



FOUNDATION INVESTIGATION AND DESIGN REPORT

*Overhead Sign Supports and High Mast Light Poles, QEW Widening from West of Mississauga Road to West of Hurontario Street, City of Mississauga
Ministry of Transportation, Ontario, G.W.P. 2002-13-00*

Submitted to:

Morrison Hershfield Limited

125 Commerce Valley Drive West, Suite 300
Markham, Ontario
L3T 7W4

Submitted by:

Golder Associates Ltd.

6925 Century Avenue, Suite #100 Mississauga
Ontario, L5N 7K2 Canada
+1 905 567 4444
1662333 - 7

December 13, 2018

GEOCRES No. 30M12-433

Latitude: 43.557930

Longitude: -79.610152



Distribution List

1 PDF & 1 Copy - Ministry Transportation, Ontario (Central Region)

1 PDF & 1 Copy - Ministry Transportation, Ontario (Foundations Section)

1 PDF - Morrison Hershfield Limited

1 PDF - Golder Associates Ltd.

Table of Contents

PART A – FOUNDATION INVESTIGATION REPORT

| | |
|--|-----------|
| 1.0 INTRODUCTION | 1 |
| 2.0 SITE DESCRIPTION | 1 |
| 3.0 INVESTIGATION PROCEDURES | 1 |
| 3.1 Previous Investigation | 1 |
| 3.2 Current Investigation | 2 |
| 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS | 4 |
| 4.1 Regional Geology | 4 |
| 4.2 Subsurface Conditions | 5 |
| 4.2.1 Overburden Conditions | 5 |
| 4.2.1.1 Overhead Sign 1 – Station 15+529 | 5 |
| 4.2.1.2 High Mast Lighting Pole 1 – Station 15+875 | 6 |
| 4.2.1.3 Overhead Sign 2 – Station 16+989 | 7 |
| 4.2.1.4 Overhead Sign 5 – Station 16+052 | 8 |
| 4.2.1.5 High Mast Lighting Pole 2 – Station 16+275 | 10 |
| 4.2.1.6 Overhead Sign 4 – Station 16+512 | 11 |
| 4.2.1.7 Overhead Sign 3 – Station 17+425 | 12 |
| 4.2.2 Bedrock / Refusal Conditions | 13 |
| 4.2.3 Groundwater Conditions | 15 |
| 5.0 CLOSURE | 17 |

PART B – FOUNDATION DESIGN REPORT

| | |
|--|-----------|
| 6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS | 18 |
| 6.1 General | 18 |
| 6.2 Design of Sign Support Foundations | 18 |
| 6.2.1 Site-Specific Caisson Foundation Design in Soil | 19 |
| 6.2.2 Caisson Foundations Embedded or Socketted into Bedrock | 20 |
| 6.3 Design of High Mast Light Pole Foundations | 20 |
| 6.3.1 Caisson Foundation Design in Soil | 21 |

| | | |
|------------|---|-----------|
| 6.3.2 | Caisson Foundation with Tip Nominally Socketted in Rock | 21 |
| 6.3.3 | Caisson Foundations Embedded into Rock..... | 21 |
| 6.3.4 | Foundations Anchored into Bedrock..... | 21 |
| 6.4 | Construction Considerations | 22 |
| 6.4.1 | Control of Soil and Groundwater..... | 22 |
| 6.4.2 | Foundations in Bedrock | 22 |
| 6.4.3 | Obstructions | 23 |
| 7.0 | CLOSURE | 23 |

REFERENCES

TABLES

| | |
|---------------|---|
| Table 1 | Geotechnical Design Parameters for Overhead Sign Foundations, G.W.P. 2002-13-00 |
| Table 2 | Geotechnical Design Parameters for High Mast Light Pole Foundation, G.W.P. 2002-13-00 |

DRAWINGS

| | |
|-----------|--------------------|
| Drawing 1 | Borehole Locations |
| Drawing 2 | Borehole Locations |
| Drawing 3 | Borehole Locations |

APPENDICES

Appendix A Previous Investigation (GEOCRETS No. 30M12-238)

Lists of Symbols and Abbreviations
Record of Boreholes 1 to 4
Figure 1 - Borehole Location Plan

Appendix B Current Investigation - Record of Borehole and Record of Drillhole Sheets and Bedrock Core Photographs

Lists of Symbols and Abbreviations
Lithological and Geotechnical Rock Description Terminology

Record of Boreholes OHS-1 to OHS-5, HMLP-1, HMLP-2, MO-08A, MO-08B, SWMW-3 and NRW7-1
Record of Drillholes OHS-1, OHS-2, OHS-4, OHS-5, HMLP-1, HMLP-2 and SWMW-3

| | |
|------------|---|
| Figure B-1 | Bedrock Core Photographs – Borehole OHS-1 (3.61 m to 7.26 m) |
| Figure B-2 | Bedrock Core Photographs – Borehole OHS-2 (3.81 m to 7.47 m) |
| Figure B-3 | Bedrock Core Photographs – Borehole OHS-4 (1.73 m to 5.56 m) |
| Figure B-4 | Bedrock Core Photographs – Borehole OHS-5 (4.06 m to 7.95 m) |
| Figure B-5 | Bedrock Core Photographs – Borehole HMLP-1 (3.05 m to 6.53 m) |
| Figure B-6 | Bedrock Core Photographs – Borehole HMLP-2 (2.29 m to 5.77 m) |
| Figure B-7 | Bedrock Core Photographs – Borehole SWMW-3 (2.36 m to 6.89 m) |

Appendix C Geotechnical Laboratory Test Results

| | |
|-------------|---|
| Figure C-1 | Grain Size Distribution – Silt / Silt and Sand / Silty Sand (Fill) |
| Figure C-2 | Grain Size Distribution – Silty Clay (Fill) |
| Figure C-3 | Plasticity Chart – Silty Clay (Fill) |
| Figure C-4 | Grain Size Distribution – Sand Silt to Silt and Sand |
| Figure C-5 | Grain Size Distribution – Clayey Silt to Silty Clay |
| Figure C-6 | Plasticity Chart – Clayey Silt to Silty Clay |
| Figure C-7 | Grain Size Distribution – Sandy Clayey Silt to Silty Clay (Till) |
| Figure C-8 | Plasticity Chart – Sandy Clayey Silt to Silty Clay (Till) |
| Figure C-9 | Grain Size Distribution – Silt and Sand to Gravelly Silt and Sand (Till) |
| Figure C-10 | Plasticity Chart – Silt and Sand to Gravelly Silt and Sand (Till) |
| Figure C-11 | Grain Size Distribution – Clayey Silt with Sand to Silty Clay (Residual Soil) |
| Figure C-12 | Plasticity Chart – Clayey Silt with Sand to Silty Clay (Residual Soil) |

Bedrock Laboratory Testing Results - Geomechanica

Appendix D Non-Standard Special Provisions and Notice to Contractor

NSSP - Deep Foundations

Notice to Contractor - Obstructions

PART A

FOUNDATION INVESTIGATION REPORT
OVERHEAD SIGNS AND HIGH MAST LIGHT POLES
QEW WIDENING FROM WEST OF MISSISSAUGA ROAD TO WEST OF
HURONTARIO STREET, CITY OF MISSISSAUGA
MTO, G.W.P. 2002-13-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed Queen Elizabeth Way (QEW) widening from west of Mississauga Road to west of Hurontario Street in the City of Mississauga, in the Regional Municipality of Peel, Ontario, including three bridges; replacement of two culverts; two storm water management ponds; an access road, retaining walls; noise barrier walls; and high mast light pole supports in and overhead sign supports. This report addresses the results of the foundation investigation carried out for the overhead sign (OHS) supports and high mast light poles (HMLP) supports.

The purpose of this investigation is to establish the subsurface soil, bedrock and groundwater conditions at the location of the proposed OHS and HMLP supports / foundations, by borehole drilling, rock coring and geotechnical laboratory testing on selected soil and rock core samples.

The Terms of Reference (TOR) and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated July 2016, which forms part of the Consultant's Assignment Number (Number 2015-E-0033) for this project. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated February 3, 2017.

2.0 SITE DESCRIPTION

The section of the QEW along which the OHS support and HMLP foundation investigation was carried out extends from west of Mississauga Road at about Station 15+527 to about Credit River bridge at about Station 17+425 west of Credit River Bridge, in the City of Mississauga. The QEW alignment in the project area is oriented generally in a southwest-northeast direction; for the purposes of this report, the QEW alignment is described as being in an east-west orientation.

The ground (roadway) surface of the QEW along the project area gradually slopes downwards easterly from about Elevation 101.6 m at the west limit of the project area to Elevation 95.5 m at near the Credit River bridge and then gradually slopes upwards to about Elevation 98.5 m to the east limit of the project area. Land use adjacent to both sides of the QEW corridor is primarily residential, and a golf course is located immediately to the north of the Mississauga Road interchange. The Credit River flows in the north to south direction beneath the QEW Credit River bridge.

3.0 INVESTIGATION PROCEDURES

3.1 Previous Investigation

Golder carried out a foundation investigation in December 1997 in the vicinity of the QEW – Mississauga Road Interchange within the current project limits. At that time, four boreholes (Boreholes 1 to 4) were drilled to depths between 2.9m to 4.6 m below ground surface and the results of the investigation are presented in a report titled:

- "Foundation Investigation, High Mast Lighting, W.P. 167-86-00, Mississauga Road Interchange, Queen Elizabeth Way (QEW)", Report No. 971-8040, dated March 1998, GEOCRE No. 30M12-238.

The approximate location of the Boreholes 1 to 4 are shown on Drawing 1 and the Record of Boreholes 1 to 4 are included in Appendix A. The ground surface elevation at each borehole advanced during this investigation was not obtained at the time of the investigation; however, the northing and easting coordinates from the previous investigation were interpreted from Drawing 1 (in GEOCRE 30M12-238) and then coordinates were plotted on the digital terrain model provided by MH, to obtain the approximate ground surface elevations based on the current

grades. The borehole locations in MTM NAD 83 (Zone 10) coordinates, ground surface elevations referenced to Geodetic datum and the drilled depths are as follows:

| Borehole No. | Location (MTM NAD 83 Zone 10) | | Approximate Ground Surface Elevation* (m) | Borehole Depth (m) |
|--------------|-------------------------------|-------------------------------|---|--------------------|
| | Northing (m) (Latitude, °) | Easting (m) (Longitude, °) | | |
| 1 | 4,823,501.3 (43.551389) | 295,453.6 (-79.615677) | 99.7 | 4.6 |
| 2 | 4,823,416.0 (43.550619) | 295,317.2 (-79.617363) | 100.3 | 3.1 |
| 3 | 4,823,369.0 (43.550195) | 295,245.5 (-79.618250) | 100.8 | 2.9 |
| 4 | 4,823,418.1 (43.550638) | 295,302.7 (-79.617542) | 100.5 | 3.8 |

* Based on current grades at the borehole locations.

3.2 Current Investigation

Field work for the current foundation investigation was carried out between July 16 and September 6, 2018, during which time a total of seven sampled boreholes (designated as Boreholes OHS-1 to OHS-5 and HMLP-1 to HMLP-2) were advanced at the location of the proposed Overhead Sign and High Mast Lighting Pole foundations. This information was supplemented with Boreholes SWMW-3, MO-08A, MO-08B and NRW7-1 drilled for other immediately adjacent structures associated with the project, such as the storm water management pond, Mississauga Road overpass and noise barrier walls. The location of the boreholes are shown on Drawing 1.

The field borehole investigation was carried out using track-mounted CME 55 and truck-mounted CME 75 drill rigs supplied and operated by Davis Drilling of Milton, Ontario, truck-mounted CME 55 drill rigs, supplied and operated by Aardvark Drilling Inc. of Guelph, Ontario and portable drilling equipment (tripod) supplied and operated by Walker Drilling of Utopia, Ontario. With the exception of Borehole OHS-4, the boreholes were advanced using 150 mm solid-stem augers or 200 mm outside diameter hollow-stem augers through the overburden, and HW-size casing and an HQ core barrel through the bedrock. Borehole OHS-4 was advanced using a portable tripod drill equipped with NW-size casing throughout the overburden and an NQ core barrel through the bedrock.

Soil and bedrock surface samples were obtained at 0.75 m intervals of depth, using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer on the drill rigs or cathead/safety hammer on the portable drilling rig (for Borehole OHS-4), performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-08)¹.

¹ ASTM D1586-08a – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the soil.

With the exception of Borehole OHS-3, the boreholes were cored into bedrock, to depths ranging from about 5.6 m to 8.0 m below existing ground surface as detailed below. Samples of the bedrock were obtained using an 'NQ' or 'HQ'-size rock core barrel and coring techniques in the seven boreholes.

The groundwater conditions and water levels in the open boreholes were observed during and immediately following overburden drilling operations. All boreholes were backfilled with bentonite upon completion, in accordance with Ontario Regulation 903 (as amended).

The field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in-situ testing operations, logged the boreholes and examined the soil and bedrock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. Unconfined compression (UC) tests (including assessment of Young's modulus, Poisson's ratio, and core density) were carried out on selected specimens of the bedrock core samples by Geomechanica Inc., on behalf of Golder.

The as-drilled borehole locations and the ground surface elevations of Boreholes OHS-4, HMLP-1 and HMLP-2 were obtained using a GPS (Trimble XH 3.5G), having an accuracy of 0.1 m in the vertical and 0.1 m in the horizontal directions. The as-drilled locations of Boreholes OHS-1 to OHS-3 and OHS-5 were referenced to site features and then plotted on the borehole location drawing to obtain the coordinates of the locations; and the ground surface elevations were obtained by plotting the coordinates on the digital terrain model and interpreting the elevation. The locations given on the Record of Borehole/ Drillhole sheets and shown on Drawing 1 are positioned relative to MTM NAD 83 (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and drilled depths are summarized below.

| Borehole No. (Structure Location) | Location (MTM NAD 83) | | Ground Surface Elevation (m) | Borehole Depth (m) |
|--------------------------------------|-------------------------------|-------------------------------|------------------------------|--|
| | Northing (m) (Latitude, °) | Easting (m) (Longitude, °) | | |
| OHS-1 (STA 15+529) | 4,823,166.2 (43.548372) | 295,038.8 (-79.620817) | 101.6 | 7.3 (including 3.7 m of bedrock core) |
| OHS-2 (STA 15+989) | 4,823,411.0 (43.550588) | 295,425.9 (-79.616021) | 100.6 | 7.5 (including 3.7 m bedrock core) |
| OHS-3 (STA 17+425) | 4,824,956.0 (43.561460) | 296,389.4 (-79.606530) | 95.0 | 7.8 |
| OHS-4 (STA 16+512) | 4,823,828.9 (43.554333) | 295,734.3 (-79.612205) | 97.3 | 5.6 (including 3.9 m bedrock core) |

| Borehole No. (Structure Location) | Location (MTM NAD 83) | | Ground Surface Elevation (m) | Borehole Depth (m) |
|---|-------------------------------|-------------------------------|---------------------------------|---|
| | Northing (m) (Latitude, °) | Easting (m) (Longitude, °) | | |
| OHS-5 (STA 16+052) | 4,823,467.9 (43.551058) | 295,463.2 (-79.615622) | 100.5 | 8.0 (including 3.9 m bedrock core) |
| HMLP-1 (STA 15+875) | 4,823,418.1 (43.550638) | 295,302.7 (-79.617543) | 100.5 | 6.5 (including 3.5 m bedrock core) |
| HMLP-2 (STA 16+275) | 4,823,653.9 (43.552765) | 295,615.1 (-79.613680) | 98.8 | 5.8 (including 3.4 m bedrock core) |
| MO-08A (STA 16+275) | 4,823,630.5 (43.552545) | 295,614.5 (-79.613684) | 98.9 | 2.2 |
| MO-08B (STA 16+275) | 4,823,632.0 (43.552559) | 295,615.8 (-79.613668) | 98.9 | 2.1 |
| SWMW-03 (STA 16+052) | 4,823,513.7 (43.551490) | 295,424.7 (-79.616000) | 99.4 | 6.9 (including 4.5 m of bedrock core) |
| NRW7-1 (STA 17+425) | 4,824,601.6 (43.564250) | 296,209.0 (-79.603826) | 95.0 | 11.3 |

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The project area is located within the Iroquois Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putman, 1984)².

