



**FOUNDATION INVESTIGATION AND DESIGN REPORT**

**Highway 11/12 Coldwater Road Interchange  
High Mast Light Pole Relocations  
Orillia Township, District of Owen Sound  
Ministry of Transportation, Ontario  
GWP 2494-15-00**

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**PART A**

**FOUNDATION INVESTIGATION REPORT  
HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE  
HIGH MAST LIGHT POLE RELOCATIONS  
TOWNSHIP OF ORILLIA, DISTRICT OF OWEN SOUND  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 2494-15-00**

## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder), a member of WSP, has been retained by McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) on behalf of the Ministry of Transportation, Ontario (MTO) to provide preliminary design foundation engineering services as part of the design-build ready assignment for the Highway 11 interchange improvements at the Highway 12 (Coldwater Road) north junction and Highway 12 (Old Barrie Road) south junction.

The Coldwater Road interchange improvements includes the replacement of the existing Coldwater Road Underpass bridge structure and reconfiguration of the existing interchange ramps, as well as the design of two noise barrier walls, a stormwater management pond, and four high mast light pole relocations. This report addresses the foundation investigation for the relocation of four existing 35 m high, high mast light poles (HMLPs). Foundation investigations for the noise barrier walls, stormwater management pond, and bridge structure, as well as the Old Barrie Road interchange improvements are addressed in separate reports.

## 2.0 SITE DESCRIPTION

The orientation (i.e., north, south, east, and west) stated in the text of this report is referenced to project north and therefore may differ from magnetic north shown on Drawing 1. For the purpose of this report, Highway 12 / Coldwater Road is oriented in a west-east direction on a slight skew to Highway 11, which generally runs in a north-south direction.

In general, the topography in the area, including the Highway 11 platform is relatively flat with the exception of the elevated Highway 12/Coldwater Road platform and associated interchange ramps. The ground surface within the vicinity of the interchange is landscaped with grass cover and a few limited zones of tree cover along the perimeter (interior and exterior) of the interchange ramps. The land use in the area (i.e., beyond the MTO right-of-way) is a mix of residential and commercial properties.

### 3.0 INVESTIGATION PROCEDURES

The fieldwork for this subsurface exploration program included a total of four boreholes (Boreholes HMLP-1 to HMLP-4). Borehole HMLP-4 was advanced on 10 May 2022 and Borehole HMLP-1 to HMLP-3 were advanced between 31 October and 2 November 2022. The approximate locations of the boreholes are shown in Drawing 1.

The boreholes were advanced using a Diedrich D-50 track-mounted drilling rig, supplied and operated by Walker Drilling Ltd. (Walker) of Utopia, Ontario, equipped with 108 millimetre (mm) inside diameter hollow-stem augers. Traffic control was performed in accordance with the Ontario Traffic Manual Book 7 – Temporary Conditions by Alliance Traffic Control Inc. of Etobicoke, Ontario.

Soil samples were generally obtained at 0.75 metre (m) and 1.5 m intervals of depth, using 50 mm outside diameter split-spoon samplers driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586)<sup>1</sup>. Field vane shear tests were conducted in cohesive soils for measurement of undrained shear strengths (ASTM D2573)<sup>2</sup> using an MTO Standard 'N'-size vane.

The groundwater levels in the open boreholes were observed during and upon completion of drilling. The boreholes were backfilled in accordance with Ontario Regulation 903 Wells (as amended).

The field work was monitored by members of Golder's technical staff who located the boreholes in the field, arranged for the clearance of underground utilities, supervised the drilling and sampling operations, logged the boreholes, and examined the soil samples. The soil samples were identified in the field, placed in individually labelled containers, and transported to Golder's geotechnical laboratory in Mississauga for further examination and laboratory testing. Index and classification testing consisting of water contents, grain size distributions, and Atterberg limits determinations were carried out on selected soil samples. The geotechnical laboratory testing was completed according to MTO LS and ASTM standards, as applicable. Further, four soil samples were obtained using appropriate protocols and submitted to a specialist analytical laboratory under chain of custody procedures for testing a suite of parameters including pH, resistivity, conductivity, chlorides, sulphates, and sulphides.

The as-drilled borehole locations and corresponding ground surface elevations were surveyed on-site by Callon Dietz Inc. of London, Ontario. The NAD83 Canadian Spatial Reference System (CSRS) V6:2010 MTM Zone 10 northing and easting coordinates, World Geodetic System 1984 (WGS 84) geographic coordinates, ground surface elevations (referenced to the Canadian Geodetic Vertical Datum (CGVD) 1928:1978 adjustment), and borehole depths at each location are presented on the borehole records in Appendix A and are summarized below.

| Borehole No. | Location (MTM And 83 Zone 10) |          | Location (WGS 84) |               | Ground Surface Elevation (m) | Borehole Depth (m) |
|--------------|-------------------------------|----------|-------------------|---------------|------------------------------|--------------------|
|              | Northing                      | Easting  | Latitude (°)      | Longitude (°) |                              |                    |
| HMLP-1       | 4941167.0                     | 308976.7 | 44.610507         | -79.447381    | 255.8                        | 12.8               |
| HMLP-2       | 4941281.0                     | 309099.3 | 44.611532         | -79.445836    | 256.3                        | 12.8               |
| HMLP-3       | 4941112.0                     | 309117.4 | 44.610011         | -79.445609    | 256.8                        | 12.8               |
| HMLP-4       | 4941051.0                     | 309237.5 | 44.609461         | -79.444096    | 257.7                        | 12.8               |

<sup>1</sup> ASTM D1586/D1586M-18 Standard Test Method for Standard Penetration Test (SPT) and Split Barrel Sampling of Soils.

<sup>2</sup> ASTM D2573/D2573M-18 Standard Test Method of Field Vane Shear Test in Saturated Fine-Grained Soils.



## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

Based on the Surficial Geology of Southern Ontario<sup>3</sup> mapping, the Coldwater Road interchange site is located within a glaciolacustrine plain deposit, primarily consisting of sand and gravel with minor silt and clay foreshore and basinal deposits, bordered by stone-poor, sandy silt to silty sand till deposits.

Based on geological mapping by the Ministry of Northern Development and Mines (MNDM)<sup>4</sup>, the site is underlain by bedrock from the Ordovician era consisting of limestone, dolostone, shale, arkose, and sandstone from the Simcoe Group.

### 4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of the in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix A. The detailed results of the geotechnical laboratory testing are contained in Appendix B. The results of the in situ field tests (i.e., SPT 'N' values and field vane undrained shear strengths), as presented in the Record of Borehole sheets and in the subsections below, are uncorrected. The stratigraphic boundaries shown in the Record of Borehole sheets are inferred from non-continuous sampling and therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface soils encountered at the site generally consisted of surficial layers of topsoil and/or fill materials underlain by a deposit of silty sand to sand, which is interrupted by relatively thin deposits of silt and clayey-silt to silt. Detailed descriptions of the subsurface conditions encountered in the boreholes are provided in the following subsections.

#### 4.2.1 TOPSOIL – SILTY SAND (SM)

A 50 mm to 700 mm thick layer of dark brown to brown, moist, silty sand topsoil, trace to some gravel, trace to some organics was encountered at the ground surface in Boreholes HMLP-1 to HMLP-4 (Elev. 257.7 m to 255.8 m).

SPT 'N'-values measured within the topsoil were 7 blows and 21 blows indicating a loose to compact state of compactness.

Materials designated as topsoil were classified based solely on visual and textural evidence. Testing of organic content or for other nutrients was not carried out. Therefore, the use of materials classified as topsoil cannot be relied upon for support and growth of landscape vegetation.

#### 4.2.2 SILTY SAND (SM) to SAND (SP-SM) FILL

A 0.5 m to 1.7 m thick deposit of brown, moist, silty sand to sand fill, trace gravel was encountered below the topsoil in Boreholes HMLP-1 to HMLP-3. The surface of the silty sand to sand fill was encountered between Elevations 256.3m and 255.7 m.

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<sup>3</sup> Ministry of Natural Resources, Surficial Geology of Southern Ontario. Ontario Geological Society Electronic Mapping.

<sup>4</sup> Ministry of Northern Development of Mines. Bedrock Geology of Ontario – Southern Sheet, Ontario Geological Survey – Map 2544.



SPT 'N'-values measured within the silty sand to sand fill ranged from 5 blows to 19 blows per 0.3 m of penetration, indicating a loose to compact state of compactness.

Water contents measured on two samples of the silty sand to sand fill were 9% and 15%.

#### **4.2.3 CLAYEY SILT-SILT (CL-ML) FILL**

A 1.5 m thick deposit of brown, moist, sandy clayey silt-silt fill, was encountered below sand fill in Borehole HMLP-2. The clayey silt-silt fill was encountered at Elevation 255.6 m and extended to Elevation 254.1m.

SPT 'N'-values measured within the clayey silt-silt fill ranged from 14 to 23 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency.

Water contents measured on two samples of the clayey silt-silt fill were 15% and 16%.

The results of a grain size distribution test completed on one sample of the clayey-silt to silt fill are presented in Figure B-1 in Appendix B.

Atterberg limits testing on one sample of the clayey silt-silt fill yielded a liquid limit of about 21%, a plastic limit of about 16%, and a corresponding plasticity index of about 5%, indicating clayey silt of low plasticity to a slightly plastic silt. The results of the Atterberg limits test are presented in Figure B-2 in Appendix B.

#### **4.2.4 SILTY SAND (SM) to SAND (SP-SM)**

A 3.0 m to 6.5 m thick upper deposit of brown, moist to wet, silty sand, trace clay was encountered below the silty sand to sand fill in Boreholes HMLP-1 and HML-3, the clayey-silt to silt fill in Borehole HMLP-2 and the topsoil in Borehole HMLP-4. The surface of the upper silty sand to sand deposit was encountered between Elevation 257.0 m and 254.1 m.

SPT 'N'-values measured within the upper silty sand to sand deposit ranged from 2 blows to 70 blows per 0.3 m of penetration, indicating a very loose to very dense state of compactness.

The water contents measured on six samples of the upper silty sand to sand deposit range from 5% to 16%.

The results of grain size distribution tests completed on four samples of the upper silty sand to sand deposits are presented in Figure B-3 in Appendix B.

#### **4.2.5 SILT (ML)**

A 0.8 m to 3.0 m thick deposit of brown, moist to wet, silt, trace gravel, trace sand, trace to some clay was encountered below the upper silty sand to sand deposit in Boreholes HMLP-1 to Borehole HMLP-4. The surface of the silt deposit was encountered between Elevations 252.1 m and 248.4 m.

SPT 'N'-values measured within the silt deposit ranged between 11 blows and 75 blows per 0.3 m of penetration, indicating a compact to very dense state of compactness.

Water contents measured on five samples of the silt deposit range from about 19% to 22%.

The results of grain size distribution tests completed on four samples of the silt deposit are presented in Figure B-4 in Appendix B.

Atterberg limits testing on five samples of the silt deposit yielded liquid limits of about 20% to 22%, plastic limits of about 17% to 19%, and corresponding plasticity indices of about 1% to 3%, indicating a silt of slight plasticity. The results of the Atterberg limits tests are presented in Figure B-5 in Appendix B.

#### 4.2.6 CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL)

A 0.8 m to 1.5 m thick deposit of brown, wet, clayey silt-silt to clayey silt, trace to some sand, trace gravel was encountered below the silt deposit in Boreholes HMLP-1 to HMLP-4. The surface of the clayey silt to silt deposit was encountered between Elevation 250.2 m and 247.5 m.

SPT 'N'-values measured within the clayey silt-silt to clayey silt deposit were 19 blows and 21 blows per 0.3 m of penetration, indicating a very stiff consistency. In one instance, the split-spoon sampler did not penetrate the entire SPT depth, due to refusal conditions (i.e., split-spoon bouncing) on an inferred cobble (or possible boulder) obstruction.

Water contents measured on three samples of the clayey silt-silt to clayey silt range from about 15% to 24%.

The results of grain size distribution tests completed on a sample of the clayey silt-silt to clayey silt deposit are presented in Figure B-6 in Appendix B.

Atterberg limits testing on three samples of the clayey silt-silt to clayey silt yielded liquid limits of about 18% to 24%, plastic limits of about 13% to 16%, and corresponding plasticity indices of about 5% to 8%, indicating a clayey silt-silt to clayey silt of low plasticity. The results of the Atterberg limits tests are presented in Figure B-7 in Appendix B.

#### 4.2.7 SILTY SAND (SM) to SAND (SP-SM) - Lower

A lower deposit of brown, wet, silty sand to sand, trace gravel, trace silt, trace clay was encountered below the clayey silt-silt to clayey silt deposit in Boreholes HMLP-1 to HMLP-4. The surface of the deposit was encountered between Elevations 249.4 m and 246.0 m and Boreholes HMLP-1 to HMP-4 were terminated after penetrating 1.1 m to 6.4 m into the deposit.

SPT 'N'-values measured within the lower silty sand to sand deposit ranged from 9 blows to 58 blows per 0.3 m of penetration, indicating a loose to very dense state of compactness.

The water contents measured on five samples of the lower silt sand to sand deposit range from 11% to 19%.

The results of grain size distribution test completed on five samples of the lower silty sand to sand deposit are presented in Figure B-8 in Appendix B.

### 4.3 Groundwater Conditions

The groundwater levels were measured within the open boreholes upon completion of drilling. The observed groundwater conditions are summarized in the table below. Groundwater levels are subject to seasonal fluctuations and variations due to precipitation events and snow melt conditions.

| Borehole No. | Groundwater Level |               | Date         | Reading Type                                   |
|--------------|-------------------|---------------|--------------|--|
|              | Depth (m)         | Elevation (m) |              |  |
| HMLP-1       | 5.6               | 250.2         | 31 Oct. 2022 | Open borehole<br>(upon completion of drilling) |
| HMLP-2       | 4.2               | 252.1         | 1 Nov. 2022  |  |
| HMLP-3       | 8.2               | 248.6         | 2 Nov. 2022  |  |
| HMLP-4       | 5.6               | 252.1         | 10 May 2021  |  |

## 4.4 Analytical Testing

The results of analytical testing of four soil samples, which were submitted to Bureau Veritas (an accredited analytical testing laboratory), are detailed in the laboratory test report (Certificate of Analysis) included in Appendix C and are summarized below.

| Borehole and Sample No.   | Depth / Elevation (m) | Resistivity (ohm-cm) | Conductivity (µmho/cm) | pH   | Chloride (µg/g)  | Sulphate (µg/g)  | Sulphide (mg/kg) |
|---------------------------|-----------------------|----------------------|------------------------|------|------------------|------------------|------------------|
| HMLP-1<br>Sample No. 3    | 1.8 / 254.0           | 13,000               | 76                     | 7.86 | <20 <sup>1</sup> | <20 <sup>1</sup> | 0.8              |
| HMLP-2 SA<br>Sample No. 3 | 1.8 / 254.5           | 11,000               | 95                     | 7.18 | <20 <sup>1</sup> | <20 <sup>1</sup> | <0.5             |
| HMLP-3<br>Sample No. 3    | 1.8 / 255.0           | 18,000               | 55                     | 7.12 | <20 <sup>1</sup> | <20 <sup>1</sup> | 0.7              |
| HMLP-4<br>Sample No. 3    | 1.8 / 255.8           | 19,000               | 53                     | 7.36 | <20 <sup>1</sup> | <20 <sup>1</sup> | 0.9              |

Note 1: Chloride and sulphate concentrations are less than the reportable detection limit (RDL).

## 5.0 CLOSURE

The field drilling program was supervised by Mr. Kevin Rupke, P.Geo., C.E.T. and Mr. Maor Levy under the overall direction of Mr. Mark Henderson, P.Eng., and Mr. David Muldowney, P.Eng. The Foundation Investigation Report was prepared by Mr. Mark Henderson, P.Eng., and Mr. David Muldowney, P.Eng., an MTO Foundations Designated Contact, conducted an independent technical and quality control review of the report.

## Signature Page

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**PART B**

**FOUNDATION DESIGN REPORT  
HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE  
HIGH MAST LIGHT POLE RELOCATIONS  
TOWNSHIP OF ORILLIA, DISTRICT OF OWEN SOUND  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 2494-15-00**

## 6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

### 6.1 General

This section of the report provides geotechnical engineering parameters and foundation recommendations for the design of four replacement high mast light poles (HMLPs) at the Highway 11/12 Coldwater Road interchange. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the subsurface exploration. The design report, with the interpretation and recommendations, is intended for the use of the Ministry of Transportation to provide the designers with sufficient information to carry out detail design of the HMLP foundations and shall not be used or relied upon for any other purpose or by any other parties, including the constructor or design-build contractor. The contractor must make their own interpretation based on the factual data in the Foundation Investigation Report (i.e., Part A of the report). Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions or operation constraints may be required in the Contract Documents. Contractors must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

### 6.2 Design of High Mast Light Pole Foundations

In general, the as-drilled boreholes (HMLP-1 to HMLP-4) are located within approximately 2 m to 3 m of the proposed HMLP foundations. The HMLP foundations should be designed in accordance with MTO's *Guidelines for the Design of High Mast Pole Foundations*, (MTO 2004), based on the interpreted stratigraphy and groundwater conditions and the recommended geotechnical design parameters given in Table 1 following the text of this report. Table 1 provides a summary of the subsurface conditions encountered within the borehole advanced at each HMLP location. The parameters presented in Table 1 are based on field and laboratory test data as well as accepted correlations (NAVFAC, 1986, Bowles, 1997, and Kulhawy and Mayne, 1990) and the analysis was tempered by engineering judgement based on experience in similar soils.

Where both undrained shear strength,  $S_u$ , and effective stress,  $\phi'$ , parameter values are provided in Table 1, for the cohesive deposits, the structural assessment should be completed for both the undrained and drained soil cases, and the more conservative approach (design) should be adopted.

In the design of the foundations, the passive resistance of the soil within the upper 1.7 m below ground surface should be neglected to account for frost action as interpreted from OPSD 3090.101 (Foundation, Frost Penetration Depth for Southern Ontario). Horizontal deflection is required to fully mobilize passive earth pressure conditions. For granular soils, the passive condition requires a horizontal deflection of about 2% to 4% of the HMLP foundation length for full mobilization. For cohesive soils, the passive condition requires a horizontal deflection of about 5% of the pole foundation length for full mobilization<sup>5</sup>. Therefore, the values of  $K_p$  provided in Table 1 may need to be reduced by an appropriate factor to account for such conditions.

<sup>5</sup> Clough, G.W. & Duncan, J.M. 1991. Earth Pressures. In *Foundation Engineering Handbook*, ed. H-Y. Fang, pp. 224-235. Van Nostrand Reinhold, New York.

## 6.2.1 Resistance to Lateral Loads

The design of footings/drilled shafts subjected to lateral loads should take into account such factors as the relative rigidity of the drilled shaft to the surrounding soil, the structural capacity of the footings/drilled shafts to withstand bending moments, the soil resistance that can be mobilized, the tolerable lateral deflections at the top of the footings/drilled shaft. For design purposes, both the structural and geotechnical resistances should be evaluated to establish the governing case.

The resistance to lateral loading in front of a footing/drilled shaft may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction,  $k_h$  (kPa/m), is based on the equations below. However, the response of a footing/drilled shaft to lateral loads is highly non-linear and methods that assume linear behavior (such as subgrade reaction theory) are only appropriate where the maximum drilled shaft deflections are less than 1% of the pile or drilled shaft diameter, where the loading is static (no cycling) and where the pile material is linear (CFEM, 2006). If one or more of these conditions are not satisfied, lateral pile analysis should be carried out using p-y curves.

For non-cohesive soils:

$$k_h = \frac{n_h z}{B}$$

where:

- $n_h$  = coefficient related to soil density (kPa/m)
- $z$  = depth of the caisson below finished grade (m), and,
- $B$  = width of pile or diameter of drilled shaft (m)

For cohesive soils:

$$k_h = \frac{67s_u}{B}$$

where:

- $s_u$  = undrained shear strength of the soil (kPa), and,
- $B$  = width of pile or diameter of drilled shaft (m)

The values of  $n_h$  (Terzaghi, 1955) and  $s_u$  to be incorporated into the calculations of the coefficient of horizontal subgrade reaction ( $k_h$ ) within the native overburden, to be used for the structural analysis of the footings/drilled shafts at this site are summarized in Table 1 following the text of this report.

## 6.3 Construction Considerations

### 6.3.1 Foundations

The foundations for the HMLPs are assumed to consist of drilled shafts (caissons). The drilled shafts (caissons) should be constructed in accordance with Ontario Provincial Standard Specification, provincially oriented (OPSS.PROV) 631 (Concrete Footings and Maintenance Platforms for High Mast Lighting Poles) and OPSS.PROV 903 (Deep Foundations), as amended by the attached Non-Standard Design Build Special Provision (NSBDSP) 0903.



