

November 28, 2016

Government of Yukon  
Department of Energy, Mines and Resources  
Assessment and Abandoned Mines  
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ISSUED FOR USE  
FILE: ENG.WARC03063-01  
Via Email: jeff.moore@gov.yk.ca

**Attention:** Mr. Jeff Moore  
Project Officer

**Subject:** 2016 Annual Geotechnical Inspection Report on Earth Structures  
Mount Nansen Site, YT

## 1.0 INTRODUCTION

As requested, Tetra Tech EBA Inc. (Tetra Tech EBA) has completed the annual geotechnical inspection of earth structures located at the abandoned Mount Nansen mine site west of Carmacks, YT. The intent of the inspection was to provide a geotechnical engineering report on the stability of the tailings, water-retaining, and water diversion structures as part of the on-going care and maintenance program. The format of this inspection conforms to that recommended in the Surveillance - Engineering Inspections section of the Canadian Dam Association's (CDA) Dam Safety Guidelines (2013). The tailings dam is classified as "Significant" with respect to the consequences of failure per the CDA Guidelines, and engineering inspections are required on an annual basis. Similar inspections have been completed by Tetra Tech EBA in previous years. The scope of work for this study was to include two site inspections in 2016 - one in the spring (at or near freshet) with an interim report, and one in the fall, just before freeze-up for the final report. This letter presents the Annual Geotechnical Inspection Report that is based on these two inspections. A copy of the spring (June 2016) inspection report is included in Appendix A.

This work was authorized by Jeff Moore of Yukon Government, Department of Energy, Mines and Resources, Assessment and Abandoned Mines Branch (YG-AAM) under Tetra Tech EBA's Standing Offer Agreement, and through Engineering Agreement No. C00032838 dated March 31, 2016.

## 2.0 OBSERVATIONS AND RECOMMENDATIONS

Mr. Richard Trimble, P.Eng. of Tetra Tech EBA's Whitehorse Office completed one-day inspections on May 13 and September 23, 2016. Both inspections were completed in the company of Jeff Moore from YG-AAM and representatives from Denison Environmental Services (DES). The structures examined were:

- North Interceptor Ditch/Dome Creek Diversion Ditch/Combined Emergency Spillway;
- Tailings Dam; and
- Seepage Collection Dam.

Specific observations and recommendations are presented in the following sections of this letter, including selected photos. Other photos taken are available in Tetra Tech EBA's files.

## 2.1 SAFETY CONSIDERATIONS

Prior to the first site visit, a site specific Health and Safety Plan was prepared and submitted to YG-AAM, followed by the completion of a Safety Orientation by Site Operations personnel on site (Denison Environmental Services) for both site visits, as well as the completion of a Tetra Tech EBA Safe Work Form before starting any site work.

## 2.2 NORTH INTERCEPTOR DITCH/DOME CREEK DIVERSION/EMERGENCY SPILLWAY

### Interceptor/Diversion Ditch

The ditches above and around the tailings pond, connecting to the combined spillway, were in similar conditions to prior years. In previous inspections it was observed that the dredging undertaken to remove accumulated silt/sand from the base of the ditch to improve winter flows had lowered the grade of the ditch enough so that toe erosion on the west side (left side looking downstream) of the interceptor ditch above Dome Creek was observed (see Photo 1). Elsewhere, the slopes were acceptably flattened and in a stable condition. It is recommended that future winter ice removal be completed with minimal disturbance to the base of the ditch so that ditch grades are not lowered any further. This entire section of ditch should be re-examined in the spring to see if conditions have stabilized. – If not, the placement of riprap may be required to stabilize the toe of the slope on the west side.



**Photo 1:** Interceptor ditch above Dome Creek (looking downstream)– undercut sideslopes on left side of ditch (September 23/16)

Erosion gullies created by water entering the interceptor ditch from the west were in the same condition as previous years, and should continue to be monitored. These small erosion gullies are significant contributors to sand and silt deposits in the diversion ditch. Previously recommended and subsequently implemented channel blocks using riprap were not entirely successful at containing the eroded sand; however the volume of sand entering the ditch has been reduced. If monitoring and maintenance is not being provided, then a more permanent solution (geotextile placement and regular sand cleanout) may have to be considered.

