



July 10, 2018

## FOUNDATION INVESTIGATION REPORT

**REPLACEMENT OF JACKPINE CREEK CULVERT - SITE NO. 46-577/C  
HIGHWAY 101, PINOGAMI TOWNSHIP, ONTARIO  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 5266-13-00, WP 5219-13-01**

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REPORT





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# **PART A**

**FOUNDATION INVESTIGATION REPORT  
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## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by LEA Consulting Ltd. (LEA) on behalf of the Ministry of Transportation, Ontario (MTO) to provide detail foundation engineering services for the rehabilitation of the Jackpine Creek Culvert (Site No. 46-577/C), located on Highway 101, 29 km West of Foleyet in Pinogami Township, Ontario. The key plan showing the general location of this section of Highway 101 and the location of the investigated area are shown on Drawing 1.

The purpose of this investigation is to establish the subsurface soil conditions at the existing culvert location by borehole drilling and laboratory testing on selected soil and samples.

The Terms of Reference and Scope of Work for the Foundation Investigation are outlined in MTO's Request for Proposal dated April, 2016. Golder's proposal for foundation engineering services associated with replacement of this structure is contained in Section 17.8 of LEA's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundations engineering services for this project, dated January 11, 2017.

## **2.0 SITE DESCRIPTION**

The existing Jackpine Creek Culvert consists of a 27 m long, 3.4 m diameter corrugated steel pipe. The approximate invert of the culvert is Elevation 364 m and the embankment thickness / depth of cover on the culvert is about 1.9 m. In general, the topography at the culvert site is relatively flat, the ground surface being covered/vegetated with grass, shrubs and trees. The existing highway grade is at Elevation 369 m and the water level in the creek was measured at the culvert site by Golder at Elevation 365.3 m in September 2017.

Photographs at the culvert area are shown on Photographs 1 to 4, following the text of this report.

## **3.0 INVESTIGATION PROCEDURES**

The field work was carried out between September 25 and September 28, 2017, during which time six boreholes (JP-1 to JP-6) were advanced at the locations shown on Drawing 1. The borehole and drillhole records are presented in Appendix A. The field investigation was carried out using the following drilling equipment:

- Boreholes JP-1 and JP-3 to JP-6 were advanced using a CME-55 track-mounted drill rig supplied and operated by Downing Drilling Inc. (Downing) of Grenville-sur-la-Rouge, Quebec.
- Borehole JP-2 was advanced using a portable tripod drill rig supplied and operated by Downing.

The boreholes were advanced using 76 mm inside diameter hollow-stem augers and/or NW casing with wash boring. Soil samples were obtained in the boreholes at 0.75 m and 1.5 m intervals of depth using 50 mm outer diameter split-spoon samplers driven by an automatic hammer on the CME-55 drill rig and a manual half-weight hammer (Acker) on the portable drill rig, in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). The 'N'-values obtained using the half weight hammer were corrected to those that would have been obtained by a full weight hammer. The groundwater level in the open boreholes was observed during and immediately following the drilling operations as described on the Record of Borehole sheets in Appendix A. The boreholes were backfilled upon completion in accordance with Ontario Regulation 903 Wells (as amended).



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The field work was supervised on a full-time basis by a member of Golder's staff, who located the boreholes in the field, cleared the site for buried services, directed the drilling and sampling operations and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder's Sudbury Laboratory for further examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Index and classification tests consisting of water content, Atterberg limits and grain size distribution were carried out on selected soil samples. The results of the laboratory testing on samples from the boreholes are presented on the borehole records in Appendix A, and on the figures in Appendix B.

A soil sample was obtained on September 25, 2017, in Borehole JP-4, using appropriate sampling protocols and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of parameters including pH, resistivity, conductivity, sulphates and chlorides. The results of the analytical testing are summarized in Table B1 included in Appendix B.

The borehole locations and elevations were measured in the field by Golder personnel, relative to existing site features and surveyed to point HCP-100. The borehole locations (referenced to the MTM NAD83 co-ordinate system), ground surface elevations (referenced to Geodetic datum) and borehole depths are presented on the borehole records in Appendix A and are summarized below.

| Borehole | Location<br>(MTM NAD 83, Zone13) |          | Location<br>(World Geodetic System 84) |            | Ground<br>Surface<br>Elevation<br>(m) | Borehole<br>(DCPT)<br>Depth<br>(m) |
|----------|----------------------------------|----------|--|------------|---------------------------------------|------------------------------------|
|          | Northing                         | Easting  | Latitude                               | Longitude  |                                       |                                    |
| JP-1     | 5326504.2                        | 401004.4 | 48.070175                              | -82.708943 | 367.1                                 | 11.3                               |
| JP -2    | 5326517.8                        | 401004.6 | 48.070297                              | -82.708937 | 365.4                                 | 7.6                                |
| JP -3    | 5326498.8                        | 401011.4 | 48.070125                              | -82.708850 | 369.0                                 | 15.8                               |
| JP -4    | 5326512.1                        | 401019.2 | 48.070243                              | -82.708742 | 369.0                                 | 15.5                               |
| JP -5    | 5326503.4                        | 401028.2 | 48.070164                              | -82.708624 | 365.9                                 | 9.8                                |
| JP -6    | 5326513.3                        | 401028.1 | 48.070253                              | -82.708623 | 365.6                                 | 9.4                                |

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain (NOEGTS)<sup>1</sup> mapping, the Jackpine Creek Site is located within organic terrain consisting primarily of peat and muck bordered to the north by a ground moraine deposit consisting primarily of sandy till materials and to the south by bedrock knobs.

Based on geological mapping by the Ontario Ministry of Northern Development and Mines (MNDM)<sup>2</sup>, the site is underlain by gneissic tonalite bedrock.

### 4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are presented on the borehole records in Appendix A

1 Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41JNW  
2 Ontario Ministry of Northern Development and Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2543



and the laboratory test sheets in Appendix B. The results of the in-situ field tests (i.e., SPT 'N'-values) as presented on the borehole records and in Section 4 are uncorrected, except for those obtained by use of the half weight hammer as noted in Section 3.0. The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic profile and cross-section on Drawings 1 and 2 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations. A summary of the subsurface conditions as encountered in Boreholes JP-1 to JP-6 is presented below.

### 4.2.1 Subsoil Conditions

A description of the soil deposits encountered in the boreholes is provided below.

| Deposit/Layer Description                     | Boreholes              | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows)                | Laboratory Testing                       |
|---|------------------------|-----------------------|-------------------------------|---------------------------------|--|
|   |                        |                       |                               | Field Vane Results (kPa)        |  |
|   |                        |                       |                               | Consistency or Relative Density |  |
| Asphalt                                       | JP-3, JP-4             | 0.23 – 0.25           | 369.0                         | n/a                             | n/a                                      |
| (FILL) Sand; Gravelly Sand to Sand and Gravel | JP-1, JP-3, JP-4       | 1.5 – 5.8             | 368.8 – 367.1                 | N = 6 – 47                      | w = 4% – 11%<br>3 – M (Fig. B1)          |
|   |                        |                       |                               | n/a                             |  |
|   |                        |                       |                               | Very loose to Dense             |  |
| Wood (Fill)                                   | JP-6                   | 0.7                   | 363.3                         | N = 3                           | n/a                                      |
|   |                        |                       |                               | n/a                             |  |
|   |                        |                       |                               | n/a                             |  |
| Peat (Amorphous/Fibrous)                      | JP-1 to JP-3, and JP-5 | 0.1 – 2.2             | 365.9 – 365.4                 | N = 1 – 6                       | w = 135%                                 |
|   |                        |                       |                               | n/a                             |  |
|   |                        |                       |                               | Very soft to firm               |  |
| Organic Sand; Organic Silt                    | JP-2 and JP-3          | 0.7 – 1.0             | 366.4 – 363.9                 | N = 4 – 12                      | n/a                                      |
|   |                        |                       |                               | n/a                             |  |
|   |                        |                       |                               | Very loose to compact           |  |
| Silt and Sand                                 | JP-3                   | 2.4                   | 365.3                         | N = 5 – 8                       | w = 18%<br>1 – MH (Fig. B2)<br>OC = 3.4% |
|   |                        |                       |                               | n/a                             |  |
|   |                        |                       |                               | Loose                           |  |



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| Deposit/Layer Description   | Boreholes             | Deposit Thickness (m)                            | Deposit Surface Elevation (m) | N Values (blows)                | Laboratory Testing  |
|---|-----------------------|--|-------------------------------|---------------------------------|---|
|   |                       |  |                               | Field Vane Results (kPa)        |   |
|   |                       |  |                               | Consistency or Relative Density |   |
| Sand  | JP-1, JP-2 and JP-5   | 0.8 – 1.5  | 363.8 – 363.2                 | N = 2 – 20                      | w = 11% – 39%<br>2 – MH (Fig. B3)<br>OC= 2.6%   |
|   |                       |  |                               | n/a                             |   |
|   |                       |  |                               | Very loose to compact           |   |
| Silt  | JP-1 to JP-6          | 4.6 – 7.0  | 362.9 – 361.9                 | N = 4 - 38                      | w = 19% – 27%<br>9 – MH (Fig. B4)<br>1 – AL (NP)<br>1 – AL (Fig B5.)<br>w <sub>l</sub> = 22%<br>w <sub>p</sub> = 16%<br>I <sub>p</sub> = 6% |
|   |                       |  |                               | n/a                             |   |
|   |                       |  |                               | Very loose to dense             |   |
| Boulder(s)  | JP-1 and JP-6         | 0.4 and 0.3                                      | 357.1 and 356.8               | -                               | -   |
| (TILL) Silty Sand; Silt and Sand; Sandy Silt; Silty Sand and Gravel <sup>1</sup> , trace clay | JP-1 and JP-3 to JP-6 | >0.3–>3.6 (Boreholes terminated in this deposit) | 357.2 – 355.5                 | N = 61 – 121;102/0.15           | w = 11% – 14%<br>2 – MH (Fig. B6)   |
|   |                       |  |                               | n/a                             |   |
|   |                       |  |                               | Very dense                      |   |

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration  
s<sub>u</sub> = undrained shear strength from in situ field 'N'-vane (kPa)  
S = calculated sensitivity  
w = natural moisture content (%)  
M = sieve analysis  
MH = combined sieve and hydrometer analysis  
AL = Atterberg limits test  
w<sub>p</sub> = plastic limit (%)  
w<sub>l</sub> = liquid limit (%)  
I<sub>p</sub> = plasticity index (%)  
NP = non-plastic test result in Atterberg limits  
Oc = organic content test

Notes:

<sup>1</sup>A cobble was encountered in Borehole JP-3 from 13.0 m to 13.1 m; cobbles were encountered in Borehole JP-4 between 13.1 m and 13.5 m.