The glacial Iroquois Plain stretches along the northern shoreline of Lake Ontario, extending from the Niagara Escarpment in the west to the Scarborough Bluffs in the east. The Iroquois Plain soils consist of glaciolacustrine sediments deposited in Lake Iroquois, primarily sands, silts and gravels, with a shallow cover of till remaining over the bedrock.

The bedrock of the Georgian Bay Formation that underlies the study area consists mainly of blue-grey shale, containing siltstone, sandstone and limestone interbeds. Outcrops of this formation are commonly found along water

² Chapman, L.J. and Putman, D.F., 1984, *The Physiography of Southern Ontario*, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.)

courses on the west side of Toronto and in Mississauga, notably in the Humber River, Mimico Creek, Etobicoke Creek and Credit River valleys.

4.2 Subsurface Conditions

The relevant Record of Borehole sheets from the previous investigation (Boreholes 1 to 4) carried out by Golder are presented in Appendix A. As part of the current subsurface investigation, seven boreholes were advanced at the location of the proposed overhead signs and high mast light poles, and the subsurface information of a numbers of these locations is supplemented with addition four boreholes drilled for other structures associated with this project. The detailed subsurface soil, bedrock and groundwater conditions encountered in the eleven boreholes, as well as the summary results of in-situ testing and laboratory testing carried out on selected soil and bedrock core samples are presented on the Records of Borehole and Drillhole sheets provided in Appendix B. The results of the geotechnical laboratory test on soil and bedrock core specimens are presented in Appendix C, respectively. The results of the in-situ field tests (i.e. SPT “N” values) as presented on the Record of Borehole sheets and in sub-sections of Section 4.2.1 are uncorrected.

The stratigraphic boundaries shown on the Record of Borehole/ Drillhole sheets are inferred from observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsoil conditions will vary between and beyond the borehole locations.

A detailed description of the subsurface conditions encountered at each of the proposed overhead sign and high mast light pole locations is provided in the following sub-sections.

4.2.1 Overburden Conditions

4.2.1.1 Overhead Sign 1 – Station 15+529

Borehole OHS-1 was advanced on the QEW Toronto bound right lane at the proposed location of Overhead Sign 1 as shown on Drawing 1.

In general, the subsoil conditions encountered in Borehole OHS-1 consist of asphalt, underlain by concrete and fill consisting of gravelly sand and silt and sand, underlain by a till deposit consisting of silty clay, which in turn is further underlain by clayey silt residual soil and shale bedrock. A description of the soil deposits depths/elevation, results of SPT testing carried out in the boreholes and the geotechnical laboratory test results are provided below.

| Deposit/Layer Description | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|---------------------------|-----------------------|-------------------------------|----------------------------|------------------------------|
| | | | Consistency or Compactness | |
| Asphalt and Concrete | 0.13 | 101.6 | n/a | n/a |
| Concrete | 0.25 | 101.5 | n/a | n/a |
| Gravelly sand (FILL) | 0.5 | 101.2 | N = 24 | n/a |
| | | | Compact | |
| Silt and sand (FILL) | 0.6 | 100.7 | N = 20 | w = 22% 1 – MH (Fig. C-1) |
| | | | Compact | |

| Deposit/Layer Description | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|---|-----------------------|-------------------------------|---|--|
| | | | Consistency or Compactness | |
| Silty Clay, trace to some gravel, trace to some sand (TILL) | 1.3 | 100.1 | N = 12, 35 | w = 12%, 22% w _l = 36% w _p = 21% I _p = 15% 1 – MH (Fig. C-7) 1 – AL (Fig. C-8) |
| | | | Stiff to Hard | |
| Clayey Silt, some sand to sandy, some shale fragments (RESIDUAL SOIL) | 0.8 | 98.8 | N = 61 | w = 15%, 18% |
| | | | Hard | |
| SHALE (BEDROCK) | -- | 98.0 | See Section 4.2.2 for details of bedrock core and laboratory testing results. | |

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration

w = natural moisture content (%)

MH = combined sieve and hydrometer analysis

AL = Atterberg limits test

w_p = plastic limit (%)w_l = liquid limit (%)I_p = plasticity index (%)**4.2.1.2 High Mast Lighting Pole 1 – Station 15+875**

Boreholes 3 and 4 from GEOCRE 30M12-238 were advanced east and west of the proposed location of HMPL-1. During the current investigation, Borehole HMLP-1 was advanced in the grassy area near the proposed location of HMLP-1, as shown on Drawing 1.

In general, the subsoil conditions encountered in Borehole HMLP-1 consist of fill materials comprising sandy clayey silt and silty sand, underlain by a deposit of clayey silt residual soil and shale bedrock. A description of the soil deposits depths/elevation, results of SPT testing carried out in the boreholes and the geotechnical laboratory test results are provided below.

| Deposit/Layer Description | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|---|-----------------------|-------------------------------|---|---|
| | | | Consistency or Compactness | |
| Sandy clayey silt, some gravel (FILL) | 0.7 | 100.5 | N = 8 | n/a |
| | | | Firm | |
| Silty sand, trace to some gravel, trace to some clay (FILL) | 0.8 | 99.8 | N = 8 | w = 10% 1 – MH (Fig. C-1) |
| | | | Loose | |
| Sandy clayey silt (FILL) | 0.7 | 99.0 | N = 3 | w = 35% |
| | | | Soft | |
| Clayey Silt, some sand, some gravel, some shale fragments (RESIDUAL SOIL) | 0.8 | 98.3 | N = 100/250 mm | w = 10% w _l = 32% w _p = 21% I _p = 12% 1 – AL (Fig. C-12) |
| | | | Hard | |
| SHALE (BEDROCK) | -- | 97.5 | See Section 4.2.2 for details on bedrock core and laboratory testing results. | |

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration

w = natural moisture content (%)

MH = combined sieve and hydrometer analysis

AL = Atterberg limits test

w_p = plastic limit (%)w_l = liquid limit (%)I_p = plasticity index (%)**4.2.1.3 Overhead Sign 2 – Station 16+989**

Borehole OHS-2 was advanced on the QEW Toronto bound right shoulder at the proposed location of Overhead Sign 2 as shown on Drawing 1.

In general, the subsoil conditions encountered in Borehole OHS-2 consist of asphalt, underlain by fill comprised of gravelly sand, underlain by a till deposit consisting of clayey silt, and shale bedrock. A description of the soil deposits depths/elevation, results of SPT testing carried out in the boreholes and the geotechnical laboratory test results are provided below.

| Deposit/Layer Description | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|---|-----------------------|-------------------------------|---|--|
| | | | Consistency or Compactness | |
| Asphalt | 0.10 | 100.6 | n/a | n/a |
| Gravelly sand, trace to some silt (FILL) | 1.4 | 100.5 | N = 25, 19 | n/a |
| | | | Compact | |
| Clayey Silt, trace gravel, some sand, some shale fragments (TILL) | 2.2 | 99.1 | N = 9, 35, 66 | w = 9% - 24% w _l = 31% w _p = 17% I _p = 14% 1 – MH (Fig. C-7) 1 – AL (Fig. C-8) |
| | | | Stiff to Hard | |
| SHALE (BEDROCK) | -- | 96.9 | See Section 4.2.2 for details on bedrock core and laboratory testing results. | |

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration

w = natural moisture content (%)

MH = combined sieve and hydrometer analysis

AL = Atterberg limits test

w_p = plastic limit (%)w_l = liquid limit (%)I_p = plasticity index (%)**4.2.1.4 Overhead Sign 5 – Station 16+052**

Borehole OHS-5 was advanced on the QEW Niagara bound left shoulder – Mississauga Road Off-Ramp at the proposed the location of Overhead Sign 5, and Borehole SWME-3 was advanced about 20 m north of the overhead sign location on the southeast end of the proposed storm water management pond located within the grassy area in Off-Ramp loop, as shown in Drawing 1.

In general, the subsoil conditions encountered Borehole OHS-5 consist of asphalt, underlain by fill comprised of a layer of gravelly sand and a layer of silty clay, underlain by clayey silt residual soil, underlain by shale bedrock. A description of the soil deposits depths/elevation, results of SPT testing carried out in the boreholes and the geotechnical laboratory test results are provided below.

| Deposit / Layer Description | Borehole | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|---|-----------------|-----------------------|-------------------------------|---|---|
| | | | | Consistency or Compactness | |
| Asphalt | OHS-5 | 0.20 | 100.5 | n/a | n/a |
| Gravelly sand, trace to some silt (FILL) | OHS-5 | 1.6 | 100.3 | N = 19, 37 Compact to Dense | w = 23% 1 – MH (Fig. C-1) |
| Silty clay, trace sand, trace gravel (FILL) | OHS-5 | 1.2 | 98.7 | N = 5, 48 Firm to Hard | w = 25% w _l = 42% w _p = 20% I _p = 23% 1 – MH (Fig. C-2) 1 – AL (Fig. C-3) |
| Silty Clay | SWMW-3 | 0.6 | 99.3 | N = 9 Stiff | w = 15% w _l = 45% w _p = 15% I _p = 30% 1 – MH (Fig. C-5) 1 – AL (Fig. C-6) |
| Sandy Clayey Silt to Clayey Silt, some sand, some shale fragments (RESIDUAL SOIL) | OHS-5 SWMW-3 | 0.7 1.5 | 97.5 98.7 | N = 18, 55, 100/200 mm Very Stiff to Hard | n/a |
| SHALE (BEDROCK) | OHS-5 SWMW-3 | -- | 96.8 97.2 | See Section 4.2.2 for details on bedrock core and laboratory testing results. | |

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration

w = natural moisture content (%)

MH = combined sieve and hydrometer analysis

AL = Atterberg limits test

w_p = plastic limit (%)w_l = liquid limit (%)I_p = plasticity index (%)

4.2.1.5 High Mast Lighting Pole 2 – Station 16+275

Borehole HMLP-2 was advanced in the grassy area north of the QEW Hamilton bound lanes and east of Mississauga Road, near the proposed location of HMLP 2; and as part of the investigation for the Mississauga Road underpass Boreholes MO-08A and MO-08B were advanced about 15 m south of the proposed HMLP-2, at the location shown on Drawing 2.

In general, the subsoil conditions encountered in Borehole HMLP-2, MO-08A and MO-08B consist of fill materials comprising clayey silt / sandy silt, silty sand, underlain by a deposit of clayey silt residual soil, underlain by shale bedrock. A description of the soil deposits depths/elevation, results of SPT testing carried out in the boreholes and the geotechnical laboratory test results are provided below.

| Deposit/Layer Description | Borehole Numbers | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|--|----------------------------|-----------------------|-------------------------------|---|--|
| | | | | Consistency or Compactness | |
| Sandy silt to silty sand topsoil (FILL) | HMLP-2 MO-08A MO-08B | 0.5 | 98.9- 98.8 | N = 10-19 | w = 10%, 11%, 14%, 15%, 16%, 19% 1 – MH (Fig. C-1) 1-AL (NP) |
| | | | | Compact | |
| Clayey Silt, trace sand, trace gravel, some rootlets (FILL) | MO-08B | 0.5 | 98.8 | N = 9 | w = 14% |
| | | | | Stiff | |
| Clayey Silt | MO-08A MO-08B | 0.9 | 97.7 | N = 20, 35, 100/0.25 | w = 11%, 14%, 15%, 20% w _l = 33% w _p = 20% I _p = 13% 1 – MH (Fig. C-5) 1 – AL (Fig. C-6) |
| | | 0.4 | 97.5 | Very Stiff to Hard | |
| Clayey Silt, some sand, some shale fragments (RESIDUAL SOIL) | HMLP-2 | 1.3 | 97.8 | N = 31, 50/0.08 | w = 9%, 11% w _l = 33% w _p = 21% I _p = 12% 1 – MH (Fig C-11) 1 – AL (Fig. C-12) |
| | | | | Hard | |
| SHALE (BEDROCK) | HMLP-2 MO-08A MO-08B | -- | 96.5 96.8 97.1 | See Section 4.2.2 for details on bedrock core and laboratory testing results. | |

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration

w = natural moisture content (%)

MH = combined sieve and hydrometer analysis
 AL = Atterberg limits test
 w_p = plastic limit (%)
 w_l = liquid limit (%)
 I_p = plasticity index (%)
 NP = Non-plastic

4.2.1.6 Overhead Sign 4 – Station 16+512

Borehole OHS-4 was advanced on the grassy area north of the QEW Niagara bound lanes near the proposed location of Overhead Sign 4, as shown on Drawing 2.

In general, the subsoil conditions encountered in Borehole OHS-4 consists of topsoil, underlain by fill consisting of gravel some sand, underlain by clayey silt residual soil and shale bedrock. A description of the soil deposits depths/elevation, results of SPT testing carried out in the boreholes and the geotechnical laboratory test results are provided below.

| Deposit/Layer Description | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|--|-----------------------|-------------------------------|---|---|
| | | | Consistency or Compactness | |
| Topsoil | 0.3 | 97.3 | 64 | n/a |
| | | | Hard | |
| Gravel, some sand, some silt (FILL) | 0.4 | 97.0 | n/a | n/a |
| Clayey Silt, some sand, trace gravel, some shale fragments (RESIDUAL SOIL) | 1.0 | 96.6 | N = 47, 100/0.10 | w = 16% w _l = 39% w _p = 21% I _p = 18% 1 – MH (Fig. C-11) 1 – AL (Fig. C-12) |
| | | | Hard | |
| SHALE (BEDROCK) | -- | 95.6 | See Section 4.2.2 for details on bedrock core and laboratory testing results. | |

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration
 w = natural moisture content (%)
 MH = combined sieve and hydrometer analysis
 AL = Atterberg limits test
 w_p = plastic limit (%)
 w_l = liquid limit (%)
 I_p = plasticity index (%)

4.2.1.7 Overhead Sign 3 – Station 17+425

Borehole OHS-3 was advanced on the QEW Toronto bound left lane at the proposed location of Overhead Sign 3; and Borehole NRW7-1 was advanced on the QEW Toronto bound right lane for a proposed retaining wall, as shown on Drawing 3.