The remainder of the diversion ditch from the Dome Creek interceptor was in good shape, and no work is recommended at this time other than continued monitoring for slope instability caused by toe erosion.

Photo 2, below, shows the stable condition of the diversion ditch downstream of the Dome Creek intersection.



**Photo 2:** Diversion Ditch with stable sideslopes, looking downstream (September 23/16)

The primary concern with all these ditches is the effects of erosion at the toes of the banks that contribute to widening, grade flattening due to channel infill, oversteep slopes during periods of high water flow, and the transport of sediment that increases total suspended solids further downstream. If regular maintenance is not provided, then some base and slope armoring will be required.

As previously noted, it is recommended that ice removal in the winter be completed with minimal disturbance to the base of the existing ditches – the grade of the upper portion of the ditch near Dome Creek has been lowered substantially, and eventually this will affect future water flow. If this occurs, granular fill may be required to raise the grade of the upper section of ditch to restore original design conditions.

### Combined Emergency Spillway and Diversion Ditch

The combined emergency spillway/Dome Creek diversion channel was in a similar condition to previous years. Work that was completed in 2014 on the outlet from the tailings pond has created a stable configuration that is adequate to carry the design flows. No recommendations for additional work are required at this time.



**Photo 3:** View of stable emergency spillway upstream of combined channel (September 23/16)

It is understood that some woody vegetation was removed following the 2015 inspection – there is still some woody vegetation (willows, etc.) just above the confluence with the original Dome Creek channel that should be removed. The primary purpose is to not impede water flow during future flood events.



**Photo 4:** Minor willow and vegetation growth in the lower portion of combined emergency spillway and diversion channel – foreground of photo (September 23/16)

## 2.3 TAILINGS DAM

The tailings dam is considered stable in its present condition and no concerns are noted.



**Photo 5:** View of the tailings dam crest looking north (September 23/16)

Tailings dam surface settlement monitoring pins were installed during maintenance activities completed in 2014, and have been monitoring by YG-AAM annually since then. Table 1 below shows the difference in elevation of these pins since installation.

**Table 1: Summary of Settlement Pin Monitoring – Tailings Dam Crest (upstream)**

Survey Pin Number	Original 2014 Elevation (m)	Elevation on 2016Sept23 (m)	Difference (m)
Dam 1	1099.694	1099.716	0.022
Dam 2	1099.592	1099.603	0.011
Dam 3	1099.536	1099.520	-0.016
Dam 4	1099.661	1099.645	-0.016

On September 23/16 the water in the tailings pond was just below the base of the installed staff gauge, but a trench had been excavated to view the water level on the gauge. Subsequent to the inspection, the gauge and water level were surveyed by YG-AAM. The water level reading was 0.71 m on the first staff gauge, which corresponds to an elevation of 1095.21 m. This was nearly identical to the Fall 2015 elevation (1095.22 m).

Table 2 summarizes the existing and design elevation details for the tailings pond, and the water level at the time of the inspection.

**Table 2: Summary of Design Elevations and Existing Water Level – Tailings Dam**

Description	Elevation
Crest of Dam	1099.6 m
Top of Geocomposite Liner	1098.8 m
Design Flood Water Elevation	1098.6 m
Spillway Invert	1097.8 m
Maximum Operating Level	1097.8 m
<b>September 23/16 Water Level</b>	<b>1095.2 m</b>

The current water level in the pond is low as compared to historical levels, and well below the spillway invert. From a geotechnical perspective, low water levels are good for stability.

A maintenance item from the May 2016 inspection was to fill in the permafrost thaw depressions near the downstream toe at the south end. This work was completed satisfactorily as shown in Photo 6 below.



