**Via Email**

FEB 24 2020

FEB 24 2020

Mr. Joseph Mackenzie
Chair
Wek'èezhìı Land and Water Board
1-4905 48 STREET
YELLOWKNIFE NT X1A 3S3

Dear Mr. Mackenzie:

**Submission of Information Request Responses for Quarry Operations Plan Versions 2.0 and 3.0**

Please find attached the Government of the Northwest Territories' Department of Infrastructure's (GNWT-INF) submission of the Information Request Responses (IRRs) for the Tłı̨chǫ All Season Road (W2016L8-0001 and W2016E0004). The IRRs pertain to the Information Request issued by the Wek'èezhìı Land and Water Board (WLWB) on February 19, 2020, for the Quarry Operations Plan Versions 2.0 and 3.0.

Attached to the IRRs are the test pit locations, borehole logs, and the relevant section (7.2) of the Laboratory Testing Program from the 2017 geotechnical report, used for testing and interpreting procedures for Pit #48. In a separate but related document, North Star Infrastructure/GNWT-INF has already submitted/shared a link to various test pit photos with the WLWB, including photos of borehole core boxes and borehole logs from the 2018 geotechnical drilling program.

Should you have any questions or concerns please contact me at (867) 767-9086 ext. 31117 or by email at Ziaur_Rahman@gov.nt.ca at your earliest convenience.

Sincerely,

Ziaur Rahman
Manager, Surface Design and Construction
Department of Infrastructure

c. Ms. Laura Duncan, Tłı̨chǫ Executive Officer
Tłı̨chǫ Government

**1. An updated 'Quarry Summary Table' that clarifies:**

**a. The status of development for each source (i.e., which sources have already been developed (partially/fully), are actively being used, and are planned to be used for the remainder of Construction). Please also identify sources that GNWT-INF no longer plans to use (if any).**

Response: *The simplified table below summarizes Project's current plan and highlights the two pits to be addressed in Version 4.0 QOP. Table also provides corrected distance to nearest watercourse for each prospect.*

| Area | Source No. | Prospect | Approximate Station NSI Alignment (km) | Distance to Nearest Watercourse (m) | Current Status / Plan |
|---|---|---|---|---|---|
| Territorial | 1 | Prospect 1000 | 0.0 | 1,100 | Not Using |
| | 2 | Prospect 1 | 1.2 | 40 | No plans to utilize at this time |
| | 3 | Prospect 2B | 4.5 | 840 | Currently active (crushing) |
| | 4 | Prospect 3 | 6.6 | 700 | Complete, reclaimed |
| | 5 | Prospect 13B | 16.8 | 675 | No plans to utilize at this time |
| | 6 | Prospect 13C | 19.5 | 695 | Currently active (partially reclaimed) |
| | 7 | Prospect 13D | 18.5 | 10 | No plans to utilize at this time |
| | 8 | Prospect 21B | 24.2 | 120 | Currently active |
| | 9 | Prospect 29 | 31.0 | 1,100 | No plans to utilize at this time |
| | 10 | Prospect 32B | 35.2 | 430 | Not using |
| | 11 | Prospect 33A | 36.7 | 680 | Currently active (partially reclaimed) |
| | 12 | Prospect 48 | 53.2 | 20 | Awaiting WLWB approval V 3.0 (Feb 27th) |
| | 13 | Prospect 1001 | 59.4 | 225 | Not using |
| | 14 | Prospect 68A | 64.0 | 65 | Test pits required (include in v 4.0 QOP) |
| | 15 | Prospect 69 | 64.3 | 893 | Will utilize |
| | 16 | Prospect 76 | 69.0 | 170 | Will utilize |
| TLICHO | 17 | Prospect 86 | 76.3 | 745 | Will utilize |
| | 18 | Prospect 98 | 83.0 | 130 | Will utilize |
| | 19 | Prospect 105 | 89.0 | 585 | Will utilize |
| | 20 | Prospect 109 | 92.7 | 80 | Test pits required (include in v 4.0 QOP) |

**b. The 'Quarry Summary Table' identifies that Prospects 1000, 32B, 1001, and 109 still require geochemical verification (i.e., as per the column 'Geochemical Analysis Completed', these pits still require data). The approved QOP (Version 1.1) states on page 2-18 that material that has been "cleared through a geochemical verification process will be utilized for the road surface to avoid moderate to high ARD or ML." It is not clear as to**

**whether or not these Pits have been used already or are planned to be used in the future, and whether the required geochemical verification has, or will be, undertaken.**

Response: – *Please see the simplified summary table above. As stated in previous email correspondence, Pits 1000, 32B and 1001 are not required for the project. Also as described in previous emails, Pit 109 will be utilized and the required information (AOA/AIA and ARD/ML) will be provided in Version 4.0 QOP.*

**c. No geochemical data is available yet for Pit 68A. Board staff note that the 'Quarry Summary Table' also states that data is already included for Pit 68A, even though Section 2.15 of the QOP states that this information will be provided at a later date. Please confirm and update the 'Quarry Summary Table' to reflect whether geochemical analysis and verification is already available or will be required and expected in the future.**