### 6.3.2 Control of Soil and Groundwater

The unstabilized groundwater levels measured in the open boreholes upon completion of drilling ranged from about Elevations 248.6 m to 252.1 m. Standpipe piezometers were previously installed in Boreholes CR-7 and CR-3 in support of the Highway 12 Coldwater Road Underpass replacement. The stabilized groundwater levels within the piezometers ranged from about Elevation 251.1 on 7 October 2021 and Elevation 251.3 m on 28 September 2021. Additional details regarding the subsurface (soil and groundwater) conditions encountered within Boreholes CR-3 and CR-7 are provided in our previously issued Foundation Investigation and Design report for the Highway 12 Coldwater Road Underpass Replacement (GEOCRE 31D-802). For the HMLP foundations, a groundwater level at Elevation 251.5 m (i.e., stabilized piezometer readings rounded up to the nearest 0.5 m) has been selected for design purposes, as shown in Table 1. The piezometers installed in Boreholes CR-3 and CR-7 will remain operational so they can be used by the Design-Builder in the future bid or execution phase; they are then to be decommissioned by the successful Design-Build Contractor.

Water-bearing non-cohesive soils, as encountered in the boreholes at this site, should be expected to run or flow into the holes for the drilled shafts during or after drilling for the HMLP foundations. Therefore, appropriate equipment and procedures, such as use of casings and water/drilling fluid to maintain a positive head of pressure within the drilled hole, will be required to minimize ground loss during drilling. Further, concrete should be placed using tremie techniques. As noted in section 4.3, groundwater levels are subject to seasonal fluctuations and variations due to precipitation events and snow melt conditions.

### 6.3.3 Obstructions

Cobble (and potentially boulder) obstructions are inferred to be present within the clayey silt deposit based on an instance of split-spoon refusal (i.e., hammer bouncing) as encountered in Boreholes HMPL-2. As these obstructions could affect the installation of HMLP foundation systems, it is recommended that a Notice to Contractor be developed during detail design to alert the Design-Build Contractor to the presence of cobble/boulder obstructions. Note that the extent and depth of the cobble and boulder obstructions may vary beyond and between the borehole locations.

### 6.3.4 Corrosion Assessment and Protection

The results of analytical testing on selected soil samples from each HMLP borehole are presented in Section 4.4 and the analytical laboratory test report is included in Appendix C. The suite of parameters tested is intended to allow the design engineer to assess the requirements for the appropriate type of cement to be used in construction and the need for corrosion protection of steel elements.

The analytical test results for sulphate were compared to CSA A23.1 Table 3 (*“Additional requirements for concrete subjected to sulphate attack”*) to assess the potential severity of sulphate attack on concrete during its service life. The sulphate concentration measured on the submitted soil samples are less than 0.002%, which is below the Moderate degree of exposure (i.e., below the Class S-3 exposure limits) and the degree of sulphate attack is considered ‘Negligible’ according to Table 7.2 in MTO’s *Gravity Pipe Design Guidelines* (2014). Therefore, based on the soil samples tested, when the designer is selecting the exposure class for the concrete structure, the effects of sulphates from within the site soils in contact with any portion of the proposed structures constructed below the ground surface may not need to be considered.

The measured pH ranged between 7.18 and 7.86. According to the MTO Gravity Pipe Design Guidelines (2014), a pH less than 5.5 is considered strongly acidic while a pH greater than 8.5 is considered strongly alkaline; both of which are indicative of an increased potential for corrosion. It should be noted that the water levels in the area are subject to seasonal fluctuations and variations due to the precipitation events and the soil/water chemistry could also be variable.

The resistivity measured in the tested soil samples (ranging between 11,000 ohm-cm and 19,000 ohm-cm) indicates that the soil corrosiveness is very low ( $R > 10,000$ ) as per Table 3.2 of the *Gravity Pipe Design Guidelines* (MTO, 2014). However, given that the structure foundations could be exposed to de-icing salts from the adjacent highways and/or interchange ramps, consideration should be given by the designer to designing for a "C" type exposure class as defined by CSA A23.1 Table 1.

These recommendations are provided as guidance only; the structural designer should take the results of the laboratory testing and the potential for corrosion into consideration as part of the materials selection. Ultimately, it is the Design-Build Contractor's decision to determine the appropriate exposure class and to ensure that all aspects of CSA A23.1 Section 4.1.1 (Durability Requirements) are satisfied.

## 7.0 CLOSURE

This Foundation Design Report was prepared by Mr. Mark Henderson, P.Eng. Mr. David Muldowney, P.Eng., an MTO Foundations Designated Contact for WSP Golder, conducted an independent technical and quality control review of this report.

## Signature Page

### Golder Associates Ltd.



Mark Henderson, P.Eng.  
*Geotechnical Engineer*



David Muldowney, P.Eng.  
*MTO Foundations Designated Contact / Senior Engineer*

MH/DAM/ca

[https://golderassociates.sharepoint.com/sites/120052/project files/6 deliverables/2. reporting/07 - hmlp/3. final/rev0/19135676-r-rev0-8000-coldwater hmlp fidr 13jan\\_23.docx](https://golderassociates.sharepoint.com/sites/120052/project%20files/6%20deliverables/2.%20reporting/07%20-%20hmlp/3.%20final/rev0/19135676-r-rev0-8000-coldwater%20hmlp%20fidr%2013jan_23.docx)

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### ASTM International

|            |   |
|------------|---|
| ASTM D1586 | Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils |
| ASTM D2573 | Standard Test Method of Field Vane Shear Test in Saturated Fine-Grained Soils         |

### Ontario Provincial Standard Drawings (OPSD)

|               |   |
|---------------|---|
| OPSD 3090.101 | Foundation, Frost Penetration Depths for Southern Ontario |
|---------------|---|

### Ontario Provincial Standard Specifications (OPSS)

|               |   |
|---------------|---|
| OPSS.PROV 903 | Construction Specification for Deep Foundations   |
| OPSS.PROV 631 | Construction Specification for Concrete Footings and Maintenance Platforms for High Mast Lighting Poles |

### Ontario Water Resource Act

|                |                    |
|----------------|--------------------|
| Regulation 903 | Wells (as amended) |
|----------------|--------------------|

TABLE 1  
GEOTECHNICAL DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS

| Reference Borehole | Ground Surface Elevation at Reference Borehole (m) | Design Groundwater Elevation <sup>1</sup> (m) | Stratum  | Depth Relative to Existing Ground Surface (m) <sup>2</sup> | Elevation in Reference Borehole (m) | Design Parameters <sup>3, 4</sup> |    |                        |                         |                        |                |                   |
|--------------------|--|---|--|--|-------------------------------------|-----------------------------------|----|------------------------|-------------------------|------------------------|----------------|-------------------|
|                    |  |   |  |  |                                     | S <sub>u</sub> (kPa)              | Φ' | γ (kN/m <sup>3</sup> ) | γ' (kN/m <sup>3</sup> ) | n <sub>h</sub> (kPa/m) | K <sub>p</sub> | K <sub>p2:1</sub> |
| HMLP-1             | 255.8  | 251.5   | Silty sand topsoil   | 0.0 to 0.1   | 255.8 to 255.7                      | -                                 | 27 | 12                     | 2                       | -                      | -              | -                 |
|                    |  |   | Compact silty sand fill                                      | 0.1 to 0.7   | 255.7 to 255.1                      | -                                 | 34 | 20                     | 10                      | 6500                   | 3.54           | 1.34              |
|                    |  |   | Loose to compact silty sand                                  | 0.7 to 3.7   | 255.1 to 252.1                      | -                                 | 32 | 19                     | 9                       | 6500                   | 3.25           | 1.23              |
|                    |  |   | Compact silt (above the groundwater level)                   | 3.7 to 4.3   | 252.1 to 251.5                      | -                                 | 30 | 18                     | 8                       | 6500                   | 3.00           | 1.12              |
|                    |  |   | Compact silt (below the groundwater level)                   | 4.3 to 5.6   | 251.5 to 250.2                      |                                   | 30 | 18                     | 8                       | 4500                   | 3.00           | 1.12              |
|                    |  |   | Clayey silt-silt   | 5.6 to 6.4   | 250.2 to 249.4                      | 100                               | 30 | 17                     | 7                       | 4500                   | 3.00           | 1.12              |
|                    |  |   | Compact to dense sand  | 6.4 to 11.1  | 249.4 to 244.7                      | -                                 | 32 | 19                     | 9                       | 11000                  | 3.25           | 1.23              |
|                    |  |   | Dense silty sand   | 11.1 to 12.8   | 244.7 to 243.0                      | -                                 | 32 | 19                     | 9                       | 11000                  | 3.25           | 1.23              |
| HMLP-2             | 256.3  | 251.5   | Silty sand topsoil   | 0.0 to 0.2   | 256.3 to 256.1                      | -                                 | 27 | 12                     | 2                       | -                      | -              | -                 |
|                    |  |   | Compact sand fill  | 0.2 to 0.7   | 256.1 to 255.6                      | -                                 | 34 | 20                     | 10                      | 6000                   | 3.54           | 1.34              |
|                    |  |   | Stiff to very stiff clayey silt-silt fill                    | 0.7 to 2.2   | 255.6 to 254.1                      | 100                               | 30 | 17                     | 7                       | 6500                   | 3.00           | 1.12              |
|                    |  |   | Loose to very dense silty sand (above the groundwater level) | 2.2 to 4.1   | 254.1 to 251.5                      | -                                 | 32 | 19                     | 9                       | 6500                   | 3.25           | 1.23              |
|                    |  |   | Dense silty sand (below the groundwater level)               | 4.1 to 7.9   | 251.5 to 248.8                      | -                                 | 32 | 19                     | 9                       | 11000                  | 3.25           | 1.23              |
|                    |  |   | Silt   | 7.9 to 8.7   | 248.4 to 247.6                      | -                                 | 30 | 18                     | 8                       | 4500                   | 3.00           | 1.12              |
|                    |  |   | Clayey silt  | 8.7 to 10.2  | 247.6 to 246.1                      | 100                               | 30 | 17                     | 7                       | 4500                   | 3.00           | 1.12              |
|                    |  |   | Compact to very dense sand                                   | 10.2 to 12.8   | 246.1 to 243.5                      | -                                 | 32 | 19                     | 9                       | 11000                  | 3.25           | 1.23              |
| HMLP-3             | 256.8  | 251.5   | Compact silty sand topsoil                                   | 0.0 to 0.5   | 256.8 to 256.3                      | -                                 | 27 | 12                     | 2                       | -                      | -              | -                 |
|                    |  |   | Loose to compact silty sand fill                             | 0.5 to 2.2   | 256.3 to 254.6                      | -                                 | 34 | 20                     | 10                      | 2500                   | 3.54           | 1.34              |
|                    |  |   | Loose sand   | 2.2 to 5.0   | 254.6 to 251.8                      | -                                 | 32 | 19                     | 9                       | 2500                   | 3.25           | 1.23              |
|                    |  |   | Compact silt (above the groundwater level)                   | 5.0 to 5.3   | 251.8 to 251.5                      | -                                 | 30 | 18                     | 8                       | 6500                   | 3.00           | 1.12              |
|                    |  |   | Compact silt (above the groundwater level)                   | 5.3 to 7.2   | 251.85 to 249.6                     | -                                 | 30 | 18                     | 8                       | 4500                   | 3.00           | 1.12              |
|                    |  |   | Very stiff clayey silt                                       | 7.2 to 8.7   | 249.6 to 248.1                      | 100                               | 30 | 17                     | 7                       | 4500                   | 3.00           | 1.12              |
|                    |  |   | Loose to dense sand  | 8.7 to 12.8  | 248.1 to 244.0                      | -                                 | 32 | 19                     | 9                       | 11000                  | 3.25           | 1.23              |
| HMLP-4             | 257.7  | 251.5   | Loose silty sand topsoil                                     | 0.0 to 0.7   | 257.7 to 257.0                      | -                                 | 27 | 12                     | 2                       | -                      | -              | -                 |
|                    |  |   | Very loose to compact sand (above the groundwater level)     | 0.7 to 3.7   | 257.0 to 254.0                      | -                                 | 32 | 19                     | 9                       | 2500                   | 3.25           | 1.23              |
|                    |  |   | Compact to dense sand (above the groundwater level)          | 3.7 to 6.2   | 254.0 to 251.5                      | -                                 | 32 | 19                     | 9                       | 6500                   | 3.25           | 1.23              |
|                    |  |   | Very loose to dense sand (above the groundwater level)       | 6.2 to 7.2   | 251.5 to 250.5                      | -                                 | 32 | 19                     | 9                       | 4500                   | 3.25           | 1.23              |
|                    |  |   | Dense to very dense silt                                     | 7.2 to 10.2  | 250.5 to 247.5                      | -                                 | 30 | 18                     | 8                       | 11000                  | 3.00           | 1.12              |
|                    |  |   | Very stiff clayey silt                                       | 10.2 to 11.7   | 247.5 to 246.0                      | 100                               | 30 | 17                     | 7                       | 4500                   | 3.00           | 1.12              |
|                    |  |   | Compact silty sand   | 11.7 to 12.8   | 246.0 to 244.9                      | -                                 | 32 | 19                     | 9                       | 1000                   | 3.25           | 1.23              |

NOTES:

1. The design groundwater level was evaluated using stabilized groundwater level readings from standpipe piezometers previously installed in support of the Highway 12 Coldwater Road Underpass replacement (i.e., stabilized piezometer readings from Boreholes CR-7 and CR-3 rounded up to the nearest 0.5 m).
2. Depths are given at the existing borehole location or proposed pole locations relative to the estimated proposed ground surface following construction, including any regrading. Although S<sub>u</sub>, Φ' and K<sub>p</sub> parameters are given for the full depth of the soil, the passive resistance in the upper 1.8 m should be neglected in the high mast light pole design to account for frost action. Design parameters are not provided for topsoil materials since lateral load resistance of these soils should be neglected.
3. Design parameters:

s<sub>u</sub>

= undrained shear strength (kPa);

Φ'

= effective friction angle (degrees);

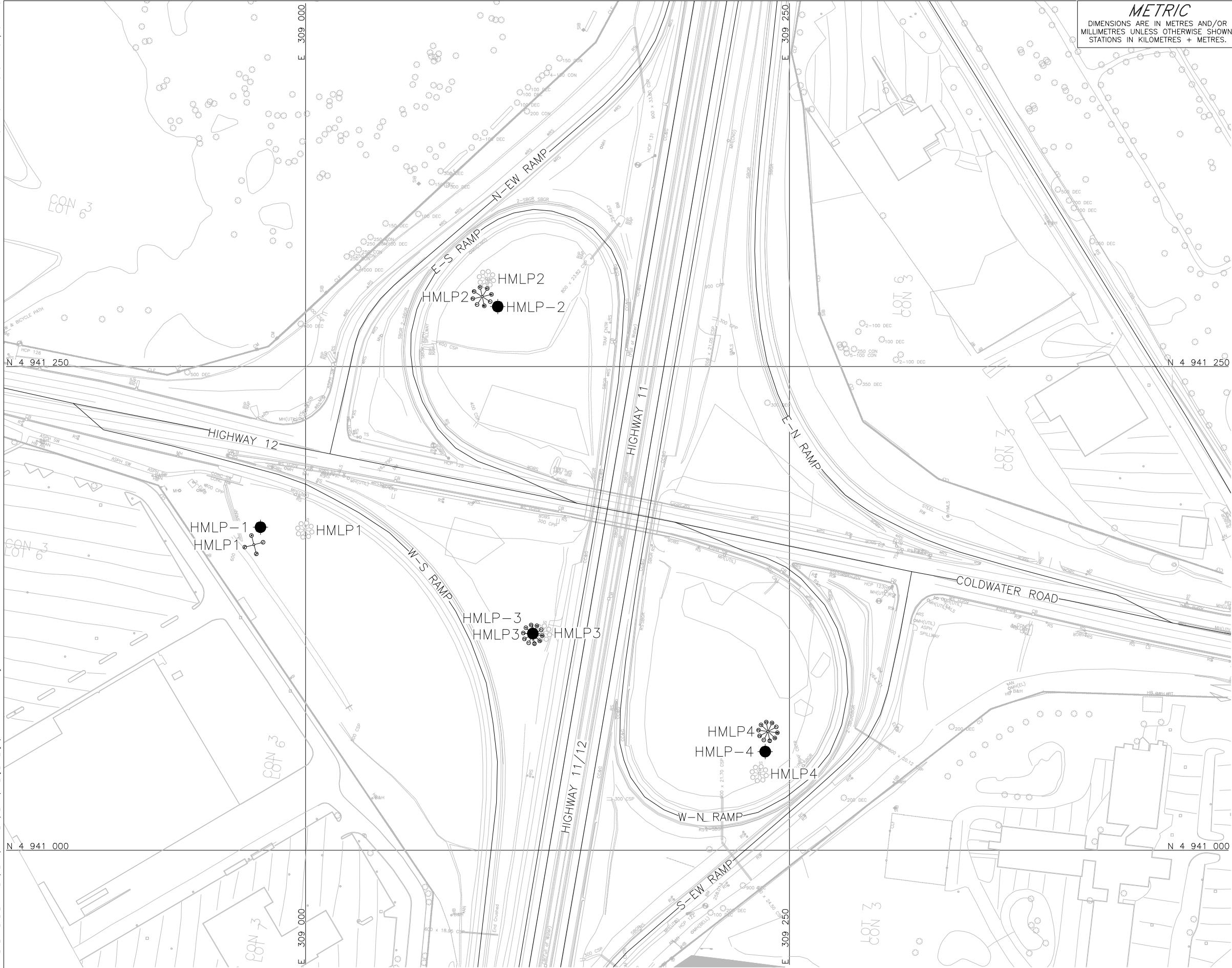
**TABLE 1**  
**GEOTECHNICAL DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS**

|            |   |
|------------|---|
| $\gamma$   | = bulk unit weight (kN/m3);   |
| $\gamma'$  | = effective unit weight below the groundwater level (kN/m3);  |
| $n_h$      | = constant of horizontal subgrade reaction (kPa/m);   |
| $K_p$      | = passive earth pressure coefficient; and   |
| $K_{p2:1}$ | = passive earth pressure coefficient adjusted to account for 2H:1V sloping ground within two caisson diameters of the foundation element. |

*\*\*Kp values are unfactored and should be reduced by an appropriate factor that considers the allowable deflection of the caisson to account for the fact that a large strain would be required for mobilization of the full passive lateral earth pressure.\*\**

4. Where both undrained shear strength and effective friction angle parameters are provided for cohesive materials, the structural assessment should be completed for both undrained and drained conditions, and the selected design should be based on the more conservative approach.