**Photo 6:** View of south downstream toe of tailings dam looking south, showing acceptable backfill and levelling of previously noted permafrost thaw depressions (September 23/16)

## 2.4 SEEPAGE COLLECTION DAM

The water level on September 23/16 was read at 0.36 m on the staff gauge, which corresponds to an elevation of 1077.26 m – this provides a freeboard of about 1.8 m, 0.8 m below the maximum operating level.

Table 3 summarizes the existing and design elevation details for the seepage collection pond, and the water level at the time of the inspection.

**Table 3: Summary of Design Elevations and Existing Water Level – Seepage Collection Dam**

Description	Elevation
Crest of Dam	1079.1 m
Top of 38 mil Arctic Liner	1078.7 m
Maximum Operating Level	1078.1 m
<b>September 23/16 Water Level</b>	<b>1077.3 m</b>

**Some minor seepage was observed from the base of the riprap at the toe of the tailings dam, and from the north terrace at the seepage pond. Both of these seepage zones were observed as containing clear water, and the flow rates were consistent with those observed in previous years. Seeps at the downstream toe of the seepage dam, as sometimes noted in previous years, were not observed during the September inspection.**

**The removal of woody** vegetation, and the clearing of ground squirrel burrows that had been previously recommended has been satisfactorily completed.



**Photo 7:** View (looking south) of downstream face of seepage collection dam showing stable condition (September 23/16)

An item noted in previous inspections, but not considered significant, is the development of erosion gullies and rills in the north abutment just downstream of the seepage collection dam.

As shown in Photo 8 below, it is recommended that these erosion gullies be filled and blocked off at the crest with rip-rap so that the gullies don't get any larger



**Photo 8:** View (looking north) at erosion gullies above downstream toe of seepage collection dam (September 23/16)

This is not an immediate stability requirement, but more of an on-going maintenance issue.

No stability concerns were noted as a result of the 2016 inspections of the pond.

### 3.0 SUMMARY OF RECOMMENDATIONS

Table 4 has been prepared to summarize the recommendations from this and previous annual geotechnical inspections. This table will be updated annually, with items noted as “completed” being removed from subsequent versions of the table, and the others carried forward, if still applicable.

**Table 4: Summary and Status of Maintenance Items from 2016 Annual Geotechnical Inspections**

Item Description	Recommended Maintenance	Status
North Interceptor, Diversion Ditch and Combined Emergency Spillway	<ul style="list-style-type: none"> <li>▪ Continue to monitor steep sideslopes and sand/silt buildup. Flatten sideslopes as required. Minimize the clean out and excavation of sand from the base of the ditch, as this creates over-steep slopes and reduces the overall ditch grade.</li> <li>▪ Remove woody vegetation growth in the lower sections of the combined diversion ditch/emergency spillway.</li> </ul>	Satisfactory maintenance has been completed, and monitoring is continuing
Tailings Dam	<ul style="list-style-type: none"> <li>▪ Stable – no issues to report.</li> <li>▪ Continue to read instrumentation on a monthly basis, and settlement pins on a semi-annual basis</li> </ul>	On-going
Seepage Collection Dam	<ul style="list-style-type: none"> <li>▪ Visually monitor seepage entering the pond from toe of tailings dam and from base of north terrace. If water becomes silty, notify a geotechnical engineer immediately.</li> <li>▪ Continue to read instrumentation on a monthly basis.</li> </ul>	On-going
Pumping of Seepage Collection Pond	<ul style="list-style-type: none"> <li>▪ Continue to record pumping rates from seepage collection pond, and notify a geotechnical engineer if the rates required to maintain a constant water pond elevation significantly increase (+25% weekly or at any time that is not related to rainfall).</li> </ul>	On-going

## 4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the Government of Yukon, Energy Mines and Resources and their agents. Tetra Tech EBA 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 Government of Yukon, Energy Mines and Resources or for any Project other than the site described herein. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in the attached General Conditions.

