Submitted to Hecla Yukon, January 3, 2023. Tetra Tech Project File 704-ENG.WARC04286-01.
- Yukon Government 2019. Quartz Mining License QML-0009. Issued by the Yukon Government Energy, Mines and Resources to Alexco Keno Hill Mining Corp. November 27, 2019.
- Yukon Water Board 2020. *Quartz Mining Type A Licence QZ18-044*. Quartz Mining Licence issued by the Yukon Water Board to Alexco Keno Hill Mining Corp. July 22, 2020.

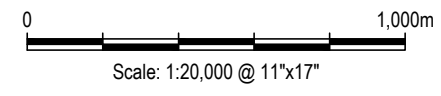
FIGURES

- Figure 1 Overall Site Plan Showing Structure Locations
- Figure 2 DSTF Area Site Plan Showing Observations

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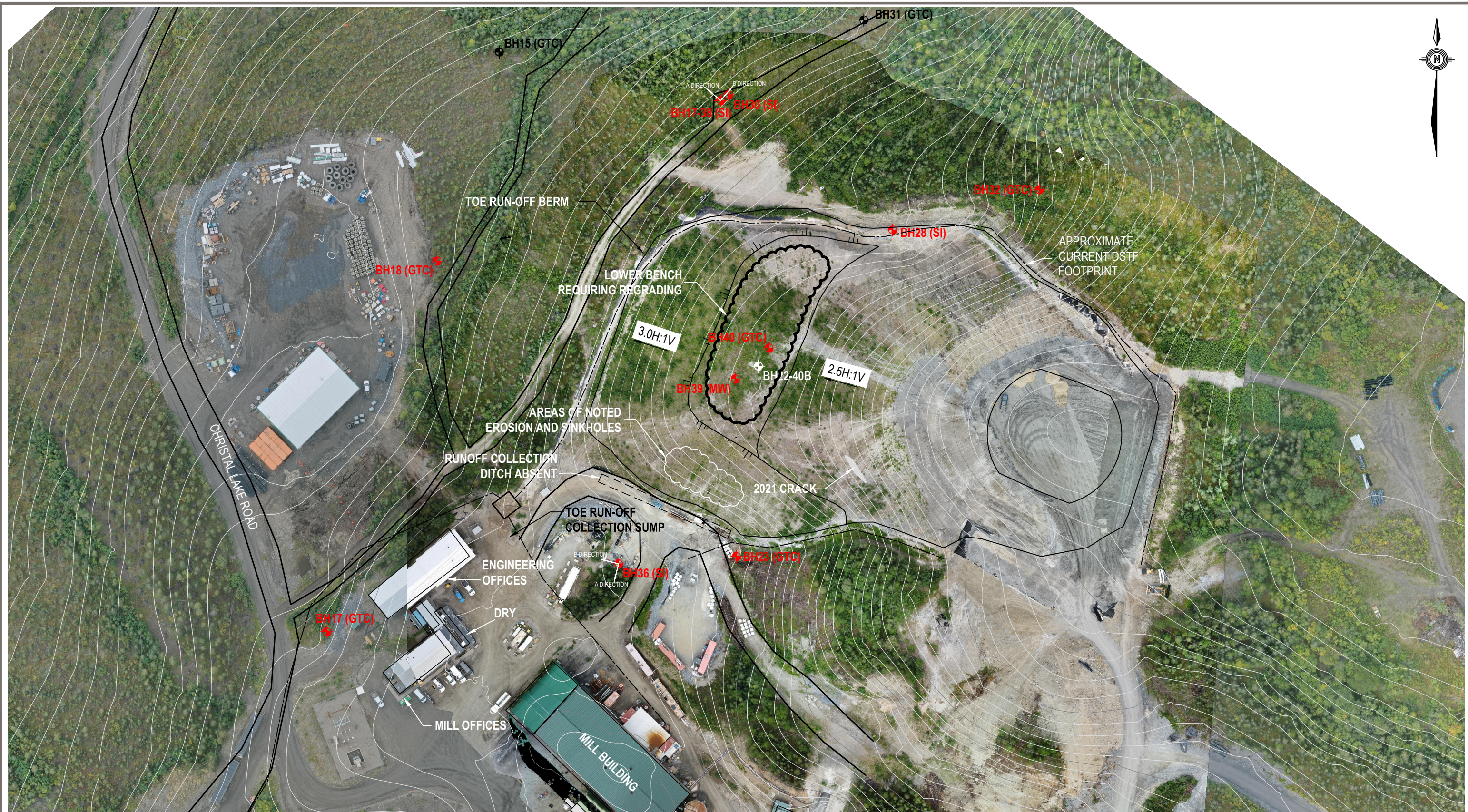


NOTES
 CONTOUR INFORMATION IS BASED ON DRAWING PROVIDED BY ALEXCO RESOURCE INC.