Response: – *The table included in Version 3.0 has an error; Pit 68A is cleared for AOA/AI, however ARD/ML is not complete, per earlier email correspondence, V 4.0 QOP will contain ARD/ML data for Pit 68A. The Quarry Summary Table will be adjusted/revised in Version 4.0 QOP.*

**d. Board staff note that Tetra Tech's technical memo for Pit 48 states that GNWT-INF plans to only use 'surficial material' but the 'Quarry Summary Table' indicates that both granular and bedrock material will be used. Please confirm whether granular and/or bedrock material will be used for the development of Pit 48 and whether the surficial materials are composed of colluvium or till.**

Response: – *According to the latest information provided in the Tetra Tech memo, bedrock in Pit 48 had one sample that was considered PAG, therefore bedrock will not be disturbed/extracted and utilized for the Project. Only surficial material (coarse sand, cobbles and weathered materials) are to be used for roadway embankment. Test pit photos and borehole logs have been provided to help describe surficial material at Pit 48.*

**e. Board staff note that in the 'Quarry Summary Table', there are only 16 values in the column 'Distance to Nearest Watercourse' for 21 sources included in the Table. Please identify and include the distances to the nearest waterbody/watercourse for each source.**

Response: – *The table has been reformatted to ensure watercourses are properly aligned with respective pits/quarries. Please see simplified table above with corrected distance to the nearest watercourse for each prospect. Also, there are 20 prospects in the table, pit 116 was deemed unsuitable (PAG) and has been removed from previous version of the QOP. The Quarry Summary Table will be adjusted/revised in Version 4.0 QOP.*

**2. Confirmation of whether there are plans, and whether there is potential, to further develop Pit 2B, Pit 3, and Pit 21B.**

Response: – *Pit 3 has been reclaimed, so no additional materials will be extracted. At this time there are no plans to further develop Pit 2B (however if this changes, additional AOA/AIA may be required). Aggregate processing of blasted rock in Pit 2B will resume in March 2020. Pit 21B is still active, with plans to extract additional materials (within the approved/cleared AOA/AIA areas) for roadway embankment.*

**3. For Pits 48 and 105:**

**a. Updated quarry maps to include locations of test pit/boreholes;**

Response: - *please clarify why this detail is required. Test pits and/or borehole locations are not shown on any maps for any other pits/quarries in the approved QOP (Version 1.1). Pit 48 test pit locations and borehole locations have been provided in a separate map.. Also, test pit locations for Pit 105 can be found in the Tłı̨chǫ All Season Road (TASR) 2017 Geotechnical Investigation of Granular & Bedrock Prospects (submitted by INF to WLWB in 2017 with application docs).*

**b. Descriptions on the locations, methodology, and other details that demonstrate how representative samples were generated from test pits and boreholes (e.g., compositing, homogenizing, etc.); and**

Response: – *For Pit 48, test pits were developed using a 30 ton excavator, samples collected in bags and transported to lab. Boreholes in Pit 48 were performed using a heli-portable hydraulic drill rig, with samples collected and stored in drill core boxes and then transported to lab. Pit 105 sampling methodology details can be found in the Tłı̨chǫ All Season Road (TASR) 2017 Geotechnical Investigation of Granular & Bedrock Prospects (submitted by INF to WLWB in 2017 with application docs).*

**c. Description of what threshold values were used for identifying low, moderate and high metal leaching potential**

Response: – *The target thresholds used to determine ML potential for Pit 48 are the same as those used for all previously approved pits/quarries contained within the approved QOP (Version 1.1). The laboratory (ALS) and consultant (Tetra Tech) used for initial 13 pits/quarries were utilized for Pit 48 to ensure consistency in sampling and in the interpretation of results. Please see Section 7.2 within the Tłı̨chǫ All Season Road (TASR) 2017 Geotechnical Investigation of Granular & Bedrock Prospects (submitted by INF to WLWB in 2017 with application docs) for details related to Pit 105 ML thresholds. Section 7.2 Laboratory Testing Program from the 2017 geotechnical report, also used for Pit 48 testing and interpretation procedures, has been provided.*

**4. In the QOP, GNWT states that for new sources, "additional testing typically includes tests after every 100,000 m3 of material withdrawn from each source." All verification sampling data to date, and a proposed method for the provision of this data to the Board moving forward.**

Response: - *Additional ARD/ML testing will be performed after every 100,000 m3 of material withdrawn from each source. To date, none of the developed/active pits have exceeded 100,000 m3. If future prospects exceed the 100,000 m3 threshold, ARD/ML reports for the additional testing will be submitted to WLWB for review.*