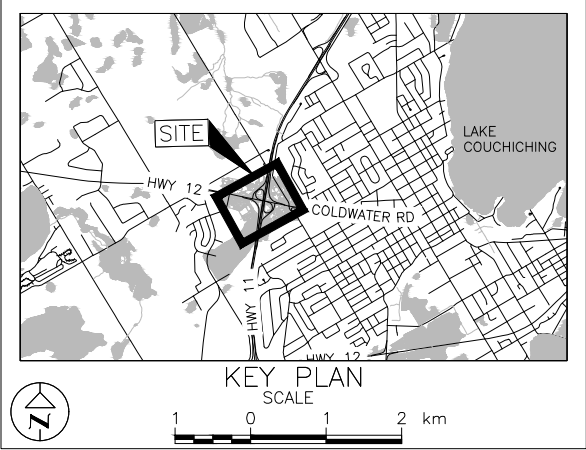


**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No. 2129-18-00

GWP No. 2129-18-00

HIGHWAY 11/12 INTERCHANGE  
HIGH MAST LIGHT POLE (HMLP) RELOCATION  
BOREHOLE LOCATION PLAN



LEGEND

Borehole - Current

Existing HMLP

Proposed HMLP

| BOREHOLE CO-ORDINATES (NAD 83 MTM ZONE 10) |           |           |          |
|--|-----------|-----------|----------|
| No.  | ELEVATION | NORTHING  | EASTING  |
| HMLP-1                                     | 255.8     | 4941167.0 | 308976.7 |
| HMLP-2                                     | 256.3     | 4941281.0 | 309099.3 |
| HMLP-3                                     | 256.8     | 4941112.0 | 309117.4 |
| HMLP-4                                     | 257.7     | 4941051.0 | 309237.5 |



**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.

**REFERENCE**

Base plans provided in digital format by McIntosh Perry, drawing file nos. x\_197147\_BASE.dwg, received May 19, 2021.

| NO.                 | DATE     | BY                   | REVISION |
|---------------------|----------|----------------------|----------|
|                     |          |                      |          |
| Geocres No. 31D-813 |          |                      |          |
| HWY. 11/12          |          | PROJECT NO. 19135676 | DIST. .  |
| SUBM'D. MH          | CHKD. .  | DATE: 01/06/2023     | SITE: .  |
| DRAWN: DD/ZS/SA     | CHKD. MH | APPD. DAM            | DWG. 1   |





**Photograph 1: Existing HMLP-1 facing east**  
(background includes the existing HMLP-3 and HMLP-4 to the left)



**Photograph 2: Existing HMLP-2, facing south**  
(background includes the existing HMLP-3 to the left and HMLP-1 to the right)



**Photograph 3: Existing HMLP-3, facing west**  
*(background includes the existing HMLP-1 to the right and HMLP-2 to the far right)*



**Photograph 4: Existing HMLP-4, facing east**

**APPENDIX A**

# Record of Boreholes

# ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

## MINISTRY OF TRANSPORTATION, ONTARIO

### PARTICLE SIZES OF CONSTITUENTS

| Soil Constituent | Particle Size Description | Millimetres    | Inches (US Std. Sieve Size) |
|------------------|---------------------------|----------------|-----------------------------|
| BOULDERS         | Not Applicable            | >200           | >8                          |
| COBBLES          | Not Applicable            | 75 to 200      | 3 to 8                      |
| GRAVEL           | Coarse                    | 19 to 75       | 0.75 to 3                   |
|                  | Fine                      | 4.75 to 19     | (4) to 0.75                 |
|                  |                           | 2.00 to 4.75   | (10) to (4)                 |
| SAND             | Coarse                    | 0.425 to 2.00  | (40) to (10)                |
|                  | Medium                    | 0.075 to 0.425 | (200) to (40)               |
|                  | Fine                      |                |                             |
| FINES            | Classified by plasticity  | <0.075         | < (200)                     |

### MODIFIERS FOR SECONDARY COMPONENTS<sup>1,2</sup>

| Percentage by Mass | Modifier   |
|--------------------|--|
| > 35               | Use 'and' to combine primary and secondary component (i.e., SAND and gravel) |
| > 20 to 35         | Primary soil name prefixed with "gravelly, sandy" as applicable              |
| > 10 to 20         | some (i.e., some sand)   |
| ≤ 10               | trace (i.e., trace fines)  |

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

### 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.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

#### Cone Penetration Test (CPT)

An 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 (q<sub>t</sub>), porewater pressure (u) and sleeve friction (f<sub>s</sub>) are recorded electronically at 25 mm penetration intervals.

#### Dynamic Cone Penetration Resistance (DCPT); N<sub>d</sub>:

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

### SAMPLES

|           |  |
|-----------|--|
| AS        | Auger sample   |
| BS        | Block sample   |
| CS        | Chunk sample   |
| DD        | Diamond Drilling   |
| DO or DP  | Seamless open ended, driven or pushed tube sampler – note size |
| DS        | Denison type sample  |
| GS        | Grab Sample  |
| MC        | Modified California Samples                                    |
| MS        | Modified Shelby (for frozen soil)                              |
| RC / SC   | Rock core / Soil core  |
| SS        | Split spoon sampler – note size                                |
| ST        | Slotted tube   |
| TO        | Thin-walled, open – note size (Shelby tube)                    |
| TP        | Thin-walled, piston – note size (Shelby tube)                  |
| WS        | Wash sample  |
| OD / ID   | Outer Diameter / Inner Diameter                                |
| HSA / SSA | Hollow-Stem Augers / Solid-Stem Augers                         |

### SOIL TESTS

|                    |   |
|--------------------|---|
| w                  | water content   |
| PL, w <sub>p</sub> | plastic limit   |
| LL, 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   |
| GS                 | specific gravity  |
| 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 (FV)             | field vane (LV-laboratory vane test)  |
| γ                  | unit weight   |

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

### COARSE-GRAINED SOILS

#### Compactness<sup>1</sup>

| Term       | SPT 'N' (blows/0.3m) <sup>2</sup> |
|------------|-----------------------------------|
| Very Loose | 0 to 4                            |
| Loose      | 4 to 10                           |
| Compact    | 10 to 30                          |
| Dense      | 30 to 50                          |
| Very Dense | > 50                              |

1. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

2. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

### FINE-GRAINED SOILS

#### Consistency

| Term       | Undrained Shear Strength (kPa) | SPT 'N' <sup>1,2</sup> (blows/0.3m) |
|------------|--------------------------------|-------------------------------------|
| Very Soft  | < 12                           | 0 to 2                              |
| Soft       | 12 to 25                       | 2 to 4                              |
| Firm       | 25 to 50                       | 4 to 8                              |
| Stiff      | 50 to 100                      | 8 to 15                             |
| Very Stiff | 100 to 200                     | 15 to 30                            |
| Hard       | > 200                          | > 30                                |

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

### Field Moisture Condition

| Term  | Description   |
|-------|---|
| Dry   | Soil flows freely through fingers.                            |
| Moist | Soils are darker than in the dry condition and may feel cool. |
| Wet   | As moist, but with free water forming on hands when handled.  |



# LIST OF SYMBOLS

## MINISTRY OF TRANSPORTATION, ONTARIO

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

#### (a) Index Properties

|                    |  |
|--------------------|--|
| $\rho(\gamma)$     | 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   |

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

#### (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 = $(w_L - w_P)$   |
| NP          | non-plastic  |
| $w_s$       | 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 (normally consolidated range)       |
| $C_r$       | recompression index (over-consolidated range)         |
| $C_s$       | swelling index  |
| $C_{a(e)}$  | secondary compression index                           |
| $C_a$       | rate of secondary compression                         |
| $C_{a(e)}$  | modified 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                         |
| $c'$             | effective cohesion                                       |
| $\phi'$          | effective angle of internal friction                     |
| $\delta$         | angle of interface friction                              |
| $\mu$            | coefficient of friction = $\tan \delta$                  |
| $c_u, s_u$       | 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 or $q'$        | $(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$ |
| $q_u$            | compressive strength $(\sigma_1 - \sigma_3)$             |
| $S_t$            | sensitivity  |

Notes: 1  
2

$\tau = c' + \sigma' \tan \phi'$   
shear strength = (compressive strength)/2

| PROJECT 19135676       |  | RECORD OF BOREHOLE No HMLP-1   |            |      |            | SHEET 1 OF 1            |                 | METRIC                                   |  |  |                           |  |                   |  |  |
|------------------------|--|--|------------|------|------------|-------------------------|-----------------|--|--|--|---------------------------|--|-------------------|--|--|
| G.W.P. 2494-15-00      |  | LOCATION N 4941167.0; E 308976.7 MTM NAD 83 ZONE 10 (LAT. 44.610506; LONG. -79.447381) |            |      |            | ORIGINATED BY KR        |                 |  |  |  |                           |  |                   |  |  |
| DIST Central HWY 11/12 |  | BOREHOLE TYPE 108 mm ID Hollow Stem Augers   |            |      |            | COMPILED BY MH          |                 |  |  |  |                           |  |                   |  |  |
| DATUM Geodetic         |  | DATE October 31, 2022  |            |      |            | CHECKED BY DAM          |                 |  |  |  |                           |  |                   |  |  |
| SOIL PROFILE           |  |  | SAMPLES    |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |  |  | UNIT WEIGHT<br>γ<br>kN/m³ | 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                          |  |  |                           |  |                   |  |  |
| 255.8                  | GROUND SURFACE   |  |            |      |            |                         |                 |  |  |  |                           |  |                   |  |  |
| 0.9                    | TOPSOIL (50 mm) - SILTY SAND (SM), some organics<br>Dark brown<br>Moist  |  | 1A<br>1B   | SS   | 11         |                         |                 |  |  |  |                           |  |                   |  |  |
| 255.1                  | Silty sand (SM), trace clay (FILL)<br>Compact<br>Brown<br>Moist  |  | 2          | SS   | 7          |                         | 255             |  |  |  |                           | 0 57 42 1  |                   |  |  |
| 0.7                    | SILTY SAND (SM), trace clay<br>Loose to compact<br>Brown<br>Moist  |  | 3          | SS   | 8          |                         | 254             |  |  |  |                           |  |                   |  |  |
|                        |  |  | 4          | SS   | 19         |                         | 253             |  |  |  |                           |  |                   |  |  |
|                        |  |  | 5          | SS   | 22         |                         | 252             |  |  |  |                           |  |                   |  |  |
| 252.1                  | SILT (ML), trace clay, trace sand<br>Compact<br>Brown<br>Wet   |  | 6          | SS   | 12         |                         | 251             |  |  |  |                           | 0 6 89 5   |                   |  |  |
| 3.7                    |  |  | 7          | SS   | 11         |                         | 250             |  |  |  |                           |  |                   |  |  |
| 250.2                  | CLAYEY SILT-SILT (CL-ML), some sand, trace gravel<br>Brown<br>Wet  |  | 8A<br>8B   | SS   | 32         |                         | 249             |  |  |  |                           |  |                   |  |  |
| 5.6                    | SAND (SP-SM), trace gravel, trace to some silt<br>Compact to dense<br>Brown<br>Wet   |  | 9          | SS   | 31         |                         | 248             |  |  |  |                           |  |                   |  |  |
| 249.4                  |  |  | 10         | SS   | 39         |                         | 247             |  |  |  |                           |  |                   |  |  |
| 6.4                    |  |  | 11A<br>11B | SS   | 18         |                         | 246             |  |  |  |                           | 5 83 (12)  |                   |  |  |
| 244.7                  | SILTY SAND (SM), trace gravel, trace clay<br>Dense<br>Brown<br>Wet   |  | 12         | SS   | 32         |                         | 245             |  |  |  |                           |  |                   |  |  |
| 11.1                   | -Approximately 0.3 m of heave inside augers at 12.2 m depth (Elev. 253.6 m).   |  |            |      |            |                         | 244             |  |  |  |                           | 2 79 17 2  |                   |  |  |
| 243.0                  | END OF BOREHOLE<br>NOTES:<br>1. Borehole caved to a depth of 6.7 m below ground surface (Elev. 249.1 m) upon completion of drilling.<br>2. Groundwater encountered at a depth of 5.6 m below ground surface (Elev. 250.2 m) upon completion of drilling. |  |            |      |            |                         |                 |  |  |  |                           |  |                   |  |  |
| 12.8                   |  |  |            |      |            |                         |                 |  |  |  |                           |  |                   |  |  |

| PROJECT 19135676       |   | RECORD OF BOREHOLE No HMLP-2   |         |      |            | SHEET 1 OF 1            |                 | METRIC                                   |                 |                 |                           |  |
|------------------------|---|--|---------|------|------------|-------------------------|-----------------|--|-----------------|-----------------|---------------------------|--|
| G.W.P. 2494-15-00      |   | LOCATION N 4941281.0; E 309099.3 MTM NAD 83 ZONE 10 (LAT. 44.611532; LONG. -79.445835) |         |      |            | ORIGINATED BY KR        |                 |  |                 |                 |                           |  |
| DIST Central HWY 11/12 |   | BOREHOLE TYPE 108 mm ID Hollow Stem Augers   |         |      |            | COMPILED BY MH          |                 |  |                 |                 |                           |  |
| DATUM Geodetic         |   | DATE November 1, 2022  |         |      |            | CHECKED BY DAM          |                 |  |                 |                 |                           |  |
| SOIL PROFILE           |   |  | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                 |                 | UNIT WEIGHT<br>γ<br>kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
| ELEV DEPTH             | DESCRIPTION   | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES |                         |                 | SHEAR STRENGTH kPa                       |                 |                 |                           |  |
|                        |   |  |         |      |            |                         |                 | 20 40 60 80 100                          | 20 40 60 80 100 | 20 40 60 80 100 |                           |  |
| 256.3                  | GROUND SURFACE  |  |         |      |            |                         |                 |  |                 |                 |                           |  |
| 0.0                    | TOPSOIL (220 mm) - SILTY SAND (SM), trace gravel, some organics   |  | 1A      | SS   | 10         |                         | 256             |  |                 |                 |                           |  |
| 0.2                    | Dark brown Moist  |  | 1B      |      |            |                         |                 |  |                 |                 |                           |  |
| 255.6                  | Sand (SP-SM), trace silt (FILL) Compact Brown Moist   |  | 2       | SS   | 23         |                         | 255             |  |                 |                 |                           | 0 24 62 14   |
| 0.7                    | Sandy clayey-silt-silt (FILL) Stiff to very stiff Brown Moist   |  | 3       | SS   | 14         |                         |                 |  |                 |                 |                           |  |
| 254.1                  | SILTY SAND (SM), trace clay Loose to very dense Brown Moist   |  | 4       | SS   | 17         |                         | 254             |  |                 |                 |                           |  |
| 2.2                    |   |  | 5       | SS   | 14         |                         | 253             |  |                 |                 |                           |  |
|                        |   |  | 6       | SS   | 8          |                         | 252             |  |                 |                 |                           | 0 84 15 1  |
|                        |   |  | 7       | SS   | 35         |                         | 251             |  |                 |                 |                           |  |
|                        |   |  | 8       | SS   | 70         |                         | 250             |  |                 |                 |                           |  |
|                        |   |  |         |      |            |                         | 249             |  |                 |                 |                           |  |
| 248.4                  | - Becoming wet at about 7.6 m (Elev. 248.7 m)   |  | 9A      | SS   | 45         |                         | 248             |  |                 |                 |                           | 3 4 86 7   |
| 7.9                    | SILT (ML), trace gravel, trace sand, trace clay Brown Wet   |  | 9B      |      |            |                         |                 |  |                 |                 |                           |  |
| 247.6                  | CLAYEY SILT (CL), some sand, trace gravel Brown Wet   |  | 10      | SS   | 100/0.07   |                         | 247             |  |                 |                 |                           |  |
|                        | - Split-spoon refusal (i.e. hammer bouncing) at 9.4 m depth (Elev. 246.9 m)   |  |         |      |            |                         |                 |  |                 |                 |                           |  |
| 246.1                  | SAND (SP-SM), trace silt Compact to very dense Brown Wet  |  | 11      | SS   | 19         |                         | 246             |  |                 |                 |                           | 0 93 (7)   |
|                        |   |  |         |      |            |                         | 245             |  |                 |                 |                           |  |
|                        |   |  | 12      | SS   | 58         |                         | 244             |  |                 |                 |                           |  |
| 243.5                  | END OF BOREHOLE   |  |         |      |            |                         |                 |  |                 |                 |                           |  |
| 12.8                   | NOTES:<br>1. Borehole caved to a depth of 9.0 m below ground surface (Elev. 247.3 m) upon completion of drilling.<br>2. Groundwater encountered at a depth of 4.2 m below ground surface (Elev. 252.1 m) upon completion of drilling. |  |         |      |            |                         |                 |  |                 |                 |                           |  |

GTA-MTO 001 S:\CLIENTS\MTOWHY\_11&amp;12\_OLD\_BARRE\_R\RD\_TO\_COLDWATER\_RD\GPJ GAL-GTA-GDT 1/6/23



| PROJECT 19135676       |   | RECORD OF BOREHOLE No HMLP-3   |         |      |            | SHEET 1 OF 1            |                 | METRIC                                   |  |  |  |  |                   |  |  |
|------------------------|---|--|---------|------|------------|-------------------------|-----------------|--|--|--|--|--|-------------------|--|--|
| G.W.P. 2494-15-00      |   | LOCATION N 4941112.0; E 309117.4 MTM NAD 83 ZONE 10 (LAT. 44.610011; LONG. -79.445608) |         |      |            | ORIGINATED BY KR        |                 |  |  |  |  |  |                   |  |  |
| DIST Central HWY 11/12 |   | BOREHOLE TYPE 108 mm ID Hollow Stem Augers   |         |      |            | COMPILED BY MH          |                 |  |  |  |  |  |                   |  |  |
| DATUM Geodetic         |   | DATE November 2, 2022  |         |      |            | CHECKED BY DAM          |                 |  |  |  |  |  |                   |  |  |
| SOIL PROFILE           |   |  | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | 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 DEPTH             | DESCRIPTION   | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES |                         |                 | SHEAR STRENGTH kPa                       |  |  |  |  | WATER CONTENT (%) |  |  |
|                        |   |  |         |      |            |                         |                 | 20 40 60 80 100                          |  |  |  |  |                   |  |  |
| 256.8                  | GROUND SURFACE  |  |         |      |            |                         |                 |  |  |  |  |  |                   |  |  |
| 0.0                    | TOPSOIL (530 mm) - SILTY SAND (SM), some gravel, some organics  |  | 1       | SS   | 21         |                         |                 |  |  |  |  |  |                   |  |  |
| 256.3                  | Compact Dark brown Moist  |  | 2       | SS   | 19         |                         |                 |  |  |  |  |  |                   |  |  |
| 0.5                    | Silty sand (SM), trace gravel (FILL)  |  | 3       | SS   | 5          |                         |                 |  |  |  |  |  |                   |  |  |
|                        | Loose to compact Brown Moist  |  | 4       | SS   | 5          |                         |                 |  |  |  |  |  |                   |  |  |
| 254.6                  | - Trace organics in Sample No. 2.   |  | 5       | SS   | 5          |                         |                 |  |  |  |  |  |                   |  |  |
| 2.2                    | SAND (SP-SM), trace silt, trace clay  |  | 6       | SS   | 6          |                         |                 |  |  |  |  |  |                   |  |  |
|                        | Loose to compact Brown Moist  |  | 7A      | SS   | 19         |                         |                 |  |  |  |  |  |                   |  |  |
| 251.8                  | - Becoming wet at about 4.6 m depth (Elevation 252.2 m)   |  | 7B      | SS   |            |                         |                 |  |  |  |  |  |                   |  |  |
| 5.0                    | SILT (ML), trace gravel, trace sand, trace clay   |  | 8       | SS   | 27         |                         |                 |  |  |  |  |  |                   |  |  |
|                        | Compact Brown Wet   |  | 9       | SS   | 19         |                         |                 |  |  |  |  |  |                   |  |  |
| 249.6                  | CLAYEY SILT (CL), trace sand, trace gravel  |  | 10      | SS   | 33         |                         |                 |  |  |  |  |  |                   |  |  |
| 7.2                    | Very stiff Brown Wet  |  | 11      | SS   | 9          |                         |                 |  |  |  |  |  |                   |  |  |
| 248.1                  | SAND (SP-SM), trace silt  |  | 12      | SS   | 38         |                         |                 |  |  |  |  |  |                   |  |  |
| 8.7                    | Loose to dense Brown Wet  |  |         |      |            |                         |                 |  |  |  |  |  |                   |  |  |
| 244.0                  | END OF BOREHOLE   |  |         |      |            |                         |                 |  |  |  |  |  |                   |  |  |
| 12.8                   | NOTES:<br>1. Borehole caved to a depth of 8.6 m below ground surface (Elev. 248.2 m) upon completion of drilling.<br>2. Groundwater encountered at a depth of 8.2 m below ground surface (Elev. 248.6 m) upon completion of drilling. |  |         |      |            |                         |                 |  |  |  |  |  |                   |  |  |

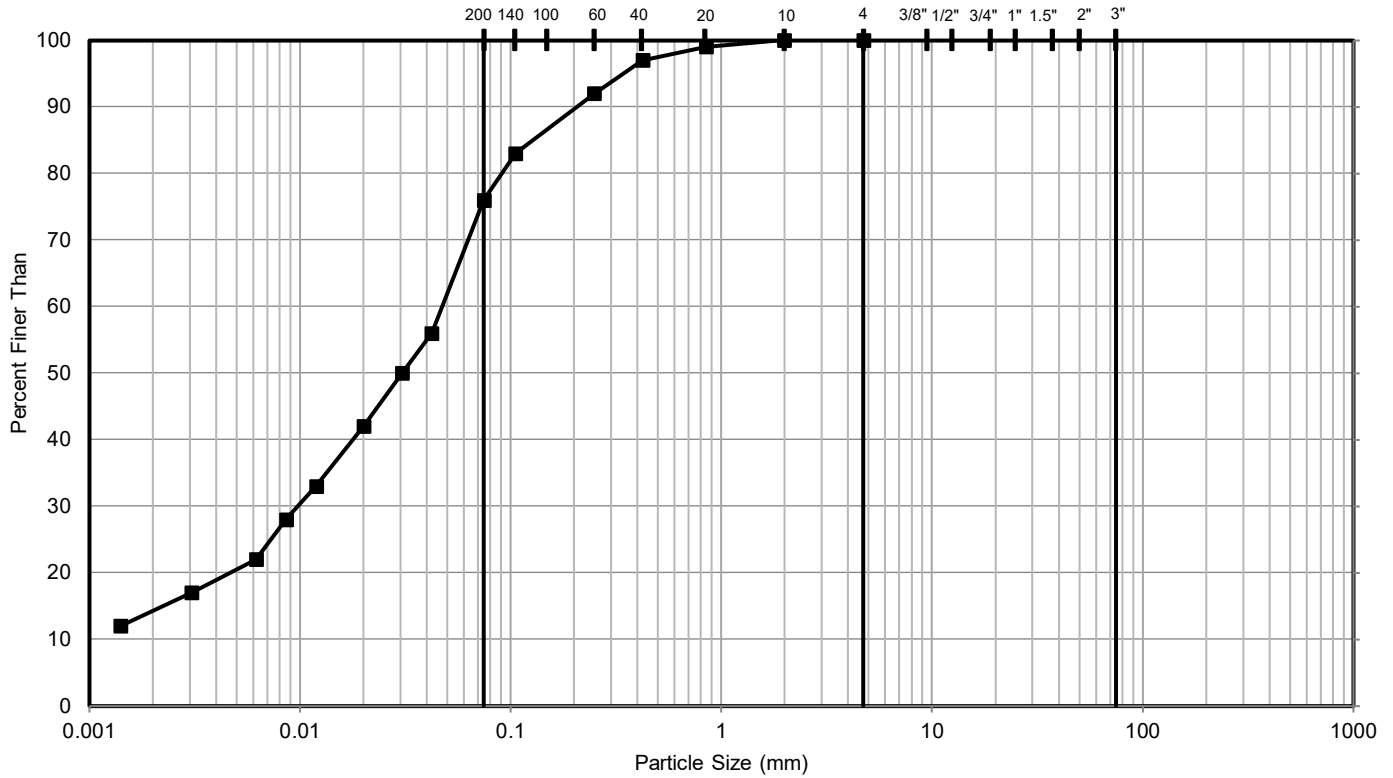
GTA-MTO 001 S:\CLIENTS\MT0\HWY 11&12 OLD BARRIE RD TO COLDWATER RD\02 DATA\GINTHWY 11&12 OLD BARRIE RD TO COLDWATER RD.GPJ GAL-GTA.GDT 16/23

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

**APPENDIX B**

# Geotechnical Laboratory Testing

# GRAIN SIZE DISTRIBUTION



|                    |      |        |        |        |        |         |          |
|--------------------|------|--------|--------|--------|--------|---------|----------|
| FINES (Silt, Clay) | SAND |        |        | GRAVEL |        | COBBLES | BOULDERS |
|                    | Fine | Medium | Coarse | Fine   | Coarse |         |          |

| Symbol | Sample Location | Sample Number | Depth (m) | Elevation (m)  |
|--------|-----------------|---------------|-----------|----------------|
| ■      | HMLP-2          | 2             | 0.8 - 1.4 | 255.5 to 254.9 |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |

CLIENT

McIntosh Perry / MTO

CONSULTANT



YYYY-MM-DD 2022-12-05

DESIGNED MH

PREPARED MH

REVIEWED DAM

APPROVED DAM

PROJECT

HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE  
HIGH MAST LIGHT POLES

TITLE

GRAIN SIZE DISTRIBUTION  
CLAYEY SILT-SILT (CL-ML) (FILL)

PROJECT NO.