In general, the subsoil conditions encountered in Borehole OHS-3 and silty sand NRW7-1 consist of asphalt, underlain by concrete, underlain by fill comprised of interlayers of silt / sandy silt / silt and sand / gravelly sand underlain by deposits of sandy silt to sand and silt, gravelly silt and sand till, and sandy clayey silt residual soil. A description of the soil deposits depths/elevation, results of SPT testing carried out in the boreholes and the geotechnical laboratory test results are provided below.

| Deposit/Layer Description | Borehole Numbers | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|---|------------------|-----------------------|-------------------------------|---|---|
| | | | | Consistency or Compactness | |
| Asphalt | OHS-3 NRW7-1 | 0.13 0.20 | 95.0 95.0 | n/a | n/a |
| Concrete | OHS-3 NRW7-1 | 0.23 0.20 | 94.9 94.8 | n/a | n/a |
| Gravelly sand (FILL) | OHS-3 NRW7-1 | 0.5 | 94.6 94.6 | N = 31, 32 Dense | n/a |
| Silt, Sandy Silt, Silt and Sand, Silty Sand to Sand (FILL) | OHS-3 NRW7-1 | 2.1 4.1 | 94.1 94.1 | N = 1 to 27 Very Loose to Compact | w = 13% - 29% org = 4.5% 3 – MH (Fig. C-1) |
| Sandy Silt to Sand and Silt | OHS-3 | 2.6 | 92.0 | N = 7 to 37 Loose to Dense | w = 13% - 29% 2 – MH (Fig. C-4) |
| Sandy Clayey Silt, trace to some gravel (TILL) | NRW7-1 | 2.7 | 92.0 | N = 5, 12 Firm to Stiff | oc = 4.5% w = 12% w _l = 22% w _p = 14% I _p = 8% 1 – MH (Fig. C-7) 1 – AL (Fig. C-8) |

| Deposit/Layer Description | Borehole Numbers | Deposit Thickness (m) | Deposit Surface Elevation (m) | N Values (blows/300 mm) | Laboratory Testing Results |
|---|------------------|-----------------------|-------------------------------|-----------------------------|--|
| | | | | Consistency or Compactness | |
| Gravelly Silt and Sand, trace to some clay, to Silt and Sand, some gravel (TILL) | OHS-3 NRW7-1 | 1.6 3.0 | 89.4 87.8 | N = 48, 50/0.06, 50/0.05 | w = 9% w _l = 17% w _p = 14% I _p = 3% 2 – MH (Fig. C-9) 2 – AL (Fig. C-10) |
| | | | | Dense to Very Dense | |
| Sand, some cobble fragments | NRW7-1 | 1.1 | 84.8 | N = 60 | W = 6% |
| | | | | Very Dense | |
| Sandy Clayey Silt, some gravel, some cobble and shale fragments (RESIDUAL SOIL) | OHS-3 | 0.6 | 87.8 | N = 50/0.17 | n/a |
| | | | | Hard | |

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration

w = natural moisture content (%)

oc = organic content (%)

MH = combined sieve and hydrometer analysis

AL = Atterberg limits test

w_p = plastic limit (%)w_l = liquid limit (%)I_p = plasticity index (%)**4.2.2 Bedrock / Refusal Conditions**

Bedrock was cored in Boreholes OHS-1, OHS-2, OHS-4, OHS-5, HMLP-1 and HMLP-2 and SWMW-03. Split-spoon refusal was encountered in Borehole OHS-3, which was terminated within the sandy clayey silt residual soils deposit. The depths and elevations of the bedrock surface (cored or inferred from split-spoon refusal) at of each borehole locations are presented below.

| Borehole Number | Depth to Bedrock Surface / Refusal (m) | Bedrock Surface / Refusal Elevation (m) | Comments |
|-----------------|--|---|--|
| OHS-1 | 3.6 | 98.0 | Bedrock cored 3.7 m |
| HMLP-1 | 3.0 | 97.5 | 0.1 m spilt-spoon penetration plus bedrock cored 3.4 m |
| OHS-2 | 3.7 | 96.9 | 0.1 m spilt-spoon penetration plus bedrock cored 3.7 m |
| OHS-5 | 3.7 | 96.8 | 0.1 m spilt-spoon penetration plus bedrock cored 3.9 m |
| HMLP-2 | 2.3 | 96.5 | 0.2 m spilt-spoon penetration plus bedrock cored 3.5 m |
| OHS-4 | 1.7 | 95.6 | Bedrock cored 3.9 m |
| OHS-3 | 7.8 | 87.2 | Inferred from refusal to split-spoon advancement |

Based on a review of the bedrock core samples, the bedrock consists of shale of the Georgian Bay Formation. In general, the bedrock core samples are described as fresh to moderately weathered, thinly to thickly bedded, fine grained, faintly porous to non-porous, weak, grey shale with limestone interbeds at varying intervals and ranging in thickness from about 10 mm to 170 mm, as presented in the Record of Drillhole sheets in Appendix B, and shown on the photographs of the recovered core samples on Figures B-1 to B-7, in Appendix B.

The degree of weathering of the bedrock samples (i.e. fresh to slightly weathered – W1 to W3), and the strength classification of the intact rock mass based on field identification (i.e. weak – R2) are described in accordance with the International Society for Rock Mechanics (ISRM³) standard classification system. More detailed descriptions of the bedrock cores are presented on the Record of Drillhole sheets in Appendix B, including data regarding the discontinuity frequency and type. The bedrock properties, as encountered in the cored boreholes, are summarized below.

³ International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

| Borehole Number | Total Core Recovery (TCR) | Solid Core Recovery (SCR) | Rock Quality Designation (RQD) ⁴ | Field Estimation of Rock Hardness ⁴ | Laboratory Testing Results |
|-----------------|---------------------------|---------------------------|---|--|---|
| OHS-1 | 97% – 100% | 72% - 100% | 72% – 100% | R2 | 1 – UC (Appendix C): UCS (shale) = 13.0 MPa γ (shale) = 2.59 g/cm ³ |
| | | | Fair to Excellent | Weak | |
| HMLP-1 | 100% | 50% – 79% | 65% – 100% | R2 | 1 – UC (Appendix C): UCS (shale) = 11.8 MPa E (shale) = 0.50 GPa γ (shale) = 2.57 g/cm ³ |
| | | | Fair to Excellent | Weak | |
| OHS-2 | 87% – 100% | 69% – 93% | 67% – 90% | R2 | 1 – UC (Appendix C): UCS (shale / limestone layers) = 23.4 MPa γ (shale) = 2.45 g/cm ³ |
| | | | Fair to Good | Weak | |
| OHS-5 | 100% | 65% – 97% | 65% – 97% | R2 | 1 – UC (Appendix C): UCS (shale) = 16.7 MPa γ (shale) = 2.60 g/cm ³ |
| | | | Fair to Excellent | Weak | |
| SWMW-03 | 100% | 94% - 100% | 67% - 100% | R3 | N/A |
| | | | Fair to Excellent | Medium Strong to Strong | |
| HMLP-2 | 94% – 100% | 78% – 87% | 62% – 79% | R2 | 1 – UC (Appendix C): UCS (shale) = 13.7 MPa E (shale) = 0.88 GPa γ (shale) = 2.59 g/cm ³ |
| | | | Fair to Good | Weak | |
| OHS-4 | 43% – 100% | 0% – 79% | 0% – 89% | R2 | N/A |
| | | | Very Poor to Good | Weak | |

Where:

UC = unconfined compression test

UCS = uniaxial compressive strength

E = Tangent Young's modulus

 γ = bulk density**4.2.3 Groundwater Conditions**

The overburden samples obtained from the boreholes were generally moist. Upon completion of drilling Borehole NRW7-1 and OHS-3 the water level was measured at a depth of 8.5 m and 3.6 m below ground surface (Elevation 86.5 m and Elevation 91.4 m), respectively. The remaining boreholes advanced for the overhead sign structures and high mast light poles or adjacent nearby boreholes advanced for other structures were observed to be dry upon

⁴ International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

completion of drilling; however, these observations are not necessarily representative of the stabilized groundwater level at the site.

Standpipe piezometers were installed in selected boreholes advanced throughout the site for other structures to allow for measurements of the groundwater levels at these locations of the site. Details of the piezometer installations and measured groundwater levels are presented in other reports prepared for this project. The groundwater levels recorded are summarized below. The groundwater levels on the west side of the Credit River range from about 2.4 m to 3.3 m below ground surface (between Elevation 99.9 m and 93.0 m). East of the Credit River the groundwater levels range from a depth of about 4.9 m (Elevation 86.8 m) near the proposed east abutment to 2.8 m below ground surface (Elevation 95.4 m) near the east limit of the project.

| Borehole Number | Station (m)* | Stratum Sealed Into | Depth to Water Level (m) | Water Level Elevation (m) | Date |
|-----------------|--------------|------------------------------------|--------------------------|---------------------------|-------------------|
| NW1-3 | 15+425 | Shale Bedrock | 2.6 | 99.8 | August 14, 2018 |
| | | | 2.5 | 99.9 | November 6, 2018 |
| SWMW-04 | 15+950 | Shale Bedrock | 2.4 | 97.4 | November 14, 2017 |
| | | | 2.4 | 97.4 | November 21, 2017 |
| | | | 2.4 | 97.4 | November 28, 2017 |
| NW5-1 | 16+350 | Shale Bedrock | 3.3 | 93.8 | August 14, 2018 |
| | | | 3.1 | 94.0 | November 6, 2018 |
| CRB-2 | 16+670 | Fill/Clayey Silt Till | 2.6 | 93.0 | March 12, 2018 |
| | | | 2.6 | 93.0 | April 30, 2018 |
| CRB-6 | 16+925 | Shale Bedrock | 5.6 | 86.0 | November 12, 2017 |
| | | | 5.0 | 86.7 | March 12, 2018 |
| | | | 4.9 | 86.8 | April 30, 2018 |
| PED-03A | 17+075 | Sand and silt to silty sand (FILL) | 4.3 | 89.8 | November 14, 2017 |
| | | | 4.4 | 89.7 | November 21, 2017 |
| | | | 4.4 | 89.7 | November 28, 2017 |
| NRW3-2 | 17+325 | Sandy Clayey Silt Till | 4.0 | 92.1 | August 14, 2018 |
| | | | 4.0 | 92.1 | November 6, 2018 |
| NRW3-9 | 17+645 | Shale Bedrock | 2.8 | 95.4 | August 14, 2018 |
| | | | 2.8 | 95.4 | November 6, 2018 |

* Referenced to QEW mainline stationing.

It should be noted that the groundwater level in the area is subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year. Also during and following precipitation events perched groundwater conditions should be expected.

5.0 CLOSURE

This report was prepared by Ms. Mo'oud Nasr, P.Eng., a Geotechnical Engineer with Golder. Ms. Sandra McGaghran, M.Eng., P.Eng., a Geotechnical Engineer and Associate with Golder reviewed the report. Mr. Jorge Costa, P.Eng., MTO Foundations Designated Contact for Golder and Senior Consultant, conducted a quality control audit of the report.

Golder Associates Ltd.

Mo'oud Nasr, P.Eng.
Geotechnical Engineer



Sandra McGaghran, M.Eng., P.Eng.
Senior Geotechnical Engineer, Associate



Jorge M.A. Costa, P.Eng.
MTO Foundations Designated Contact, Senior Consultant

MN/SMM/JMAC/rb

Golder and the G logo are trademarks of Golder Associates Corporation

[https://golderassociates.sharepoint.com/sites/11176g/shared documents/07-reporting/foundations/7 - ohs and hml/3 - final/1662333 fidr - ohs hml 2018dec13.docx](https://golderassociates.sharepoint.com/sites/11176g/shared%20documents/07-reporting/foundations/7%20-%20ohs%20and%20hml/3%20-%20final/1662333%20fidr%20-%20ohs%20hml%202018dec13.docx)

PART B

**FOUNDATION DESIGN REPORT
OVERHEAD SIGNS AND HIGH MAST LIGHT POLES
QEW WIDENING FROM WEST OF MISSISSAUGA ROAD TO WEST OF
HURONTARIO STREET, CITY OF MISSISSAUGA
MTO, G.W.P. 2002-13-00**

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides geotechnical recommendations for the design of the proposed overhead sign (OHS) supports and High Mast Light (HML) pole foundations. These recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the current subsurface investigation along the Queen Elizabeth Way (QEW) corridor between west of Mississauga Road to west of Hurontario Street, City of Mississauga, Ontario. The discussion and recommendations contained in this report are intended to provide the designers with sufficient information to complete the detail design of the proposed OHS supports and HML pole foundations. The foundation investigation report, discussion and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO) and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. The contractor undertaking the work must make their own interpretation based on the factual data in Part A (Foundation Investigation) 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 may be required in the Contract Documents. Those requiring information on aspects of construction should 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 Sign Support Foundations

Based on the details provided by Morrison Hershfield Limited (MH) on June 25, 2018, different types of sign supports are required for the five overhead signs to be constructed for the widening of the QEW. The locations of the proposed OHS signs, sign-support structure type, thickness of overburden/depth to bedrock and the depth of boreholes advanced at each overhead sign location are summarized below.

| Sign Support Designation | Approximate Sign Location | Proposed Sign Support Structure Type | Overburden Thickness (Depth of Borehole) (m) |
|--------------------------|----------------------------------|--------------------------------------|--|
| OHS-1 | Station 15+529 Toronto bound | Cantilever | 3.6 (7.3) |
| OHS-2 | Station 15+989 Toronto bound | Trichord | 3.7 (7.5) |
| OHS-3 | Station 17+425 Toronto bound | Trichord | 7.8 (7.8) |
| OHS-4 | Station 16+512 QEW Niagara bound | Cantilever | 1.7 (5.6) |
| OHS-5 | Station 16+052 QEW Niagara bound | Trichord | 3.7 (8.0) |

Caisson foundations for sign supports should be designed in accordance with the requirements in MTO's *Sign Support Manual* (MTO, 2015). The *Sign Support Manual* includes standard caisson foundation designs for each sign type as follows:

- **Cantilever Signs:** Cantilever Static Sign Supports, Section 3 and Standard Drawings SS118-3, SS118-4 and SS118-5.
- **Trichord Overhead Signs:** Tri-Chord Static Sign Supports, Section 4 and Standard Drawings SS118-3, SS118-4 and SS118-5.