### 4.3 Refusal

Refusal to further split spoon and casing advancement was recorded in Borehole JP-2 at a depth of 7.6 m (Elevation 357.8 m).



## **4.4 Groundwater Conditions**

The depths to/elevations of unstabilized groundwater levels measured in the open boreholes upon completion of drilling are presented below. It should be noted that the introduction of drilling water to advance NW casing in the boreholes may have impacted the measured groundwater levels. Water levels should be expected to vary depending on the time of year and precipitation events.

| <b>Borehole No.</b> | <b>Depth to Unstabilized<br/>Groundwater Level<br/>(m)</b> | <b>Approximate<br/>Groundwater Elevation<br/>(m)</b> |
|---------------------|--|--|
| JP-1                | 1.6  | 365.5  |
| JP-2                | At ground surface  | 365.4  |
| JP-3                | 4.5  | 364.5  |
| JP-4                | 2.7  | 366.3  |
| JP-5                | 0.9  | 365.0  |
| JP-6                | At ground surface  | 365.6  |

The water level in the creek water was measured by Golder on September 29, 2017, at Elevation 365.3 m.

## **5.0 CLOSURE**

The field drilling program was supervised by Mr. Mathew Riopelle. This Foundation Investigation Report was prepared by Ms. Aronne-Kay De Souza, EIT, and the technical aspects were reviewed by Mr. André Bom, P.Eng., a geotechnical engineer and Associate of Golder. Mr. Jorge M. A. Costa, P.Eng., an MTO Designated Foundations Contact and Senior Consultant of Golder, conducted an independent quality control review and technical audit of this report.



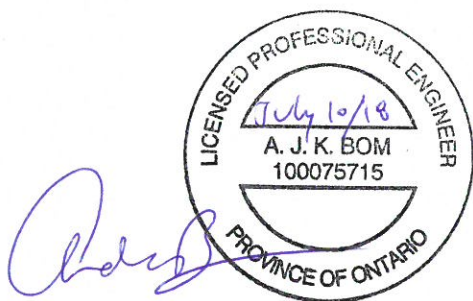


## Report Signature Page

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**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN  
STATIONS IN KILOMETRES + METRES.

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WP No. 5219-13-01

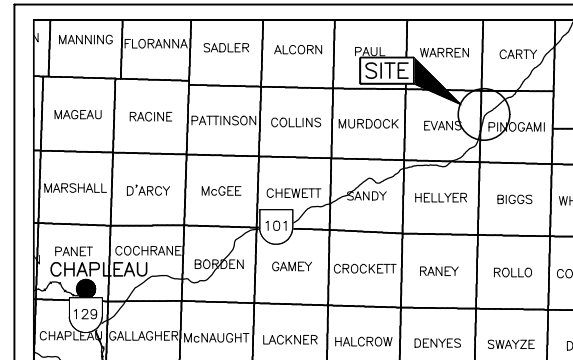


# HIGHWAY 101



## JACKPINE CREEK CULVERT

### BOREHOLE LOCATIONS AND SOIL STRATA

**SHEET**



## LEGEND

- |   |  |
|---|--|
|  | Borehole – Current Investigation                                   |
| N   | Standard Penetration Test Value                                    |
| 16  | Blows/0.3m unless otherwise stated<br>(Std. Pen. Test, 475 j/blow) |
| R   | Refusal  |
|  | WL upon completion of drilling                                     |

| BOREHOLE CO-ORDINATES |           |           |          |
|-----------------------|-----------|-----------|----------|
| No.                   | ELEVATION | NORTHING  | EASTING  |
| JP-1                  | 367.1     | 5326504.2 | 401004.4 |
| JP-2                  | 365.4     | 5326517.8 | 401004.6 |
| JP-3                  | 369.0     | 5326498.8 | 401011.4 |
| JP-4                  | 369.0     | 5326512.1 | 401019.2 |
| JP-5                  | 365.9     | 5326503.4 | 401028.2 |
| JP-6                  | 365.6     | 5326513.3 | 401028.1 |

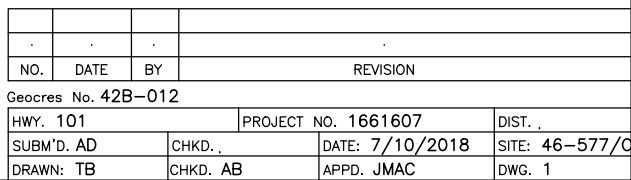
## NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

## REFERENCE

Base plans provided in digital format by LEA, drawing file nos x17197  
Jackpine Base.dwg and 17197-Jackpine Culvert-S01-General  
Arrangement.dwg, received FEB 27, 2018.





## PHOTOGRAPHS

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**Photograph 1: Jackpine Creek Culvert  
East embankment facing south (September 2017)**



**Photograph 2: Jackpine Creek Culvert  
Culvert outlet, looking east (September 2017)**







## PHOTOGRAPHS

**Photograph 3: Jackpine Creek Culvert  
North approach, looking south (September 2017)**



**Photograph 4: Jackpine Creek Culvert  
Culvert inlet, looking north-west (September 2017)**





# APPENDIX A

## Record of Boreholes



## LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

### I. GENERAL

|             |                                       |
|-------------|---------------------------------------|
| $\pi$       | 3.1416                                |
| $\ln x$ ,   | natural logarithm of x                |
| $\log_{10}$ | x or log x, logarithm of x to base 10 |
| g           | acceleration due to gravity           |
| t           | time                                  |
| FoS         | factor of safety                      |

### II. STRESS AND STRAIN

|                                |  |
|--------------------------------|--|
| $\gamma$                       | shear strain   |
| $\Delta$                       | change in, e.g. in stress: $\Delta \sigma$                                 |
| $\varepsilon$                  | linear strain  |
| $\varepsilon_v$                | volumetric strain  |
| $\eta$                         | coefficient of viscosity   |
| $\nu$                          | Poisson's ratio  |
| $\sigma$                       | total stress   |
| $\sigma'$                      | effective stress ( $\sigma' = \sigma - u$ )                                |
| $\sigma'_{vo}$                 | initial effective overburden stress  |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stress (major, intermediate, minor)                              |
| $\sigma_{oct}$                 | mean stress or octahedral stress<br>$= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| $\tau$                         | shear stress   |
| u                              | porewater pressure   |
| E                              | modulus of deformation   |
| G                              | shear modulus of deformation   |
| K                              | bulk modulus of compressibility  |

### III. SOIL PROPERTIES

|                    |  |
|--------------------|--|
| <b>(a)</b>         | <b>Index Properties</b>  |
| $\rho(\gamma)$     | bulk density (bulk unit weight)*   |
| $\rho_d(\gamma_d)$ | dry density (dry unit weight)  |
| $\rho_w(\gamma_w)$ | density (unit weight) of water   |
| $\rho_s(\gamma_s)$ | density (unit weight) of solid particles   |
| $\gamma'$          | unit weight of submerged soil<br>( $\gamma' = \gamma - \gamma_w$ )                                   |
| $D_R$              | relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ ) |
| e                  | void ratio   |
| n                  | porosity   |
| S                  | degree of saturation   |

### (a) Index Properties (continued)

|             |  |
|-------------|--|
| w           | water content  |
| $w_l$ or LL | liquid limit   |
| $w_p$ or PL | plastic limit  |
| $I_p$ or PI | plasticity index = $(w_l - w_p)$   |
| $w_s$       | shrinkage limit  |
| $I_L$       | liquidity index = $(w - w_p) / I_p$  |
| $I_C$       | consistency index = $(w_l - w) / I_p$  |
| $e_{max}$   | void ratio in loosest state  |
| $e_{min}$   | void ratio in densest state  |
| $I_D$       | density index = $(e_{max} - e) / (e_{max} - e_{min})$<br>(formerly relative density) |

### (b) Hydraulic Properties

|   |   |
|---|---|
| h | hydraulic head or potential                             |
| q | rate of flow  |
| v | velocity of flow  |
| i | hydraulic gradient                                      |
| k | hydraulic conductivity<br>(coefficient of permeability) |
| j | seepage force per unit volume                           |

### (c) Consolidation (one-dimensional)

|             |   |
|-------------|---|
| $C_c$       | compression index<br>(normally consolidated range)    |
| $C_r$       | recompression index<br>(over-consolidated range)      |
| $C_s$       | swelling index  |
| $C_\alpha$  | secondary compression index                           |
| $m_v$       | coefficient of volume change                          |
| $C_v$       | coefficient of consolidation (vertical direction)     |
| $C_h$       | coefficient of consolidation (horizontal direction)   |
| $T_v$       | time factor (vertical direction)                      |
| U           | degree of consolidation                               |
| $\sigma'_p$ | pre-consolidation stress                              |
| OCR         | over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$ |