19135676

CONTROL

0

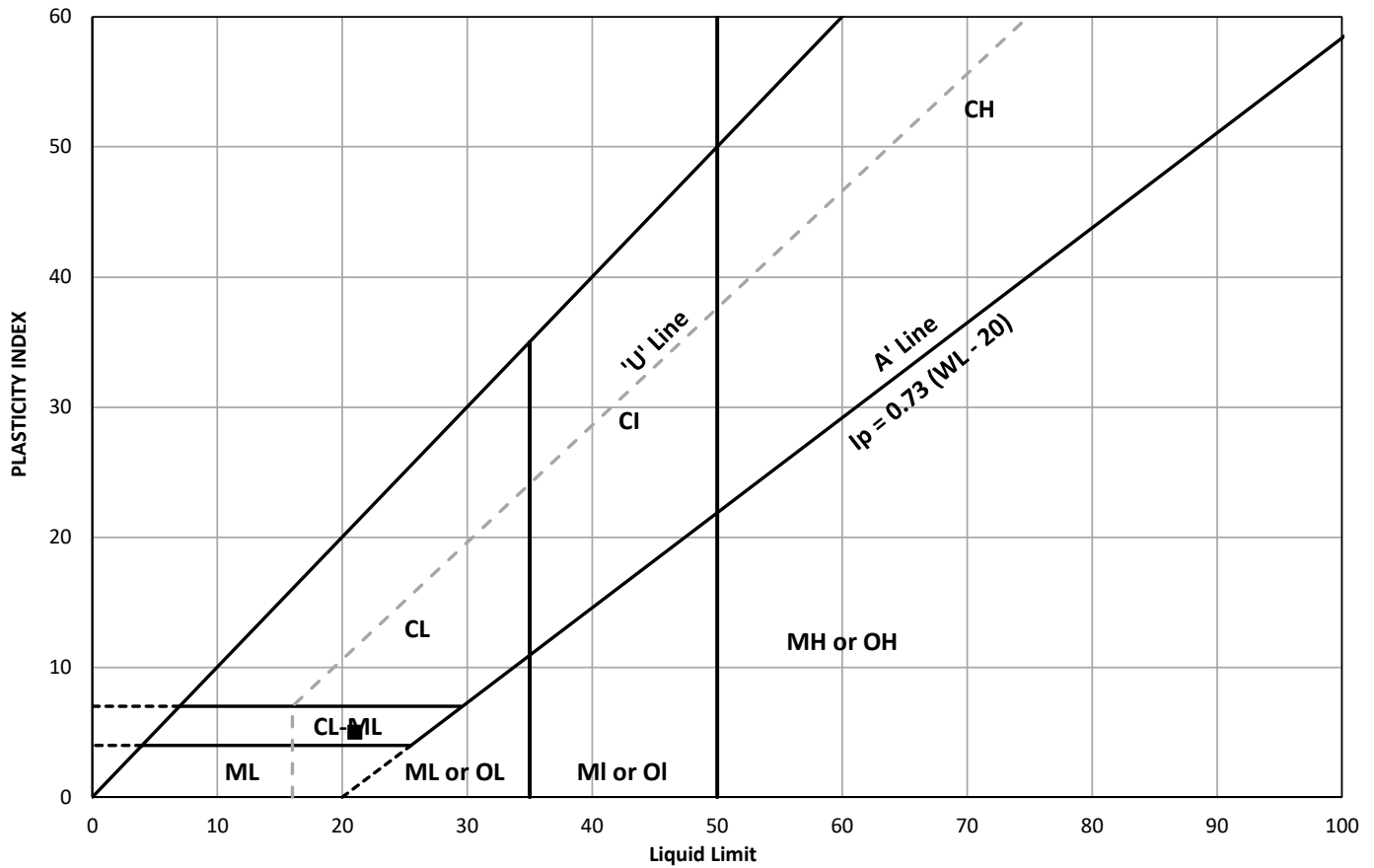
REV.

0

FIGURE

B-1

# PLASTICITY CHART

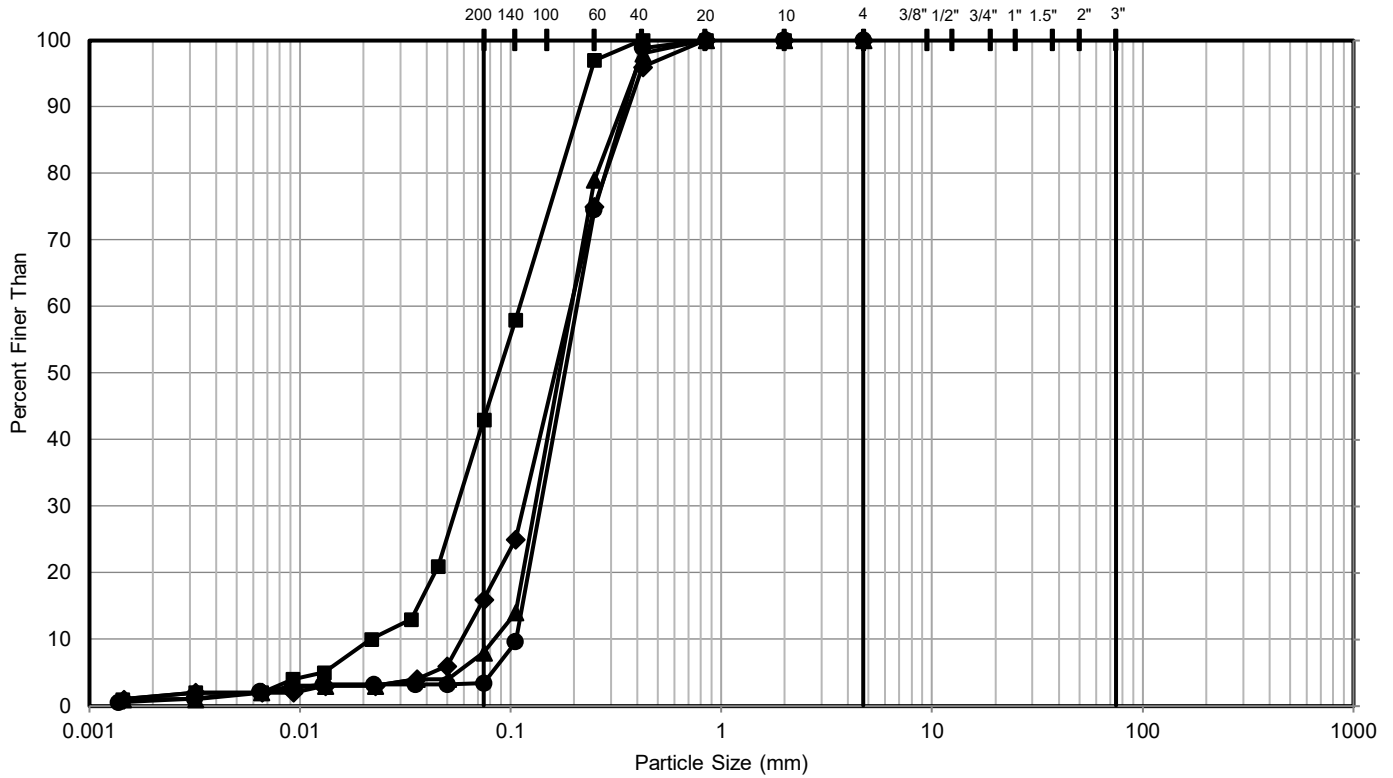


|   | Sample Location | Sample / Specimen Number | Depth (m) | Natural Water Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | Liquidity Index |
|---|-----------------|--------------------------|-----------|---------------------------|--------------|---------------|------------------|-----------------|
| ■ | HMLP-2          | 2                        | 0.8 - 1.4 | 15.2                      | 21           | 16            | 5                | -0.16           |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |

|                      |            |            |
|----------------------|------------|------------|
| CLIENT               |            |            |
| McIntosh Perry / MTO |            |            |
| CONSULTANT           | YYYY-MM-DD | 2022-12-09 |
|                      | DESIGNED   | MH         |
|                      | PREPARED   | MH         |
|                      | REVIEWED   | DAM        |
|                      | APPROVED   | DAM        |

|   |         |      |        |
|---|---------|------|--------|
| PROJECT   |         |      |        |
| HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE<br>HIGH MAST LIGHT POLES |         |      |        |
| TITLE   |         |      |        |
| PLASTICITY CHART<br>CLAYEY SILT-SILT (CL-ML) (FILL)               |         |      |        |
| PROJECT NO.   | CONTROL | REV. | FIGURE |
| 19135676  | 0       | 0    | B-2    |

# GRAIN SIZE DISTRIBUTION



| FINES (Silt, Clay) | SAND |        |        | GRAVEL |        | COBBLES | BOULDERS |
|--------------------|------|--------|--------|--------|--------|---------|----------|
|                    | Fine | Medium | Coarse | Fine   | Coarse |         |          |

| Symbol | Sample Location | Sample Number | Depth (m) | Elevation (m)  |
|--------|-----------------|---------------|-----------|----------------|
| ■      | HMLP-1          | 2             | 0.8 - 1.4 | 255.0 to 254.4 |
| ◆      | HMLP-2          | 6             | 3.8 - 4.4 | 252.5 to 251.9 |
| ▲      | HMLP-3          | 4             | 2.3 - 2.9 | 254.5 to 253.9 |
| ●      | HMLP-4          | 6             | 3.8 - 4.4 | 253.9 to 253.3 |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |

CLIENT

McIntosh Perry / MTO

CONSULTANT



YYYY-MM-DD 2022-12-05

DESIGNED MH

PREPARED MH

REVIEWED DAM

APPROVED DAM

PROJECT

HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE  
HIGH MAST LIGHT POLES

TITLE

GRAIN SIZE DISTRIBUTION  
SILTY SAND (SM) to SAND (SP-SM) - Upper

PROJECT NO.

19135676

CONTROL

0

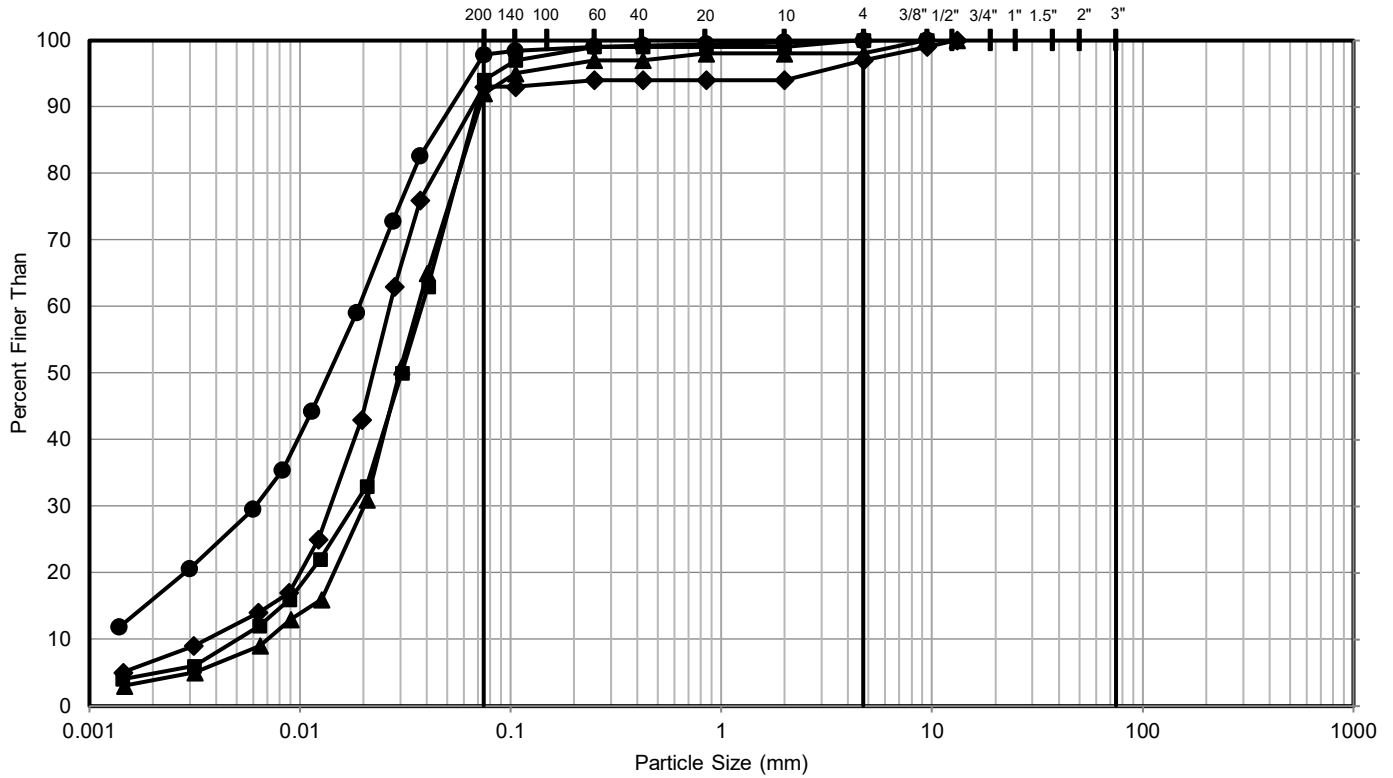
REV.

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FIGURE

B-3

# GRAIN SIZE DISTRIBUTION



| FINES (Silt, Clay) | SAND |        |        | GRAVEL |        | COBBLES | BOULDERS |
|--------------------|------|--------|--------|--------|--------|---------|----------|
|                    | Fine | Medium | Coarse | Fine   | Coarse |         |          |

| Symbol | Sample Location | Sample Number | Depth (m) | Elevation (m)  |
|--------|-----------------|---------------|-----------|----------------|
| ■      | HMLP-1          | 7             | 4.6 - 5.2 | 251.2 to 250.6 |
| ◆      | HMLP-2          | 9B            | 7.9 - 8.2 | 248.4 to 248.1 |
| ▲      | HMLP-3          | 8             | 6.1 - 6.7 | 250.7 to 250.1 |
| ●      | HMLP-4          | 9             | 7.6 - 8.2 | 250.1 to 249.5 |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |

CLIENT

McIntosh Perry / MTO

CONSULTANT



YYYY-MM-DD 2022-12-05

DESIGNED MH

PREPARED MH

REVIEWED DAM

APPROVED DAM

PROJECT

HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE  
HIGH MAST LIGHT POLES

TITLE

GRAIN SIZE DISTRIBUTION  
SILT (ML)

PROJECT NO.

19135676

CONTROL

0

REV.

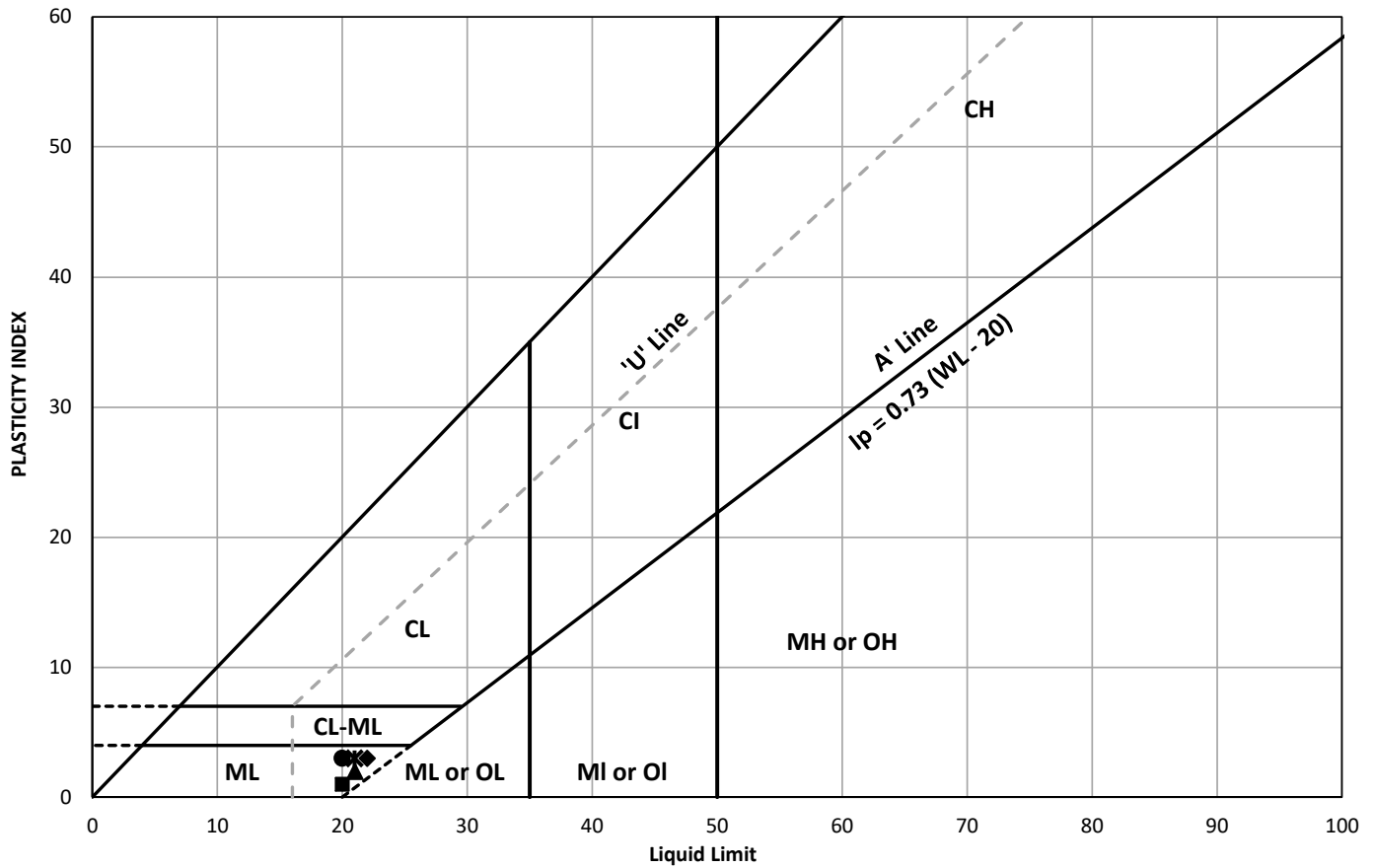
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FIGURE