## 5.0 CLOSURE

We trust this report meets your present requirements. The inspections reported herein are specifically related to geotechnical observations completed by the author regarding the north interceptor ditch/Dome Creek diversion/emergency spillway, tailings pond, and seepage collection pond at the time of the inspections. Should geotechnical stability issues be noted by site personnel during other routine inspections, Tetra Tech EBA should be notified as these observations may affect the conclusions presented in this report. Should you have any questions or comments, please contact the undersigned.

Sincerely,  
Tetra Tech EBA Inc.



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# APPENDIX A

## TETRA TECH EBA'S GENERAL CONDITIONS

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# GENERAL CONDITIONS

## GEOTECHNICAL REPORT

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This report incorporates and is subject to these "General Conditions".

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### 1.1 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of TETRA TECH's Client. TETRA TECH does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than TETRA TECH's Client unless otherwise authorized in writing by TETRA TECH. Any unauthorized use of the report is at the sole risk of the user.

This report 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 report, if required, may be obtained upon request.

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### 1.2 ALTERNATE REPORT FORMAT

Where TETRA TECH submits both electronic file and hard copy versions of reports, drawings and 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 and legally binding. The original signed and/or sealed version archived by TETRA TECH shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of TETRA TECH's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except TETRA TECH. TETRA TECH's instruments of professional service will be used only and exactly as submitted by TETRA TECH.

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

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### 1.3 ENVIRONMENTAL AND REGULATORY ISSUES

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

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### 1.4 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

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

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

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

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### 1.5 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.

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### 1.6 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

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

### 1.7 PROTECTION OF EXPOSED GROUND

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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.

### 1.8 SUPPORT OF ADJACENT GROUND AND STRUCTURES

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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.

### 1.9 INFLUENCE OF CONSTRUCTION ACTIVITY

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

### 1.10 OBSERVATIONS DURING CONSTRUCTION

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

### 1.11 DRAINAGE SYSTEMS

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

### 1.12 BEARING CAPACITY

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

### 1.13 SAMPLES

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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.

### 1.14 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

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During the performance of the work and the preparation of the report, TETRA TECH may rely on information provided by persons other than the Client. While TETRA TECH endeavours to verify the accuracy of such information when instructed to do so by the Client, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

# APPENDIX B

## TETRA TECH EBA'S JUNE 2016 INSPECTION REPORT

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July 22, 2016

ISSUED FOR USE  
OUR FILE: ENG.WARC03063-01

Government of Yukon  
Department of Energy, Mines and Resources  
Box 2703  
Whitehorse, Yukon Y1A 2C6

**Attention:** Mr. Jeff Moore  
Type II Project Officer, Assessment and Abandoned Mines

**Subject:** May 2016 Geotechnical Inspection of Earth Structures  
Mount Nansen Site, YT.

## 1.0 INTRODUCTION

As requested, Tetra Tech EBA Inc. (Tetra Tech EBA) has completed a geotechnical inspection of the earth structures located at the abandoned Mount Nansen mine site west of Carmacks, YT. The intent of the inspection was to provide a geotechnical engineering report on the stability of the tailings, water-retaining, and water diversion structures as part of the on-going care and maintenance program. The format and content of the inspection generally conforms to that recommended in the Canadian Dam Association's (CDA) *Dam Safety Guidelines* (2007, updated 2013). Similar inspections have been completed by Tetra Tech EBA in the past. The scope of work for this study was to include two site inspections in 2016 (one near freshet in the spring (May), and one just before freeze-up in the fall (September)) per Tetra Tech EBA's proposal dated March 17, 2016. The work was subsequently authorized under Contract C00032838 on March 31/16. This letter presents an interim report based on the May inspection, which will be combined with the September inspection to prepare the Annual Geotechnical Inspection Report.