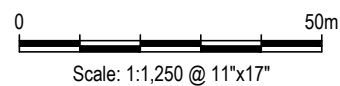
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LEGEND

- GTC - GROUND TEMPERATURE CABLE
- SI - SLOPE INDICATOR
- MW - MONITORING WELL



NOTES :

1. INSTRUMENTATION SHOWN IN RED HAS BEEN DAMAGED OR DESTROYED AND IS NOT READABLE. SOME OF THESE NEED TO BE REPAIRED AND/OR REPLACED. SEE ACCOMPANYING REPORT TEXT.
2. DRONE IMAGERY COLLECTED BY TETRATECH ON JULY 10, 2023. CONTOURS ARE APPROXIMATE, BASED ON PROCESSED DRONE IMAGERY.

CLIENT



**2023 AKHM ANNUAL INSPECTION
KENO CITY, YUKON**

**SITE PLAN SHOWING
BOREHOLE AND INSTRUMENTATION LOCATIONS**

PROJECT NO. ENG.WARC04415-05	DWN CB	CKD IM	REV 0
OFFICE EBA-WHSE	DATE October 24, 2023		

Figure 2

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

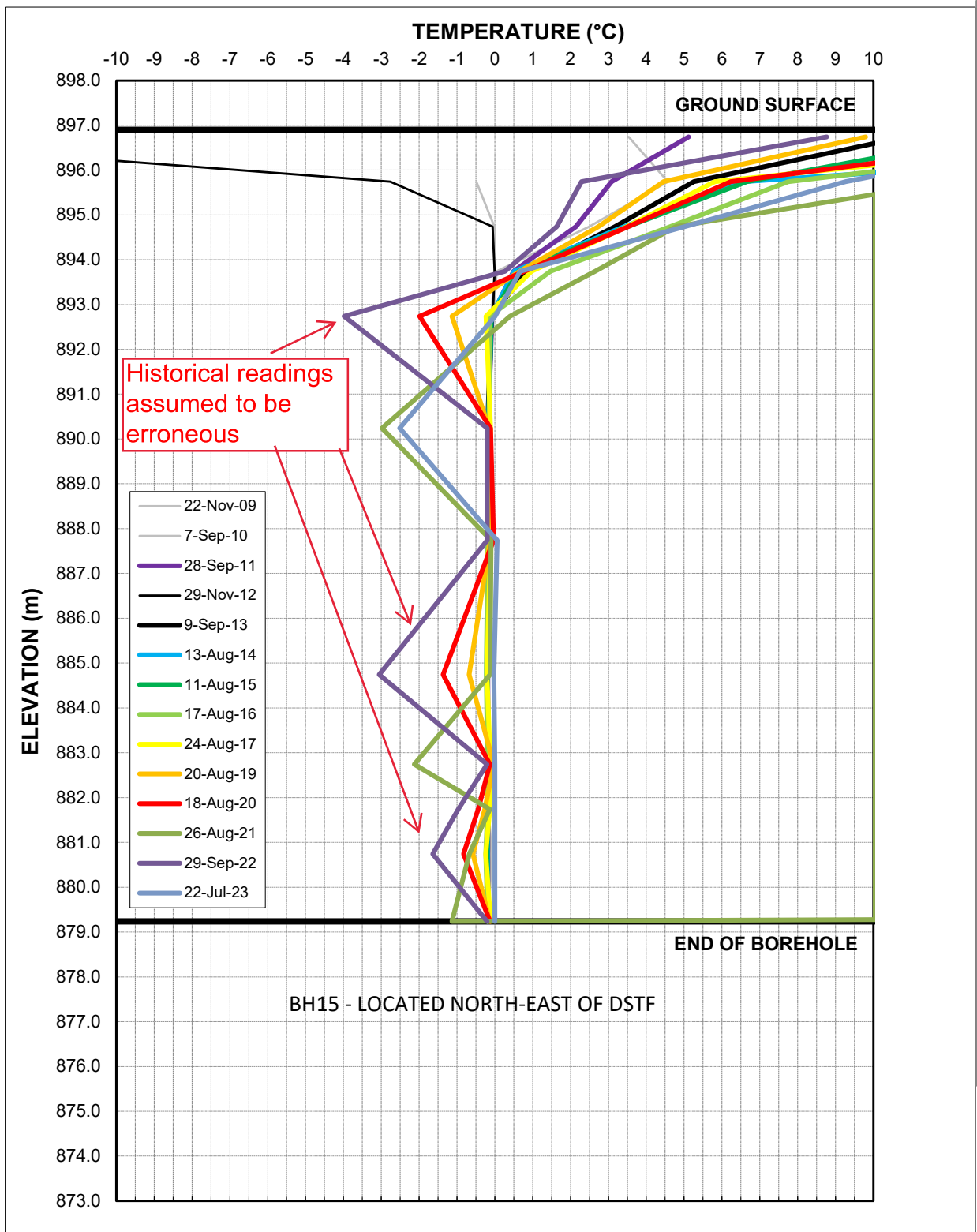
TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