B-4



# PLASTICITY CHART

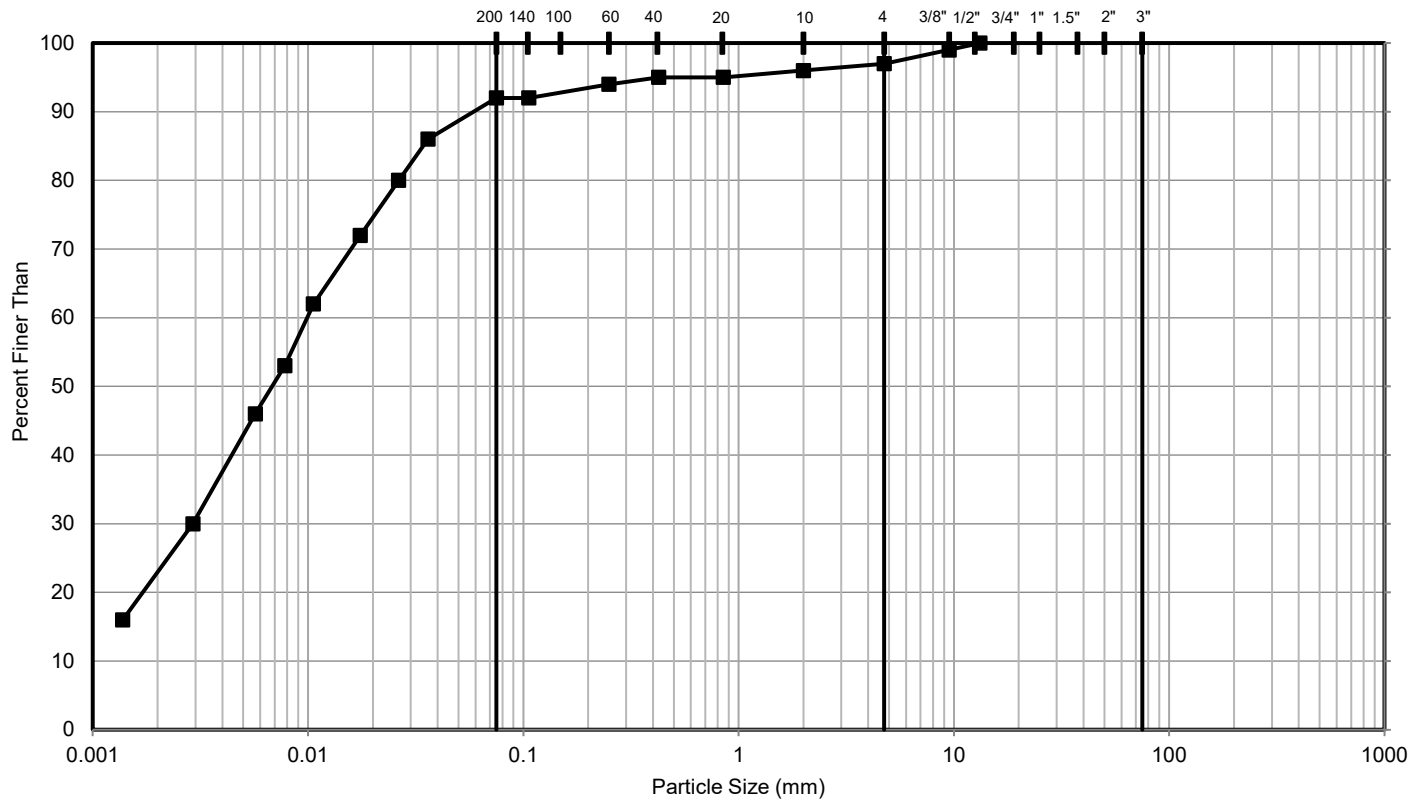


|   | Sample Location | Sample / Specimen Number | Depth (m) | Natural Water Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | Liquidity Index |
|---|-----------------|--------------------------|-----------|---------------------------|--------------|---------------|------------------|-----------------|
| ■ | HMLP-1          | 7                        | 4.6 - 5.2 | 20.7                      | 20           | 19            | 1                | 1.70            |
| ◆ | HMLP-2          | 9B                       | 7.9 - 8.2 | 21.8                      | 22           | 19            | 3                | 0.93            |
| ▲ | HMLP-3          | 8                        | 6.1 - 6.7 | 22.3                      | 21           | 19            | 2                | 1.65            |
| ● | HMLP-4          | 9                        | 7.6 - 8.2 | 21                        | 20           | 17            | 3                | 1.33            |
| * | HMLP-4          | 10                       | 9.1 - 9.8 | 19.2                      | 21           | 18            | 3                | 0.40            |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |
|   |                 |                          |           |                           |              |               |                  |                 |

|                      |            |            |
|----------------------|------------|------------|
| CLIENT               |            |            |
| McIntosh Perry / MTO |            |            |
| CONSULTANT           | YYYY-MM-DD | 2022-12-09 |
|                      | DESIGNED   | MH         |
|                      | PREPARED   | MH         |
|                      | REVIEWED   | DAM        |
|                      | APPROVED   | DAM        |


|   |         |      |        |
|---|---------|------|--------|
| PROJECT   |         |      |        |
| HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE<br>HIGH MAST LIGHT POLES |         |      |        |
| TITLE   |         |      |        |
| PLASTICITY CHART<br>SILT (ML)                                     |         |      |        |
| PROJECT NO.   | CONTROL | REV. | FIGURE |
| 19135676  | 0       | 0    | B-5    |

# GRAIN SIZE DISTRIBUTION

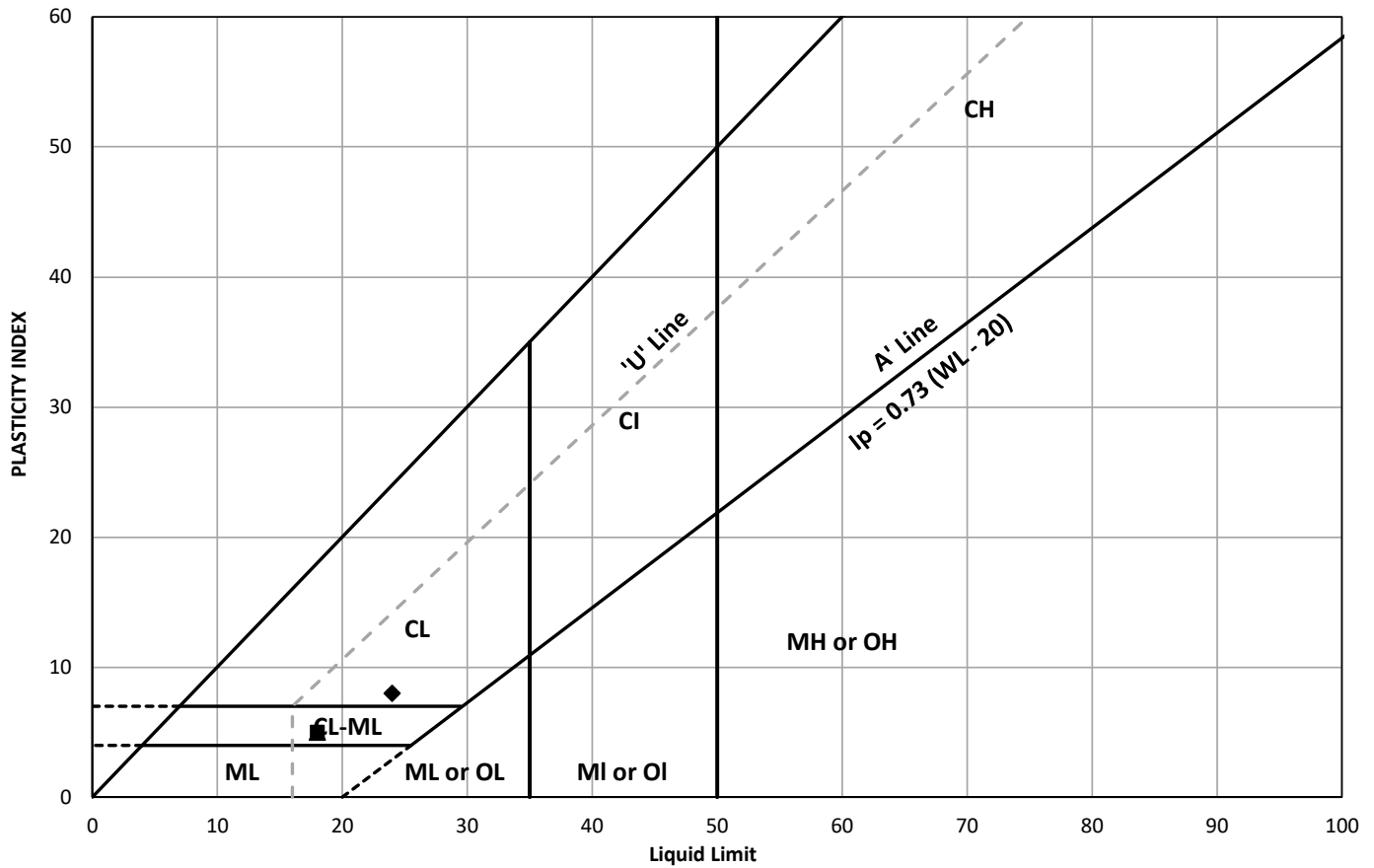


| FINES (Silt, Clay) | SAND |        |        | GRAVEL |        | COBBLES | BOULDERS |
|--------------------|------|--------|--------|--------|--------|---------|----------|
|                    | Fine | Medium | Coarse | Fine   | Coarse |         |          |

| Symbol | Sample Location | Sample Number | Depth (m) | Elevation (m)  |
|--------|-----------------|---------------|-----------|----------------|
| ■      | HMLP-3          | 9             | 7.6 - 8.2 | 249.2 to 248.6 |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |
|        |                 |               |           |                |

|  |  |            |            |  |         |      |        |
|--|--|------------|------------|--|---------|------|--------|
| CLIENT   |  |            |            | PROJECT                                  |         |      |        |
| McIntosh Perry / MTO   |  |            |            | HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE |         |      |        |
| <div>  <div>GOLDER</div> </div> |  | YYYY-MM-DD | 2022-12-05 | TITLE                                    |         |      |        |
|  |  | DESIGNED   | MH         | GRAIN SIZE DISTRIBUTION                  |         |      |        |
|  |  | PREPARED   | MH         | CLAYEY SILT (CL)                         |         |      |        |
|  |  | REVIEWED   | DAM        | PROJECT NO.                              | CONTROL | REV. | FIGURE |
|  |  | APPROVED   | DAM        | 19135676                                 | 0       | 0    | B-6    |

# PLASTICITY CHART

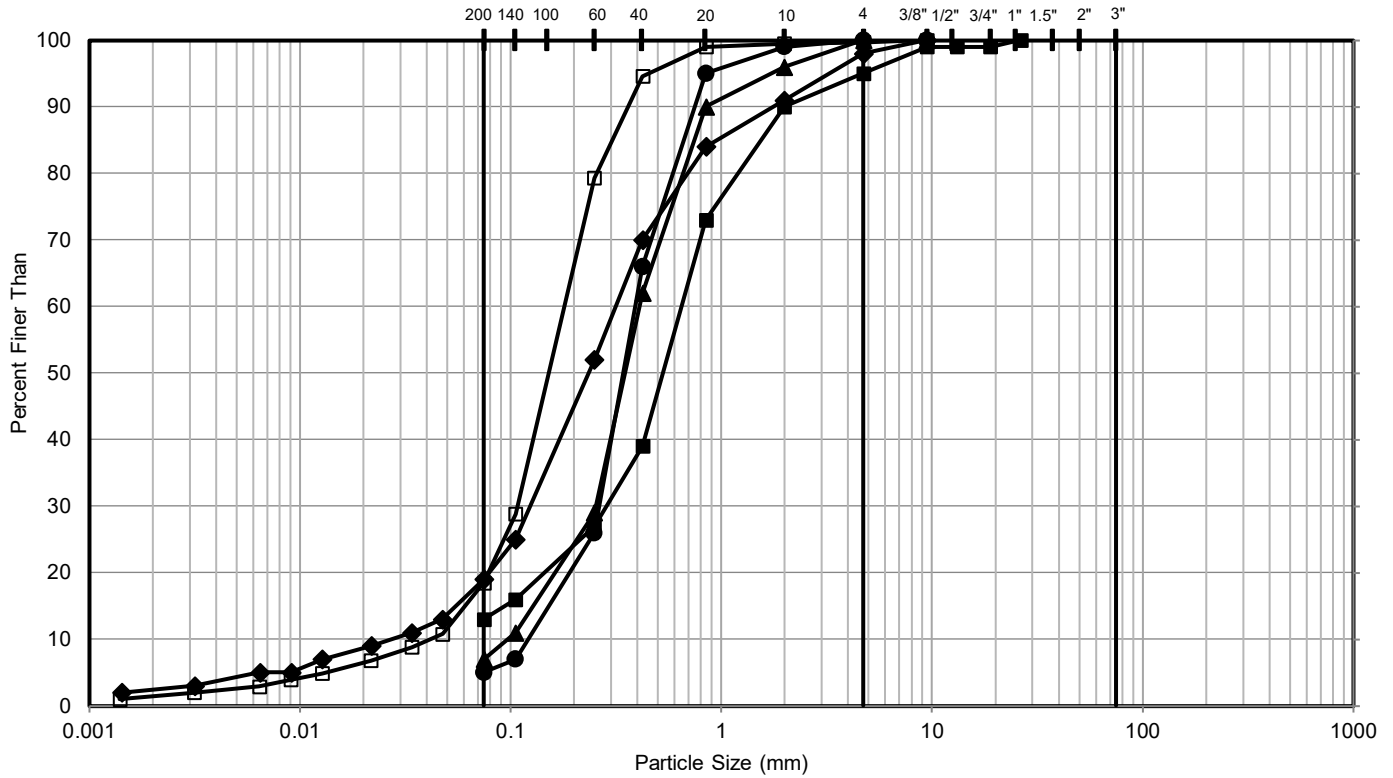


|   | Sample Location | Sample / Specimen Number | Depth (m)   | Natural Water Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | Liquidity Index |
|---|-----------------|--------------------------|-------------|---------------------------|--------------|---------------|------------------|-----------------|
| ■ | HMLP-1          | 8A                       | 6.1 - 6.4   | 14.7                      | 18           | 13            | 5                | 0.34            |
| ◆ | HMLP-3          | 9                        | 7.6 - 8.2   | 24.3                      | 24           | 16            | 8                | 1.04            |
| ▲ | HMLP-4          | 11                       | 10.7 - 11.3 | 21.4                      | 18           | 13            | 5                | 1.68            |
|   |                 |                          |             |                           |              |               |                  |                 |
|   |                 |                          |             |                           |              |               |                  |                 |
|   |                 |                          |             |                           |              |               |                  |                 |
|   |                 |                          |             |                           |              |               |                  |                 |
|   |                 |                          |             |                           |              |               |                  |                 |
|   |                 |                          |             |                           |              |               |                  |                 |
|   |                 |                          |             |                           |              |               |                  |                 |
|   |                 |                          |             |                           |              |               |                  |                 |

|                      |            |            |
|----------------------|------------|------------|
| CLIENT               |            |            |
| McIntosh Perry / MTO |            |            |
| CONSULTANT           | YYYY-MM-DD | 2022-12-09 |
|                      | DESIGNED   | MH         |
|                      | PREPARED   | MH         |
|                      | REVIEWED   | DAM        |
|                      | APPROVED   | DAM        |

|   |         |      |        |
|---|---------|------|--------|
| PROJECT   |         |      |        |
| HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE<br>HIGH MAST LIGHT POLES |         |      |        |
| TITLE   |         |      |        |
| PLASTICITY CHART<br>CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT (CL)  |         |      |        |
| PROJECT NO.   | CONTROL | REV. | FIGURE |
| 19135676  | 0       | 0    | B-7    |

# GRAIN SIZE DISTRIBUTION



| FINES (Silt, Clay) | SAND |        |        | GRAVEL |        | COBBLES | BOULDERS |
|--------------------|------|--------|--------|--------|--------|---------|----------|
|                    | Fine | Medium | Coarse | Fine   | Coarse |         |          |

| Symbol | Sample Location | Sample Number | Depth (m)   | Elevation (m)  |
|--------|-----------------|---------------|-------------|----------------|
| ■      | HMLP-1          | 10            | 9.1 - 9.8   | 246.7 to 246.1 |
| ◆      | HMLP-1          | 12            | 12.2 - 12.8 | 243.6 to 243.0 |
| ▲      | HMLP-2          | 11            | 10.7 - 11.3 | 245.6 to 245.0 |
| ●      | HMLP-3          | 10            | 9.1 - 9.8   | 247.7 to 247.1 |
| □      | HMLP-4          | 12            | 12.2 - 12.8 | 245.5 to 244.9 |
|        |                 |               |             |                |
|        |                 |               |             |                |
|        |                 |               |             |                |
|        |                 |               |             |                |
|        |                 |               |             |                |

CLIENT

McIntosh Perry / MTO

CONSULTANT



YYYY-MM-DD 2022-12-05

DESIGNED MH

PREPARED MH

REVIEWED DAM

APPROVED DAM

PROJECT

HIGHWAY 11/12 COLDWATER ROAD INTERCHANGE  
HIGH MAST LIGHT POLES

TITLE

GRAIN SIZE DISTRIBUTION  
SILTY SAND (SM) to SAND (SP-SM) - Lower

PROJECT NO.

19135676

CONTROL

0

REV.

0

FIGURE

B-8

**APPENDIX C**

# Analytical Laboratory Test Results



Your P.O. #: 19135676/8000/8004  
Your Project #: 19135676  
Site Location: HWY 11/12, ORILLIA  
Your C.O.C. #: N/A

**Attention: Mark Henderson**

Golder Associates Ltd  
6925 Century Ave  
Suite 100  
Mississauga, ON  
CANADA L5N 7K2

**Report Date: 2022/11/23**  
Report #: R7401682  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**BUREAU VERITAS JOB #: C2X4109**

**Received: 2022/11/14, 18:17**

Sample Matrix: Soil  
# Samples Received: 4

| Analyses                        | Quantity | Date       | Date       | Laboratory Method | Analytical Method    |
|---------------------------------|----------|------------|------------|-------------------|----------------------|
|                                 |          | Extracted  | Analyzed   |                   |                      |
| Chloride (20:1 extract)         | 4        | 2022/11/18 | 2022/11/19 | CAM SOP-00463     | SM 23 4500-Cl E m    |
| Conductivity                    | 4        | 2022/11/18 | 2022/11/18 | CAM SOP-00414     | OMOE E3530 v1 m      |
| Moisture (Subcontracted) (1, 2) | 4        | N/A        | 2022/11/23 | AB SOP-00002      | CCME PHC-CWS m       |
| Sulphide in Soil (1)            | 4        | N/A        | 2022/11/20 | AB SOP-00080      | EPA9030B/SM4500S2-DF |
| pH CaCl2 EXTRACT                | 4        | 2022/11/18 | 2022/11/18 | CAM SOP-00413     | EPA 9045 D m         |
| Resistivity of Soil             | 4        | 2022/11/14 | 2022/11/18 | CAM SOP-00414     | SM 23 2510 m         |
| Sulphate (20:1 Extract)         | 4        | 2022/11/18 | 2022/11/18 | CAM SOP-00464     | EPA 375.4 m          |

**Remarks:**

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

\* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Bureau Veritas Calgary (19th), 4000 19th Street NE, Calgary, AB, T2E 6P8

(2) Offsite analysis requires that subcontracted moisture be reported.



Your P.O. #: 19135676/8000/8004  
Your Project #: 19135676  
Site Location: HWY 11/12, ORILLIA  
Your C.O.C. #: N/A

**Attention: Mark Henderson**

Golder Associates Ltd  
6925 Century Ave  
Suite 100  
Mississauga, ON  
CANADA L5N 7K2

**Report Date: 2022/11/23**  
Report #: R7401682  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**BUREAU VERITAS JOB #: C2X4109**

**Received: 2022/11/14, 18:17**

**Encryption Key**

Please direct all questions regarding this Certificate of Analysis to:

Ankita Bhalla, Project Manager

Email: Ankita.Bhalla@bureauveritas.com

Phone# (905) 817-5700

=====

This report has been generated and distributed using a secure automated process.