In the standard caisson foundation design, the caisson is extended 5 m to 6.5 m depending on the sign class and corresponding caisson diameter below the design frost depth, which for this site is 1.2 m as interpreted from OPSD 3090.101 (*Foundation Frost Penetration Depths for Southern Ontario*) resulting in a total caisson length of 6.2 m to 7.7 m below the final grade. The standard sign foundation designs presented in MTO's *Sign Support Manual* have been developed based on the minimum soil conditions given below.

- **Case 1 (Non-Cohesive Soils):** Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower third of the portion of the caisson below the design frost depth.
- **Case 2 (Cohesive Soils):** Soft clay with an undrained shear strength of 25 kPa surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and "soft" clay with an undrained shear strength of 50 kPa surrounding the lower third of the portion of the caisson below the design frost depth.

The standard foundation design provided in MTO's *Sign Support Manual* does not apply to sites where extensive poor fill materials or materials looser or softer than those of Case 1 or Case 2 are present. The standard foundation design is also not applicable where bedrock is encountered within the standard foundation depth. For such subsurface conditions, a site-specific design is required.

Based on the review of the borehole information, the subsurface conditions at the proposed sign locations have been compared to the standard design requirements to assess whether a standard or site-specific design is required. The requirement for either a standard or site-specific design is summarized in Table 1, following the text of this report, together with geotechnical parameters for design. The parameters presented in Table 1 are based on field and laboratory test data as well as accepted correlations (NAVFAC 1986, Bowles, 1984 and Kulhawy and Mayne, 1990) and the analysis was tempered by engineering judgment based on experience in similar soils.

6.2.1 Site-Specific Caisson Foundation Design in Soil

A site-specific caisson foundation design may be carried out by the structural engineer to optimize the standard foundation design using the geotechnical design parameters given in Table 1, following the text of this report. In the design of the sign foundations, the passive resistance within the upper 1.2 m below ground surface should be neglected to account for frost action. The unfactored lateral resistance should be calculated assuming an equivalent width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to this unfactored lateral resistance to obtain the factored ultimate lateral geotechnical resistance.

Based on site observations, the OHS foundations will be constructed in areas of relatively flat ground; however, in the event that the OHS foundations are located on the highway embankment slope or within about 2 diameters of the crest of the slope in the direction of loading, there would be unbalanced earth pressures around the foundation due to it being located within sloping ground (assumed 2H:1V embankment). For this case, the passive earth

pressure coefficient ($K_{p2:1}$), in accordance with Figure C8.18 of the Canadian Highway Bridge Design Code and its Commentary (CHBDC (2014)), to be used in the foundation design is also included in Table 1.

6.2.2 Caisson Foundations Embedded or Socketted into Bedrock

In accordance with MTO's *Sign Support Manual*, where bedrock is encountered at a depth, y (in metres), less than 5 m below the bottom of the frost layer, the required depth (L_{caisson}) of the foundation below the frost layer may be calculated as follows:

$$L_{\text{caisson}} = Y + [(L - y) / 2]$$

Where L_{caisson} = length of caisson below frost depth

Y = the overburden thickness below the depth of frost penetration

L = length of caisson below frost depth; depending on the Type and Class of the Sign (see Drawings No SS1183 of MTO's *Sign Support Manual*).

Where bedrock is present within the "standard" foundation depth, the required depth of rock socket can be determined using the equation above based on the depths/elevations given in Table 1. Alternatively, site-specific design could be carried out for these locations (using the parameters given in Table 1) to determine whether the overburden soils can provide the required lateral resistance. From a geotechnical perspective, the rock sockets could have a diameter less than the "standard" caisson diameter of 1200 mm; in this case, the actual rock socket diameter should be determined based on site-specific design by the structural engineers, using the passive lateral resistance (f_{horiz} , in kPa) for the rock mass as provided in Table 1.

6.3 Design of High Mast Light Pole Foundations

A total of two HML pole foundations are proposed at the following locations:

- HMLP-1: In the grassy area between the QEW Niagara bound – Mississauga Road N/S Off-Ramp/ Mississauga Road N/S – QEW Niagara bound On-Ramp (off-set northerly at Sta.15+875); and,
- HMLP-2: In the grassy area north of the QEW and east of Mississauga Road (off-set northerly at Sta.16+275).

The HML pole foundations should be designed in accordance with MTO's *Guidelines for the Design of High Mast Pole Foundations*, (MTO 2004). Table 2 provides a summary of the selected relevant borehole at each HML pole location, and a summary of the subsurface conditions encountered in the boreholes. The parameters presented in Table 2 are based on field and laboratory test data as well as accepted correlations (NAVFAC 1986, Bowles, 1984 and Kulhawy and Mayne, 1990) and the analysis was tempered by engineering judgment based on experience in similar soils.

High mast light pole foundations typically consist of reinforced, cast-in-place concrete caissons constructed within the soil, nominally socketted into bedrock (where the overburden soils do not provide sufficient lateral resistance), or embedded into the bedrock (where bedrock is present at relatively shallow depth). As an alternative to embedding a caisson into the bedrock where bedrock is quite shallow, consideration could be given to supporting the HML pole on a spread footing anchored to the bedrock, or a caisson nominally socketted into the bedrock with dowels/anchors extending into the bedrock to achieve the required lateral/uplift resistance.

6.3.1 Caisson Foundation Design in Soil

As noted above, where both undrained shear strength and effective stress parameters are provided in Table 2 for HML Pole foundations, the structural assessment should be completed for both cohesive and non-cohesive soil cases, and the more conservative approach adopted. In the design of the foundations, the passive resistance within the upper 1.2 m below ground surface should be neglected to account for frost action.

It is understood that the HML pole will be constructed in an area of relatively flat ground; however, in the event that the HML Pole are located on the highway embankment slope or within about 2 diameters of the crest of the slope, there would be unbalanced earth pressures around the HML Pole foundation due to its foundation being located within sloping ground (assumed 2H:1V embankment). For this case, the passive earth pressure coefficient ($K_{p2:1}$), to be used in the foundation design is also included in Table 2.

Given the limited thickness and low strength characteristics of the overburden at both HML Pole locations (i.e. less than 3 m and loose to compact/soft to firm compactness/consistency, with a thin layer of hard strata) sufficient resistance will most likely not be provided by the overburden soils, hence the caisson foundations will have to be embedded into the shale bedrock. The depth to “sound” bedrock is provided in Table 2, together with recommended values for the factored horizontal bearing capacity of sound rock at Ultimate Limit States (f_{horiz} , as defined in *Guidelines for the Design of High Mast Pole Foundations*).

6.3.2 Caisson Foundation with Tip Nominally Socketted in Rock

The depth to bedrock at HMLP-1 and HMLP-2 is 3.0 m and 2.3 m and a foundation nominal if socketted into the bedrock will be needed. In this case, the socket depth into the rock must not be less than 0.5 times the caisson diameter. The horizontal bearing resistance of the weak shale bedrock at this site will be greater than the strength of the concrete; however, in accordance with MTO practice, the socket length must be such that the resulting horizontal bearing pressure on the rock is less than the compressive strength of the concrete in the caisson.

6.3.3 Caisson Foundations Embedded into Rock

As the bedrock surface is present at relatively shallow depth at both the HML Pole locations, consideration could be given to embedding the caisson into rock. Such caissons are required to have a minimum embedment length into sound bedrock ($RQD > 50\%$) not less than or 2.5 m below the bottom of frost penetration. The horizontal bearing resistance of the weak shale bedrock at this site will be greater than the strength of the concrete; however, in accordance with MTO practice, the socket depth must be such that the resulting horizontal bearing pressure on the rock is less than the compressive strength of the concrete in the caisson. The depth to “sound” bedrock is provided in Table 2, together with recommended values for f_{horiz} (the factored horizontal bearing capacity (resistance) of sound rock at Ultimate Limit States, as defined in *Guidelines for the Design of High Mast Pole Foundations*).

It is noted that the shale bedrock at the site is generally weak, but contains strong limestone interbeds and possibly layers, and coring, churn drilling or other appropriate techniques will be necessary to advance the socket into the bedrock. As an alternative to the minimum rock socket length of 2.5 m, caissons or spread footings anchored to the rock may be considered. Recommendations for the rock anchors are provided in the Section 6.3.4.

6.3.4 Foundations Anchored into Bedrock

If anchoring of foundations is adopted for spread footing or caissons constructed at shallow depth with the tip nominally socketted into bedrock, it is recommended that the concrete foundations (either caissons or spread footings) be embedded a minimum of 0.3 m into the bedrock. As per Section 6.2 of *Procedures for the Design of*

High Mast Pole Foundations, a minimum concrete foundation length of 1.75 m is required to allow sufficient length for the anchorage assembly.

Since the compressive strength of the caisson concrete is lower than the compressive strength of the weak shale bedrock at the site, the vertical bearing resistance should be taken as limited by the compressive strength of the concrete in the caisson.

Based on the boreholes advanced at the HML Pole sites the bedrock at all HML pole locations consists of shale. The unfactored bond strength between the grout and shale bedrock may be taken as 250 kPa for design of rock anchors/dowels to support the HML pole foundations in tension. For anchors/dowels into the rock, Section 6.2 of the *Guidelines for the Design of High Mast Pole Foundations* requires that the anchors be a minimum of 1.75 m long for 25 m, 30 m and 35 m high poles. Taking into consideration the caisson diameter, the number of anchors and the diameter of the anchor hole as presented on Table 6 of the *Guidelines for the Design of High Mast Pole Foundations* for 25 m and 30 m high poles no reduction in ultimate bond strength between the grout and bedrock (shale) is required. Further, a test program should be implemented as part of construction of HML Pole anchored foundations to confirm the allowable bond stress, as recommended in *Guidelines for the Design of High Mast Pole Foundations*.

The horizontal resistance of dowels is dependent on the strength of the bedrock, grout and steel. At this site, the rock mass is stronger than concrete, and so the design of the dowels in the rock should be handled in the same way as the dowel embedment into the concrete, assuming that the unconfined compressive strength of the grout is similar to that of the concrete. The structural strength of the dowel and the compressive strength of the grout should not be exceeded.

As these are permanent rock anchors/dowels, they should be provided with suitable corrosion protection or sacrificial thickness of steel. Anchor installation, grouting and testing should be carried out in accordance with OPSS 942 (*Construction Specification for Pre-Stressed Soil and Rock Anchors*).

6.4 Construction Considerations

6.4.1 Control of Soil and Groundwater

The water-bearing cohesionless soils at this site should be expected to run or flow into the caisson hole during or after drilling of the caisson foundations for the OHS supports or HML poles. Therefore, appropriate equipment and procedures will be required to minimize ground loss during drilling and concrete placement, such as by using temporary or permanent caisson liners, and/or using drilling mud. Foundations for the OHS supports and for the HML poles should be constructed consistent with OPSS 915 (*Sign Support Structures*) and OPSS 903 (*Deep Foundations*), respectively. It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn the Contractor of this condition; such an NSSP is provided in Appendix D.

6.4.2 Foundations in Bedrock

Caisson foundations for most of the overhead sign supports and for the high mast light pole foundation will extend into the shale bedrock, which is weak, and which contains medium strong to very strong interlayers of limestone. Appropriate construction procedures and equipment (such as coring or churn drilling equipment) will be required to penetrate the bedrock. It is recommended that an NSSP be included in the Contract Documents to warn the Contractor of this condition; such an NSSP is provided in Appendix D.

6.4.3 Obstructions

The residual soil and glacially derived soils at the site above the bedrock surface contain rock fragments, particularly immediately above the bedrock, as noted on the borehole records, which could affect the installation of OHS and HML pole foundations. A Notice to Contractor should be included in the Contract Documents to identify to the contractor the possible presence of rock fragments, or slabs of cobbles / boulders sizes within the overburden soils or immediately above the bedrock; an example Notice to Contractor is provided in Appendix D.

7.0 CLOSURE

This report was prepared by Ms. Sandra McGaghran, M.Eng., P.Eng., a Geotechnical Engineer and Associate with Golder. Mr. Jorge Costa, P.Eng., MTO Foundations Designated Contact for Golder and Senior Consultant, conducted a quality control audit of the report.

GOLDER ASSOCIATES LTD.



Sandra McGaghran, M.Eng., P.Eng.
Senior Geotechnical Engineer, Associate



Jorge M.A. Costa, P.Eng.
MTO Foundations Designated Contact, Senior Consultant

MN/SMM/JMAC/rb

Golder and the G logo are trademarks of Golder Associates Corporation

[https://golderassociates.sharepoint.com/sites/11176g/shared documents/07-reporting/foundations/7 - ohs and hml/3 - final/1662333 fidr - ohs hml 2018dec13.docx](https://golderassociates.sharepoint.com/sites/11176g/shared%20documents/07-reporting/foundations/7%20-%20OHS%20and%20HML/3%20-%20final/1662333%20fidr%20-%20OHS%20HML%202018dec13.docx)

REFERENCES

Bowles, J.E., 1984. *Physical and Geotechnical Properties of Soils*, Second Edition. McGraw Hill Book Company, New York.

Canadian Geotechnical Society. 2006. *Canadian Foundation Engineering Manual (CFEM)*, 4th Edition. The Canadian Geotechnical Society, BiTech Publisher Ltd., British Columbia.

Chapman, L.J. and Putnam, D.F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.

International Society for Rock Mechanics Commission on Test Methods. 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

Kulhawy, F.H. and Mayne, P.W., 1990. *Manual on Estimating Soil Properties for Foundation Design*. EL 6800, Research Project 1493 6. Prepared for Electric Power Research Institute, Palo Alto, California.

Foundation Investigation, High Mast Lighting, W.P. 167-86-00, Mississauga Road Interchange, Queen Elizabeth Way (QEW)", Report No. 971-8040, dated March 1998, GEOCRE No. 30M12-238

Unified Facilities Criteria, U.S. Navy. 1986. NAVFAC Design Manual 7.02. Soil Mechanics, Foundation and Earth Structures. Alexandria, Virginia.

ASTM International:

| | |
|------------|---|
| ASTM D1586 | Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils |
|------------|---|

Ontario Provisional Standard Drawing:

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

Ontario Provincial Standard Specification:

| | |
|----------|--|
| OPSS 903 | Construction Specification for Deep Foundations |
| OPSS 915 | Construction Specification for Sign Support Structures |
| OPSS 942 | Construction Specification for Prestressed Soil and Rock Anchors |

Ontario Water Resources Act:

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

Ministry of Transportation, Ontario

Ministry of Transportation Ontario. Guidelines for the Design of High Mast Pole Foundations, Fourth Edition. Bridge Office, Engineering Standards Branch, Ontario Ministry of Transportation. May 2004.