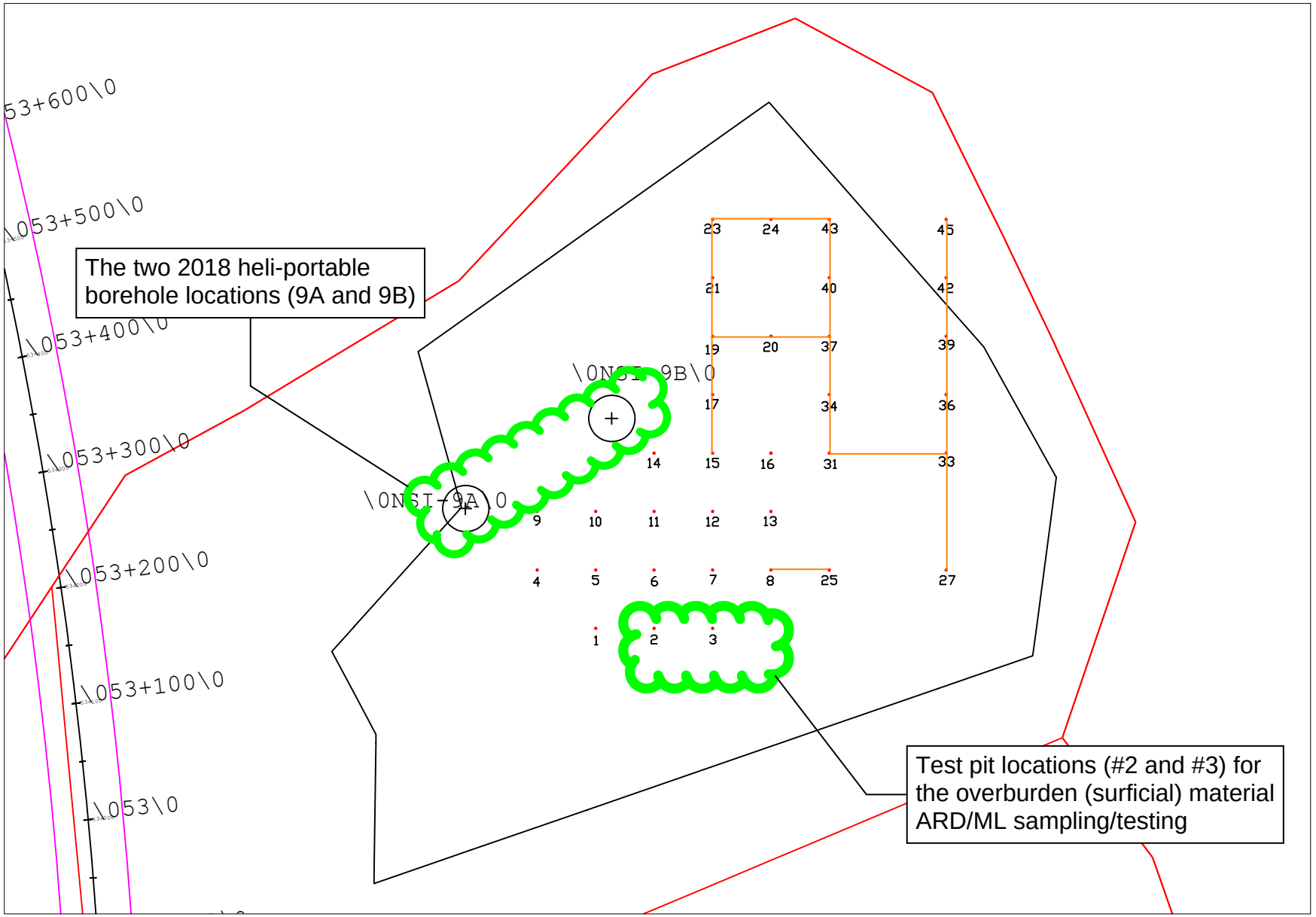
**5. Description of any post-construction/development monitoring, confirmatory sampling, or geological inspections by GNWT-INF to assess any changes in geological or geochemical characteristics of the road or quarry pits.**

Response: – *No PAG (ARD/ML) material will be extracted from any of the prospects and utilized for the Project therefore post-construction monitoring, confirmatory sampling and/or geological inspections of the road or prospects is not anticipated.*

6. **The QOP indicates that a site-specific Quarry Operations Plan will be submitted for each quarry, to document risks associated with drainage and leaching. Please confirm if this reference was intended to refer to the Quarry Development Plan required by the GNWT-Lands, and if not, when these site-specific plans would be expected.**

   Response: – *this is in reference to Quarry Development Plans (QDP) required by GNWT-Lands. Individual QDPs for each pit/quarry are submitted to Lands Inspector for review and approval prior to commencing pit/quarry development.*