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.



BUREAU  
VERITAS

Bureau Veritas Job #: C2X4109

Report Date: 2022/11/23

Golder Associates Ltd

Client Project #: 19135676

Site Location: HWY 11/12, ORILLIA

Your P.O. #: 19135676/8000/8004

Sampler Initials: MH

### SOIL CORROSIVITY PACKAGE (SOIL)

|                          |              |                   |            |                 |                           |            |                 |                   |            |                 |
|--------------------------|--------------|-------------------|------------|-----------------|---------------------------|------------|-----------------|-------------------|------------|-----------------|
| <b>Bureau Veritas ID</b> |              | UHM318            |            |                 | UHM318                    |            |                 | UHM319            |            |                 |
| <b>Sampling Date</b>     |              | 2022/10/31        |            |                 | 2022/10/31                |            |                 | 2022/11/01        |            |                 |
| <b>COC Number</b>        |              | N/A               |            |                 | N/A                       |            |                 | N/A               |            |                 |
|                          | <b>UNITS</b> | <b>HMLP-1 SS3</b> | <b>RDL</b> | <b>QC Batch</b> | <b>HMLP-1 SS3 Lab-Dup</b> | <b>RDL</b> | <b>QC Batch</b> | <b>HMLP-2 SS3</b> | <b>RDL</b> | <b>QC Batch</b> |

|  |         |         |      |         |     |    |         |          |      |         |
|--|---------|---------|------|---------|-----|----|---------|----------|------|---------|
| <b>Calculated Parameters</b>   |         |         |      |         |     |    |         |          |      |         |
| Resistivity  | ohm-cm  | 13000   |      | 8347960 |     |    |         | 11000    |      | 8347960 |
| <b>Inorganics</b>  |         |         |      |         |     |    |         |          |      |         |
| Soluble (20:1) Chloride (Cl-)  | ug/g    | <20     | 20   | 8354122 |     |    |         | <20      | 20   | 8354122 |
| Conductivity   | umho/cm | 76      | 2    | 8353989 |     |    |         | 95       | 2    | 8353989 |
| Available (CaCl2) pH   | pH      | 7.86    |      | 8353926 |     |    |         | 7.18     |      | 8353926 |
| Soluble (20:1) Sulphate (SO4)  | ug/g    | <20     | 20   | 8354143 | <20 | 20 | 8354143 | <20      | 20   | 8354143 |
| Sulphide   | mg/kg   | 0.8 (1) | 0.5  | 8360245 |     |    |         | <0.5 (1) | 0.5  | 8360245 |
| <b>Physical Testing</b>  |         |         |      |         |     |    |         |          |      |         |
| Moisture-Subcontracted   | %       | 3.5     | 0.30 | 8364470 |     |    |         | 14       | 0.30 | 8364470 |
| RDL = Reportable Detection Limit   |         |         |      |         |     |    |         |          |      |         |
| QC Batch = Quality Control Batch   |         |         |      |         |     |    |         |          |      |         |
| Lab-Dup = Laboratory Initiated Duplicate   |         |         |      |         |     |    |         |          |      |         |
| (1) Sample extracted past method-specified hold time. Analyzed past method specified hold time |         |         |      |         |     |    |         |          |      |         |

|                          |              |                           |            |                 |                   |            |                 |                           |            |                 |
|--------------------------|--------------|---------------------------|------------|-----------------|-------------------|------------|-----------------|---------------------------|------------|-----------------|
| <b>Bureau Veritas ID</b> |              | UHM319                    |            |                 | UHM320            |            |                 | UHM320                    |            |                 |
| <b>Sampling Date</b>     |              | 2022/11/01                |            |                 | 2022/11/02        |            |                 | 2022/11/02                |            |                 |
| <b>COC Number</b>        |              | N/A                       |            |                 | N/A               |            |                 | N/A                       |            |                 |
|                          | <b>UNITS</b> | <b>HMLP-2 SS3 Lab-Dup</b> | <b>RDL</b> | <b>QC Batch</b> | <b>HMLP-3 SS3</b> | <b>RDL</b> | <b>QC Batch</b> | <b>HMLP-3 SS3 Lab-Dup</b> | <b>RDL</b> | <b>QC Batch</b> |

|  |         |     |     |         |         |      |         |      |   |         |
|--|---------|-----|-----|---------|---------|------|---------|------|---|---------|
| <b>Calculated Parameters</b>   |         |     |     |         |         |      |         |      |   |         |
| Resistivity  | ohm-cm  |     |     |         | 18000   |      | 8347960 |      |   |         |
| <b>Inorganics</b>  |         |     |     |         |         |      |         |      |   |         |
| Soluble (20:1) Chloride (Cl-)  | ug/g    | <20 | 20  | 8354122 | <20     | 20   | 8354122 |      |   |         |
| Conductivity   | umho/cm |     |     |         | 55      | 2    | 8353989 | 55   | 2 | 8353989 |
| Available (CaCl2) pH   | pH      |     |     |         | 7.12    |      | 8353926 | 7.11 |   | 8353926 |
| Soluble (20:1) Sulphate (SO4)  | ug/g    |     |     |         | <20     | 20   | 8354143 |      |   |         |
| Sulphide   | mg/kg   | 0.8 | 0.5 | 8360245 | 0.7 (1) | 0.5  | 8360245 |      |   |         |
| <b>Physical Testing</b>  |         |     |     |         |         |      |         |      |   |         |
| Moisture-Subcontracted   | %       |     |     |         | 8.9     | 0.30 | 8364470 |      |   |         |
| RDL = Reportable Detection Limit   |         |     |     |         |         |      |         |      |   |         |
| QC Batch = Quality Control Batch   |         |     |     |         |         |      |         |      |   |         |
| Lab-Dup = Laboratory Initiated Duplicate   |         |     |     |         |         |      |         |      |   |         |
| (1) Sample extracted past method-specified hold time. Analyzed past method specified hold time |         |     |     |         |         |      |         |      |   |         |





BUREAU  
VERITAS

Bureau Veritas Job #: C2X4109

Report Date: 2022/11/23

Golder Associates Ltd

Client Project #: 19135676

Site Location: HWY 11/12, ORILLIA

Your P.O. #: 19135676/8000/8004

Sampler Initials: MH

### SOIL CORROSIVITY PACKAGE (SOIL)

|  |              |                   |            |                 |
|--|--------------|-------------------|------------|-----------------|
| <b>Bureau Veritas ID</b>   |              | UHM321            |            |                 |
| <b>Sampling Date</b>   |              | 2022/05/10        |            |                 |
| <b>COC Number</b>  |              | N/A               |            |                 |
|  | <b>UNITS</b> | <b>HMLP-4 SS3</b> | <b>RDL</b> | <b>QC Batch</b> |
| <b>Calculated Parameters</b>   |              |                   |            |                 |
| Resistivity  | ohm-cm       | 19000             |            | 8347960         |
| <b>Inorganics</b>  |              |                   |            |                 |
| Soluble (20:1) Chloride (Cl-)  | ug/g         | <20               | 20         | 8354122         |
| Conductivity   | umho/cm      | 53                | 2          | 8353989         |
| Available (CaCl2) pH   | pH           | 7.36              |            | 8353926         |
| Soluble (20:1) Sulphate (SO4)  | ug/g         | <20               | 20         | 8354143         |
| Sulphide   | mg/kg        | 0.9 (1)           | 0.5        | 8360245         |
| <b>Physical Testing</b>  |              |                   |            |                 |
| Moisture-Subcontracted   | %            | 6.2               | 0.30       | 8364470         |
| RDL = Reportable Detection Limit<br>QC Batch = Quality Control Batch<br>(1) Sample extracted past method-specified hold time. Analyzed past method specified hold time |              |                   |            |                 |



BUREAU  
VERITAS

Bureau Veritas Job #: C2X4109

Report Date: 2022/11/23

Golder Associates Ltd

Client Project #: 19135676

Site Location: HWY 11/12, ORILLIA

Your P.O. #: 19135676/8000/8004

Sampler Initials: MH

## TEST SUMMARY

**Bureau Veritas ID:** UHM318  
**Sample ID:** HMLP-1 SS3  
**Matrix:** Soil

**Collected:** 2022/10/31  
**Shipped:**  
**Received:** 2022/11/14

| Test Description         | Instrumentation | Batch   | Extracted  | Date Analyzed | Analyst           |
|--------------------------|-----------------|---------|------------|---------------|-------------------|
| Chloride (20:1 extract)  | KONE/EC         | 8354122 | 2022/11/18 | 2022/11/19    | Alina Dobreanu    |
| Conductivity             | AT              | 8353989 | 2022/11/18 | 2022/11/18    | Gurpartee K AUR   |
| Moisture (Subcontracted) | BAL             | 8364470 | N/A        | 2022/11/23    | Richard Ly        |
| Sulphide in Soil         | SPEC            | 8360245 | N/A        | 2022/11/20    | Bailey Morrison   |
| pH CaCl2 EXTRACT         | AT              | 8353926 | 2022/11/18 | 2022/11/18    | Taslina Aktar     |
| Resistivity of Soil      |                 | 8347960 | 2022/11/18 | 2022/11/18    | Automated Statchk |
| Sulphate (20:1 Extract)  | KONE/EC         | 8354143 | 2022/11/18 | 2022/11/18    | Samuel Law        |

**Bureau Veritas ID:** UHM318 Dup  
**Sample ID:** HMLP-1 SS3  
**Matrix:** Soil

**Collected:** 2022/10/31  
**Shipped:**  
**Received:** 2022/11/14

| Test Description        | Instrumentation | Batch   | Extracted  | Date Analyzed | Analyst    |
|-------------------------|-----------------|---------|------------|---------------|------------|
| Sulphate (20:1 Extract) | KONE/EC         | 8354143 | 2022/11/18 | 2022/11/18    | Samuel Law |

**Bureau Veritas ID:** UHM319  
**Sample ID:** HMLP-2 SS3  
**Matrix:** Soil

**Collected:** 2022/11/01  
**Shipped:**  
**Received:** 2022/11/14

| Test Description         | Instrumentation | Batch   | Extracted  | Date Analyzed | Analyst           |
|--------------------------|-----------------|---------|------------|---------------|-------------------|
| Chloride (20:1 extract)  | KONE/EC         | 8354122 | 2022/11/18 | 2022/11/19    | Alina Dobreanu    |
| Conductivity             | AT              | 8353989 | 2022/11/18 | 2022/11/18    | Gurpartee K AUR   |
| Moisture (Subcontracted) | BAL             | 8364470 | N/A        | 2022/11/23    | Richard Ly        |
| Sulphide in Soil         | SPEC            | 8360245 | N/A        | 2022/11/20    | Bailey Morrison   |
| pH CaCl2 EXTRACT         | AT              | 8353926 | 2022/11/18 | 2022/11/18    | Taslina Aktar     |
| Resistivity of Soil      |                 | 8347960 | 2022/11/18 | 2022/11/18    | Automated Statchk |
| Sulphate (20:1 Extract)  | KONE/EC         | 8354143 | 2022/11/18 | 2022/11/18    | Samuel Law        |

**Bureau Veritas ID:** UHM319 Dup  
**Sample ID:** HMLP-2 SS3  
**Matrix:** Soil

**Collected:** 2022/11/01  
**Shipped:**  
**Received:** 2022/11/14

| Test Description        | Instrumentation | Batch   | Extracted  | Date Analyzed | Analyst         |
|-------------------------|-----------------|---------|------------|---------------|-----------------|
| Chloride (20:1 extract) | KONE/EC         | 8354122 | 2022/11/18 | 2022/11/19    | Alina Dobreanu  |
| Sulphide in Soil        | SPEC            | 8360245 | N/A        | 2022/11/20    | Bailey Morrison |

**Bureau Veritas ID:** UHM320  
**Sample ID:** HMLP-3 SS3  
**Matrix:** Soil

**Collected:** 2022/11/02  
**Shipped:**  
**Received:** 2022/11/14

| Test Description         | Instrumentation | Batch   | Extracted  | Date Analyzed | Analyst         |
|--------------------------|-----------------|---------|------------|---------------|-----------------|
| Chloride (20:1 extract)  | KONE/EC         | 8354122 | 2022/11/18 | 2022/11/19    | Alina Dobreanu  |
| Conductivity             | AT              | 8353989 | 2022/11/18 | 2022/11/18    | Gurpartee K AUR |
| Moisture (Subcontracted) | BAL             | 8364470 | N/A        | 2022/11/23    | Richard Ly      |



BUREAU  
VERITAS

Bureau Veritas Job #: C2X4109  
Report Date: 2022/11/23

Golder Associates Ltd  
Client Project #: 19135676  
Site Location: HWY 11/12, ORILLIA  
Your P.O. #: 19135676/8000/8004  
Sampler Initials: MH

## TEST SUMMARY

**Bureau Veritas ID:** UHM320  
**Sample ID:** HMLP-3 SS3  
**Matrix:** Soil

**Collected:** 2022/11/02  
**Shipped:**  
**Received:** 2022/11/14

| Test Description             | Instrumentation | Batch   | Extracted  | Date Analyzed | Analyst           |
|------------------------------|-----------------|---------|------------|---------------|-------------------|
| Sulphide in Soil             | SPEC            | 8360245 | N/A        | 2022/11/20    | Bailey Morrison   |
| pH CaCl <sub>2</sub> EXTRACT | AT              | 8353926 | 2022/11/18 | 2022/11/18    | Taslima Aktar     |
| Resistivity of Soil          |                 | 8347960 | 2022/11/18 | 2022/11/18    | Automated Statchk |
| Sulphate (20:1 Extract)      | KONE/EC         | 8354143 | 2022/11/18 | 2022/11/18    | Samuel Law        |

**Bureau Veritas ID:** UHM320 Dup  
**Sample ID:** HMLP-3 SS3  
**Matrix:** Soil

**Collected:** 2022/11/02  
**Shipped:**  
**Received:** 2022/11/14

| Test Description             | Instrumentation | Batch   | Extracted  | Date Analyzed | Analyst         |
|------------------------------|-----------------|---------|------------|---------------|-----------------|
| Conductivity                 | AT              | 8353989 | 2022/11/18 | 2022/11/18    | Gurparteek KAUR |
| pH CaCl <sub>2</sub> EXTRACT | AT              | 8353926 | 2022/11/18 | 2022/11/18    | Taslima Aktar   |

**Bureau Veritas ID:** UHM321  
**Sample ID:** HMLP-4 SS3  
**Matrix:** Soil

**Collected:** 2022/05/10  
**Shipped:**  
**Received:** 2022/11/14

| Test Description             | Instrumentation | Batch   | Extracted  | Date Analyzed | Analyst           |
|------------------------------|-----------------|---------|------------|---------------|-------------------|
| Chloride (20:1 extract)      | KONE/EC         | 8354122 | 2022/11/18 | 2022/11/19    | Alina Dobreanu    |
| Conductivity                 | AT              | 8353989 | 2022/11/18 | 2022/11/18    | Gurparteek KAUR   |
| Moisture (Subcontracted)     | BAL             | 8364470 | N/A        | 2022/11/23    | Richard Ly        |
| Sulphide in Soil             | SPEC            | 8360245 | N/A        | 2022/11/20    | Bailey Morrison   |
| pH CaCl <sub>2</sub> EXTRACT | AT              | 8353926 | 2022/11/18 | 2022/11/18    | Taslima Aktar     |
| Resistivity of Soil          |                 | 8347960 | 2022/11/18 | 2022/11/18    | Automated Statchk |
| Sulphate (20:1 Extract)      | KONE/EC         | 8354143 | 2022/11/18 | 2022/11/18    | Samuel Law        |



BUREAU  
VERITAS

Bureau Veritas Job #: C2X4109

Report Date: 2022/11/23

Golder Associates Ltd

Client Project #: 19135676

Site Location: HWY 11/12, ORILLIA

Your P.O. #: 19135676/8000/8004

Sampler Initials: MH

### GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

|           |       |
|-----------|-------|
| Package 1 | 4.0°C |
|-----------|-------|

Results relate only to the items tested.



BUREAU  
VERITAS

Bureau Veritas Job #: C2X4109

Report Date: 2022/11/23

## QUALITY ASSURANCE REPORT

Golder Associates Ltd

Client Project #: 19135676

Site Location: HWY 11/12, ORILLIA

Your P.O. #: 19135676/8000/8004

Sampler Initials: MH

| QC Batch | Parameter                                  | Date       | Matrix Spike |           | SPIKED BLANK |           | Method Blank |         | RPD       |           |
|----------|--|------------|--------------|-----------|--------------|-----------|--------------|---------|-----------|-----------|
|          |  |            | % Recovery   | QC Limits | % Recovery   | QC Limits | Value        | UNITS   | Value (%) | QC Limits |
| 8353926  | Available (CaCl <sub>2</sub> ) pH          | 2022/11/18 |              |           | 101          | 97 - 103  |              |         | 0.21      | N/A       |
| 8353989  | Conductivity                               | 2022/11/18 |              |           | 106          | 90 - 110  | <2           | umho/cm | 0.55      | 10        |
| 8354122  | Soluble (20:1) Chloride (Cl <sup>-</sup> ) | 2022/11/19 | 126          | 70 - 130  | 108          | 70 - 130  | <20          | ug/g    | NC        | 35        |
| 8354143  | Soluble (20:1) Sulphate (SO <sub>4</sub> ) | 2022/11/18 | 124          | 70 - 130  | 112          | 70 - 130  | <20          | ug/g    | NC        | 35        |
| 8360245  | Sulphide                                   | 2022/11/20 | 23 (1)       | 75 - 125  | 112          | 75 - 125  | <0.5         | mg/kg   | NC        | 30        |
| 8364470  | Moisture-Subcontracted                     | 2022/11/23 |              |           |              |           | <0.30        | %       |           |           |

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Matrix spike exceeds acceptance limits due to matrix interference.



BUREAU  
VERITAS

Bureau Veritas Job #: C2X4109  
Report Date: 2022/11/23

Golder Associates Ltd  
Client Project #: 19135676  
Site Location: HWY 11/12, ORILLIA  
Your P.O. #: 19135676/8000/8004  
Sampler Initials: MH

### VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

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Cristina Carriere, Senior Scientific Specialist

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Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

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Suwan (Sze Yeung) Fock, B.Sc., Scientific Specialist

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Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by {0}, {1} responsible for {2} {3} laboratory operations.



6740 Campobello Road, Mississauga, Ontario L5N 2L8  
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266  
CAM FCD-01191/6

## WORK ORDER

### CHAIN OF CUSTODY RECORD

Page 1 of 1

| Invoice Information  |  | Report Information (if differs from invoice)   |  | Project Information (where applicable)  |                    | Turnaround Time (TAT) Required   |                     |
|--|--|--|--|---|--------------------|--|---------------------|
| Company Name:  | Golder Associates Ltd.                         | Company Name:  | Golder Associates Ltd.                                 | Quotation #:  |                    | <input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses                         |                     |
| Contact Name:  | Canada Accounts Payable                        | Contact Name:  | Mark Henderson   | P.O. #/ AFE#:   | 19135676/8000/8004 | PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS  |                     |
| Address:   | 6925 Century Ave. Suite 100<br>Mississauga, ON | Address:   | 6925 Century Ave. Suite 100<br>Mississauga, ON L5N 7K2 | Project #:  | 19135676           | Rush TAT (Surcharges will be applied)  |                     |
| Phone:   | 905-567-4444 Fax: 905-567-6561                 | Phone:   | 647-233-7791 Fax: 905-567-6561                         | Site Location:  | Hwy 11/12, Orillia | <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days |                     |
| Email:   | canadaaccountspayableinvoices@golder           | Email:   | mark.henderson@wsp.com                                 | Site Location Province:   | Ontario            | Date Required:   |                     |
| MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY   |  |  |  | Sampled By:   | MH/ML              | Rush Confirmation #:   |                     |
| <b>Regulation 153</b>  |  | <b>Other Regulations</b>   |  | <b>Analysis Requested</b>   |                    |  |                     |
| <input checked="" type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/ Fine<br><input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse<br><input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/ Other<br><input type="checkbox"/> Table _____<br>FOR RSC (PLEASE CIRCLE) Y / N |  | <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw<br><input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw<br><input type="checkbox"/> PWQIQ Region _____<br><input type="checkbox"/> Other (Specify) _____<br><input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED)<br><input type="checkbox"/> REG 406 Table _____ |  | # OF CONTAINERS SUBMITTED<br>FIELD FILTERED (CIRCLE) Metals / Hg / CVI<br>BTEX / PHC F1<br>PHCs F2 - F4<br>VOCs<br>REG 153 METALS & INORGANICS<br>REG 153 ICPMS METALS<br>REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)<br>Corrosivity Package (+ sulphide)<br>HOLD- DO NOT ANALYZE |                    |  |                     |
| Include Criteria on Certificate of Analysis: Y / N   |  | SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS   |  | LABORATORY USE ONLY   |                    |  |                     |
| SAMPLE IDENTIFICATION  |  | DATE SAMPLED (YYYY/MM/DD)  | TIME SAMPLED (HH:MM)                                   | MATRIX  | CUSTODY SEAL Y / N |  |                     |
|  |  |  |  |   | Present            | Intact   | COOLER TEMPERATURES |
| 1  | HMLP-1 SS3                                     | 2022-10-31   | AM   | SOIL  | 2                  |  |                     |
| 2  | HMLP-2 SS3                                     | 2022-11-01   | AM   | SOIL  | 2                  |  |                     |
| 3  | HMLP-3 SS3                                     | 2022-11-02   | AM   | SOIL  | 2                  |  |                     |
| 4  | HMLP-4 SS3                                     | 2022-05-10   | AM   | SOIL  | 2                  |  |                     |
| 5  |  |  |  |   |                    |  |                     |
| 6  |  |  |  |   |                    |  |                     |
| 7  |  |  |  |   |                    |  |                     |
| 8  |  |  |  |   |                    |  |                     |
| 9  |  |  |  |   |                    |  |                     |
| 10   |  |  |  |   |                    |  |                     |
| RELINQUISHED BY: (Signature/Print)   |  | DATE: (YYYY/MM/DD)   | TIME: (HH:MM)  | RECEIVED BY: (Signature/Print)  |                    | DATE: (YYYY/MM/DD)   | TIME: (HH:MM)       |
| [Signature] / MAOS Levy  |  | 2022/11/14   | 18:15  | Ankur Anand Pandya  |                    | 2022/11/14   | 18:17               |

14-Nov-22 18:17

Ankita Bhalla



C2X4109

AVI ENV-961

**APPENDIX D**

# Non-Standard Special Provisions



## **AMENDMENT TO OPSS 903, APRIL 2016**

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Special Provision No. DBSP0903

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OPSS 903, April 2016, is deleted in its entirety and replaced with the following:

### **CONSTRUCTION SPECIFICATION FOR DEEP FOUNDATIONS**

#### **903.01 SCOPE**

This specification covers the requirements for the supply and installation of deep foundation units.