## 2.0 OBSERVATIONS AND RECOMMENDATIONS

Mr. Richard Trimble, P.Eng. of EBA's Whitehorse Office completed a one-day inspection on May 13, 2016 in the company of Jeff Moore from the Yukon Government, Assessment and Abandoned Mines (YG-AAM), and two representatives from Denison Environmental Services (the site Care and Maintenance Contractor) – Tyrell Vance and Richard Wilkinson. The structures examined were:

- North Interceptor Ditch/Dome Creek Diversion Ditch/Emergency Spillway
- Tailings Dam
- Seepage Collection Dam

Specific observations and recommendations are presented in the following sections of this letter, including selected photos. Other photos taken are available for review in Tetra Tech EBA's files. Prior to the site visit, a site specific Health and Safety Plan was prepared and submitted to YG-AAM to forward to the site maintenance personnel, followed by the completion of an onsite safety orientation prior to accessing the site(s).

## 2.1 NORTH INTERCEPTOR DITCH/DOME CREEK DIVERSION/EMERGENCY SPILLWAY

### 2.1.1 Interceptor Ditch

The ditches above and around the tailings pond, connecting to the emergency spillway are intended to keep runoff water out of the tailings area, and were generally in a similar condition to that observed in previous years. Site personnel indicated that there was minimal ice excavation and cleanout required to keep the ditch flowing over the previous winter. Some evidence of toe erosion by water flow was observed, but not significant --see Photos below.

The primary concern with these ditches is over-steepening of the slopes caused by erosion at the toes of the banks – this will have to be monitored and corrective actions taken when tension cracks are observed at the access road elevation at the crest of the slope. This might normally occur during spring runoff or after large rainfall events. The corrective actions should include flattening the slopes to 1.5:1 and possible riprap placement at the toe of the slope to minimize this over-steepening.



**Photo 1:**

Interceptor ditch slopes just south of Dome Creek intersection, looking downstream. Undercut slope toes are evident between the two snow patches in about centre of photo (May 13/16)

When maintenance activities along the ditches occur, care should be taken to maintain the width of the access road to be at least 6 m in this area. The excavated material from the upstream side could be re-used as fill on the downstream side to maintain the road width.

Erosion gullies from water entering the interceptor ditch were in the same condition as previous years and should continue to be monitored. These small erosion gullies are significant contributors to sand and silt deposits in the diversion ditch. Riprap has been placed at all these gullies, as previously recommended (see Photo 2). This hasn't been entirely effective in minimizing sand migration into the ditch, but does provide some stability to the

sideslopes at these locations. A complete sand/silt barrier at these locations would require additional annual maintenance to clean out materials on the other side of the ditch, which is not considered necessary at this time.

It is understood that these sand/silt deposits have been cleaned out with a backhoe over the past year, to maintain flow in the ditches. This practice should be continued.



**Photo 2:**

Armouring to minimize sand deposition from contributory gullies into channel bottom upstream of Dome Creek intersection looking west (May 13/16)

### 2.1.2 Diversion Ditch

The diversion ditch was in an acceptable and stable condition – no work is required at this time other than regular maintenance to remove silt/sand in the spring and fall of each year, as required to maintain flow and side slope stability. Photo 3 shows the typical condition of the diversion ditch.



**Photo 3:**  
Typical condition of the Dome Creek diversion ditch looking upstream (May 13/16)

### 2.1.3 Combined Diversion Ditch and Emergency Spillway

The combined diversion ditch and emergency spillway was in an acceptable and stable condition.

The top “velocity check” immediately downstream of the vehicle crossing was previously noted as needing additional boulders in the centre of the stream, which were placed in 2015. Photo 4 shows this area. The Denison Environmental personnel asked if these could be removed in the late fall to facilitate ice removal in the winter – this is acceptable to Tetra Tech EBA provided they are replaced prior to spring freshet, and this was acknowledged by the Denison personnel.



**Photo 4:**

Velocity check just below bridge showing the addition of several large boulders (in channel at centre of photo) to maintain its effectiveness during periods of high flow – looking east (May 13/16).