### (d) Shear Strength

|                  |  |
|------------------|--|
| $\tau_p, \tau_r$ | peak and residual shear strength                         |
| $\phi'$          | effective angle of internal friction                     |
| $\delta$         | angle of interface friction                              |
| $\mu$            | coefficient of friction = $\tan \delta$                  |
| $c'$             | effective cohesion                                       |
| $c_u, s_u$       | undrained shear strength ( $\phi = 0$ analysis)          |
| p                | mean total stress $(\sigma_1 + \sigma_3)/2$              |
| $p'$             | mean effective stress $(\sigma'_1 + \sigma'_3)/2$        |
| q                | $(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$ |
| $q_u$            | compressive strength $(\sigma_1 - \sigma_3)$             |
| $S_t$            | sensitivity  |

\* Density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1  
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

### I. SAMPLE TYPE

|    |                     |
|----|---------------------|
| AS | Auger sample        |
| BS | Block sample        |
| CS | Chunk sample        |
| DS | Denison type sample |
| FS | Foil sample         |
| RC | Rock core           |
| SC | Soil core           |
| SS | Split-spoon         |
| ST | Slotted tube        |
| TO | Thin-walled, open   |
| TP | Thin-walled, piston |
| WS | Wash sample         |

### III. SOIL DESCRIPTION

#### (a) Non-Cohesive (Cohesionless) Soils

| Density Index    | N                        |
|------------------|--------------------------|
| Relative Density | Blows/300 mm or Blows/ft |
| Very loose       | 0 to 4                   |
| Loose            | 4 to 10                  |
| Compact          | 10 to 30                 |
| Dense            | 30 to 50                 |
| Very dense       | over 50                  |

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

#### (b) Cohesive Soils Consistency

|            | kPa        | Cu, Su | psf            |
|------------|------------|--------|----------------|
| Very soft  | 0 to 12    |        | 0 to 250       |
| Soft       | 12 to 25   |        | 250 to 500     |
| Firm       | 25 to 50   |        | 500 to 1,000   |
| Stiff      | 50 to 100  |        | 1,000 to 2,000 |
| Very stiff | 100 to 200 |        | 2,000 to 4,000 |
| Hard       | over 200   |        | over 4,000     |

#### Dynamic Cone Penetration Resistance (DCPT); Nd:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Qt), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

### IV. SOIL TESTS

|                 |   |
|-----------------|---|
| w               | water content   |
| w <sub>p</sub>  | plastic limit   |
| w <sub>l</sub>  | liquid limit  |
| C               | consolidation (oedometer) test  |
| CHEM            | chemical analysis (refer to text)   |
| CID             | consolidated isotropically drained triaxial test <sup>1</sup>                                       |
| CIU             | consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup> |
| D <sub>R</sub>  | relative density (specific gravity, G <sub>s</sub> )  |
| DS              | direct shear test   |
| M               | sieve analysis for particle size  |
| MH              | combined sieve and hydrometer (H) analysis  |
| MPC             | Modified Proctor compaction test  |
| SPC             | Standard Proctor compaction test  |
| OC              | organic content test  |
| SO <sub>4</sub> | concentration of water-soluble sulphates  |
| UC              | unconfined compression test   |
| UU              | unconsolidated undrained triaxial test  |
| V               | field vane (LV-laboratory vane test)  |
| γ               | unit weight   |

**Note:** 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

### V. MINOR SOIL CONSTITUENTS

#### Per cent by Weight

#### Modifier

|          |  |
|----------|--|
| 0 to 5   | Trace  |
| 5 to 12  | Trace to Some (or Little)                            |
| 12 to 20 | Some   |
| 20 to 30 | (ey) or (y)  |
| over 30  | And (non-cohesive (cohesionless)) or With (cohesive) |

#### Example

|  |
|--|
| Trace sand                                   |
| Trace to some sand                           |
| Some sand                                    |
| Sandy  |
| Sand and Gravel                              |
| Silty Clay with sand / Clayey Silt with sand |

| PROJECT 1661607    |   | RECORD OF BOREHOLE No JP-1  |         |      |            | 1 OF 2 METRIC           |   |  |  |  |  |  |  |
|--------------------|---|---|---------|------|------------|-------------------------|---|--|--|--|--|--|--|
| W.P. 5219-13-01    |   | LOCATION N 5326504.2; E 401004.4 MTM ZONE 13 (LAT. 48.070175; LONG. -82.708943) |         |      |            | ORIGINATED BY MR        |   |  |  |  |  |  |  |
| DIST _____ HWY 101 |   | BOREHOLE TYPE NW Casing and Wash Boring   |         |      |            | COMPILED BY AD          |   |  |  |  |  |  |  |
| DATUM GEODETIC     |   | DATE September 27, 2017   |         |      |            | CHECKED BY AB           |   |  |  |  |  |  |  |
| SOIL PROFILE       |   |   | SAMPLES |      |            | GROUND WATER CONDITIONS | DYNAMIC CONE PENETRATION RESISTANCE PLOT  |  |  |  |  | UNIT WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
| ELEV<br>DEPTH      | DESCRIPTION   | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |                         | SHEAR STRENGTH kPa  |  |  |  |  |  |  |
|                    |   |   |         |      |            |                         | 20 40 60 80 100<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED<br>WATER CONTENT (%)<br>20 40 60 |  |  |  |  |  |  |
| 367.1              | GROUND SURFACE  |   |         |      |            |                         |   |  |  |  |  |  |  |
| 0.0                | Sand, trace gravel, trace organics (FILL)<br>Loose to compact<br>Brown<br>Moist<br><br>A 25 mm thick asphalt layer encountered in Sample 2. |   | 1       | SS   | 7          |                         |   |  |  |  |  |  |  |
|                    |   |   | 2       | SS   | 15         |                         |   |  |  |  |  |  |  |
| 365.6              |   |   |         |      |            |                         |   |  |  |  |  |  |  |
| 1.5                | PEAT (Amorphous), trace gravel, trace sand<br>Very soft to soft<br>Black<br>Wet   |   | 3       | SS   | 4          |                         |   |  |  |  |  |  |  |
|                    |   |   | 4       | SS   | 4          |                         |   |  |  |  |  |  |  |
|                    |   |   | 5       | SS   | 1          |                         |   |  |  |  |  |  |  |
| 363.4              |   |   |         |      |            |                         |   |  |  |  |  |  |  |
| 3.7                | SAND, trace to some silt<br>Very loose<br>Dark brown<br>Wet   |   | 6       | SS   | 2          |                         |   |  |  |  |  |  |  |
|                    |   |   | 7       | SS   | 4          |                         |   |  |  |  |  |  |  |
| 361.9              |   |   |         |      |            |                         |   |  |  |  |  |  |  |
| 5.2                | SILT, trace sand, trace to some clay<br>Loose to compact<br>Grey<br>Wet   |   | 8       | SS   | 10         |                         |   |  |  |  |  |  |  |
|                    |   |   |         |      |            |                         |   |  |  |  |  |  |  |
|                    |   |   | 9       | SS   | 11         |                         |   |  |  |  |  |  |  |
|                    |   |   |         |      |            |                         |   |  |  |  |  |  |  |
|                    |   |   | 10      | SS   | 7          |                         |   |  |  |  |  |  |  |
| 357.1              |   |   |         |      |            |                         |   |  |  |  |  |  |  |
| 10.0               | BOULDER   |   |         |      |            |                         |   |  |  |  |  |  |  |
| 356.7              |   |   |         |      |            |                         |   |  |  |  |  |  |  |
| 10.4               | SILTY SAND, some gravel, trace clay (TILL)<br>Very dense<br>Grey<br>Wet   |   | 11      | SS   | 99         |                         |   |  |  |  |  |  |  |
| 355.8              |   |   |         |      |            |                         |   |  |  |  |  |  |  |
| 11.3               |   |   |         |      |            |                         |   |  |  |  |  |  |  |

Continued Next Page





+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

SUD-MTO 001 MTM ZN INC LAT/LONG S:\CLIENTS\MTM\1661607 LEA\_5015-E-0049\_NE REGION\02\_DATA\GINTV1661607.GPJ GAL-MISS.GDT 2/15/18 TB/JUL



| PROJECT <u>1661607</u>                |  | <b>RECORD OF BOREHOLE No JP-1</b>  |        |      |                            | 2 OF 2 <b>METRIC</b>    |  |                    |  |  |  |   |                |   |  |  |
|---------------------------------------|--|--|--------|------|----------------------------|-------------------------|--|--------------------|--|--|--|---|----------------|---|--|--|
| W.P. <u>5219-13-01</u>                |  | LOCATION <u>N 5326504.2; E 401004.4 MTM ZONE 13 (LAT. 48.070175; LONG. -82.708943)</u> |        |      |                            | ORIGINATED BY <u>MR</u> |  |                    |  |  |  |   |                |   |  |  |
| DIST <u>          </u> HWY <u>101</u> |  | BOREHOLE TYPE <u>NW Casing and Wash Boring</u>   |        |      |                            | COMPILED BY <u>AD</u>   |  |                    |  |  |  |   |                |   |  |  |
| DATUM <u>GEODETIC</u>                 |  | DATE <u>September 27, 2017</u>   |        |      |                            | CHECKED BY <u>AB</u>    |  |                    |  |  |  |   |                |   |  |  |
| SOIL PROFILE                          |  | SAMPLES  |        |      | GROUND WATER<br>CONDITIONS | ELEVATION SCALE         | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT  |                    |  |  |  | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT                                   |                |   | UNIT WEIGHT<br><br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
| ELEV<br>DEPTH                         | DESCRIPTION  | STRAT PLOT   | NUMBER | TYPE |                            |                         | "N" VALUES   | SHEAR STRENGTH kPa |  |  |  |   | W <sub>p</sub> | W |  |  |
|                                       | --- CONTINUED FROM PREVIOUS PAGE ---   |  |        |      |                            |                         | <div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED</span> <span>+ FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between;"> <span>● QUICK TRIAXIAL</span> <span>× REMOULDED</span> </div> |                    |  |  |  | <div style="display: flex; justify-content: space-between;"> <span>20 40 60</span> </div> |                |   |  |  |
|                                       | END OF BOREHOLE<br><br>Note:<br><br>1. Water level at a depth of 1.6 m below ground surface (Elev. 365.5 m) upon completion of drilling. |  |        |      |                            |                         |  |                    |  |  |  |   |                |   |  |  |