Ministry of Transportation Ontario. Sign Support Manual. Provincial Highways Management Division, Highway Standards Branch, Bridge Office. April 2015.

TABLE 1
GEOTECHNICAL DESIGN PARAMETERS FOR OVERHEAD SIGN FOUNDATIONS
QEW WIDENING FROM WEST OF MISSISSAUGA ROAD TO WEST OF HURONTARIO STREET, GWP 2002-13-00

| Overhead Sign ID (Location) | Reference Borehole (Station) | Ground Surface Elevation at Reference Borehole (m) | Estimated Ground Surface Elevation at OHS Location (m) | Standard or Site-Specific Foundation Design | Stratum | Depth Relative to Proposed Ground Surface (m) ¹ | Elevation (m) | Groundwater Elevation ² (m) | Design Parameters ^{3,4} | | | | | | |
|--------------------------------|------------------------------------|---|---|---|--|--|---------------|---|----------------------------------|----|------------------------|-------------------------|----------------|-------------------|-----------------------------|
| | | | | | | | | | S _u (kPa) | Φ' | γ (kN/m ³) | γ' (kN/m ³) | K _p | K _{p2:1} | f _{horiz} (kPa) |
| OHS-1 (Sta. 15+529) | OHS-1 | 101.6 | 101.6 | Site-Specific | Compact gravelly sand - Fill | 0.4 - 0.9 | 101.2 - 100.7 | 100 | -- | 28 | 19 | -- | 2.8 | 1.1 | -- |
| | | | | | Compact silt and sand - Fill | 0.9 - 1.5 | 100.7 - 100.1 | | -- | 28 | 19 | -- | 2.8 | 1.1 | -- |
| | | | | | Stiff to Hard Silty Clay Till | 1.5 - 2.8 | 100.1 - 98.8 | | 100 | 32 | 21 | 11 | 3.3 | 1.3 | -- |
| | | | | | Hard clayey silt (Residual Soil) | 2.8 - 3.6 | 98.8 - 98.0 | | 200 | 34 | 21 | 11 | 3.5 | 1.4 | -- |
| | | | | | Shale Bedrock | Below 3.6 | Below 98.0 | | -- | -- | 23 | 13 | -- | -- | 1,500 |
| OHS-2 (Sta. 16+989) | OHS-2 | 100.6 | 100.6 | Site-Specific | Compact gravelly sand - Fill | 0.1 - 1.5 | 100.5 - 99.1 | 97.5 | -- | 28 | 19 | 9 | 2.8 | 1.1 | -- |
| | | | | | Stiff to Hard Clayey Silt Till | 1.5 - 3.7 | 99.1 - 96.9 | | 100 | 32 | 21 | 11 | 3.3 | 1.3 | -- |
| | | | | | Shale Bedrock | Below 3.7 | Below 96.9 | | -- | -- | 23 | 13 | -- | -- | 1,500 |
| OHS-3 (Sta. 17+425) | OHS-3 NRW7-1 | 95.0 | 95.0 | Standard | Dense Gravelly sand - Fill | 0.4 - 0.9 | 95.0 - 94.6 | 93.5 | -- | 30 | 19 | 9 | 3.0 | 1.2 | -- |
| | | | | | Very loose to compact silt and sand - Fill | 0.9 - 3.0 | 94.6 - 92.0 | | -- | 28 | 19 | | 2.8 | 1.1 | -- |
| | | | | | Loose to dense Sandy Silt Sand and Silt | 3.0 - 5.6 | 92.0 - 89.4 | | | 30 | 19 | | 3.0 | 1.2 | -- |
| | | | | | Dense Gravelly Silt and Sand Till | 5.6 - 7.2 | 89.4 - 87.8 | | -- | 34 | 21 | 11 | 3.5 | 1.4 | -- |
| | | | | | Hard Sandy Clayey Silt (Residual Soil) | Below 7.2 | Below 87.8 | | 200 | 34 | 21 | 11 | 3.5 | 1.4 | -- |
| OHS-4 (Sta. 16+512) | OHS-4 | 97.3 | 97.3 | Site-Specific | Very dense gravel - Fill | 0.3 - 0.7 | 97.0 - 96.6 | 96.6 | -- | 32 | 21 | -- | 3.3 | 1.3 | -- |
| | | | | | Hard Silty Clay (Residual Soil) | 0.7 - 1.7 | 96.6 - 95.6 | | 200 | 34 | 21 | 11 | 3.5 | 1.4 | -- |
| | | | | | Weathered Shale Bedrock | 1.7 - 3.2 | 95.6 - 94.1 | | 200 | 34 | 21 | 11 | 3.5 | 1.4 | -- |
| | | | | | Shale Bedrock | Below 3.2 | Below 94.1 | | -- | -- | 23 | 13 | -- | -- | 1,500 |
| OHS-5 (Sta. 16+052) | OHS-5 SWMW-3 | 100.5 | 100.5 | Site-Specific | Compact to dense gravelly sand - Fill | 0.2 - 1.8 | 100.3 - 98.7 | 97.5 | -- | 28 | 19 | -- | 2.8 | 1.1 | -- |
| | | | | | Firm to hard silty clay - Fill | 1.8 - 3.0 | 98.7 - 97.5 | | 50 | 28 | 20 | -- | 2.8 | 1.1 | -- |
| | | | | | Hard Clayey Silt (Residual Soil) | 3.0 - 3.7 | 97.5 - 96.8 | | 200 | 34 | 21 | 11 | 3.5 | 1.4 | -- |
| | | | | | Shale Bedrock | Below 3.7 | Below 96.8 | | -- | -- | 23 | 13 | -- | -- | 1,500 |

- NOTES:
1. Depths are given at the proposed sign support locations relative to the existing ground surface. Although Su, Φ' and Kp parameters are given for the full depth of the soil, the passive resistance in the upper 1.2 m should be neglected to account for frost action.

2. Groundwater Elevations estimated from water level reading in standpipe piezometers installed in borehole advanced for other structures in the general area of the proposed sign supports locations, and in the open Borehole OHS-3 upon completion of drilling.

3. Design parameters:

S_u

= undrained shear strength (kPa);

Φ'

= effective friction angle (degrees);

γ

= bulk unit weight (kN/m3);

γ'

= effective unit weight below the groundwater level (kN/m3);

K_p

= passive earth pressure coefficient; and

K_{p2:1}

= passive earth pressure coefficient for 2H:1V sloping ground surface.

f_{horiz}

= factored lateral geotechnical resistance of sound rock at Ultimate Limit States (kPa).

4. Where both undrained shear strength and effective friction angle parameters have been provided for fill materials, the structural assessment should be completed for both cohesive soil and cohesionless soil cases, and the selected design should be based on the more conservative approach.
- Prepared by: SMM

Reviewed by: JMAC
- Golder Associates Ltd.

TABLE 2

GEOTECHNICAL DESIGN PARAMETERS FOR HIGH MAST LIGHT POLE FOUNDATIONS

QEW WIDENING FROM WEST OF MISSISSAUGA ROAD TO WEST OF HURONTARIO STREET, GWP 2002-13-00

| Reference Borehole | Approximate Station (m) | Ground Surface Elevation at Reference Borehole (m) | Estimated Ground Surface Elevation at HML (m) | Stratum | Depth Below Ground Surface at Proposed HML Pole Location (m) ¹ | Elevation (m) | Groundwater Elevation ² (m) | Design Parameters ^{3,4} | | | | | | |
|--------------------|-------------------------|--|---|--|---|---------------|--|----------------------------------|----|------------------------|-------------------------|----------------|-------------------|--------------------------|
| | | | | | | | | S _u (kPa) | Φ' | γ (kN/m ³) | γ' (kN/m ³) | K _p | K _{p2:1} | f _{horiz} (kPa) |
| HMLP-1 | 15+875 | 100.5 | 100.5 | Firm sandy clayey silt - Fill | 0 - 0.7 | 100.5 - 99.8 | 97.5 | 50 | 28 | 19 | -- | 2.8 | 1.1 | - |
| | | | | Loose silty sand - Fill | 0.7 - 1.5 | 99.8 - 99.0 | | -- | 28 | 19 | -- | 2.8 | 1.1 | - |
| | | | | Soft sandy clayey silt - Fill | 1.5 - 2.2 | 99.0 - 98.3 | | 15 | 28 | 19 | -- | 2.8 | 1.1 | - |
| | | | | Hard Clayey Silt (Residual Soil) | 2.2 - 3.0 | 98.3 - 97.5 | | 200 | 34 | 21 | 11 | 3.5 | 1.4 | - |
| | | | | Shale Bedrock | Below 3.0 | Below 97.5 | | -- | -- | 23 | 13 | - | -- | 1,500 |
| HMLP-2 | 16+275 | 98.8 | 98.8 | Compact sandy silt to silt sand - Fill | 0 - 1.0 | 98.8 - 97.8 | 96.5 | -- | 30 | 19 | -- | 3.0 | 1.2 | -- |
| | | | | Hard Clayey Silt (Residual Soil) | 1.0 - 2.3 | 97.8 - 96.5 | | 200 | 34 | 21 | -- | 3.5 | 1.4 | - |
| | | | | Shale Bedrock | Below 2.3 | Below 96.5 | | -- | -- | 23 | 13 | - | -- | 1,500 |

NOTES:

1. Depths are given at the proposed HML pole location relative to the adjacent existing borehole elevation. Although Su, ϕ' and Kp parameters are given for the full depth of the soil, the passive resistance in the upper 1.2 m should be neglected to account for frost action.
2. Groundwater level inferred based on additional boreholes in vicinity of HML Pole location.
3. Design paramel

S_u

ϕ'

γ

γ'

K_p

K_{p2:1}

f_{horiz}

= undrained shear strength (kPa);

= effective friction angle (degrees);

= bulk unit weight (kN/m3);

= effective unit weight below the groundwater level (kN/m3);

= passive earth pressure coefficient;

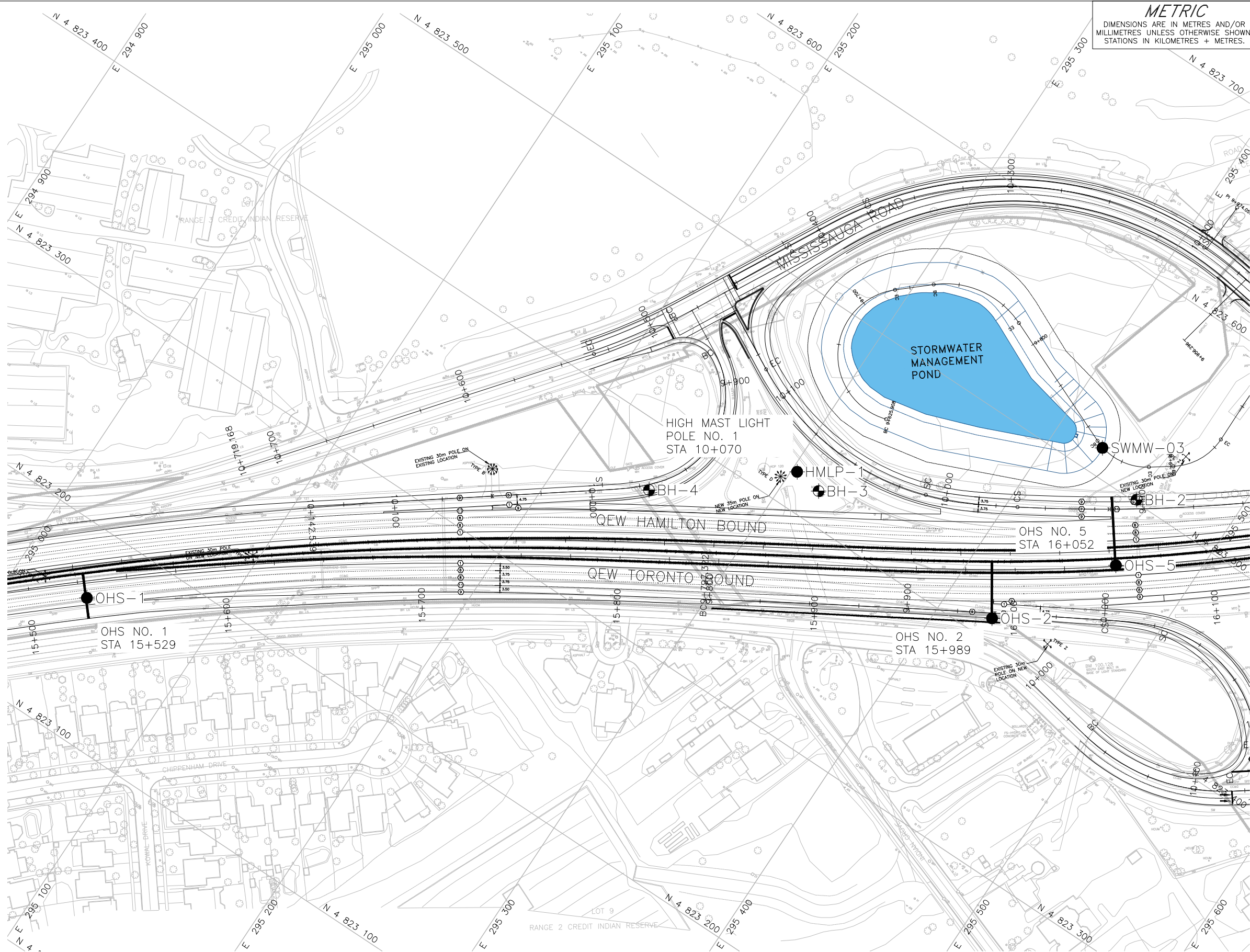
= passive earth pressure coefficient for 2H:1V sloping ground surface.

= factored lateral geotechnical resistance of sound rock at Ultimate Limit States (kPa).
4. Where both undrained shear strength and effective friction angle parametersare provided, the structural assessment should be completed for both cohesive soil and cohesionless soil cases, and the selected design should be based on the more conservative approach.

Prepared by: SMM

Reviewed by: JMAC

DRAWINGS



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

CONT No.
GWP No. 2002-13-00

QEW WIDENING MISSISSAUGA RD TO HURONTARIO ST
OVERHEAD SIGN SUPPORTS AND
HIGH MAST LIGHT POLES
BOREHOLE LOCATIONS

SHEET



KEY PLAN
SCALE
2 0 2 4 km

| LEGEND | |
|--------|----------------------------------|
| | Borehole - Current Investigation |
| | Borehole - GEOCRES No. 30M12-238 |

| BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10) | | | |
|--|-----------|-------------|------------|
| No. | ELEVATION | NORTHING | EASTING |
| BH-2 | 99.7 * | 4823501.3 * | 295453.6 * |
| BH-3 | 100.3 * | 4823416.0 * | 295317.2 * |
| BH-4 | 100.8 * | 4823369.0 * | 295245.5 * |
| HMLP-1 | 100.5 | 4823418.1 | 295302.7 |
| OHS-1 | 101.6 | 4823166.2 | 295038.8 |
| OHS-2 | 100.6 | 4823411.0 | 295425.9 |
| OHS-5 | 100.5 | 4823467.9 | 295463.2 |
| SWMW-03 | 99.4 | 4823513.7 | 295424.7 |

* Obtained from Digital Terrain Model by plotting previous investigation borehole relative to stations given on Borehole Records.