Some large willows were observed at the lower end of the emergency spillway – these should be cut down and/or removed before freeze-up. Some of these willows were getting to be of a size that could collect debris and affect flow during high flow events.

## 2.2 TAILINGS DAM

The water level in the tailings pond was well below the maximum operating level elevation, was similar to last year, and lower than has been traditionally been observed in the preceding years. The dam itself is considered to be in a stable condition with a large upstream tailings beach. No evidence of previously noted instabilities or seepage on the north abutment was observed, and there were no signs of significant erosion or permafrost thaw features that could affect stability. The surface of the dam was flattened in 2014, and this has assisted in visual monitoring. Vegetation has been adequately removed from all locations noted in previous inspections.



**Photo 5:**  
View to the north along centerline of tailings dam (May 13/16)



**Photo 6:**  
Area of historical permafrost thaw settlement on downstream face, southeast edge (May 13/16)

The southeast edge of the downstream face where it abuts natural terrain has experienced permafrost thaw settlement since construction. These settlement areas were surveyed and monitored for several years in the early 2000's, but have not experience any noticeable settlement in recent years.

It is recommended that some fill be hauled, placed and compacted in these depressions – see Photo 6. Some of the depressions are marked by survey stakes and metal pins, but all are obvious and extend from near the crest down to the toe. The purpose in having this area levelled is to facilitate future observations of permafrost thaw settlement, if any.



**Photo 7:**

Low tailings pond water level – water just barely registers on the lower staff gauge (May 13/16)

The water in the pond was recorded at 0.82 m on the first installed staff gauge which corresponds to an elevation of 1095.42 m (per May 2016 elevation survey completed by YG-AAM). This places the water at about 2.38 m below the design “pond operating level” of 1097.80 m. With respect to geotechnical stability, low water levels are always preferred.

It is recommended that the elevations of the staff gauge, pond water level and top of tailings dam be surveyed twice per year (spring and fall) to confirm that seasonal frost heave is not affecting readings on the staff gauge. It is assumed that the elevations of the geodetic benchmark (BM) and top of tailings dam are stable.

### 2.3 SEEPAGE COLLECTION DAM

The water in the seepage collection pond was recorded at a level of 0.19 m on the staff gauge, and the pumping rate to keep it at this level, according to Denison personnel, was similar to previous years. This pond elevation is close to the usual operating level of the pond over the past year, and according to the onsite maintenance personnel, it is necessary to pump at varying rates over the year to keep it at about this level. The corresponding elevation for the staff gauge reading is about 1077.09 m (per June 2015 elevation survey completed by YG-AAM) or about 1.01 m below the design operating level of 1078.10 m. Photo 8 shows the downstream face of the berm at the time of the inspection.



**Photo 8:**

View of downstream face of Seepage Collection Pond berm, looking south (May 13/16).

The three minor seeps that have been noted in previous years on the downstream face of the dam were not observed during this inspection.

The other seeps flowing into the pond from the north abutment were still observed, with similar volumes of clear water flowing – this is not a cause for concern. The two seeps from the base of the riprap on the upstream side of the pond were also observed this year, similar to previous years. The seepage water was rusty coloured but free of silt, so no cause for concern.

The ground squirrel holes and burrows along the dam crest that were noted in previous years have been filled in, and it is understood that techniques used by Orkin Canada have been effective in mitigating the ground squirrel issues at this location.

All woody vegetation, including roots, has been removed from the crest of the dam and the upstream face, and within the top 5 m of the downstream face as noted in previous inspection reports.

No stability concerns are noted as a result of this pond inspection.

### 3.0 SUMMARY OF RECOMMENDATIONS

The following Table has been prepared to summarize the recommendations from the current geotechnical inspection. This table will be updated annually, with completed items being removed from subsequent versions of the Table, and the others carried forward, if still applicable.