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| PROJECT <u>1661607</u>                |   | <b>RECORD OF BOREHOLE No JP-2</b>  |         |      |            | 1 OF 1 <b>METRIC</b>       |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|---------------------------------------|---|--|---------|------|------------|----------------------------|-----------------|---|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|---|--|
| W.P. <u>5219-13-01</u>                |   | LOCATION <u>N 5326517.8; E 401004.6 MTM ZONE 13 (LAT. 48.070297; LONG. -82.708937)</u> |         |      |            | ORIGINATED BY <u>MR</u>    |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| DIST <u>          </u> HWY <u>101</u> |   | BOREHOLE TYPE <u>Portable Tripod, NW Casing, Wash Boring</u>                           |         |      |            | COMPILED BY <u>AD</u>      |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| DATUM <u>GEODETIC</u>                 |   | DATE <u>September 28, 2017</u>   |         |      |            | CHECKED BY <u>AB</u>       |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| SOIL PROFILE                          |   |  | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
| ELEV<br>DEPTH                         | DESCRIPTION   | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |  |  |                                    |                                     |                                   |   |  |
| 365.4                                 | GROUND SURFACE  |  |         |      |            |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 0.0                                   | PEAT (Amorphous)<br>Very soft<br>Black<br>Wet   |       | 1       | SS   | 2          |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|                                       |   |  | 2       | SS   | 1          |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 363.9                                 |   |  |         |      |            |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 1.5                                   | ORGANIC SAND<br>Very loose<br>Brown to black<br>Wet   |       | 3       | SS   | 4          |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 363.2                                 |   |  |         |      |            |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 2.2                                   | SAND, trace to some organics<br>Very loose<br>Dark brown<br>Wet   |       | 4       | SS   | 4          |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 362.4                                 |   |  |         |      |            |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 3.0                                   | SILT, trace to some clay, trace sand<br>Compact<br>Grey<br>Wet  |       | 5       | SS   | 23         |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|                                       |   |  | 6       | SS   | 28         |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|                                       |   |  | 7       | SS   | 15         |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|                                       |   |  |         |      |            |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|                                       |   |  | 8       | SS   | 16         |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|                                       |   |  |         |      |            |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|                                       |   |  |         |      |            |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 357.8                                 |   |  | 9       | SS   | -          |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 7.6                                   | END OF BOREHOLE<br>SPLIT-SPOON AND CASING<br>REFUSAL<br><br>Note:<br><br>1. Water level at ground surface<br>(Elev. 365.4 m) upon completion of<br>drilling.<br><br>2. Split Spoon samples obtained by<br>driving with a 1/2 weight hammer.<br>SPT "N" values have been adjusted to<br>the inferred values that would be<br>obtained using a standard weight<br>hammer. |  |         |      |            |                            |                 |   |  |  |  |                                    |                                     |                                   |   |  |

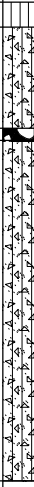
SUD-MTO 001 MTM ZNI INC LAT/LONG S:\CLIENTS\MTM\1661607 LEA\_5015-E-0049\_NE REGION\02\_DATA\GINT\1661607.GPJ GAL-MISS.GDT 2/15/18 TB/JUL

| PROJECT <u>1661607</u>                |  | <b>RECORD OF BOREHOLE No JP-3</b>   |         |      |            | 1 OF 2 <b>METRIC</b>       |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
|---------------------------------------|--|---|---------|------|------------|----------------------------|--------------------|---|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|-------------------------|---|
| W.P. <u>5219-13-01</u>                |  | LOCATION <u>N 5326498.8; E 401011.4 MTM ZONE 13 (LAT. 48.070125; LONG. -82.70885)</u> |         |      |            | ORIGINATED BY <u>MR</u>    |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| DIST <u>          </u> HWY <u>101</u> |  | BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing and Wash Boring</u>        |         |      |            | COMPILED BY <u>AD</u>      |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| DATUM <u>GEODETIC</u>                 |  | DATE <u>September 25, 2017</u>  |         |      |            | CHECKED BY <u>AB</u>       |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| SOIL PROFILE                          |  |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
| ELEV<br>DEPTH                         | DESCRIPTION  | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |                            |                    | SHEAR STRENGTH kPa                          |  |  |  |                                    |                                     |                                   |                         |   |
| 369.0                                 | GROUND SURFACE   |   |         |      |            |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| 368.8                                 | ASPHALT (225 mm)   |   |         |      |            |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| 0.2                                   | Gravelly sand, trace to some silt<br>(FILL)<br>Dense<br>Brown to grey<br>Moist           |   | 1       | SS   | 47         |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
|                                       |  |   | 2       | SS   | 45         |                            |                    |   |  |  |  |                                    |                                     |                                   |                         | 23 67 (10)  |
| 366.4                                 | ORGANIC SILT, trace sand<br>Loose to compact<br>Black<br>Wet                             |   | 3       | SS   | 12         |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| 2.6                                   |  |   | 4       | SS   | 7          |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| 365.4                                 | PEAT (Fibrous)<br>Black<br>Wet   |   | 5       | SS   | 5          |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
|                                       | SILT and SAND, trace gravel, trace<br>clay, trace organics<br>Loose<br>Dark brown<br>Wet |   | 6       | SS   | 8          |                            |                    |   |  |  |  |                                    |                                     |                                   |                         | OC = 3.4%   |
|                                       |  |   |         |      |            |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| 362.9                                 | SILT, trace to some clay, trace sand<br>Loose to compact<br>Grey<br>Wet                  |   | 7       | SS   | 14         |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
| 6.1                                   |  |   |         |      |            |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
|                                       |  |   | 8       | SS   | 9          |                            |                    |   |  |  |  |                                    |                                     |                                   |                         | 0 0 91 9  |
|                                       |  |   | 9       | SS   | 7          |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
|                                       |  |   |         |      |            |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
|                                       |  |   | 10      | SS   | 6          |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |
|                                       |  |   |         |      |            |                            |                    |   |  |  |  |                                    |                                     |                                   |                         |   |

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+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

SUD-MTO 001 MTM ZNI INC LAT/LONG S:\CLIENTS\MT01661607 LEA\_5015-E-0049\_NE REGION02\_DATAGINT\1661607.GPJ GAL-MISS.GDT 2/15/18 TB/JUL

| PROJECT <u>1661607</u>                |  | <b>RECORD OF BOREHOLE No JP-3</b>   |         |      |            | 2 OF 2 <b>METRIC</b>       |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
|---------------------------------------|--|---|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| W.P. <u>5219-13-01</u>                |  | LOCATION <u>N 5326498.8; E 401011.4 MTM ZONE 13 (LAT. 48.070125; LONG. -82.70885)</u> |         |      |            | ORIGINATED BY <u>MR</u>    |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| DIST <u>          </u> HWY <u>101</u> |  | BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing and Wash Boring</u>        |         |      |            | COMPILED BY <u>AD</u>      |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| DATUM <u>GEODETIC</u>                 |  | DATE <u>September 25, 2017</u>  |         |      |            | CHECKED BY <u>AB</u>       |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| SOIL PROFILE                          |  |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |
| ELEV<br>DEPTH                         | DESCRIPTION  | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |  |  |  |                                    |                                     |                                   |  |  |
|                                       | --- CONTINUED FROM PREVIOUS PAGE ---   |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| 356.8                                 |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| 12.2                                  | SILTY SAND, trace gravel, trace clay (TILL)<br>Very dense<br>Grey<br>Wet   |      | 11      | SS   | 80         |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| 356.0                                 | COBBLE   |   |         |      |            | 356                        |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| 13.1                                  | SILT and SAND, trace gravel, trace to some clay (TILL)<br>Very dense<br>Grey<br>Wet  |   | 12      | SS   | 103        | 355                        |                 |   |  |  |  |  |                                    |                                     |                                   | 5 36 50 9  |  |
|                                       |  |   |         |      |            | 354                        |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| 353.2                                 |  |   | 13      | SS   | 121        |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |
| 15.8                                  | END OF BOREHOLE<br><br>Note:<br><br>1. Water level at a depth of 4.5 m below ground surface (Elev. 364.5 m) upon completion of drilling. |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |

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|                                       |  |  |  |  |  |                         |  |
|---------------------------------------|--|--|--|--|--|-------------------------|--|
| PROJECT <u>1661607</u>                |  | <b>RECORD OF BOREHOLE No JP-4</b>  |  |  |  | 1 OF 2 <b>METRIC</b>    |  |
| W.P. <u>5219-13-01</u>                |  | LOCATION <u>N 5326512.1; E 401019.2 MTM ZONE 13 (LAT. 48.070243; LONG. -82.708742)</u> |  |  |  | ORIGINATED BY <u>MR</u> |  |
| DIST <u>          </u> HWY <u>101</u> |  | BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing and Wash Boring</u>         |  |  |  | COMPILED BY <u>AD</u>   |  |
| DATUM <u>GEODETIC</u>                 |  | DATE <u>September 25, 2017</u>   |  |  |  | CHECKED BY <u>AB</u>    |  |