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 Morrison Hershfield, drawing file no. X11609340Base.dwg, received April 12, 2018.
Design plan provided in digital format by Morrison Hershfield, drawing file no. QEW Credit River DP OHS HML.dwg, received March 9, 2018.
Alignment plan provided in digital format by Morrison Hershfield, drawing file no. X1160934_Align.dwg, received November 19, 2018.

PLAN
SCALE
20 0 20 40 m



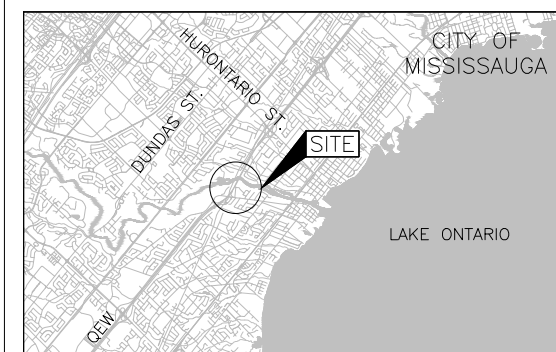
| NO. | DATE | BY | REVISION |
|-----------------------|---------------------|------------------|---------------|
| | | | |
| Geocres No. 30M12-433 | | | |
| HWY. QEW | PROJECT NO. 1662333 | | DIST. CENTRAL |
| SUBM'D. CL/AM | CHKD. DM | DATE: 12/13/2018 | SITE: . |
| DRAWN: DD | CHKD. SMM | APPD. JMAC | DWG. 1 |

CONT No.
GWP No. 2002-13-00



QEW WIDENING MISSISSAUGA RD TO HURONTARIO ST
OVERHEAD SIGN SUPPORTS AND
HIGH MAST LIGHT POLES
BOREHOLE LOCATIONS



SHEET



KEY PLAN
SCALE



LEGEND

-  Borehole – Current Investigation
 Borehole – GEOCREs No. 30M12-238

| BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10) | | | |
|--|-----------|-----------|----------|
| No. | ELEVATION | NORTHING | EASTING |
| BH-1 | 97.4 * | 4823817.5 | 295745.2 |
| HMLP-2 | 98.8 | 4823653.9 | 295615.1 |
| MO-08A | 98.9 | 4823630.5 | 295614.5 |
| MO-08B | 98.9 | 4823632.0 | 295615.8 |
| NW2-3 | 97.8 | 4823813.0 | 295722.8 |
| OHS-4 | 97.3 | 4823828.9 | 295734.3 |

* Obtained from Digital Terrain Model by plotting previous investigation borehole relative to stations given on Borehole Records.

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.

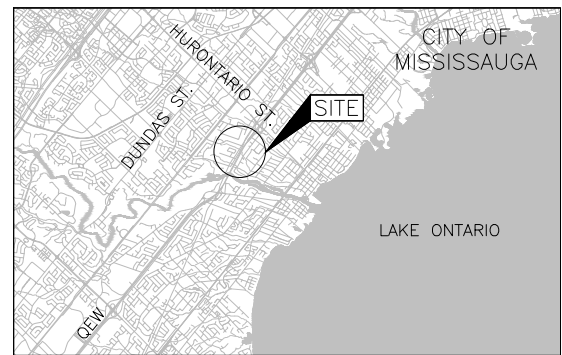
REFERENCE

Base plans provided in digital format by Morrison Hershfield, drawing file no. X11609340Base.dwg, received April 12, 2018.
Design plan provided in digital format by Morrison Hershfield, drawing file no. QEW Credit River DP_OHS HML.dwg, received March 9, 2018.
Alignment plan provided in digital format by Morrison Hershfield, drawing file no. X1160934_Aln.dwg, received November 19, 2018.

| | | | | | |
|-----------------------|-----------|------------------|---------------------|--------|---------------|
| | | | | | |
| NO. | DATE | BY | REVISION | | |
| Geocres No. 30M12-433 | | | | | |
| HWY. QEW | | | PROJECT NO. 1662333 | | DIST. CENTRAL |
| SUBM'D. CL/AM | CHKD. DM | DATE: 11/20/2018 | | SITE: | |
| DRAWN: DD | CHKD. SMM | APPD. JMAC | | DWG. 2 | |



SHEET



LEGEND

● Borehole — Current Investigation

| BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10) | | | |
|--|-----------|-----------|----------|
| No. | ELEVATION | NORTHING | EASTING |
| NRW7-1 | 95.0 | 4824601.8 | 296209.0 |
| OHS-3 | 95.0 | 4824620.8 | 296190.9 |

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.

Base plans provided in digital format by Morrison Hershfield, drawing file no. X11609340Base.dwg, received April 12, 2018.

Design plan provided in digital format by Morrison Hershfield, drawing file no. QEW Credit River DP OHS HML.dwg, received March 9, 2018.

Alignment plan provided in digital format by Morrison Hershfield, drawing file no. X1160934_Align.dwg, received November 19, 2018.

| | | | | | |
|-----------------------|------|-----------|---------------------|---|---------------|
| | - | | | - | |
| NO. | DATE | BY | REVISION | | |
| Geocres No. 30M12-433 | | | | | |
| HWY. QEW | | | PROJECT NO. 1662333 | | DIST. CENTRAL |
| SUBM'D. CL/AM | | CHKD. DM | DATE: 12/13/2018 | | SITE: . |
| DRAWN: DD | | CHKD. SMM | APPD. JMAC | | DWG. 3 |



PLAN
SCALE

20 0 20 40 m

APPENDIX A

**Data from Previous Investigation
(GEOCRES NO. 30M12-238)**

LIST OF ABBREVIATIONS

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

I SAMPLE TYPE

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

II PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60° conical tip and a projected end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

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

IV. SOIL TESTS

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

Note:

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

LIST OF SYMBOLS

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

I GENERAL

| | |
|---------------------------|-----------------------------|
| π | = 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 |
| F | factor of safety |
| V | volume |
| W | weight |

II STRESS AND STRAIN

| | |
|--------------------------------|--|
| γ | shear strain |
| Δ | change in, e.g. in stress: $\Delta \sigma$ |
| ϵ | linear strain |
| ϵ_v | volumetric strain |
| η | coefficient of viscosity |
| ν | Poisson's ratio |
| σ | total stress |
| σ' | effective stress ($\sigma' = \sigma - u$) |
| σ'_{vo} | initial effective overburden stress |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stresses (major, intermediate, minor) |
| σ_{oct} | mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| τ | 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 |
| γ' | unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$) |
| 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 ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity) |

(a) Index Properties (con't.)

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

(c) Hydraulic Properties

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

(d) Consolidation (one-dimensional)

| | |
|-------------|--|
| C_c | compression index (normally consolidated range) |
| C_r | recompression index (overconsolidated range) |
| C_s | swelling index |
| C_α | coefficient of secondary consolidation |
| m_v | coefficient of volume change |
| c_v | coefficient of consolidation |
| T_v | time factor (vertical direction) |
| U | degree of consolidation |
| σ'_p | pre-consolidation pressure |
| OCR | Overconsolidation ratio = σ'_p / σ'_{vo} |

(e) Shear Strength

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

Notes: 1. $\tau = c' + \sigma' \tan \phi'$

2. Shear strength = (Compressive strength)/2

NS040001 BHS

W.P. 167-86-00

RECORD OF BOREHOLE 1

SHEET 1 OF 1

DIST.

BORING DATE: DEC 19/97

DATUM:

LOCATION: Sta. 16+780/28m Rt

PROJECT: 981-8040



| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | HYDRAULIC CONDUCTIVITY, k, cm/s | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION |
|-----------------------|-----------------------|--|--------------------------------------|---------|-------|---|---|---|--|----------------------------|---|
| | | DESCRIPTION | STRATA PLOT ELEV. DEPTH (m) | NUMBER | TYPE | BLOWS/0.3m | SHEAR STRENGTH Cu, kPa nat V - + rem V - ⊕ U - ○ | WATER CONTENT, PERCENT Wp -----○ W----- Wl | | | |
| 0 | POWER AUGER DRILL RIG | GROUND SURFACE | | | | | | | | | |
| | | Topsoil | 0.00 | | | | | | | | |
| | | | 0.30 | | | | | | | | |
| 1 | | Clayey Silt, trace sand and gravel Stiff to very stiff Grey (Glacial Till) | | 1 | SO DO | 11 | | | | | |
| 2 | | | | 2 | SO DO | 26 | | | | | |
| 3 | | | | | | | | | | | |
| | | | 2.13 | | SO DO | 50/03 | | | | | |
| 4 | | Shale with limestone and dolomite interbeds Weathered to fresh Grey | | | | | | | | | |
| 5 | | END OF BOREHOLE | 4.57 | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | | | | | | | | | |

Open hole dry on completion of drilling.

DATA INPUT: PS MAR 12/98

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: ASP

N804003 BHS

W.P. 167-86-00

RECORD OF BOREHOLE 3

SHEET 1 OF 1

DIST.

BORING DATE: DEC.18/97

DATUM:

LOCATION: Sta. 17+365/35m Rt.

PROJECT: 981-8040



| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | HYDRAULIC CONDUCTIVITY, k, cm/s | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION | |
|-----------------------|-----------------------|---|-------------|-----------------------|----------|---|------------|------------------------------------|------------------------------------|----------------------------|---|---|
| | | DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | NUMBER | TYPE | BLOWS/0.3m | SHEAR STRENGTH Cu, kPa | nat V - + Q - ● rem V - ⊕ U - ○ | | | WATER CONTENT, PERCENT Wp — W — Wl |
| | | | | | | | | | | | | |
| 0 | POWER AUGER DRILL RIG | GROUND SURFACE | | | | | | | | | | |
| | | Topsoil | | 0.00 | | | | | | | | |
| | | | | 0.25 | | | | | | | | |
| 1 | | Clayey Silt, trace sand and gravel Hard Grey (Glacial Till) | | 1 | 50 DO | 50 | | | | | | |
| 2 | | | 2 | 50 DO | 67 | | | | | | | |
| | | Shale with limestone interbeds Weathered Grey | | 2.13 | 3 | 50 DO | 60/ .06 | | | | | |
| 3 | | END OF BOREHOLE Refusal to further auger penetration | | 2.90 | | | | | | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | |

Open hole dry on
completion of
drilling.

DATA INPUT: PS MAR.12/98

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: JY

CHECKED: ASP

NG040004 BHS

W.P. 167-86-00

RECORD OF BOREHOLE 4

SHEET 1 OF 1



DIST.

BORING DATE: DEC.19/97

DATUM:

LOCATION: Sta. 17+450/30m Rt

PROJECT: 981-8040

| DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | | SAMPLES | | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | | HYDRAULIC CONDUCTIVITY, k, cm/s | | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION |
|-----------------------|-----------------------|--|-----------------------------|----------|----------|---|---------------------------|------------------------------------|---|----------------------------|---|
| | | DESCRIPTION | STRATA PLOT DEPTH (m) | NUMBER | TYPE | BLOWS/0.3m | SHEAR STRENGTH Cu, kPa | nat V - + Q - ● rem V - ⊕ U - ○ | WATER CONTENT, PERCENT Wp ----- W ----- Wi | | |
| 0 | POWER AUGER DRILL RIG | GROUND SURFACE | | | | | | | | | |
| | | Gravelly Sand Brown (Fill) | 0.00 | 1 | AS | | | | | | |
| 1 | | Silty Clay, trace sand and organics (wood fragments) Firm to very stiff Grey to brown (Fill) | 0.61 | 2 | 50 DO | 20 | | | | | |
| 2 | | | 3 | 50 DO | 21 | | | | | | |
| 3 | | | 4 | 50 DO | 7 | | | | | | |
| | | | 5 | 50 DO | 8 | | | | | | |
| 4 | | Shale Weathered Grey | 3.66 | 50 DO | 50 | | | | | | |
| | | END OF BOREHOLE Refusal to further auger penetration | 3.83 | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | | | | | | | | | |

Open hole dry on
completion of
drilling.

DATA INPUT: PS MAR.12/98

SOILM6

DEPTH SCALE

1 to 50

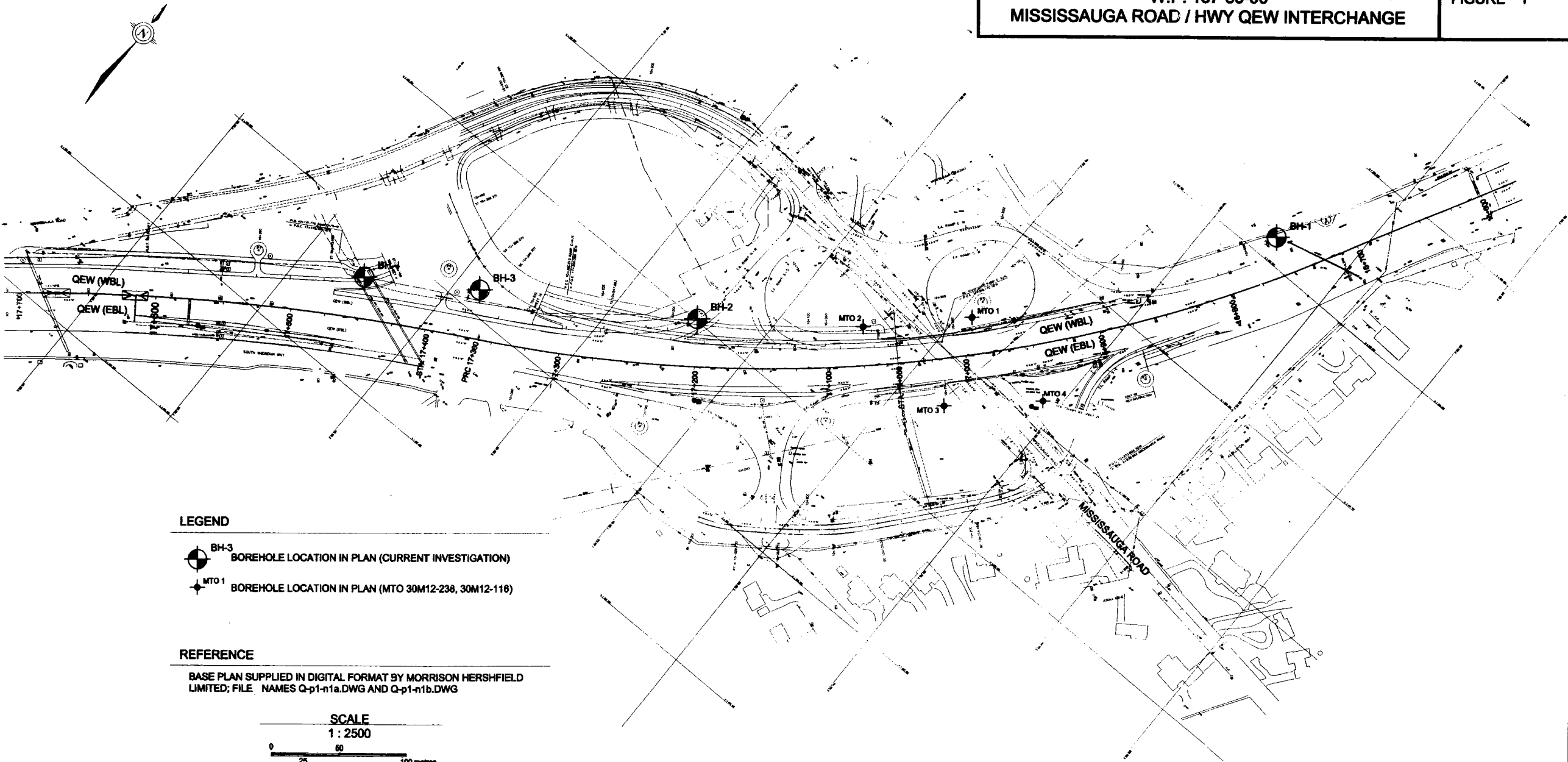
Golder Associates

LOGGED: JY

CHECKED: ASP

BOREHOLE LOCATION PLAN
W.P. 167-86-00
MISSISSAUGA ROAD / HWY QEW INTERCHANGE

FIGURE 1

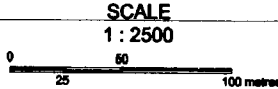


LEGEND

-  BH-3 BOREHOLE LOCATION IN PLAN (CURRENT INVESTIGATION)
-  MTO 1 BOREHOLE LOCATION IN PLAN (MTO 30M12-238, 30M12-118)