**Table 1: Summary and Status of Recommended Maintenance and Monitoring Items from June 2016 Geotechnical Inspections**

Item Description	Maintenance	Monitoring	Status
North Interceptor, Diversion Ditch and Emergency Spillway	Cut/remove woody vegetation from lower portion of spillway – some of the willows are getting to be a size that could impact flow in the channel.	Monitor the condition of bank sideslopes on a regular basis, and if undercut/over-steepened by erosion, then either repair or provide armour consisting of non-woven geotextile and riprap.	Vegetation to be removed in 2016
Tailings Dam	Add compacted fill to downstream face of dam along southeast edge, to fill in permafrost thaw-settlements and create a flat surface to assist in future monitoring.	Continue to visually monitor permafrost thaw settlement on the downstream face near the south abutment.	Fill to be added in 2016
		Determine elevation of top of staff gauges, water level, and top of tailings dam in spring and fall of each year, relative to adjacent geodetic BM.	Spring 2016 survey completed, add fall 2016 survey
Seepage Collection Dam	No maintenance required.	Monitor seepage zones from below riprap at toe of tailings dam, from base of north terrace, and at the three previously identified locations on the downstream face of the dam. If seepage volumes significantly increase from that observed, or if water becomes silty, notify a geotechnical engineer immediately.	On-going
		Continue to record pumping rates from seepage collection pond, and notify a geotechnical engineer if the rates significantly increase to maintain a constant water pond elevation.	On-going

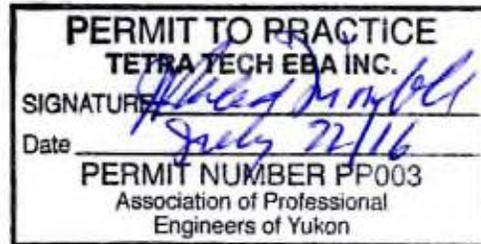
## 4.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the Government of Yukon, Energy Mines and Resources and their agents. Tetra Tech EBA Inc. 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 Government of Yukon, Energy Mines and Resources or for any Project other than the site described herein. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in the attached General Conditions.

## 5.0 CLOSURE

We trust this report meets your present requirements. The inspections reported herein are specifically related to geotechnical observations completed by the author regarding the north interceptor ditch/Dome Creek diversion/emergency spillway, tailings pond, and seepage collection pond at the time of the inspections. Should geotechnical stability issues be noted by site personnel during other routine inspections, EBA should be notified as these observations may affect the conclusions presented in this report. Should you have any questions or comments, or require any additional information, please contact the undersigned.

Sincerely,  
Tetra Tech EBA Inc.



J. Richard Trimble, P.Eng., FEC  
Principal Consultant, Arctic Region  
Direct Line: 867.668.9216  
Email: richard.trimble@tetrattech.com

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# GENERAL CONDITIONS

## GEOTECHNICAL REPORT

This report incorporates and is subject to these "General Conditions".

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### 1.0 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site, a specific development and a specific scope of work. It is not applicable to any other sites nor should it be relied upon for types of development other than that to which it refers. Any variation from the site or development would necessitate a supplementary geotechnical assessment.

This report and the recommendations contained in it are intended for the sole use of EBA's Client. EBA does not accept any responsibility for the accuracy of any of the data, the analyses or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

### 2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. EBA's instruments of professional service will be used only and exactly as submitted by EBA.

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

### 3.0 ENVIRONMENTAL AND REGULATORY ISSUES

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

### 4.0 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

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

Classification and identification of geological units are judgmental in nature as to both type and condition. EBA 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.

### 5.0 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.

### 6.0 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

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

## 7.0 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.

## 8.0 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.

## 9.0 INFLUENCE OF CONSTRUCTION ACTIVITY

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

## 10.0 OBSERVATIONS DURING CONSTRUCTION

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

## 11.0 DRAINAGE SYSTEMS

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

## 12.0 BEARING CAPACITY

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

## 13.0 SAMPLES

EBA 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.

## 14.0 INFORMATION PROVIDED TO EBA BY OTHERS

During the performance of the work and the preparation of the report, EBA may rely on information provided by persons other than the Client. While EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.