  

| SOIL PROFILE |  |            | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |    |    |     | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |   |                | UNIT WEIGHT $\gamma$<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
|--------------|--|------------|---------|------|------------|-------------------------|-----------------|--|----|----|----|-----|---|---|----------------|---|--|
| ELEV. DEPTH  | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                         |                 | SHEAR STRENGTH kPa                       |    |    |    |     | WATER CONTENT (%)                                   |   |                |   |  |
|              |  |            |         |      |            |                         |                 | 20                                       | 40 | 60 | 80 | 100 | W <sub>p</sub>                                      | W | W <sub>L</sub> |   |  |
| 369.0        | GROUND SURFACE   |            |         |      |            |                         |                 |  |    |    |    |     |   |   |                |   |  |
| 0.0          | ASPHALT (250 mm)   |            |         |      |            |                         |                 |  |    |    |    |     |   |   |                |   |  |
| 0.3          | Gravelly sand to sand and gravel, trace to some silt (FILL)<br>Loose to dense<br>Grey to brown<br>Moist to wet |            | 1       | SS   | 29         |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            | 2       | SS   | 13         |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            | 3       | SS   | 40         |                         |                 |  |    |    |    |     |   |   |                | 26 62 (12)                                |  |
|              |  |            | 4       | SS   | 35         |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            | 5       | SS   | 7          |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            | 6       | SS   | 6          |                         |                 |  |    |    |    |     |   |   |                | 48 47 (5)                                 |  |
|              |  |            |         |      |            |                         |                 |  |    |    |    |     |   |   |                |   |  |
| 362.9        | SILT, trace to some clay, trace sand<br>Loose to compact<br>Grey<br>Wet  |            | 7       | SS   | 16         |                         |                 |  |    |    |    |     |   |   |                |   |  |
| 6.1          |  |            |         |      |            |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            | 8       | SS   | 18         |                         |                 |  |    |    |    |     |   |   |                | 0 0 95 5                                  |  |
|              |  |            |         |      |            |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            | 9       | SS   | 16         |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            |         |      |            |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            | 10      | SS   | 7          |                         |                 |  |    |    |    |     |   |   |                |   |  |
|              |  |            |         |      |            |                         |                 |  |    |    |    |     |   |   |                |   |  |






Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

SUD-MTO 001 MTM ZNI INC LAT/LONG S:\CLIENTS\MTM\1661607 LEA\_5015-E-0049\_NE REGION02\_DATA\GINTV1661607.GPJ GAL-MISS.GDT 2/15/18 TB/JUL

| PROJECT <u>1661607</u>                |   | RECORD OF BOREHOLE <b>No JP-4</b>  |         |      |            | 2 OF 2 <b>METRIC</b>       |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |                   |
|---------------------------------------|---|--|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|
| W.P. <u>5219-13-01</u>                |   | LOCATION <u>N 5326512.1; E 401019.2 MTM ZONE 13 (LAT. 48.070243; LONG. -82.708742)</u> |         |      |            | ORIGINATED BY <u>MR</u>    |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |                   |
| DIST <u>          </u> HWY <u>101</u> |   | BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing and Wash Boring</u>         |         |      |            | COMPILED BY <u>AD</u>      |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |                   |
| DATUM <u>GEODETIC</u>                 |   | DATE <u>September 25, 2017</u>   |         |      |            | CHECKED BY <u>AB</u>       |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |                   |
| SOIL PROFILE                          |   |  | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                                     |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |
| ELEV<br>DEPTH                         | DESCRIPTION   | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED |    |    |    |     |                                    |                                     |                                   |  |  | WATER CONTENT (%) |
|                                       | --- CONTINUED FROM PREVIOUS PAGE ---  |  |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |  |                   |
| 355.9                                 | SILT, trace to some clay, trace sand<br>Loose to compact<br>Grey<br>Wet   |       | 11      | SS   | 22         |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |  | 0 1 80 19         |
| 13.1                                  | COBBLES   |  |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |                   |
| 355.5                                 | Sandy SILT, some gravel, trace to<br>some clay (TILL)<br>Very dense<br>Grey<br>Wet                                      |  | 12      | SS   | 61         |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |  | 13 29 52 6        |
| 13.5                                  |   |  |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |                   |
| 353.5                                 | END OF BOREHOLE   |  | 13      | SS   | 100/0.15   |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |                   |
| 15.5                                  | Note:<br><br>1. Water level at a depth of 2.7 m<br>below ground surface (Elev. 366.3 m)<br>upon completion of drilling. |  |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |                   |

SUD-MTO 001 MTM ZN INC LAT/LONG S:\CLIENTS\MTM\1661607 LEA\_5015-E-0049\_NE REGION\02\_DATA\GINT\1661607.GPJ GAL-MISS.GDT 2/15/18 TB/JUL

| PROJECT <u>1661607</u>                |   | <b>RECORD OF BOREHOLE No JP-5</b>  |         |      |            | 1 OF 1 <b>METRIC</b>  |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
|---------------------------------------|---|--|---------|------|------------|---|-----------------|--|----|----|----|-----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| W.P. <u>5219-13-01</u>                |   | LOCATION <u>N 5326503.4; E 401028.2 MTM ZONE 13 (LAT. 48.070164; LONG. -82.708624)</u> |         |      |            | ORIGINATED BY <u>MR</u>   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| DIST <u>          </u> HWY <u>101</u> |   | BOREHOLE TYPE <u>NW Casing and Wash Boring</u>   |         |      |            | COMPILED BY <u>AD</u>   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| DATUM <u>GEODETIC</u>                 |   | DATE <u>September 27, 2017</u>   |         |      |            | CHECKED BY <u>AB</u>  |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| SOIL PROFILE                          |   |  | SAMPLES |      |            | GROUND WATER CONDITIONS   | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |    |    |     | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH                            | DESCRIPTION   | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES |   |                 | SHEAR STRENGTH kPa                       |    |    |    |     |                                 |                               |                                |                  |                                       |
| 365.9                                 | GROUND SURFACE  |  |         |      |            |   |                 | 20                                       | 40 | 60 | 80 | 100 |                                 |                               |                                |                  |                                       |
| 0.0                                   | PEAT (Amorphous), trace sand<br>Soft to firm<br>Black<br>Wet  |       | 1       | SS   | 6          |  | 365             |  |    |    |    |     |                                 |                               |                                |                  |                                       |
|                                       |   |  | 2       | SS   | 4          |   | 364             |  |    |    |    |     |                                 |                               |                                |                  |                                       |
|                                       |   |  | 3       | SS   | 3          |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| 363.8                                 |   |  |         |      |            |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| 2.1                                   | SAND, some gravel, trace to some silt, trace clay<br>Compact<br>Grey<br>Wet                                       |       | 4       | SS   | 20         |   |                 |  |    |    |    |     |                                 |                               |                                |                  | 12 80 6 2                             |
| 362.9                                 |   |  |         |      |            |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| 3.0                                   | SILT, trace to some clay, trace sand<br>Very loose to dense<br>Grey<br>Wet  |       | 5       | SS   | 20         |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
|                                       |   |  | 6       | SS   | 15         |   |                 |  |    |    |    |     |                                 |                               |                                |                  | 0 1 94 5                              |
|                                       |   |  | 7       | SS   | 9          |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
|                                       |   |  | 8       | SS   | 4          |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
|                                       |   |  | 9       | SS   | 38         |   |                 |  |    |    |    |     |                                 |                               |                                |                  | 0 1 86 13                             |
| 357.2                                 |   |  |         |      |            |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| 8.7                                   | SILTY SAND, trace gravel, trace clay (TILL)<br>Very dense<br>Grey<br>Wet  |     | 10      | SS   | 78         |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| 356.1                                 |   |  |         |      |            |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
| 9.8                                   | END OF BOREHOLE   |  |         |      |            |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |
|                                       | Note:<br><br>1. Water level at a depth of 0.9 m below ground surface (Elev. 365.0 m) upon completion of drilling. |  |         |      |            |   |                 |  |    |    |    |     |                                 |                               |                                |                  |                                       |

SUD-MTO 001 MTM ZN INC LAT/LONG S:\CLIENTS\MTM\1661607 LEA\_5015-E-0049\_NE REGION02\_DATAGINT\1661607.GPJ GAL-MISS.GDT 2/15/18 TB/JUL

| PROJECT <u>1661607</u>                |  |            | RECORD OF BOREHOLE <b>No JP-6</b>  |      |            | 1 OF 1 <b>METRIC</b>       |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
|---------------------------------------|--|------------|--|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---|--|-------------------|----|----|
| W.P. <u>5219-13-01</u>                |  |            | LOCATION <u>N 5326513.3; E 401028.1 MTM ZONE 13 (LAT. 48.070253; LONG. -82.708623)</u> |      |            | ORIGINATED BY <u>MR</u>    |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| DIST <u>          </u> HWY <u>101</u> |  |            | BOREHOLE TYPE <u>NW Casing and Wash Boring</u>   |      |            | COMPILED BY <u>AD</u>      |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| DATUM <u>GEODETIC</u>                 |  |            | DATE <u>September 28, 2017</u>   |      |            | CHECKED BY <u>AB</u>       |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| SOIL PROFILE                          |  |            | SAMPLES  |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |                   |    |    |
| ELEV<br>DEPTH                         | DESCRIPTION  | STRAT PLOT | NUMBER   | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |   |  | WATER CONTENT (%) |    |    |
|                                       |  |            |  |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |   |  | 20                | 40 | 60 |
| 365.6                                 | GROUND SURFACE   |            |  |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| 0.0                                   | Organic sand (FILL)<br>Very loose to loose<br>Grey to brown<br>Wet                               |            | 1  | SS   | 3          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
|                                       |  |            | 2  | SS   | 3          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
|                                       |  |            | 3  | SS   | 6          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| 363.3                                 | Wood (FILL)<br>Brown<br>Wet  |            | 4  | SS   | 3          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| 2.3                                   |  |            |  |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| 362.6                                 | SILT, trace to some clay, trace sand<br>Loose to compact<br>Grey<br>Wet                          |            | 5  | SS   | 19         |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   | 0 1 93 6   |                   |    |    |
| 3.0                                   |  |            | 6  | SS   | 13         |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
|                                       |  |            | 7  | SS   | 9          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
|                                       |  |            | 8  | SS   | 8          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   | 0 1 94 5   |                   |    |    |
|                                       |  |            | 9  | SS   | 8          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| 356.8                                 | BOULDER  |            |  |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| 356.5                                 | SILTY SAND and GRAVEL, trace clay<br>(TILL)<br>Very dense<br>Grey<br>Wet                         |            | 10   | SS   | 102/0.15   |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| 356.2                                 | END OF BOREHOLE  |            |  |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |
| 9.4                                   | Note:<br><br>1. Water level at ground surface<br>(Elev. 365.6 m) upon completion of<br>drilling. |            |  |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |   |  |                   |    |    |