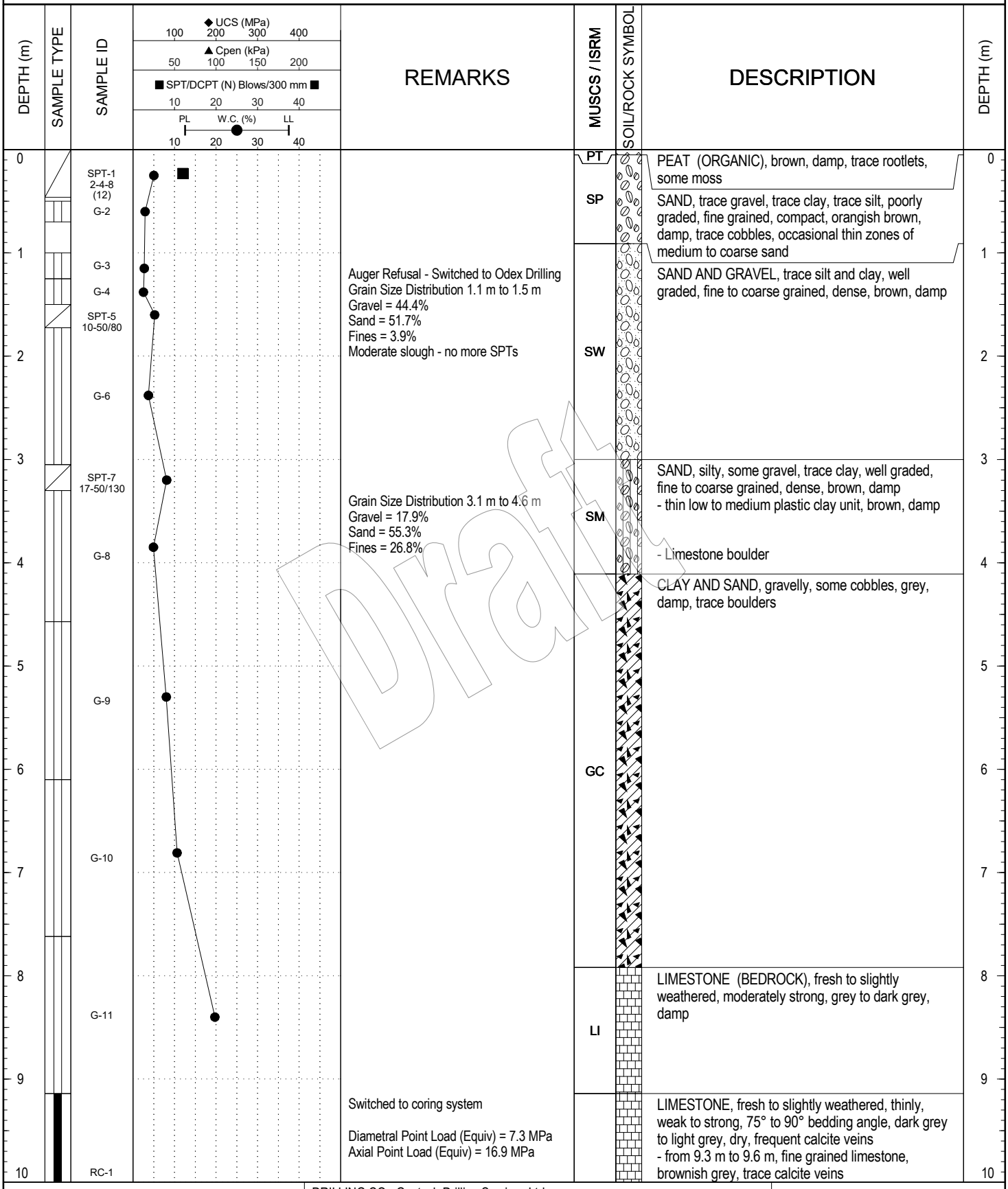
# Pit 48 - Borehole and Test Pit Locations - ARD/ML Testing



| CLIENT: Kiewit | PROJECT: Tlicho All Season Road Geotechnical Investigation | TEST HOLE NO: **NSI-9A** |
|---|---|---|
| PROJECT NO: 18145 | UTM 13 NAD 83, Northing: 6967607 m, Easting: 508595 m | ELEVATION: |

SAMPLE TYPE: Standard Penetration Test | Grab Sample | Rock Core

BACKFILL TYPE:



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| DRILLING CO.: Geotech Drilling Services Ltd. | | |
|---|---|---|
| RIG TYPE: Heli Wet Rotary | COMPILED BY: | COMPLETION DEPTH: 12.2 m |
| DRILL METHOD: ODEX/Coring | REVIEWED BY: SAP | COMPLETION DATE: 8/29/2018 |
| INSPECTOR: CNH | | Page 1 of 2 |

| CLIENT: Kiewit | PROJECT: Tlicho All Season Road Geotechnical Investigation | TEST HOLE NO: **NSI-9A** |
|---|---|---|
| PROJECT NO: 18145 | UTM 13 NAD 83, Northing: 6967607 m, Easting: 508595 m | ELEVATION: |

SAMPLE TYPE: Standard Penetration Test | Grab Sample | Rock Core

BACKFILL TYPE:

| DEPTH (m) | SAMPLE TYPE | SAMPLE ID | ◆ UCS (MPa) 100 200 300 400 / ▲ Cpen (kPa) 50 100 150 200 / ■ SPT/DCPT (N) Blows/300 mm ■ 10 20 30 40 / PL W.C. (%) LL 10 20 30 40 | REMARKS | MUSCS / ISRM | SOIL/ROCK SYMBOL | DESCRIPTION | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|
| 10 | | REC = 82%<br>RQD = 18%<br>SCR = 58%<br>FI = 26 | | Diametral Point Load (Equiv) = 6.5 MPa<br>Axial Point Load (Equiv) = 15.3 MPa | LI | | | 10 |
| 11 | | | ◆ | Diametral Point Load (Equiv) = 31.9 MPa<br>Axial Point Load (Equiv) = 55.5 MPa | | | - majority of fractures are between 11.2 m and 11.6 m. Typically 70°-90°, irregular, rough to smooth | 11 |
| 12 | | RC-2<br>REC = 92%<br>RQD = 60%<br>SCR = 75%<br>FI = 17 | ◆ | | | | END OF HOLE at 12.2 m<br>- no seepage<br>- moderate slough<br>- backfilled with bentonite chips<br>- bentonite seal at surface | 12 |
| 13 | | | | | | | | 13 |
| 14 | | | | | | | | 14 |
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| DRILLING CO.: Geotech Drilling Services Ltd. | | |
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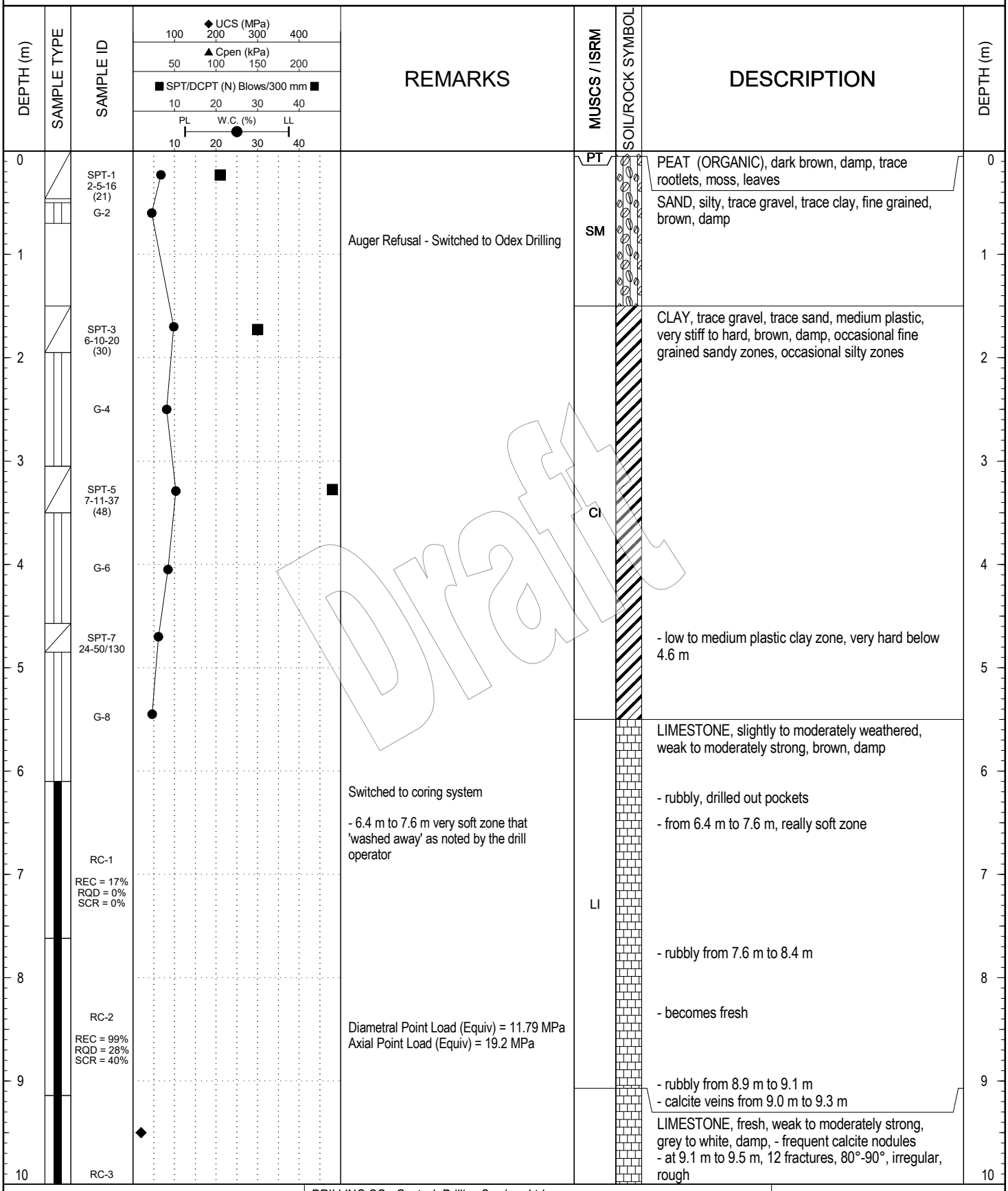
| RIG TYPE: Heli Wet Rotary | COMPILED BY: | COMPLETION DEPTH: 12.2 m |
| DRILL METHOD: ODEX/Coring | REVIEWED BY: SAP | COMPLETION DATE: 8/29/2018 |
| INSPECTOR: CNH | | Page 2 of 2 |

| CLIENT: Kiewit | PROJECT: Tlicho All Season Road Geotechnical Investigation | TEST HOLE NO: **NSI-9B** |
|---|---|---|
| PROJECT NO: 18145 | UTM 13 NAD 83, Northing: 6967674 m, Easting: 508727 m | ELEVATION: |

SAMPLE TYPE: Standard Penetration Test | Grab Sample | Rock Core

BACKFILL TYPE:



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| DRILLING CO.: Geotech Drilling Services Ltd. | | |
|---|---|---|
| RIG TYPE: Heli Wet Rotary | COMPILED BY: | COMPLETION DEPTH: 13.0 m |
| DRILL METHOD: ODEX/Coring | REVIEWED BY: SAP | COMPLETION DATE: 8/30/2018 |
| INSPECTOR: CNH | | Page 1 of 2 |

| CLIENT: Kiewit | PROJECT: Tlicho All Season Road Geotechnical Investigation | TEST HOLE NO: **NSI-9B** |
|---|---|---|
| PROJECT NO: 18145 | UTM 13 NAD 83, Northing: 6967674 m, Easting: 508727 m | ELEVATION: |

SAMPLE TYPE: Standard Penetration Test | Grab Sample | Rock Core

BACKFILL TYPE:

| DEPTH (m) | SAMPLE TYPE | SAMPLE ID | ◆ UCS (MPa) 100 200 300 400 / ▲ Cpen (kPa) 50 100 150 200 / ■ SPT/DCPT (N) Blows/300 mm ■ 10 20 30 40 / PL W.C. (%) LL 10 20 30 40 | REMARKS | MUSCS / ISRM | SOIL/ROCK SYMBOL | DESCRIPTION | DEPTH (m) |
|---|---|---|---|---|---|---|---|---|
| 10 | | REC = 99%<br>RQD = 52%<br>SCR = 79%<br>FI = 29 | | Diametral Point Load (Equiv) = 12.2 MPa<br>Axial Point Load (Equiv) = 26.2 MPa | | | - at 9.5 m to 10.1 m, 7 fractures, 80°-90°, irregular, rough<br>- at 10.3 m to 10.7 m, 10 fractures, 70°-90°, irregular, rough | 10 |
| 11 | | RC-4<br>REC = 100%<br>RQD = 72%<br>SCR = 80%<br>FI = 6 | ◆ | | LI | | - at 10.9 m, 25 mm thick rubbly zone infilled w/ clay gauge<br>- at 11.1 thin fractured zone, rubbly with clay gauge<br>- at 11.4 m, 75 mm rubbly zone infilled with grey clay gauge<br>- at 11.6 m to 11.9 m, rubbly zone<br>- at 11.9 m fracture, 70°-90°, irregular, rough<br>- at 12.0 m fracture, 50°-90°, irregular, rough<br>- at 12.3 m fracture, 85°, irregular, rough | 11 |
| 12 | | RC-5<br>REC = 97%<br>RQD = 57%<br>SCR = 80%<br>FI = 4 | ◆ | Diametral Point Load (Equiv) = 18.4 MPa<br>Axial Point Load (Equiv) = 7.1 MPa | | | - at 12.6 m fracture, 80°-90°, irregular, rough<br>- at 12.7 m fracture, 80°-90°, irregular, rough<br>- at 12.8 m fracture, 80°-90°, irregular, rough<br>END OF HOLE at 13.0 m<br>- no seepage<br>- moderate slough<br>- backfilled with bentonite chips<br>- bentonite seal at surface | 12 |
| 13 | | | | | | | | 13 |
| 14 | | | | | | | | 14 |
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| DRILLING CO.: Geotech Drilling Services Ltd. | | |
|---|---|---|
| RIG TYPE: Heli Wet Rotary | COMPILED BY: | COMPLETION DEPTH: 13.0 m |
| DRILL METHOD: ODEX/Coring | REVIEWED BY: SAP | COMPLETION DATE: 8/30/2018 |
| INSPECTOR: CNH | | Page 2 of 2 |

Recovered drill core was placed in wooden core boxes and immediately logged during drilling. Coring depths were recorded and verified by the Tetra Tech representative in communication with the drilling crew. Rock core logging included measurements to determine total core recovery, rock quality expressed as RQD; rock strength as per the ISRM standard, and weathering/alteration grading. The logging also identified various discontinuities in the core including joints, bedding, and faults and recorded their orientation, joint conditions and depths. Lithology and geological parameters was described with depth in each core run, and field logs included a comments section to note additional geological and geotechnical features, and drilling observations including water return and run blocking.

During the borehole logging, notes were made of parameters relevant to the ML/ARD geochemical characterization, including visible sulphide and carbonate occurrences and the presence of weathering and alteration variabilities.

Each core box was labelled with the borehole ID, start and end depths for the box, project ID, and core box number. Photographs were taken of the recovered core in the core boxes. A wet and dry photograph of the core was taken. Core photographs are provided in the Photographs section.

Notes were made during core logging regarding potential sampling locations for the laboratory test programs. Samples for ML/ARD geochemical characterization were collected from the core boxes after the photographs were taken. A record of the sampling location was recorded in the core box. Sample intervals for laboratory index and material testing were recorded. Samples for this testing were sent in the core boxes to the laboratory. Pieces of representative material from the sampling intervals were retained in the core boxes as a supplement to core photos as a record of the recovered bedrock material.