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.

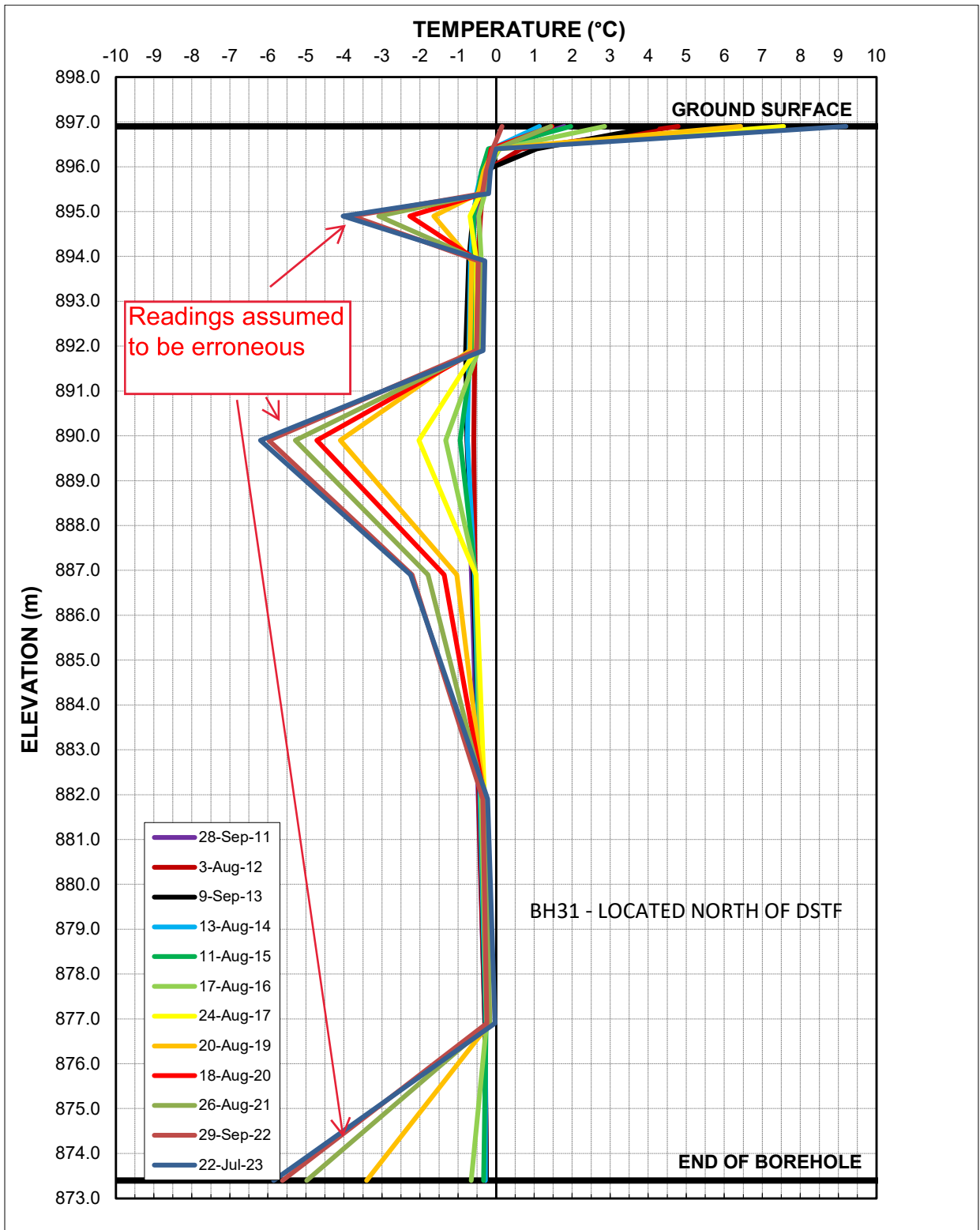
APPENDIX B

GROUND TEMPERATURE READINGS FOR ACTIVE CABLES



Install Date August 30, 2009
 Last Updated July 22, 2023
 Cable No: 2207

Ground Temperature Profile
Keno Hill District Mill Site Borehole BH15



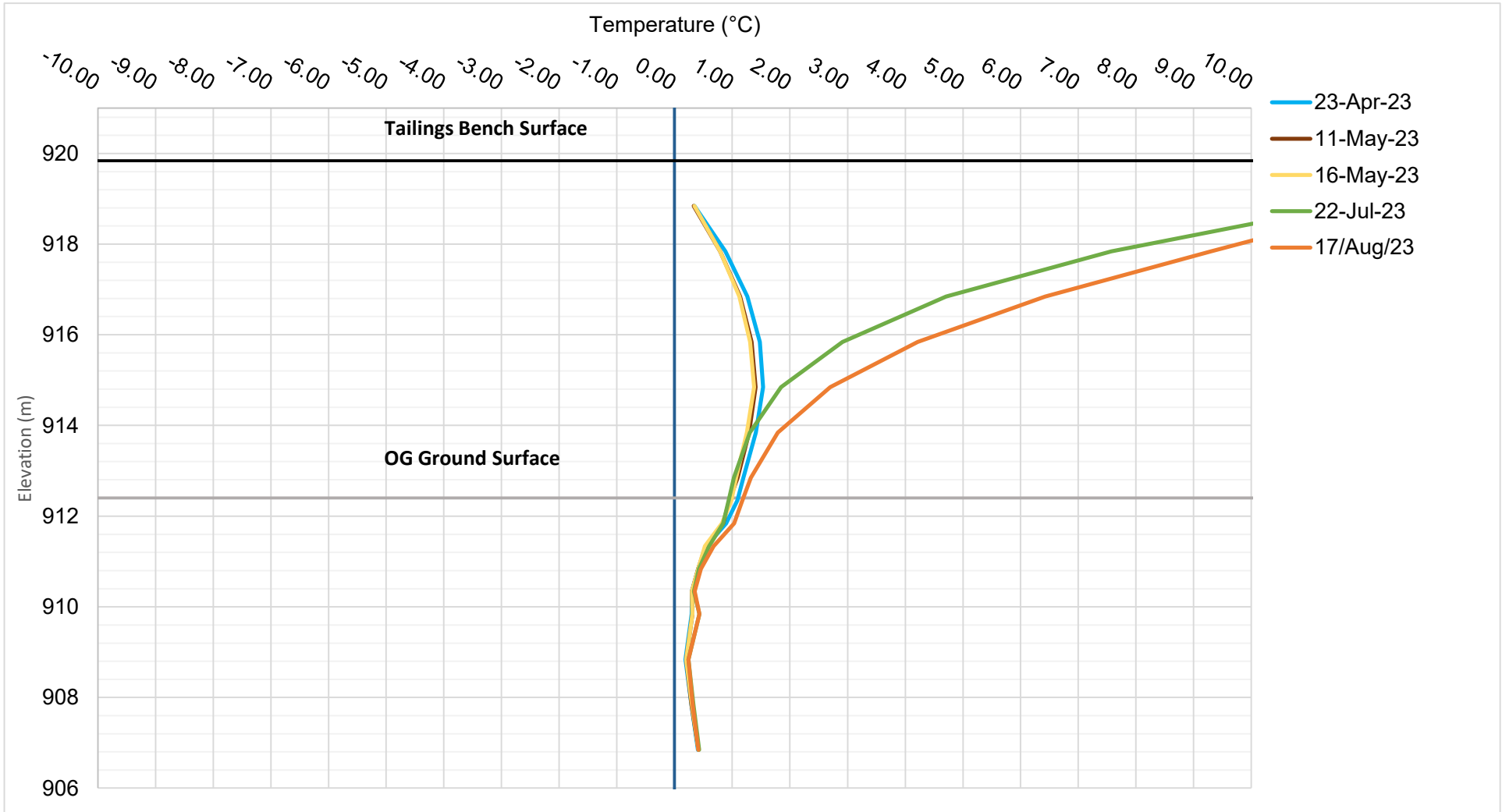
Install Date February 22, 2011
 Last Updated July 22, 2023
 Cable No: 2263

Ground Temperature Profile
Keno Hill District Mill Site Borehole BH31

Ground Temperature Readings

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

ISSUED FOR USE
2023 Ground Temperature Data



Instrument ID: BH22-40B
Cable ID: 2824