# APPENDIX B

## Laboratory Testing



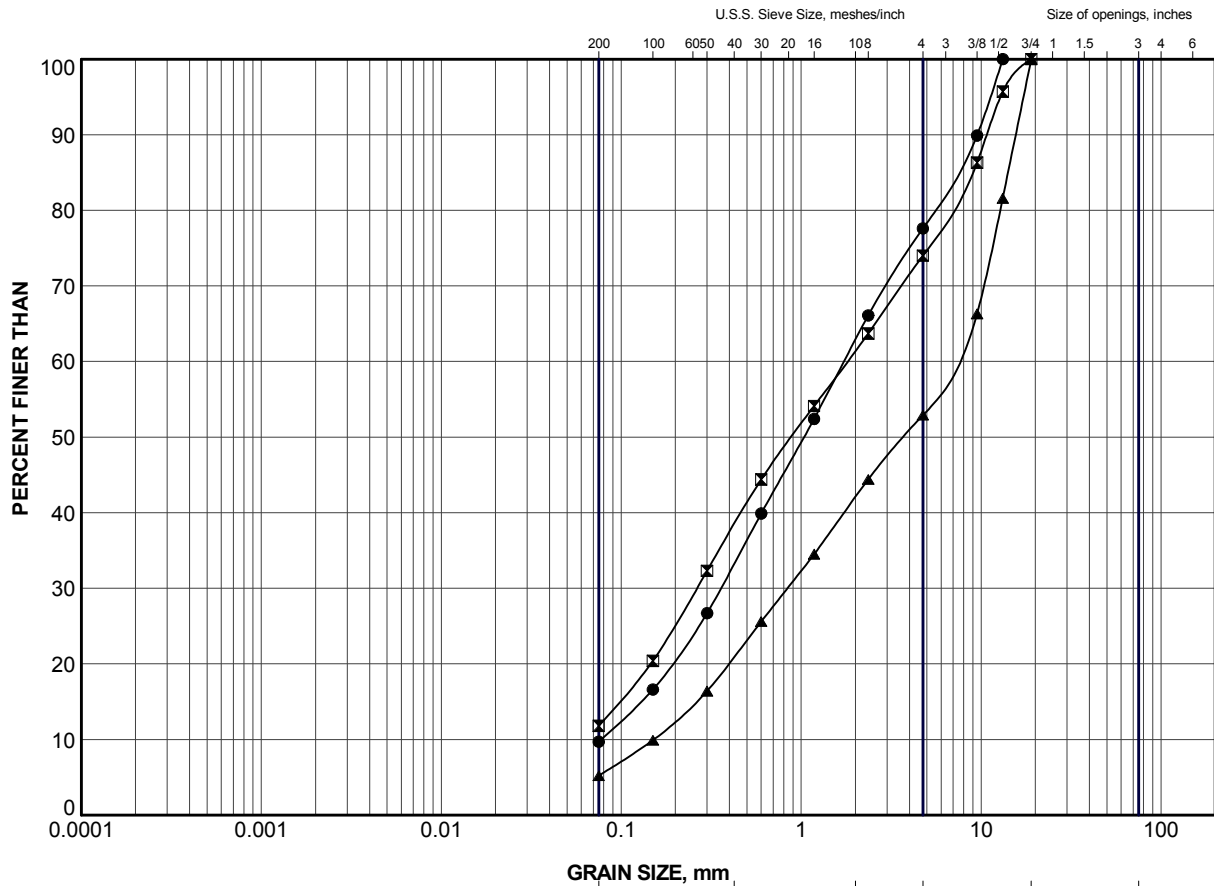
**Table B1 - Summary of Analytical Testing of Soil Sample**

| Parameter    | Units   | (Borehole JP-4) |
|--------------|---------|-----------------|
| Resistivity  | ohm-cm  | 5,900           |
| Conductivity | µmho/cm | 171             |
| pH           | pH      | 7.79            |
| Sulphate     | µg/g    | Not detected    |
| Chloride     | µg/g    | 35              |

Notes:

1. Sample obtained September 25, 2017
2. Analytical testing carried out by Maxxam Analytics Inc.

Prepared by: AD  
Reviewed by: AB



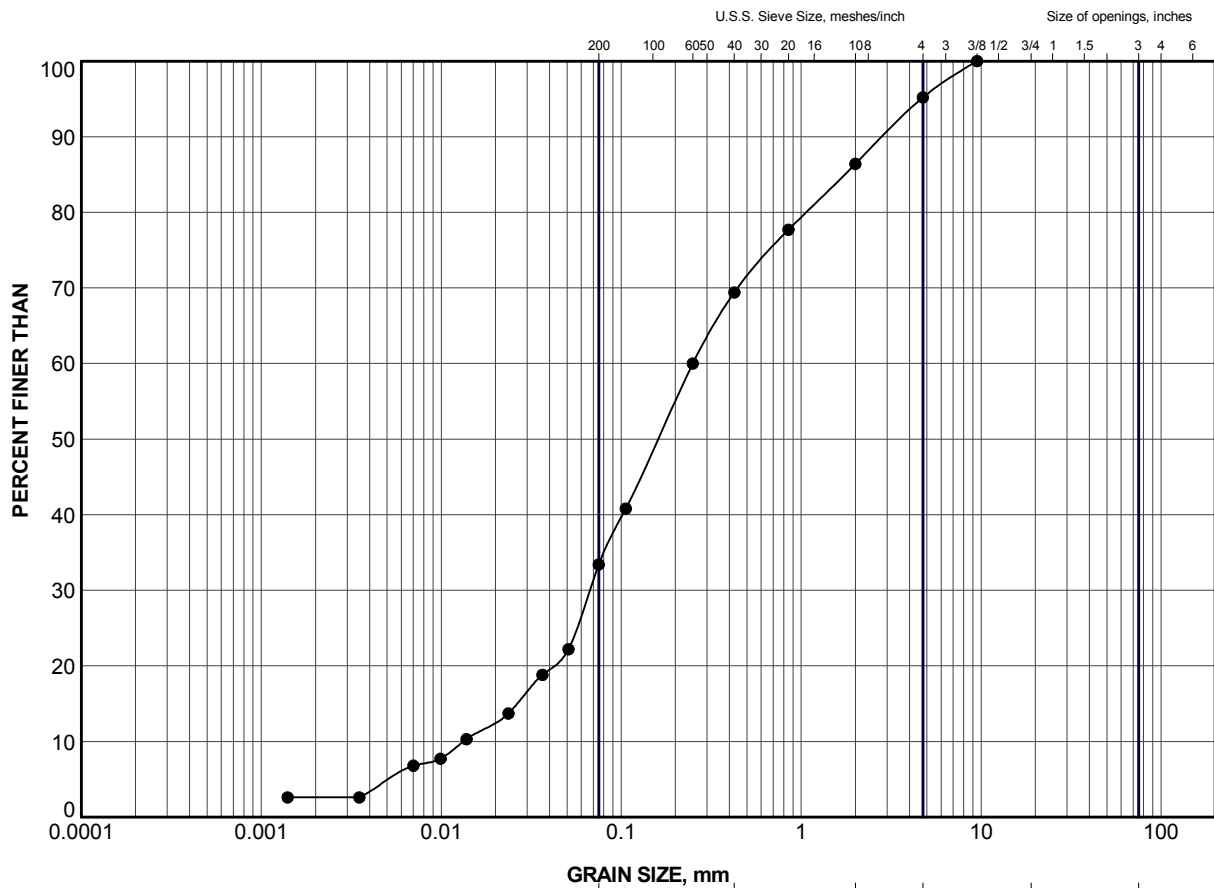
|               |                 |        |        |             |        |             |
|---------------|-----------------|--------|--------|-------------|--------|-------------|
| CLAY AND SILT | GRAVEL SIZE, mm |        |        |             |        | Cobble Size |
|               | fine            | medium | coarse | fine        | coarse |             |
|               | SAND SIZE       |        |        | GRAVEL SIZE |        |             |

### LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ●      | JP-3     | 2      | 367.2    |
| ⊠      | JP-4     | 3      | 366.4    |
| ▲      | JP-4     | 6      | 364.1    |

|  |      |          |                  |                      |      |
|--|------|----------|------------------|----------------------|------|
| PROJECT  |      |          |                  |                      |      |
| HIGHWAY 101<br>JACKPINE CREEK CULVERT                              |      |          |                  |                      |      |
| TITLE  |      |          |                  |                      |      |
| GRAIN SIZE DISTRIBUTION<br>GRAVELLY SAND to SAND and GRAVEL (FILL) |      |          |                  |                      |      |
| PROJECT No.  |      | 1661607  |                  | FILE No. 1661607.GPJ |      |
| DRAWN  | TB   | Feb 2018 | SCALE            | N/A                  | REV. |
| CHECK  | AB   | Feb 2018 |                  |                      |      |
| APPR   | JMAC | Feb 2018 |                  |                      |      |
|  |      |          | <b>FIGURE B1</b> |                      |      |