## 7.2 Laboratory Testing Program

### 7.2.1 Index and Materials Testing

Laboratory index and materials testing was completed by Tetra Tech at the Yellowknife and Edmonton laboratories. Granular material samples were analysed for soil classification and determination of relevant engineering properties to gauge their suitability for use in highway construction as granular fill and aggregate. Additional testing on select samples included resistance of aggregates to abrasion (Los Angeles Abrasion testing), petrographic analysis as well as fracture face counts and determination of flat and elongated particles on a 20 mm laboratory crush. The petrographic analyses were performed in accordance with Canadian Standards Association (CSA) A23.2-15A, petrographic examination of aggregates.

The granular material laboratory index testing and petrographic results are presented in Appendix C1 and C3.

### 7.2.2 Geochemical Characterization Testing

Geochemical characterization analysis was completed for all prospect materials, including both granular fill and bedrock material, to identify metal leaching (ML) and acid rock drainage (ARD) potential of the materials. Geochemical testing for metal leaching and acid rock drainage potential was completed by ALS Laboratories in the North Vancouver, BC and Burnaby, BC labs, with support from the Yellowknife ALS lab to prepare samples.

Geochemical characterization methods, including sample collection, analysis, interpretation and classification follow the best practise guidelines presented in the Mine Environment Neutral Drainage (MEND) Program's *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials, MEND Report 1.20.1* (Price, 2009).

The risks associated with ML/ARD will depend on the final excavated and placed material volumes, construction uses, and location of placement. Larger volumes of disturbed rock materials may translate to increased metal loading. The risks to aquatic life associated with metal leaching and acid rock drainage are increased when the disturbed rock materials are placed proximal to surface water receptors. ML/ARD risks can be mitigated by placing construction materials sub-aqueously to limit the reactions and weathering which produce ML/ARD.

#### 7.2.2.1 Sample Collection Methods and Sample Numbers

Bedrock samples for geochemical characterization were collected from fresh drill core during the core drilling program. Granular material samples for geochemical characterization were selected from materials testing intervals selected from the testpit program.

Samples were selected to be representative of the materials encountered in the boreholes and testpits, and were selected to provide a good spatial variability of the material encountered.

The number of samples collected for each prospect area was determined based on site specific observations with respect to material variability, including mineralogy, weathering and alteration, and in consideration of expected material excavation volumes. The sample numbers were reduced from the proposed scope of work due to observations of material homogeneity, and a low potential for ML/ARD based on visual observations of high carbonate content, low sulphide content, and limited accessory mineral content in the encountered materials.

#### 7.2.2.2 Analysis Program Methods

The samples were submitted to ALS Laboratories for a suite of four static geochemical characterization analyses. Details of the testing methods and purpose of the analysis are provided in the proceeding sections.

- Whole Rock Analysis by X-Ray Fluorescence (XRF)
- Acid-Base Accounting (ABA) Analysis
- Trace Element Analysis by ICP-MS
- Shake Flask Extraction (SFE) Analysis

A brief summary of general findings is provided in the proceeding sections, with complete data presentation and prospect specific results presented in Section 8.0.

The geochemistry testing laboratory certificates are presented in Appendix D1. Lab data summary tables, along with comparison criteria and data statistics, are presented in Appendix D2.

##### Whole Rock Analysis by Lithium Borate Fusion and XRF

The nature of lithophile elements and the matrices in which they occur require fusion methods for complete dissolution. The samples are prepared using lithium borate fusion and then run on the X-Ray Fluorescence (XRF) machine to provide oxide percentages for the whole rock composition.

The CaO and MgO percentages are normalized to calcite and dolomite proportions, and remaining element oxides normalized to the impurities proportion. Normalized concentrations are plotted on a carbonate ternary plot diagram to determine rock classification and to visualize the compositional variability of the materials within a prospect area and relative to other prospect areas.

**General observations:**

- Bedrock samples are plotted in the lower zone of the ternary diagram with less than 20% impurities, and variable calcite and dolomite compositions. The granular samples generally plot in the upper zone of the diagram with greater than 60% impurities.

##### Acid-Base Accounting (ABA) Analysis

Acid-Base Accounting (ABA) analysis was conducted to assess the potential for ARD to be produced from the sampled rock. ABA analysis includes whole rock paste pH, total sulphur and carbonate carbon (CO2) by LECO furnace analysis, sulphate sulphur by HCl leach, neutralization potential (NP) by Standard Sobek method, and fizz rating. The sulphide sulphur is calculated by subtracting the measured sulphate sulphur from the measured total

sulphur. Total sulphur is used to calculate the maximum potential acidity (MPA). The net neutralization potential (NNP) is determined by subtracting the AP from the Sobek NP (NNP = Sobek NP – AP). The Sobek neutralization potential ratio (Sobek NPR) is the ratio of neutralization potential to the maximum potential acidity (Sobek NP:MPA). Carbonate NP is calculated from carbonate carbon (CO2%) and used to calculate a carbonate NPR value (Carbonate NP:AP).

The NPR value is used for material classification in accordance with the MEND Guidelines (Price, 2009). The guidelines state that a sample with a NPR value of less than one is classified as potentially acid generating (PAG) and as non-acid generating (NAG) if the NPR is greater than two. Material characterized by an NPR of between one and two is classified as "Uncertain", and requires additional information to determine the acid rock drainage potential.