REFERENCE

BASE PLAN SUPPLIED IN DIGITAL FORMAT BY MORRISON HERSHFIELD LIMITED; FILE NAMES Q-p1-n1a.DWG AND Q-p1-n1b.DWG



Date FEBRUARY, 1998
Project 971-8040

Golder Associates

Drawn IDR
Chkd ASP

M804000.1

APPENDIX B

**Current Investigation - Borehole
and Drillhole Records and Bedrock
Core Photographs**

LIST OF SYMBOLS

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

I. GENERAL

| | |
|-------------|---------------------------------------|
| π | 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

| | |
|--------------------------------|--|
| γ | shear strain |
| Δ | change in, e.g. in stress: $\Delta \sigma$ |
| ε | linear strain |
| ε_v | volumetric strain |
| η | coefficient of viscosity |
| ν | Poisson's ratio |
| σ | total stress |
| σ' | effective stress ($\sigma' = \sigma - u$) |
| σ'_{vo} | initial effective overburden stress |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stress (major, intermediate, minor) |
| σ_{oct} | mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| τ | 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 |
| γ' | unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$) |
| D_R | relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s) |
| e | void ratio |
| n | porosity |
| S | degree of saturation |

(a) Index Properties (continued)

| | |
|-------------|--|
| w | water content |
| w_l or LL | liquid limit |
| w_p or PL | plastic limit |
| I_p or PI | plasticity index = $(w_l - w_p)$ |
| w_s | shrinkage limit |
| I_L | liquidity index = $(w - w_p) / I_p$ |
| I_c | consistency index = $(w_l - w) / I_p$ |
| e_{max} | void ratio in loosest state |
| e_{min} | void ratio in densest state |
| I_D | density index = $(e_{max} - e) / (e_{max} - e_{min})$ (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 (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_{α} | 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 |
| σ'_p | pre-consolidation stress |
| OCR | over-consolidation ratio = σ'_p / σ'_{vo} |

(d) Shear Strength

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

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

Notes: 1
2

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

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

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

(b) Cohesive Soils Consistency

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

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

| Per cent by Weight | Modifier | Example |
|--------------------|--|---|
| 0 to 5 | Trace | Trace sand |
| 5 to 12 | Trace to Some (or Little) | Trace to some sand |
| 12 to 20 | Some | Some sand |
| 20 to 30 | (ey) or (y) | Sandy |
| over 30 | And (non-cohesive (cohesionless)) or With (cohesive) | Sand and Gravel Silty Clay with sand / Clayey Silt with sand |

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

| <u>Description</u> | <u>Bedding Plane Spacing</u> |
|---------------------|------------------------------|
| Very thickly bedded | Greater than 2 m |
| Thickly bedded | 0.6 m to 2 m |
| Medium bedded | 0.2 m to 0.6 m |
| Thinly bedded | 60 mm to 0.2 m |
| Very thinly bedded | 20 mm to 60 mm |
| Laminated | 6 mm to 20 mm |
| Thinly laminated | Less than 6 mm |

JOINT OR FOLIATION SPACING

| <u>Description</u> | <u>Spacing</u> |
|--------------------|------------------|
| Very wide | Greater than 3 m |
| Wide | 1 m to 3 m |
| Moderately close | 0.3 m to 1 m |
| Close | 50 mm to 300 mm |
| Very close | Less than 50 mm |

GRAIN SIZE

| <u>Term</u> | <u>Size*</u> |
|---------------------|-------------------------|
| Very Coarse Grained | Greater than 60 mm |
| Coarse Grained | 2 mm to 60 mm |
| Medium Grained | 60 microns to 2 mm |
| Fine Grained | 2 microns to 60 microns |
| Very Fine Grained | Less than 2 microns |

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

| | |
|---------------------|-------------------|
| JN Joint | PL Planar |
| FLT Fault | CU Curved |
| SH Shear | UN Undulating |
| VN Vein | IR Irregular |
| FR Fracture | K Slickensided |
| SY Stylolite | PO Polished |
| BD Bedding | SM Smooth |
| FO Foliation | SR Slightly Rough |
| CO Contact | RO Rough |
| AXJ Axial Joint | VR Very Rough |
| KV Karstic Void | |
| MB Mechanical Break | |

| PROJECT | | 1662333 | | RECORD OF BOREHOLE No OHS-1 | | | | SHEET 1 OF 1 | | METRIC | | | | | | | |
|---------------|---|-----------------|---------|-----------------------------|------------|---|-----------------|--|--|--------|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. | | 2002-13-00 | | LOCATION | | N 4823166.2; E 295038.8 MTM NAD 83 ZONE 10 (LAT. 43.548372; LONG. -79.620817) | | ORIGINATED BY | | CC | | | | | | | |
| DIST | | Central HWY QEW | | BOREHOLE TYPE | | CME 75, 152 mm O.D. Solid Stem Augers | | COMPILED BY | | SK | | | | | | | |
| DATUM | | Geodetic | | DATE | | July 16, 2018 | | CHECKED BY | | SMM | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| 101.6 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT (130 mm) | | | | | | | | | | | | | | | | |
| | CONCRETE (250 mm) | | | | | | | | | | | | | | | | |
| 0.4 | Gravelly sand (FILL) | | 1 | SS | 24 | | | | | | | | | | | | |
| 100.7 | Compact Brown Moist | | | | | | | | | | | | | | | | |
| 0.9 | Silt and sand (FILL) | | 2 | SS | 20 | | | | | | | | | | | | |
| 100.1 | Compact Brown to grey below 1.2 m | | | | | | | | | | | | | | | | |
| 1.5 | Moist to wet | | | | | | | | | | | | | | | | |
| | SILTY CLAY, trace to some gravel, trace to some sand, trace rootlets from 1.5 m to 2.1 m (TILL) | | 3 | SS | 12 | | | | | | | | | | | | |
| | Stiff to hard | | | | | | | | | | | | | | | | |
| 98.8 | Grey Moist | | 4 | SS | 35 | | | | | | | | | | | | |
| 2.8 | CLAYEY SILT, some sand to sandy, some shale fragments (RESIDUAL SOIL) | | 5A | SS | 61 | | | | | | | | | | | | |
| 98.0 | Hard Brown Wet | | 5B | SS | | | | | | | | | | | | | |
| 3.6 | SHALE (BEDROCK) Grey | | 1 | RC | REC 100% | | | | | | | | | | | | |
| | Bedrock cored from a depth of 3.6 m to 7.3 m | | | | | | | | | | | | | | | | |
| | For bedrock coring details, refer to Record of Drillhole OHS-1 | | | | | | | | | | | | | | | | |
| | | | 2 | RC | REC 97% | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 3 | RC | REC 100% | | | | | | | | | | | | |
| 94.3 | END OF BOREHOLE | | | | | | | | | | | | | | | | |
| 7.3 | NOTES: 1. Borehole dry prior to rock coring. | | | | | | | | | | | | | | | | |

PROJECT: 1662333

RECORD OF DRILLHOLE: OHS-1

SHEET 1 OF 1

LOCATION: N 4823166.2 ;E 295038.8

DRILLING DATE: July 16, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Davis Drilling

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | | | | | | | | | | | | | | | | FEATURES | R0/R1 ZONES | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|-----------------|-------------------------------|--------------|-----------------------|---------|---|-----------------|-------------|----------------------------------|---------------------------------------|---------------------------------|----|----|---------------------------|----------------------------------|--|--------------------------|--|--|--|--|----------|-------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| | | | | | | RECOVERY | | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA | | | | ROCK STRENGTH INDEX | | | WEATH- ERING INDEX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | TOTAL CORE % | SOLID CORE % | | | B Angle DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Jr | Ja | R4 R3 R2 R1 | W1 W2 W3 W4 W5 W6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | HQ Core | Continued from Borehole OHS-1 | | 97.95 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50



GOLDER

LOGGED: CC

CHECKED: SK

GTA-RCK 054 S:\CLIENTS\MTQ\QEW-CREDIT_RIVER\GPJ GAL-MISS.GDT 12/14/18

| PROJECT 1662333 | | RECORD OF BOREHOLE No OHS-2 | | | | SHEET 1 OF 1 | | METRIC | | | | | | |
|----------------------|---|--|---------|------|------------|-------------------------|-----------------|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. 2002-13-00 | | LOCATION N 4823411.0; E 295425.9 MTM NAD 83 ZONE 10 (LAT. 43.550588; LONG. -79.616021) | | | | ORIGINATED BY AM | | | | | | | | |
| DIST Central HWY QEW | | BOREHOLE TYPE CME 55, 210 mm O.D., Hollow Stem Augers | | | | COMPILED BY SK | | | | | | | | |
| DATUM Geodetic | | DATE July 16, 2018 | | | | CHECKED BY SMM | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | |
| 100.6 | GROUND SURFACE | | | | | | | | | | | | | |
| 0.0 | ASPHALT (100 mm) | | | | | | | | | | | | | |
| | Gravelly sand, trace to some silt (FILL) | | 1 | SS | 25 | | | | | | | | | |
| | Compact Brown Moist | | 2 | SS | 19 | | | | | | | | | |
| 99.1 | | | | | | | | | | | | | | |
| 1.5 | CLAYEY SILT, trace gravel, some sand, some shale fragments (TILL) | | 3 | SS | 9 | | | | | | | | | 3 15 47 35 |
| | Stiff to hard Grey to brown Moist | | 4 | SS | 35 | | | | | | | | | |
| | | | 5A | SS | 66 | | | | | | | | | |
| | | | 5B | SS | 66 | | | | | | | | | |
| 96.9 | | | | | | | | | | | | | | |
| 3.7 | SHALE (BEDROCK) Grey | | 6 | SS | 100/100 | | | | | | | | | |
| | Bedrock cored from a depth of 3.8 m to 7.5 m | | 1 | RC | REC 87% | | | | | | | | | RQD = 69% |
| | For bedrock coring details, refer to Record of Drillhole OHS-2 | | 2 | RC | REC 96% | | | | | | | | | RQD = 89% |
| | | | 3 | RC | REC 100% | | | | | | | | | RQD = 93% |
| 93.1 | | | | | | | | | | | | | | |
| 7.5 | END OF BOREHOLE | | | | | | | | | | | | | |
| | NOTES: | | | | | | | | | | | | | |
| | 1. Borehole dry prior to rock coring. | | | | | | | | | | | | | |

PROJECT: 1662333

RECORD OF DRILLHOLE: OHS-2

SHEET 1 OF 1

LOCATION: N 4823411.0 ; E 295425.9

DRILLING DATE: July 16, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Aardvark Drilling

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | | | | | | | | | | | | | | | | | | FEATURES | R0/R1 ZONES | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|-----------------|-------------------------------|--------------|-----------------------|---------|---|-----------------|---------------------------------------|-------------|----------------------------------|---------------------------------|----|----|----|----|----|---------------------------|----|----|--------------------------|----|----|----|----------|-------------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| | | | | | | RECOVERY | | | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA | | | | | | ROCK STRENGTH INDEX | | | WEATH- ERING INDEX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | TOTAL CORE % | SOLID CORE % | B Angle DIP w.r.t. CORE AXIS | | | TYPE AND SURFACE DESCRIPTION | Jr | Ja | R4 | R3 | R2 | R1 | W1 | W2 | W3 | W4 | W5 | W6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | HQ Core | Continued from Borehole OHS-2 | | 96.80 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: AM