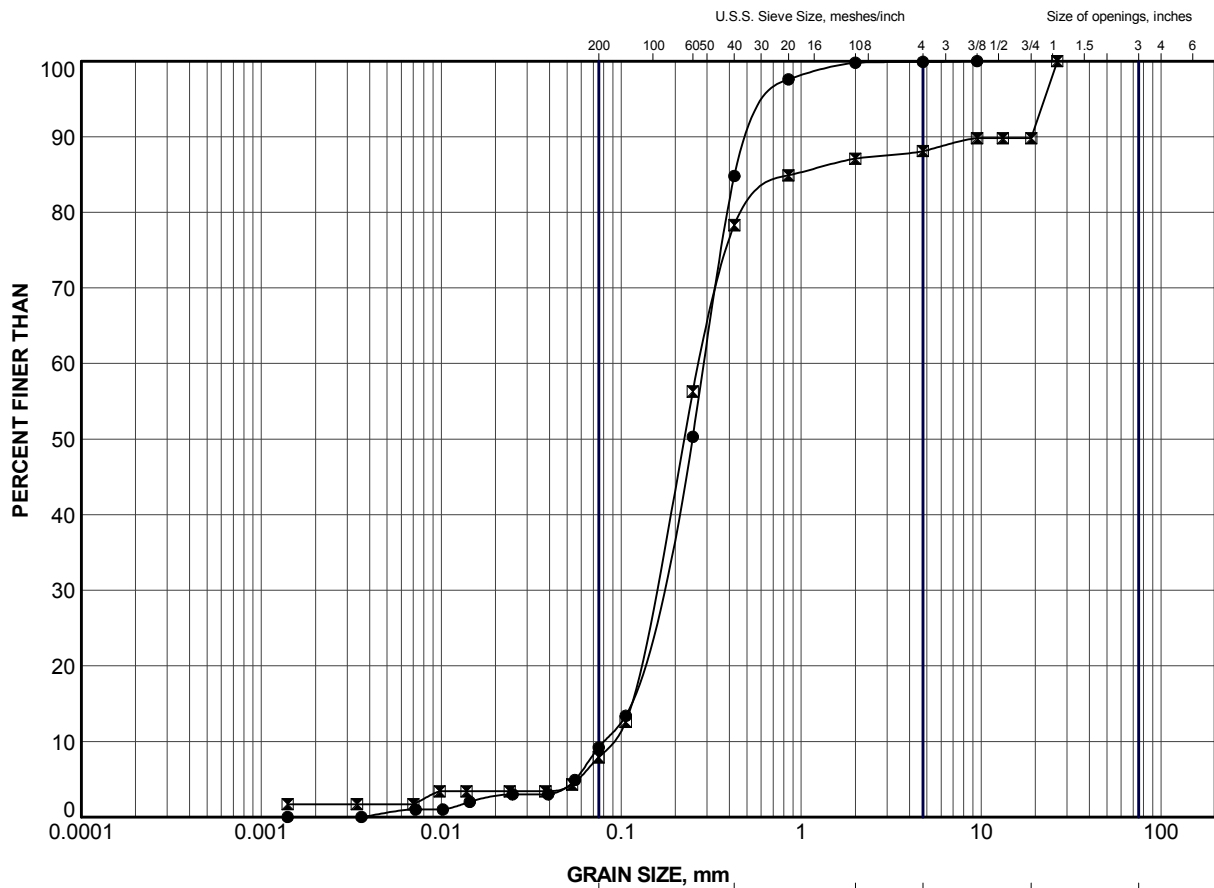


| GRAIN SIZE, mm |           |        |        |             |        |             |
|----------------|-----------|--------|--------|-------------|--------|-------------|
| CLAY AND SILT  | fine      | medium | coarse | fine        | coarse | Cobble Size |
|                | SAND SIZE |        |        | GRAVEL SIZE |        |             |
|                |           |        |        |             |        |             |

### LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ●      | JP-3     | 5      | 364.9    |


|  |      |          |                  |                      |      |
|--|------|----------|------------------|----------------------|------|
| PROJECT  |      |          |                  |                      |      |
| HIGHWAY 101<br>JACKPINE CREEK CULVERT  |      |          |                  |                      |      |
| TITLE  |      |          |                  |                      |      |
| GRAIN SIZE DISTRIBUTION<br>SILT and SAND   |      |          |                  |                      |      |
| PROJECT No.  |      | 1661607  |                  | FILE No. 1661607.GPJ |      |
| DRAWN  | TB   | Feb 2018 | SCALE            | N/A                  | REV. |
| CHECK  | AB   | Feb 2018 |                  |                      |      |
| APPR   | JMAC | Feb 2018 |                  |                      |      |
|  <b>Golder Associates</b><br>SUDBURY, ONTARIO |      |          | <b>FIGURE B2</b> |                      |      |

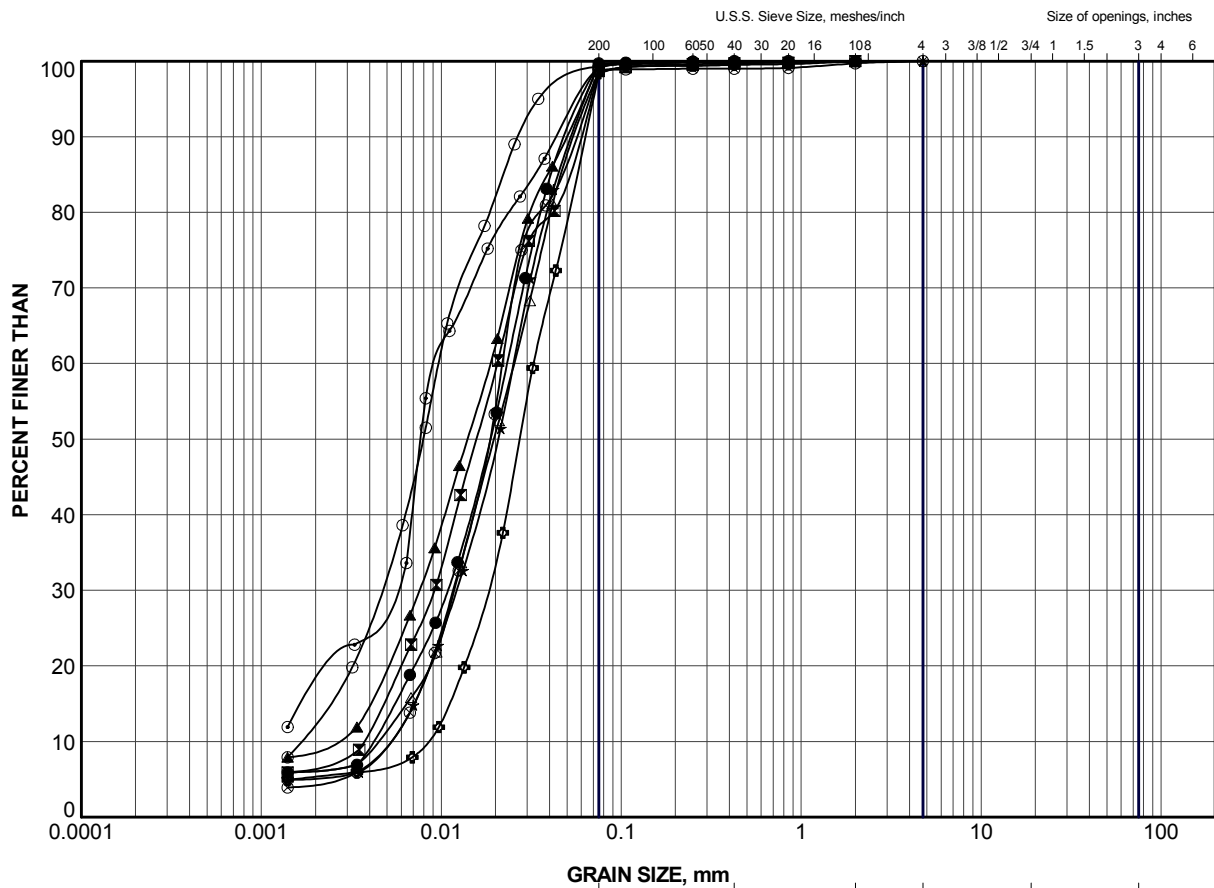


| GRAIN SIZE, mm |           |        |        |             |        |             |
|----------------|-----------|--------|--------|-------------|--------|-------------|
| CLAY AND SILT  | fine      | medium | coarse | fine        | coarse | Cobble Size |
|                | SAND SIZE |        |        | GRAVEL SIZE |        |             |

### LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ●      | JP-1     | 7      | 362.2    |
| ⊠      | JP-5     | 4      | 363.3    |

|  |  |         |  |                  |  |
|--|--|---------|--|------------------|--|
| PROJECT  |  |         |  |                  |  |
| HIGHWAY 101<br>JACKPINE CREEK CULVERT  |  |         |  |                  |  |
| TITLE  |  |         |  |                  |  |
| GRAIN SIZE DISTRIBUTION<br>SAND  |  |         |  |                  |  |
| PROJECT No.  |  | 1661607 |  | FILE No.         |  |
| DRAWN  |  | TB      |  | Feb 2018         |  |
| CHECK  |  | AB      |  | Feb 2018         |  |
| APPR   |  | JMAC    |  | Feb 2018         |  |
| SCALE  |  | N/A     |  | REV.             |  |
|  <b>Golder Associates</b><br>SUDBURY, ONTARIO |  |         |  | <b>FIGURE B3</b> |  |



| CLAY AND SILT | GRAVEL SIZE, mm |        |        |             |        | Cobble Size |
|---------------|-----------------|--------|--------|-------------|--------|-------------|
|               | fine            | medium | coarse | fine        | coarse |             |
|               | SAND SIZE       |        |        | GRAVEL SIZE |        |             |

### LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ●      | JP-1     | 9      | 359.2    |
| ⊠      | JP-2     | 6      | 361.3    |
| ▲      | JP-3     | 8      | 361.1    |
| ★      | JP-4     | 8      | 361.1    |
| ⊙      | JP-4     | 11     | 356.5    |
| ⊕      | JP-5     | 6      | 361.8    |
| ○      | JP-5     | 9      | 358.1    |
| △      | JP-6     | 5      | 362.3    |
| ⊗      | JP-6     | 8      | 359.2    |