### General observations:

- All samples analyzed are classified as non-acid generating (NAG).
- Total sulphur is low and variable in the bedrock samples. Total sulphur is uniformly low in the granular materials. The sulphur balance indicates that sulphide sulphur is the dominant form.
- The Carbonate NP tracks well across the majority of samples with the Sobek NP and indicates that the primary form of neutralization potential in the encountered materials is from carbonate sources.

## Trace Element Analysis by ICP-MS

The results of the trace elemental analysis on bedrock samples were compared against average crustal abundance values for "Sedimentary rocks – Carbonates" (Price, 1997). The results of the trace elemental analysis on granular material samples were compared against average crustal abundance values in earth's crust for all material types (Multiple sources, https://en.wikipedia.org/wiki/Abundance_of_elements_in_Earth's_crust). Elemental concentrations exceeding the respective average crustal abundance values by greater than an order of magnitude are flagged for further consideration.

### General observations:

- Trace element concentrations are low, and typically fall within an order of magnitude within the respective average crustal abundance comparison values.
- Selenium concentrations in all bedrock samples and the majority of granular material samples are greater than the average crustal abundance value by greater than order of magnitude. This is a function of the limitation of testing and not highlighted as an elevated concentration.
- Cobalt concentrations in a majority of bedrock samples are greater than the average crustal abundance value by greater than an order of magnitude. Bismuth concentrations in a majority of granular material samples are greater than the average crustal abundance value by greater than an order of magnitude. These observations are commonly noted across multiple geologic regions, and appear to be a function of a low average crustal abundance rather than an identification of elevated concentrations in the analyzed samples.

## Shake Flask Extraction (SFE) Analysis

The Shake Flask Extraction (SFE) analysis is a short term leachate analysis method used to determine the dissolved parameters of readily soluble components in the rock samples. The test is completed using a 100 g sample of minus 6.35 mm mixed with 300 ml of de-ionized water of known chemical composition. This represents a 3:1 water to solids ratio by weight. The sample is gently agitated on a shake table or gyrator shaker for 24 hours to ensure continuous exposure of all surfaces and mixing of the rinse solution. The resulting supernatant water is submitted for multi-element chemical analysis by ICP-MS.

The results of the SFE analysis were compared against the CCME freshwater aquatic life guidelines (CCME, 2017) and the BC Ministry of the Environment approved water quality (BCAWQ) guidelines (BC MEM, 2017) as a reference points for dissolved concentrations in the leachate from the test samples. Elevated concentrations of dissolved metals in the SFE analysis do not necessarily result in elevated constituents in a field setting; however it can be used to identify which leachable constituents may be of future concern. This test work and analysis does not take into account the receiving water chemistry, dilution volumes or long term metal dissolution for evaluating the impact of metal leaching potential on surface water receptors.

**General observations:**

- Trace element concentrations are low and typically fall within an order of magnitude the guideline values.

## 7.3 Geophysical Program

Geophysical data was collected at six prospect sites. Table 7-1 lists the sites surveyed along with the type and quantity of geophysical data collected.

**Table 7-1: Geophysical Survey Locations along TASR Alignment**

| Prospect ID | Prospect Type | Kilometer Mark | Geophysical Data Collected | Approximate Quantity Collected, (linear meters) | Figure Number |
|---|---|---|---|---|---|
| Prospect 33A | Bedrock | 36+700 | GPR | 3330 | 9 |
| Prospect 68A | Granular | 63+700 | GPR | 1210 | 10 |
| Prospect 69 | Granular | 64+500 | GPR | 1130 | 10 |
| Prospect 76 | Granular | 69+000 | GPR | 1400 | 11 |
| Prospect 86 | Bedrock | 76+500 | GPR | 800 | 12 |
| Prospect 98 | Granular | 83+000 | GPR and OhmMapper | 1230 (GPR) / 680 (OhmMapper) | 13 |

The Geophysical program was generally focused on sites with more difficult access requiring helicopter support. At these sites testpitting using an excavator was not possible and practical operational and mobility issues with the heli portable drill limited both the number of drill holes achievable as well as the possible drill depth in coarser material.

At granular sites, the intent was to collect geophysical profiles that provided interpreted stratigraphic cross sections tying collected borehole information together as well as providing qualitative information on the variability of the granular resource, quality and quantitative information on the depth and nature of the underlying lithological contact.

OhmMapper data was collected at site P98 to provide additional insight into the granular material data quality, variability and potential presence of permafrost soils based on measured resistivity values. It also served to back check the granular deposit thickness by providing a second source of information to compare with the GPR data interpretation.

At the bedrock sites, the primary interest was confirming the rock type, rock quality, overburden thickness and the variation of the bedrock surface between borehole locations.

Where additional information has been inferred from the geophysical data, such as significant granular material at bedrock sites, or the presence of likely frozen material, this has been noted.

### 7.3.1 Geophysical Equipment

Two different geophysical instruments were used:

- A Ground Penetrating Radar (GPR). Malå CuII System, using 100 MHz Rough Terrain Antennas (RTA); and,
- A Capacitively Coupled Resistivity (CCR) System (Geometrics TR5 OhmMapper);