#### **903.02 REFERENCES**

This specification refers to the following specifications, standards, or publications:

##### **Design-Build Special Provisions**

DBSP 0904 Concrete Structures  
DBSP 0909 Prestressed Concrete - Precast Girders  
DBSP 1350 Concrete – Materials and Production

##### **Ontario Provincial Standard Specifications, Construction**

OPSS 904 Concrete Structures  
OPSS 905 Steel Reinforcement for Concrete  
OPSS 911 Coating Structural Steel Systems

##### **Ontario Provincial Standard Specifications, Material**

OPSS 1302 Water  
OPSS 1440 Steel Reinforcement for Concrete  
OPSS 1350 Concrete – Materials and Production

##### **CSA Standards**

G40.20/40.21-13 (R2018) General Requirements for Rolled or Welded Structural  
Quality Steel/Structural Quality Steel  
CAN3-056-1962 (R2006) Round Timber Piles  
O80 Series-08 Wood Preservation  
W47.1-09 (R2014) Certification of Companies for Fusion Welding of Steel  
W48-18 Filler Metals and Allied Materials for Metal Arc Welding  
W59-18 Welded Steel Construction (Metal Arc Welding)  
W178.1-18 Certification of Welding Inspection Organizations  
W178.2-18 Certification of Welding Inspectors

## **Canadian General Standards Board (CGSB)**

48.9712-2006      Non-destructive Testing, Qualification and Certification of Personnel

## **ASTM International**

A 252-98(2007)      Welded and Seamless Steel Pipe Piles  
A 328/A 328M-07      Steel Sheet Piling  
D 1143/ D 1143M-07      Standard Test Methods for Deep Foundations under Static Axial Compressive Load  
D 3689-07      Standard Test Methods for Deep Foundations under Static Axial Tensile Load  
D 3966-07      Standard Test Method for Deep Foundations under Lateral Loads

## **American Petroleum Institute (API)**

API 13A      Drilling Fluid Materials, 17th Edition, 10.00.08  
RP 13B-1      Standard Procedure for Field Testing Water Based Drilling Fluids, 4th Edition,

## **Joint Publications of the Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE)**

SSPC-SP6/NACE No. 3-2007      Commercial Blast Cleaning  
SP10/NACE No.2      Near-White Blast Cleaning

## **International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)**

17025      General Requirements for the Competence of the Testing and Calibration Laboratories

## **903.03                      DEFINITIONS**

For the purpose of this specification, the following definitions apply:

**Anvil** means the component of a diesel hammer that acts as an impact block for the ram

**Bedrock** means a natural solid bed of the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin that may or may not be weathered.

**Caisson Pile** means a cast in place deep foundation unit with or without an enclosing liner formed by placing concrete in a bored or excavated hole.

**Cap Block** means a material placed on top of the helmet to cushion the blow of the hammer and to attenuate the peak impact energy without causing excessive loss of the impact energy.

**Casing** means open ended enclosing cylindrical steel tubing or pipe permanently installed in the ground. Casings are structurally required and can be used to stabilize and excavated hole.

**Deep Foundation Unit** means a structural member, driven or otherwise, installed in the ground to transfer the loads from a structure to soil or rock and derives supporting resistance from the surrounding soil or rock or from the soil or rock strata below its tip or a combination of both.

**Design Engineer** means the Engineer retained by the Contractor who has sealed and signed the Issued for Construction Drawings and/or Working Drawings required to complete all or part of the work specified in the contract.

**Design Engineer's Designee** means a foundations Engineer who under the direct supervision of the design Engineer performs monitoring of the deep foundation work specified in the Contract Documents or as required by the design Engineer.

**Displacement Caisson Pile** means a pile formed in the ground by driving a casing or liner with a concrete plug or an expendable metal plate attached to it and replacing the displaced soil with unreinforced or reinforced concrete.

**Driven Pile** means one of the following pile types: steel H, tube, or sheet piles; wooden pile; or precast reinforced concrete pile that has been installed by means of a pile driver.

**Driving Shoe** means reinforcement attached to the bottom of the pile and designed to protect the pile during driving or to penetrate a hard stratum.

**Driving to a Set** means driving the pile to the requirement that satisfies pile driving criteria correlated to a required pile resistance.

**Follower** means a removable extension that transmits the hammer blows to the head of the pile.

**Helmet** means a formed steel cap that fits over the top of a pile head to retain in position a resilient cap block.

**Jetting** means the use of a jet of water at high pressure directed into the ground below the pile tip to assist its penetration

**Liner** means open ended enclosing steel tubing or pipe temporarily installed in the ground to facilitate the construction of caisson piles

**Pile** means a relatively slender structural element that is installed, wholly or partly in the ground by driving, drilling, auguring, jetting, or other means.

**Pile Cap** means a footing, or some other structural component used to transfer the load to the piles as well as maintaining them in position.

**Pile Cushion** means a pad of resilient material placed between the helmet and the top of a precast reinforced concrete or wooden pile to minimize damage to the head during driving.

**Pile Group** means the piles supporting a pile cap.

**Pumped Concrete** means a method of transporting concrete through hose or pipe by means of positive and continuous pressure.

**Ram** means the moving or driving part of an air, steam, diesel, or drop pile hammer that delivers an impact blow to an anvil and to the pile.

**Retapping** means verifying that the specified resistance previously attained has been sustained by imparting appropriate hammer energy to the pile and monitoring pile penetration.

**Rock Points** means a specially designed steel tip fitted to piles to enable them to be driven into hard, sound sloped bedrock.

**Sheet Pile** means a pile that is designed to interlock with adjacent piles and form a continuous wall for the purpose of resisting mainly lateral forces and to reduce seepage.

**Slurry** means a drilling fluid, consisting of water mixed with one or more of various solids or polymers, used to maintain the stability of the side walls and bottom of an excavation.

**Tremie** means a hopper with a vertical pipe used for placing concrete under water. The foot of the pipe is always submerged in concrete except during commencement of concreting and the upper level of the concrete in the pipe is always above water level.

## **903.04 DESIGN AND SUBMISSION REQUIREMENTS**

### **903.04.01 Design Requirements**

#### **903.04.01.01 Concrete**

The Contractor is responsible for providing plastic concrete with suitable characteristics for installation. The concrete shall be flowable, non-segregating concrete that does not exhibit rapid slump loss.

## **903.04.02 Submission Requirements**

### **903.04.02.01 General**

All submissions shall bear the seal and signature of the design Engineer experienced in the field of deep foundations.

When welded field splices are used, the Contractor shall submit the welding procedures to the Contract Administrator for the purpose of quality assurance and documentation. The Canadian Welding Bureau shall have approved the welding procedures.

### **903.04.02.02 Preconstruction Survey**

Prior to commencing the work, the Contractor shall submit to the Contract Administrator, a condition survey of property and structures that may be affected by the work. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site.

### **903.04.02.03 Materials**

#### **903.04.02.03.01 Mill Certificates**

The Contractor shall submit to the Contract Administrator at the time of delivery 1 copy of the mill certificates, indicating that the steel meets the requirements for the appropriate standards for H-piles, tube piles, and sheet piles.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificates verified by testing by a Canadian laboratory. The laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian testing laboratory.

#### **903.04.02.03.02 Concrete**

The Contractor shall submit a suitable, site-specific concrete mix design that meets the requirements of the hardened concrete to the Contract Administrator 14 Days prior to construction, for the purpose of quality assurance and documentation.

#### **903.04.02.03.03      Slurry**

The Contractor shall submit the following to the Contract Administrator 14 Days prior to construction, for the purpose of quality assurance and documentation:

- a) The type, source, and physical and chemical properties of the bentonite or polymer.
- b) The source of water.
- c) Method of mixing slurry.
- d) The water solids ratio and the mass and volumes of the constituent parts, including any chemical admixtures or physical treatment employed to produce slurry with the required physical properties.
- e) Details of procedure to be used for monitoring the quality of the slurry.
- f) A test report showing the properties of the slurry and certifying that the slurry meets the requirements of API RP 13B-1.
- g) Method of disposal of the slurry.

#### **903.04.02.04              Installation**

##### **903.04.02.04.01      Driven Piles**

The Contractor shall submit the following to the Contract Administrator 14 Days prior to construction, for the purpose of quality assurance and documentation:

- a) A schedule of work identifying time and sequence of activities. A Request to Proceed to allow for quality assurance oversight by the Contract Administrator.
- b) Type of equipment, anvil, helmet, and hammer details, including the hammer energy assumed by the Contractor, stated potential energy (rated energy) of the hammer, operating efficiency, and weight of ram.
- c) Working Drawings of precast concrete piles showing the pile dimensions, concrete strength, tendon arrangement, working stresses and arrangement of steel reinforcement, schedules, elongation calculations, method and sequence of casting, complete specifications and details of the prestressing steel, and lift anchors and lifting point locations.
- d) The method of maintaining the steel reinforcement cages in position, when steel reinforcement cages are used in tube piles.
- e) Procedure for monitoring pile installation.

- f) Details of the method of attaching proprietary driving shoes.
- g) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation and the details of the load application, components, equipment, testing apparatus, and method of monitoring.
- h) Information pertinent to establishing the resistance of a pile when the wave equation analysis method is used.

#### **903.04.02.04.02      Caisson Piles**

The Contractor shall submit the following to the Contract Administrator 14 Days prior to construction, for the purpose of quality assurance and documentation:

- a) A schedule of work identifying time and sequence of activities. A Request to Proceed to allow for quality assurance oversight by the Contract Administrator.
- b) Detailed procedures for caisson excavation in overburden and rock.
- c) Detailed procedures for casing and liner installation and for the withdrawal of the liner.
- d) Detailed procedures for slurry displacement method of excavation, including disposal of slurry upon completion.
- e) Detailed procedures for tremie concrete, including the size of tremie delivery pipe.
- f) Detailed procedure for placing concrete in the dry.
- g) Method of maintaining the steel reinforcement cages in position in the caisson.
- h) Details of filling the annular void around a casing.
- i) Details of procedure to be used for monitoring installation.
- j) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation, details of the load application, components, equipment, testing apparatus, and method of monitoring.

#### **903.04.02.04.03      Displacement Caisson Piles**

The Contractor shall submit the following to the Contract Administrator 14 Days prior to construction, for the purpose of quality assurance and documentation:

- a) A schedule of work identifying time and sequence of activities. A Request to Proceed to allow for quality assurance oversight by the Contract Administrator.

- b) Type of equipment, anvil, helmet, and hammer details, including the hammer energy assumed by the Contractor, stated potential energy (rated energy) of the hammer, operating efficiency, maximum stroke or drop, and weight of the ram.
- c) Details of procedures used for installation of displacement caisson piles, including detailed procedures for liner installation and withdrawal.
- d) Method of maintaining the steel reinforcement cages in position in the pile.
- e) Details of procedure to be used for monitoring pile installation.
- f) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation, and the details of the load application, components, equipment, testing apparatus, and method of monitoring.

#### **903.04.02.04.04      Steel Reinforcement Cages**

The Contractor shall submit Working Drawings showing the fabrication details of the steel reinforcement cages, including the lifting points and lifting lugs, to the Contract Administrator 14 Days prior to fabrication, for the purpose of quality assurance and documentation.

### **903.05                      MATERIALS**

#### **903.05.01                  Wooden Piles**

Wooden piles shall be according to CAN3-056 and shall be clean and peeled. Treated piles shall be pressure treated with creosote according to CAN/CSA O80.

Wooden piles shall be provided with collars sufficiently strong to prevent splitting of the head of the wooden pile during driving.

#### **903.05.02                  Steel Piles**

##### **903.05.02.01              H-Piles**

Steel H-piles shall be according to CAN/CSA G40.20/G40.21, Grade 350 W.

##### **903.05.02.02              Tube Piles**

Steel tube piles shall be according to ASTM A 252, minimum Grade 2.

##### **903.05.02.03              Sheet Piles**

Steel sheet piles shall be according to ASTM A 328M.



#### **903.05.02.04            Straightness Tolerance for Steel Piles, Casings, and Liners**

Steel piles, casings, and liners shall conform to a straightness tolerance of 1.5 mm maximum per metre of length.

Steel sheet piles shall be sufficiently straight to prevent binding in the interlock during driving.

#### **903.05.03                Driving Shoes and Rock Points**

Rock points and driving shoes shall be as specified in the Contract Documents.

Driving shoes shall transfer the driving stresses to the pile over the full cross-sectional area of the pile.

Where precast concrete piles are driven into dense or hard material, a steel driving shoe cast into the concrete shall be provided.

Where wooden piles are driven into dense material, a steel plate driving shoe shall be provided to prevent damage to the bottom of the pile.

#### **903.05.04                Casing for Caissons**

Casings shall be according to ASTM A 252, Grade 2. If welded, they shall be welded by the electric arc method according to CSA W59.

The casing wall thickness specified is the minimum that shall be supplied. The wall thickness shall be increased as required to ensure the casing is not damaged during handling and installation.

#### **903.05.05                Steel Reinforcement**

Steel reinforcement shall be according to OPSS 1440.

#### **903.05.06                Concrete**

##### **903.05.06.01            General**

Concrete shall be according to DBSP 1350.

##### **903.05.06.02            Tube Piles**

Concrete shall have a slump of 150 to 180 mm.

### **903.05.06.03            Caisson Piles**

Concrete shall have a slump of 150 to 180 mm. When approved by the Contractor's Engineer in writing, admixtures may be used. Where the liner is to be withdrawn, sufficient retarder shall be added to prevent arching of concrete during liner withdrawal and to prevent setting of concrete until after the liner is withdrawn.

### **903.05.07                Precast Concrete Piles**

The production of precast reinforced concrete piles shall be according to DBSP 0904, OPSS 905, and DBSP 0909.

Steel reinforcement shall be placed such that direct loading during the ram stroke shall not occur.

Lifting anchors shall be at least 25 mm clear from reinforcement or prestressing steel in the pile.

Concrete in precast reinforced concrete piles shall be according to DBSP 1350 and have a nominal minimum 28-Day compressive strength of 45 MPa.

Concrete for precast reinforced concrete piles shall be cured according to DBSP 0904.

Concrete for precast reinforced concrete piles shall be placed in smooth mortar-tight forms that are supported to prevent excessive deformation or settlement during placing or curing.

Unformed surfaces shall be finished smooth.

When removed from the form, the pile shall present true, smooth, even surfaces free from honeycombs and voids. The pile shall be straight so that a line stretched from butt to tip on any face shall not be more than 25 mm from the face of the pile at any point.

Each precast reinforced concrete pile shall have the date of manufacture (i.e., yyyy-mm-dd) inscribed on it.

### **903.05.08                Slurry**

#### **903.05.08.01           Solids**

Bentonite and polymers shall be according to API Spec 13A.

#### **903.05.08.02           Water**

Water shall be according to OPSS 1302.

### **903.05.08.03            Slurry Composition**

The slurry shall consist of a stable colloidal suspension of pulverized solids or polymers thoroughly mixed with water. The density, viscosity, sand content, and pH of the slurry being used during excavation shall be according to API RP 13B-1.

## **903.06                    EQUIPMENT**

### **903.06.01                Hammers**

Hammers shall be capable of installing the piles, casings, and liners to the depth or resistance specified in the Contract Documents, without damage to the portions that are not cut off.

The hammer used to chisel the rock point into the rock shall be capable of delivering a controlled blow in 10% increments ranging in energy from zero to the maximum hammer energy.

For precast reinforced concrete piles, the heaviest hammer practicable shall be employed and the stroke limited so as not to damage the piles. When choosing the size of the hammer, consideration shall be given to whether the pile is to be driven to a resistance or to a given depth.

### **903.06.02                Helmets and Striker Plates**

The head of steel piles shall be protected by a striker plate or a helmet. Helmets shall have adequate and suitable cushioning material. Helmets and striker plates shall distribute the blow of the hammer evenly throughout the cross-section of the pile head.

### **903.06.03                Leads**

Pile driver leads shall be built to afford freedom of movement for the hammer and shall be held in position at the top and bottom by guys, stiff braces, or other approved means to ensure support of the pile, casing, or liner while it is being driven. Swinging leads shall not be permitted.

Batter piles, casings, or liners shall be driven with leads aligned parallel to the axis of the pile, casing, or liner. The leads shall be equipped with a fixed, rigid, adjustable kicker.

### **903.06.04                Followers**

When use of followers are specified in the Contract Documents, followers shall be of type, size, shape, length, and weight as to permit driving the pile, casing, or liner at the location and to the required depth or ultimate resistance specified in the Contract Documents. The follower shall be provided with a socket or hood carefully fitted to the

top of the pile, casing, or liner to minimize loss of energy and to prevent damage to the pile, casing, or liner, and shall have sufficient rigidity to prevent "whip" during driving.

When followers are permitted, an identical follower shall be used when the set is being determined.

## **903.07 CONSTRUCTION**

### **903.07.01 Transporting, Storing, and Handling Piles, Casings, Liners, and Reinforcing Steel Reinforcement Cages**

#### **903.07.01.01 General**

Piles, casings, liners, and steel reinforcement shall be transported, stored, and handled in such a manner that damage is prevented and the strength of the components is not affected by deterioration or deformation.

Components shall be lifted and placed using appropriate lifting equipment, temporary bracing, guys, or stiffening devices so that the components are at no time overloaded, unstable, or unsafe.

Material shall be supported to prevent unequal settlement when stacked.

#### **903.07.01.02 Wooden Piles**

Cant hooks, dogs, pile pulls, or use of other lifting methods that might damage the integrity of the pressure treated surface shall not be used. Cuts or breaks in the surface of treated piling shall be given three brush coats of hot creosote oil. Bolt holes shall be treated with three applications of hot creosote oil applied with a bolt hole treater.

#### **903.07.01.03 Handling Holes in Steel Piles**

Unless otherwise approved by the design Engineer, holes shall only be made in the portion of the pile to be cut off or in the portion of the pile to be encased in concrete.

When other holes are approved to be cut in a pile, they shall be covered by splice plates placed on both sides of the section. The thickness and the mechanical properties of the plate material shall be at least equivalent to the pile material.

#### **903.07.01.04 Precast Reinforced Concrete Piles**

Precast concrete piles shall be handled only from the designated lifting points.

When lifting or transporting precast reinforced concrete piles lift anchors, slings, or other approved means shall be used. Care shall be taken when lifting and transporting to avoid any overstressing of the pile or cracking of the concrete.

Precast reinforced concrete piles shall be so handled to avoid breaking or chipping their edges.