PROJECT

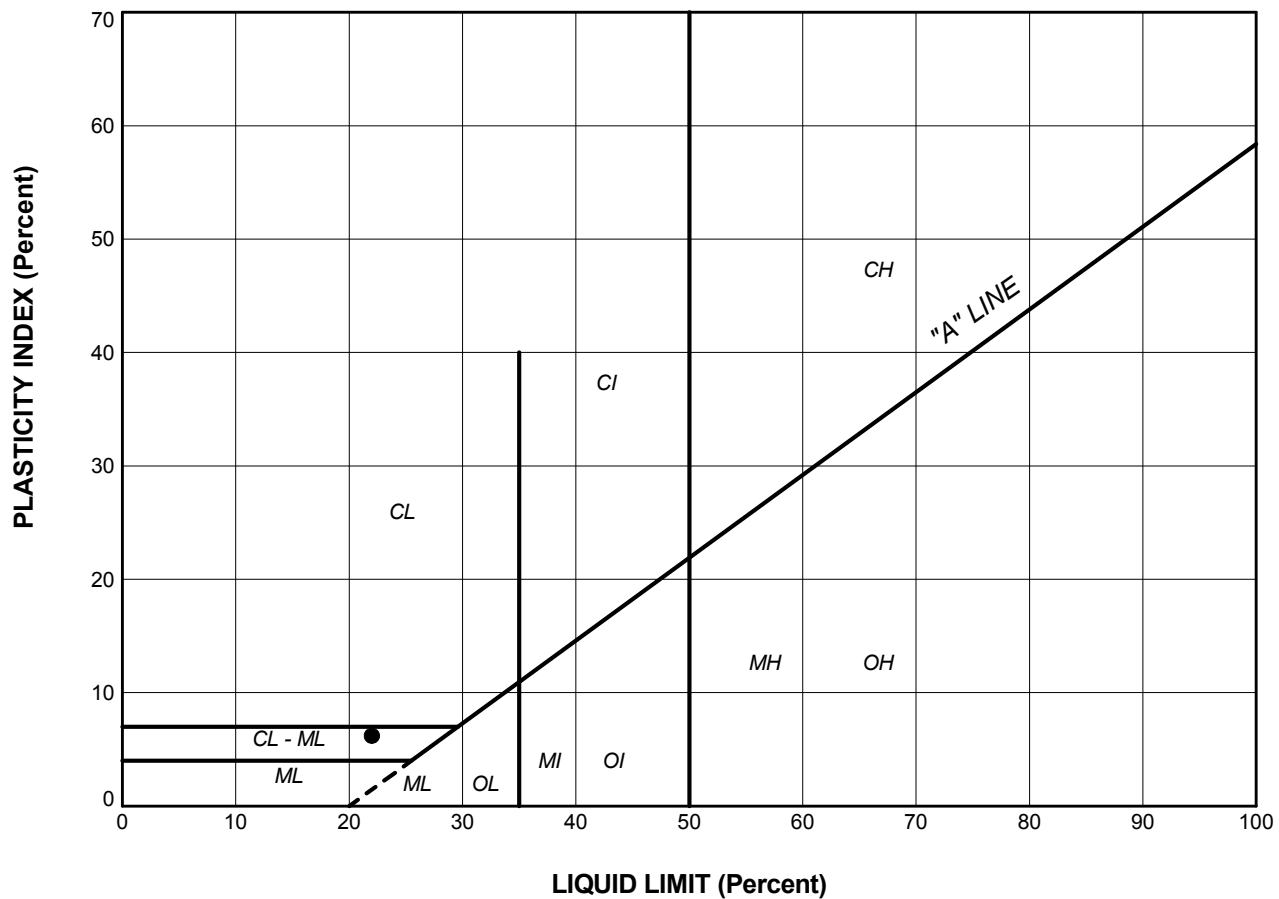
HIGHWAY 101  
JACKPINE CREEK CULVERT


TITLE

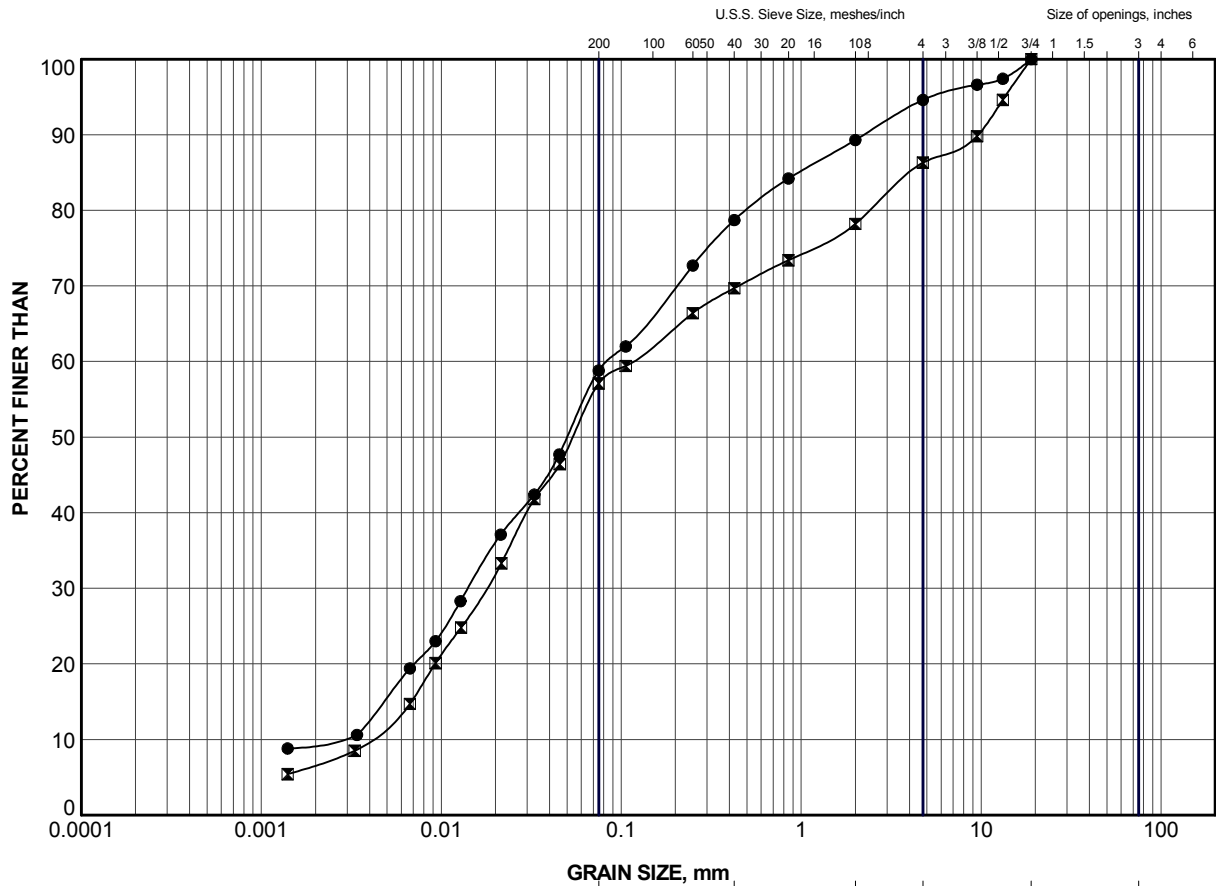
**GRAIN SIZE DISTRIBUTION**  
SILT



|                     |      |          |                      |     |      |
|---------------------|------|----------|----------------------|-----|------|
| PROJECT No. 1661607 |      |          | FILE No. 1661607.GPJ |     |      |
| DRAWN               | TB   | Feb 2018 | SCALE                | N/A | REV. |
| CHECK               | AB   | Feb 2018 | <b>FIGURE B4</b>     |     |      |
| APPR                | JMAC | Feb 2018 |                      |     |      |



|   |             |      |          |                  |     |
|---|-------------|------|----------|------------------|-----|
| PROJECT   |             |      |          |                  |     |
| HIGHWAY 101<br>JACKPINE CREEK CULVERT   |             |      |          |                  |     |
| TITLE   |             |      |          |                  |     |
| PLASTICITY CHART<br>SILT  |             |      |          |                  |     |
| <br><b>Golder Associates</b><br>SUDBURY, ONTARIO | PROJECT No. |      | 1661607  | FILE No.         |     |
|   | DRAWN       | TB   | Feb 2018 | SCALE            | N/A |
|   | CHECK       | AB   | Feb 2018 | REV.             |     |
|   | APPR        | JMAC | Feb 2018 | <b>FIGURE B5</b> |     |
|   |             |      |          |                  |     |



|               |           |        |        |             |        |             |
|---------------|-----------|--------|--------|-------------|--------|-------------|
| CLAY AND SILT | SAND SIZE |        |        | GRAVEL SIZE |        | Cobble Size |
|               | fine      | medium | coarse | fine        | coarse |             |

### LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ●      | JP-3     | 12     | 355.0    |
| ×      | JP-4     | 12     | 355.0    |

|             |      |          |         |     |      |   |  |  |             |  |  |
|-------------|------|----------|---------|-----|------|---|--|--|-------------|--|--|
| PROJECT     |      |          |         |     |      | HIGHWAY 101<br>JACKPINE CREEK CULVERT                         |  |  |             |  |  |
| TITLE       |      |          |         |     |      | GRAIN SIZE DISTRIBUTION<br>SANDY SILT to SILT and SAND (TILL) |  |  |             |  |  |
| PROJECT No. |      |          | 1661607 |     |      | FILE No.  |  |  | 1661607.GPJ |  |  |
| DRAWN       | TB   | Feb 2018 | SCALE   | N/A | REV. |   |  |  |             |  |  |
| CHECK       | AB   | Feb 2018 |         |     |      |   |  |  |             |  |  |
| APPR        | JMAC | Feb 2018 |         |     |      |   |  |  |             |  |  |
|             |      |          |         |     |      | <b>FIGURE B6</b>  |  |  |             |  |  |





At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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