Lift anchors shall be removed, and the holes filled with a non-shrink grout or epoxy installed according to the manufacturer's recommendations.

#### **903.07.01.05            Caisson Casings and Liners**

Casings and liners shall be handled and stored in such a manner to avoid damage or distortion to them. The casings and liners shall be maintained circular within  $\pm 2\%$  of the casing or liner diameter.

#### **903.07.02                Driven Piles**

##### **903.07.02.01            Pile Driving Requirements and Restrictions**

Piles shall not be driven until embankment work or excavation work has been completed to the underside of the footing. When driving of the piles is completed, all material between the piles shall be removed to the correct elevation and any holes or voids created shall be filled to the correct elevation with compacted material approved by the Contractor's design Engineer or design Engineer's designee.

Piles shall be installed at the locations specified in the Contract Documents and to the set or depth specified without being damaged. Damage to the pile, casing, or liner during driving shall be prevented by limiting the drop or energy and number of blows of the hammer. The hammer, helmet, cap block, striker plate, and pile shall be coaxial and shall sit squarely upon each other.

A shorter stroke shall be used, and proper precaution shall be taken when there is a danger of damaging or over driving the piles, casing, or liners under conditions such as:

- a) In the early stages of driving a long pile where a hard layer near the ground surface has to be penetrated.
- b) Where there is very soft material of a considerable depth and a large penetration is achieved at each hammer blow.
- c) Where it is anticipated the pile shall meet refusal on rock or other impenetrable soil.
- d) When piles are driven onto sloping bedrock.

Damage to adjacent structures, Utilities, and fresh concrete shall be prevented during pile installation. Piles shall not be driven within a radius of 8 m of concrete that has been in place for less than 72 hours. Piles shall not be driven within a radius of 15 m of concrete that has been in place for less than 72 hours without the approval of the design Engineer.

The tops of all piles shall be either square to the longitudinal axis of the pile or horizontal as indicated in the Contract Documents.

Piles shall not be forced into their proper position using excessive manipulation. Pile damage due to excessive driving shall be avoided.

#### **903.07.02.02          Driving Shoes and Rock Points**

Driving shoes and rock points shall be installed in locations specified in the Contract Documents.

Driving shoes shall be welded in accordance with the Contract Documents.

When driving shoes are specified in the Contract Documents, the Titus H bearing pile point, standard model, may be substituted for the driving shoes.

When Oslo points are specified in the Contract Documents, the Titus H bearing pile point, rock injector model, may be substituted for the pile points.

Where proprietary driving shoes are used, they shall be welded or otherwise attached to the driven piles according to the manufacturer's specifications.

#### **903.07.02.03          Splicing**

##### **903.07.02.03.01      General**

Any damaged material shall be cut-off prior to splicing.

##### **903.07.02.03.02      Wooden Piles**

Wooden piles shall not be spliced.

##### **903.07.02.03.03      H-Piles, Tube Piles, and Sheet Piles**

Welding shall be according to CSA W59 and shall be done by a qualified welder employed by a firm certified according to CSA W47.1, Division 1 or Division 2.1.

Steel H-piles and steel tube piles may be spliced providing that the pieces being spliced are not less than 3 m long, except for piles at integral abutments for which the pieces being spliced shall not be less than 7 m long. Splices in piles located into a watercourse shall only be introduced under the low water level, unless the piles are encased in concrete.

Sheet piles shall not be spliced without approval by the design Engineer.

#### **903.07.02.03.04      Precast Reinforced Concrete Piles**

Precast reinforced concrete piles shall only be spliced when specified in the Contract Documents and the splices shall only be made with approved mechanical splicing devices.

#### **903.07.02.04              Concrete in Steel Tube Piles**

Concrete in steel tube piles shall be placed according to DBSP 0904.

#### **903.07.02.05              Cutting Off Piles**

##### **903.07.02.05.01      General**

Driven piles shall be cut to the elevation as specified in the Contract Documents.

The length of pile supplied shall be sufficient to ensure there is no damaged material below the cut off. Damaged material at the pile head shall be cut off.

Piles shall not be cut off until retapping, redriving, and specified load testing are complete.

##### **903.07.02.05.02      Wooden Piles**

Where wooden piles are broomed, splintered, or otherwise damaged below the cut-off elevation, the pile shall be considered defective and shall be replaced.

#### **903.07.02.06              Protective Coating for Steel H and Steel Tube Piles**

Exposed steel H and steel tube piles shall have a coal tar epoxy protective coating applied from an elevation 600 mm below the low water level or finished ground surface up to the top of the exposed steel.

The steel surfaces shall be cleaned according to SSPC-SP10 prior to application of a coal tar epoxy system that shall be according to OPSS 911.

#### **903.07.02.07              Monitoring Driven Piles**

##### **903.07.02.07.01      General**

The Contractor shall submit a Request to Proceed to Contract Administrator. The driving of piles shall be carefully monitored and controlled and pile driving records produced for each pile under the direction of the Contractor's design Engineer or design Engineer's designee. A pile driving record shall be submitted to the Contract Administrator for the purpose of quality assurance and documentation.

The Contractor shall not overdrive the piles. When driving to a specified ultimate resistance, or driving to bedrock, the Contractor shall drive the piles to the anticipated tip elevation. If a pile does not reach set at the anticipated tip elevation, the Contractor shall notify the design Engineer for review and decision prior to proceeding with driving of that pile.

In soils where there is a possibility of piles moving upward due to ground heave, elevations of completed pile tops shall be measured at time intervals determined by the design Engineer or design Engineer designee while nearby piles are being installed. The readings shall be recorded and submitted to the design Engineer and Contract Administrator (for the purpose of quality assurance and documentation) as the work proceeds.

#### **903.07.02.07.02 Driving to a Specified Elevation**

Piles shall be driven to an elevation specified in the Contract Documents. Driving piles to other elevations shall only be done when approved in writing by the design Engineer.

#### **903.07.02.07.03 Driving to a Specified Ultimate Resistance**

##### **903.07.02.07.03.01 General**

When piles are specified to be driven to a specified ultimate resistance, the specified ultimate resistance shall be determined using High Strain Dynamic Testing (Pile Driving Analyzer, or PDA) at end of initial driving as specified in the Contract Documents. PDA testing shall be completed on a minimum of 10% of the piles or three piles, whichever is greater, rounded up to the nearest whole number, for each foundation element and stage of foundation construction.

If the specified ultimate resistance is not achieved, retap/restrike shall be conducted after initial driving as specified in the Contract Documents.

A Request to Proceed shall be submitted to the Contract Administrator after the design ultimate resistance is achieved.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

##### **903.07.02.07.03.02 Driving to a Set**

The founding elevation shall be established by driving to a set determined in accordance with the dynamic formula specified in the Contract Documents or by the application of the wave equation analysis procedure that verifies the pile resistance. This set shall be established on the first pile of every ten piles driven in a pile group.



The other piles shall be controlled by the pile penetration rate in blows per millimetre that correlates to the set.

When new conditions, such as change in hammer size, change in pile size, or change in soil material occur, new sets shall be determined.

#### **903.07.02.07.03.03 Driving to Bedrock**

When driving piles to bedrock, the Contractor shall adequately seat the pile on bedrock without damaging the pile.

Where rock points are used, the rock points shall penetrate into the rock. Piles driven using rock points shall be driven to ensure adequate seating on the bedrock without damaging the pile.

Driving of piles on sloping bedrock shall be stopped when initial contact is made with the bedrock. The bedrock elevation shall be recorded. Driving shall then continue, commencing with energy of 10% of the maximum energy of the hammer. The pile shall be driven in sets of 20 blows at this energy until no penetration is observed. Twenty additional blows shall be applied, and, if no penetration is observed, the energy shall be increased by an additional 10% and the above procedure repeated.

Driving shall continue with these stepped increases in energy and with the same series of blows as described above, until the pile has been seated on the bedrock.

If unrealistic excessive penetration per blow is observed, driving shall be stopped, and this excessive penetration immediately reported to the design Engineer and Contract Administrator.

The design Engineer shall determine when the hammer energy can be increased and when the driving is complete for each pile.

#### **903.07.02.07.04 Wave Equation Analysis**

When requested by the Contract Administrator, the Contractor shall supply all equipment, material, and personnel to conduct the wave equation analysis procedure. The design Engineer shall review the results of the analysis and submit a report with recommendations to the Contract Administrator.

#### **903.07.02.07.05 Hammer Performance**

When requested by the Contract Administrator, the Contractor's design Engineer or design Engineer designee shall verify the hammer performance using the pile driving analyzer or other approved equivalent. Hammer performance shall be verified to ensure that the actual potential energy (rated energy) is not less than 90% of the stated potential energy. The Contractor shall provide all instrumentation, access, and

assistance for the testing and monitoring. The Contractor shall provide a copy of the hammer performance verification results.

#### **903.07.02.07.06      Retapping Tests on Piles**

In each pile group, 10% of the piles rounded up to the next whole number, but no fewer than two piles, shall be retapped no sooner than 24 hours after installation of the individual pile to confirm that the ultimate axial resistance has been sustained.

Retapping of piles driven to bedrock is not required.

#### **903.07.02.07.07      Retapping and Redriving Piles**

When the retapping tests indicate that the ultimate axial resistance has not been achieved on any one pile, all piles in the group shall be retapped.

Where the retapping reveals that the ultimate axial resistance of the piles has not been achieved, the piles that have not achieved the ultimate axial resistance shall be redriven to the specified resistance.

Where piles have risen, the piles shall be redriven to the original depth.

#### **903.07.02.08              Jetting**

Jetting shall be carried out in such a manner that the resistance of the piles already in place and the safety of adjacent structures shall not be impaired. Jetting shall be stopped at least 1 m above the final expected pile-tip elevation and at least 1 m above the tip elevation of any piles previously driven within 2 m of the jet. Where piles are to be end bearing on rock, jetting may be carried to the rock surface.

The driving and jetting of precast reinforced concrete piles shall not be carried out simultaneously.

#### **903.07.03                  Caisson Piles**

##### **903.07.03.01              General**

Caissons shall be constructed as specified in the Contract Documents.

The final bearing elevation shall be as specified in the Contract Documents or as determined by the design Engineer. When permanent casings are not specified, the caisson shall be constructed in a drilled hole with or without the use of a temporary liner or slurry as determined by the Contractor.

## **903.07.03.02        Excavation**

### **903.07.03.02.01     General**

Sidewall stability and basal stability shall be maintained throughout the excavation and concrete placement operation. Soil cave-in into the excavation hole shall be prevented.

The bottom of the excavation shall be cleaned before the start of concrete placement.

Excavation methods shall be such that the sides and bottom of the hole are straight and free of loose material that might prevent intimate contact of the concrete with undisturbed soil or bedrock.

Except when founded on sloping rock, the caisson bottom shall be level. On sloping rock, the caisson bottom may be stepped, with each step not greater than  $\frac{1}{4}$  the diameter of the bearing area.

### **903.07.03.02.02     Casings**

When an auger is used to excavate for a casing, the diameter of the auger shall be no greater than the outside diameter of the casing.

### **903.07.03.02.03     Liners**

The diameter of the excavation for the installation of liners shall not exceed the diameter of the liner by more than 150 mm.

### **903.07.03.02.04     Slurry Method**

The level of slurry in the excavation shall be sufficient to prevent the intrusion of water and to maintain a stable wall with no cave-in, sloughing, or basal heave.

Slurry shall be tested as specified in API RP 13B-1. The Contractor shall provide all test equipment required for the tests. A slurry sampler capable of obtaining samples at any depth within the caisson hole shall always be available.

At least 1 set of tests shall be completed every 4 hours during the slurry operation. Samples shall be taken from the mud tank and from within the caisson at a depth within 300 mm of the bottom.

## **903.07.03.03        Inspection of the Excavation**

The bottom of excavations shall be visually inspected. Each excavated shaft shall be inspected and accepted by the Contract Administrator prior to proceeding with construction. The bottom of each excavated shaft for the Coldwater Road Underpass foundation element(s) shall be inspected using both a Shaft Inspection Device SID and

Shaft Quantitative Inspection Device (SQUID) to verify shaft bottom cleanliness and thickness of debris/sediment prior to concreting as specified in the Contract Documents. Concrete is to be placed as soon as possible, and not exceeding 6 hours after completing cleaning of the shaft excavation, inspecting and finding it satisfactory, and immediately after placing reinforcing steel.

#### **903.07.03.04          Dewatering**

Where dewatering is required, the Contractor shall affect a dewatering scheme in such a manner as to prevent any disturbance to the base founding material. The dewatering shall not create subsidence or cause ground loss that may adversely affect the work or adjacent structures.

#### **903.07.03.05          Backfilling Liners Left in Place**

The annular space between a liner permanently left in place and shaft excavation shall be filled with concrete or fluid grout.

#### **903.07.03.06          Steel Reinforcement**

Steel reinforcement steel shall be installed according to OPSS 905. Steel reinforcement cages shall be checked to ensure conformance to the Working Drawings prior to installation and during placement of concrete.

The steel reinforcement cage shall be fabricated in one piece.

Welding of steel reinforcement and use of splices shall not be done unless specified in the Contract Documents.

The steel reinforcement shall not be displaced or distorted during the construction of the caisson.

#### **903.07.03.07          Concrete**

##### **903.07.03.07.01      General**

A Request to Place Structural Concrete shall be submitted to the Contract Administrator prior to concrete placement.

The placement of concrete shall not proceed until the Contract Administrator has issued a Notice to Proceed to the Contractor.

Concrete shall be placed in the caisson according to DBSP 0904, and as specified herein.

The reinforcement shall not be displaced or distorted during the construction of the caisson.

When casing or liner withdrawal is part of the design, arching of concrete during casing or liner withdrawal shall be prevented.

#### **903.07.03.07.02 Concrete Placed in the Dry**

The concrete may be placed free fall provided the fall is vertically down the centre of the opening and transverse ties, spacers or other objects do not impede the free fall. In the event of interference with the concrete free fall, an elephant trunk or other means shall be used to prevent concrete segregation.

Concrete shall be placed in a continuous operation from the bottom to the top of the caisson or, where columns are cast integral with the caisson, to the elevation of the bottom of the column steel reinforcement cage. The concrete shall be vibrated for the last 1.5 m of the pour.

#### **903.07.03.07.03 Concrete Placed Under Water or Under Slurry**

Tremie or pumped concrete shall be carried out in one continuous operation. The tremie or pumping operation shall be a continuous flow of concrete that prevents the inflow of water or slurry.

Where tremie concrete is to be placed in a caisson under water, the Contractor shall maintain an adequate head of water within the excavations to prevent the inflow of water through the base or walls of the caisson as the concrete is being placed.

Where tremie is placed under slurry, the caisson shall be filled with concrete entirely by tremie and the method of deposition shall not be changed part way up the caisson.

When concrete placement is not started within 6 hours of acceptance of the excavation, the excavation shall be redrilled, cleaned, and the slurry tested before concrete placement commences.

#### **903.07.03.07.04 Withdrawal of Liners**

Arching of concrete during withdrawal of the liner shall be prevented.

During withdrawal, the bottom of the liner shall have a minimum embedment into the concrete being placed and a sufficient head of concrete shall always be maintained above the bottom of the liner to prevent intrusion of soil and water into the hole.

During withdrawal, upward or downward movement of the steel reinforcement shall be monitored. Upward or downward movement shall be restricted to 150 mm.

A theoretical concrete level shall be calculated based on the quantity of concrete placed and the caisson dimensions, and this theoretical level shall be compared to the actual level of concrete in the caisson to provide a check for possible separation of shaft concrete during liner withdrawal.

#### **903.07.03.07.05      Founding Elevation**

The final founding elevation shall be as specified in the Contract Documents or an elevation approved in writing by the design Engineer. When casings are not specified in the Contract Documents, the caisson shall be constructed in a drilled hole with or without the use of a liner or slurry as determined by the Contractor.

Mini-Sid and/or SQUID shall be used to verify the founding soil.

Except when founded on sloping unweathered bedrock, the caisson bottom shall be level. On sloping unweathered bedrock, the caisson bottom may be stepped, with each step not greater than one quarter the diameter of bearing area.

The bearing area of the caisson pile shall be approved by the design Engineer. A Request to Place Structural Concrete shall be submitted to the Contract Administrator prior to placing concrete. Complete access to inspect the bearing area of the caisson pile prior to the placement of concrete shall be given to the Contract Administrator. The placement of concrete shall not proceed until the Contract Administrator has issued a Notice to Proceed to the Contractor.

#### **903.07.04                  Displacement Caisson Piles**

Work shall be carried out in accordance with the displacement caisson pile suppliers' installation procedures. A permanent liner shall be used when specified in the Contract Documents.

The sequence of installation shall be such as to prevent damage to any recently completed piles.

The pile shall not be founded above or below the specified pile tip elevation without approval in writing from the design Engineer.

The Contractor's design Engineer or design Engineer's designee shall witness the pile installation operation.

#### **903.07.05                  Tolerances**

##### **903.07.05.01              Driven Piles**

a) Cut-off elevation  $\pm 25$  mm.

- b) Deviation from vertical not more than 1H:50V, except in the case of a pile cap or footing supporting only a single row of piles the deviation shall not be more than 1H:75V in the direction of the span.
- c) The deviation from the specified inclination for battered piles shall not exceed 1H:25V.
- d) The centre of the pile at the junction with the pile cap shall be within 150 mm measured horizontally of that specified except in the case of a pile cap or footing supported on a single row of piles the deviation shall not be more than 75 mm measured horizontally in the direction of the span.

#### **903.07.05.02            Caissons and Displacement Caisson Piles**

- a) Cut-off elevation  $\pm 25$  mm.
- b) Horizontal location at cut-off not more than 5% of shaft diameter or 75 mm, whichever is less.
- c) Vertical alignment not more than 2% of the caisson length from vertical for vertical caissons, or 2% of the caisson length from the specified inclination for battered caissons.

#### **903.07.06                Load Test**

When a load test is specified in the Contract Documents, the testing shall be according to ASTM D 1143M for piles under vertical static load, ASTM D 3689 for piles under tensile load, and ASTM D 3966 for piles under lateral loads. The Contractor's design Engineer, or design Engineer's designee, shall organize and notify the Contract Administrator of the scheduled test. The Contractor's design Engineer, or design Engineer's designee, and the Contract Administrator shall witness the pile load test. All records and results of the pile load test shall be submitted to the Contract Administrator for the purpose of quality assurance and documentation.

The Contractor shall provide all necessary personnel, equipment, and material to make adjustments during the tests and shall have at least one skilled worker present for the complete duration of each test. The Contractor shall ensure that this worker shall have demonstrated experience in load testing of piles.

The Contractor shall do all necessary grading work to ensure a level dry working area at the test location and shall erect an adequate enclosure sufficient to provide complete protection from adverse weather conditions for the complete duration of the tests, including all temporary work required to obtain access to the site for the personnel, equipment, and materials.

On completion of the tests, the Contractor shall clear and restore the site to the satisfaction of the Contract Administrator. Piles that are not part of the finished work shall be cut off 1.2 m below ground level or 0.6 m below stream bed level. Any resulting void shall be backfilled with suitable fill material.

#### **903.07.07                      Repair of Welds**

Any section of weld that does not meet the requirements of the Contract Documents shall be removed and rewelded.

#### **903.08                              Quality Assurance**

##### **903.08.01                      Visual Inspection of Welds**

Complete access to visually inspect the welds shall be given to the Contract Administrator.

All welds shall conform with the requirements of CSA W59 and the Contract Documents. A representative sample of splice welds, not less than 30% of the welds will be selected by the Contract Administrator for visual inspection. The selected splice welds shall be taken from different piles.

If the sample welds do not pass the visual inspection and need to be repaired, the visual inspection by the Contract Administrator may be increased up to 100% of the welds.

##### **903.08.02                      Non-Destructive Testing of Welds**

The Contract Administrator shall be notified in writing, 48 hours in advance of installing piles which will require weld splicing. The Contract Administrator shall be immediately notified in writing, if there are any schedule changes for each pile requiring weld splicing.

A Request to Proceed shall be submitted to the Contract Administrator after the completion of splice welds for each construction stage of work.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

Radiographic or ultrasonic testing shall be carried out by the Contract Administrator using procedures according to CSA W59.

Ultrasonic or radiographic testing shall be carried out on the entire length of selected splice welds chosen at random by the Contract Administrator.



If any welds do not pass the ultrasonic or radiographic-testing and need to be repaired, these non-destructive testing requirements may be increased up to 100% of the welds.

All welds that have been repaired shall be visually inspected and shall undergo non-destructive testing performed by the Contract Administrator.

Results from completed Visual Inspection Reports and Non-Destructive Test Reports will be provided upon request.

### 903.08.03 Displacement Caisson Piles

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

**903.10 BASIS OF PAYMENT – Not Used**



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