CHECKED: SK

GTA-RCK 054 S:\CLIENTS\MTQ\QEW-CREDIT_RIVER\GPJ GAL-MISS.GDT 12/14/18

| PROJECT 1662333 | | RECORD OF BOREHOLE No OHS-3 | | | | SHEET 1 OF 1 | | | METRIC | | | | | | |
|--|---|--|---------|------|------------|-------------------------|-----------------|--|--------|---|---------------------------------|-------------------------------|--------------------------------|-------------------|---------------------------------------|
| G.W.P. 2002-13-00 | | LOCATION N 4824620.8; E 296190.9 MTM NAD 83 ZONE 10 (LAT. 43.561475; LONG. -79.606570) | | | | ORIGINATED BY CC | | | | | | | | | |
| DIST Central HWY QEW | | BOREHOLE TYPE CME 75, 152 mm O.D., Solid Stem Augers | | | | COMPILED BY SK | | | | | | | | | |
| DATUM Geodetic | | DATE July 17, 2018 | | | | CHECKED BY SMM | | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | |
| 95.0 | GROUND SURFACE | | | | | ▽ | 94 | 20 40 60 80 100 | | | | | | kN/m ³ | GR SA SI CL |
| 0.0 | ASPHALT (130 mm) | | | | | | | 20 40 60 80 100 | | | | | | | |
| | CONCRETE (230 mm) | | | | | | | 20 40 60 80 100 | | | | | | | |
| 0.4 | Gravelly sand (FILL) | | 1 | SS | 31 | | | 20 40 60 80 100 | | | | | | | |
| 94.1 | Dense Brown Moist | | | | | | | 20 40 60 80 100 | | | | | | | |
| 0.9 | Silt and sand, trace clay (FILL) | | 2 | SS | 26 | | | 20 40 60 80 100 | | | | ○ | | | |
| | Very loose to compact Brown Moist to wet below 1.9 m | | 3 | SS | 3 | | | 20 40 60 80 100 | | | | | ○ | | |
| | | | 4 | SS | 11 | | | 20 40 60 80 100 | | | | | ○ | | |
| 92.0 | | | | | | | | 20 40 60 80 100 | | | | | ○ | | |
| 3.0 | Sandy SILT to SAND and SILT, trace to some clay | | 5 | SS | 7 | | | 20 40 60 80 100 | | | | | ○ | | |
| | Loose to dense Grey Wet | | 6 | SS | 25 | 20 40 60 80 100 | | | | ○ | | | | | |
| | | | 7 | SS | 37 | 20 40 60 80 100 | | | | ○ | | | | | |
| 89.4 | | | | | | 20 40 60 80 100 | | | | | | | | | |
| 5.6 | Gravelly SILT and SAND, trace to some clay (TILL) | | 8 | SS | 48 | 20 40 60 80 100 | | | | ○ | H | | | | |
| | Dense Grey Moist | | | | | 20 40 60 80 100 | | | | | | | | | |
| 87.8 | | | | | | 20 40 60 80 100 | | | | | | | | | |
| 7.2 | Sandy CLAYEY SILT, some gravel, trace cobbles and shale fragments (RESIDUAL SOIL) | | 9 | SS | 50/0.17 | 20 40 60 80 100 | | | | | | | | | |
| 87.2 | Hard Grey Moist | | | | | 20 40 60 80 100 | | | | | | | | | |
| 7.8 | END OF BOREHOLE SPLIT-SPOON REFUSAL | | | | | 20 40 60 80 100 | | | | | | | | | |
| NOTES: 1. Water level in open borehole at a depth of 3.6 m below ground surface (Elev. 91.4 m) upon completion of drilling. | | | | | | | | | | | | | | | |

| PROJECT 1662333 | | RECORD OF BOREHOLE No OHS-4 | | | | SHEET 1 OF 1 | | METRIC | | | | | | | | |
|----------------------|--|--|---------|------|------------|-------------------------|-----------------|--|--|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. 2002-13-00 | | LOCATION N 4823828.9; E 295734.3 MTM NAD 83 ZONE 10 (LAT. 43.554333; LONG. -79.612205) | | | | ORIGINATED BY AM | | | | | | | | | | |
| DIST Central HWY QEW | | BOREHOLE TYPE Portable Tripod | | | | COMPILED BY DH | | | | | | | | | | |
| DATUM Geodetic | | DATE September 6, 2018 | | | | CHECKED BY SMM | | | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | |
| 97.3 | GROUND SURFACE | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL (300mm) | | 1 | SS | 64 | | | | | | | | | | | |
| 96.6 | Gravel, some sand, some silt (FILL) Hard Brown Moist | | 2 | SS | 47 | | | | | | | | | | | |
| 0.7 | | | | | | | | | | | | | | | | |
| 95.6 | SILTY CLAY, some sand, trace gravel, some shale fragments (RESIDUAL SOIL) Brown, oxidation staining Hard Moist | | 3 | SS | 100/0.10 | | | | | | | | | | | 5 14 49 32 |
| 1.7 | | | 1 | RC | REC 100% | | | | | | | | | | | RQD = 0% |
| | SHALE (BEDROCK) Grey | | 2 | RC | REC 43% | | | | | | | | | | | RQD = 0% |
| | Bedrock cored from a depth of 1.7 m to 5.6 m For bedrock coring details, refer to Record of Drillhole OHS-4 | | 3 | RC | REC 53% | | | | | | | | | | | RQD = 0% |
| | | | 4 | RC | REC 82% | | | | | | | | | | | RQD = 35% |
| | | | 5 | RC | REC 92% | | | | | | | | | | | RQD = 89% |
| 91.7 | END OF BOREHOLE | | | | | | | | | | | | | | | |
| 5.6 | NOTES: 1. Borehole dry prior to rock coring. | | | | | | | | | | | | | | | |

GTA-MTO 001 S:\CLIENTS\MTQEW-CREDIT_RIVER\02_DATA\INTQEW-CREDIT_RIVER.GPJ GAL-GTA.GDT 12/14/18

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Walker Drilling

[illegible]

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50



GOLDER

LOGGED: AM

CHECKED: AB

GTARCK 054 S:\CLIENTS\MTQ\QEW-CREDIT RIVER\02 DATA\GINT\QEW-CREDIT RIVER.GPJ GAL-MISS.GDT 12/14/18

| PROJECT 1662333 | | RECORD OF BOREHOLE No OHS-5 | | | | SHEET 1 OF 1 | | METRIC | | | | | | | | |
|----------------------|--|--|---------|------|------------|-------------------------|-----------------|--|--|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. 2002-13-00 | | LOCATION N 4823467.9; E 295463.2 MTM NAD 83 ZONE 10 (LAT. 43.551058; LONG. -79.615622) | | | | ORIGINATED BY CC/AM | | | | | | | | | | |
| DIST Central HWY QEW | | BOREHOLE TYPE CME 75, 152 mm O.D., Solid Stem Augers | | | | COMPILED BY SK | | | | | | | | | | |
| DATUM Geodetic | | DATE July 9, 2018 | | | | CHECKED BY SMM | | | | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | |
| 100.5 | GROUND SURFACE | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT (200 mm) | | | | | | | | | | | | | | | |
| 0.2 | Silty sand, trace to some silt (FILL) Compact to dense Brown Moist | | 1 | SS | 37 | | | | | | | | | | | |
| | | | 2A | SS | 19 | | | | | | | | | | | |
| | | | 2B | | | | | | | | | | | | | |
| 98.7 | | | 3A | SS | 5 | | | | | | | | | | | |
| 1.8 | Silty clay, trace sand, trace gravel (FILL) Firm to hard Grey Moist | | 3B | | | | | | | | | | | | | |
| | | | 4A | | | | | | | | | | | | | |
| | | | 4B | SS | 48 | | | | | | | | | | | |
| 97.5 | - Cobble fragments encountered between depths of about 2.6 m and 2.9 m | | 5 | SS | 100/0.20 | | | | | | | | | | | |
| 3.0 | CLAYEY SILT, some sand, trace shale fragments (RESIDUAL SOIL) | | 6 | SS | 50/0.10 | | | | | | | | | | | |
| 96.8 | Hard Brown Moist | | | | | | | | | | | | | | | |
| 3.7 | SHALE (BEDROCK) Grey | | 1 | RC | REC 100% | | | | | | | | | | | |
| | Bedrock cored from a depth of 4.1 m to 8.0 m | | | | | | | | | | | | | | | |
| | For bedrock coring details, refer to Record of Drillhole OHS-5 | | 2 | RC | REC 100% | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 3 | RC | REC 93% | | | | | | | | | | | |
| 92.5 | | | | | | | | | | | | | | | | |
| 8.0 | END OF BOREHOLE | | | | | | | | | | | | | | | |
| | NOTE: 1. Borehole dry prior to rock coring. | | | | | | | | | | | | | | | |

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Davis Drilling

[illegible]



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

PROJECT: 1662333

RECORD OF DRILLHOLE: HMLP-1

SHEET 1 OF 1

LOCATION: N 4823418.1 ;E 295302.7

DRILLING DATE: August 8, 2018

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Davis Drilling

| DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols. | | | | | | | | | | | | | | | | FEATURES | R0/R1 ZONES | NOTES WATER LEVELS INSTRUMENTATION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|-----------------|--|--------------|-----------------------|---------|---|--------------------------------------|-------------|----------------------------------|--------------------|----------------------------|---------------------------------|----|----|----|---------------------------|----|--------------------------|----|----|----|----------|-------------|--|----|----|----|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| | | | | | | RECOVERY | | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA | | | | | | ROCK STRENGTH INDEX | | WEATH- ERING INDEX | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | TOTAL CORE % | SOLID CORE % | | | B Angle | DIP w.r.t. CORE AXIS | TYPE AND SURFACE DESCRIPTION | Jr | Ja | R4 | R3 | R2 | R1 | W1 | W2 | W3 | | | | W4 | W5 | W6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | 000000 000000 000000 000000 | 000000 000000 000000 000000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Continued from Record of Borehole HMLP-1 | | 97.43 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: AM

CHECKED: SK

GTA-RCK 054 S:\CLIENTS\MTQ\QEW-CREDIT_RIVER\GPJ GAL-MISS.GDT 12/14/18

| PROJECT | | 1662333 | | RECORD OF BOREHOLE | | No HMLP-2 | | SHEET 1 OF 1 | | METRIC | | | | | | | |
|---------------|---|-----------------|---------|--------------------|------------|---|-----------------|--|--|--------|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. | | 2002-13-00 | | LOCATION | | N 4823653.9; E 295615.1 MTM NAD 83 ZONE 10 (LAT. 43.552765; LONG. -79.613680) | | ORIGINATED BY | | AM | | | | | | | |
| DIST | | Central HWY QEW | | BOREHOLE TYPE | | CME 75, 210 mm O.D., Hollow Stem Augers | | COMPILED BY | | SK | | | | | | | |
| DATUM | | Geodetic | | DATE | | August 7, 2018 | | CHECKED BY | | SMM | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| 98.8 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | Sandy silt (FILL) | | 1A | SS | 11 | | | | | | | | | | | | |
| 98.3 | Compact | | 1B | | | | | | | | | | | | | | |
| 0.5 | Light brown | | | | | | | | | | | | | | | | |
| | Wet | | | | | | | | | | | | | | | | |
| 97.8 | Silty sand (FILL) | | 2A | | | | | | | | | | | | | | |
| 1.0 | Compact | | 2B | | | | | | | | | | | | | | |
| | Light brown | | 2C | SS | 31 | | | | | | | | | | | | |
| | Moist | | | | | | | | | | | | | | | | |
| | CLAYEY SILT with sand, trace gravel, some shale fragments, oxidation staining (RESIDUAL SOIL) | | 3A | | | | | | | | | | | | | | |
| | Hard | | 3B | | | | | | | | | | | | | | |
| | Grey - brown | | | | | | | | | | | | | | | | |
| 96.5 | Dry | | 4 | SS | 100/0.23 | | | | | | | | | | | | |
| 2.3 | SHALE (BEDROCK) | | | | | | | | | | | | | | | | |
| | Grey | | 1 | RC | REC 100% | | | | | | | | | | | | |
| | Bedrock cored from a depth of 2.3 m to 5.8 m | | | | | | | | | | | | | | | | |
| | For bedrock coring details, refer to Record of Drillhole HMLP-2 | | | | | | | | | | | | | | | | |
| | | | 2 | RC | REC 100% | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 3 | RC | REC 100% | | | | | | | | | | | | |
| 93.0 | END OF BOREHOLE | | | | | | | | | | | | | | | | |
| 5.8 | NOTE: | | | | | | | | | | | | | | | | |
| | 1. Borehole dry prior to rock coring. | | | | | | | | | | | | | | | | |

GTA-MTO 001 S:\CLIENTS\MTQEW-CREDIT_RIVER02_DATA\INTQEW-CREDIT_RIVER.GPJ GAL-GTA.GDT 12/14/18

[illegible]

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50



GOLDER

LOGGED: AM

CHECKED: SK

| PROJECT | | 1662333 | | RECORD OF BOREHOLE | | No MO-08A | | SHEET 1 OF 1 | | METRIC | | | | | | | |
|---|---|-----------------|---------|--------------------|------------|---|-----------------|--|--|--------|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. | | 2002-13-00 | | LOCATION | | N 4823630.5; E 295614.5 MTM NAD 83 ZONE 10 (LAT. 43.552545; LONG. -79.613684) | | ORIGINATED BY | | JL | | | | | | | |
| DIST | | Central HWY QEW | | BOREHOLE TYPE | | 64 mm O.D. 51 mm I.D. Split Spoon Sampler | | COMPILED BY | | DM | | | | | | | |
| DATUM | | Geodetic | | DATE | | December 21, 2017 | | CHECKED BY | | GDS | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| 98.9 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL (180 mm) | | 1A | | 10 | | | | | | | | | | | | |
| 0.2 | Silty sand, trace gravel, some organics (FILL) Compact Brown Moist to wet | | 1B | SS | | | | | | | | | | | | | |
| | | | 2 | SS | 19 | | | | | | | | | | | | |
| 97.7 | | | | | | | | | | | | | | | | | |
| 1.2 | CLAYEY SILT, trace to some sand, trace to some gravel Very stiff to hard Grey to brown Moist | | 3A | SS | 20 | | | | | | | | | | | | |
| | | | 3B | | | | | | | | | | | | | | |
| 96.8 | | | 4A | SS | 100/0.25 | | | | | | | | | | | | |
| | | | 4B | | | | | | | | | | | | | | |
| 2.2 | SHALE (BEDROCK) Grey END OF BOREHOLE | | | | | | | | | | | | | | | | |
| NOTE: 1. Borehole dry upon completion of drilling. | | | | | | | | | | | | | | | | | |

GTA-MTO 001 S:\CLIENTS\MTQEW-CREDIT_RIVER02_DATA\INTQEW-CREDIT_RIVER.GPJ GAL-GTA.GDT 12/14/18

| PROJECT | | 1662333 | | RECORD OF BOREHOLE | | No MO-08B | | SHEET 1 OF 1 | | METRIC | | | | | | | |
|---|--|----------------|---------|--------------------|------------|---|-----------------|--|--|--------|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. | | 2002-13-00 | | LOCATION | | N 4823632.0; E 295615.8 MTM NAD 83 ZONE 10 (LAT. 43.552559; LONG. -79.613668) | | ORIGINATED BY | | JL | | | | | | | |
| DIST | | Central HWY QE | | BOREHOLE TYPE | | 64 mm O.D. 51 mm I.D. Split Spoon Sampler | | COMPILED BY | | DM | | | | | | | |
| DATUM | | Geodetic | | DATE | | December 21, 2017 | | CHECKED BY | | GDS | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| 98.9 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | TOPSOIL (100 mm) | | | | | | | | | | | | | | | | |
| 98.3 | Clayey silt, trace sand, trace gravel, some rootlets (FILL) | | 1 | SS | 9 | | | | | | | | | | | | |
| 0.6 | Stiff | | | | | | | | | | | | | | | | |
| | Brown to black | | 2 | SS | 11 | | | | | | | | | | | | |
| | Moist | | | | | | | | | | | | | | | | |
| 97.5 | Silty sand, trace to some clay, trace gravel, some rootlets (FILL) | | 3A | SS | 35 | | | | | | | | | | | | |
| 1.4 | Compact | | | | | | | | | | | | | | | | |
| 97.1 | Brown | | 3B | SS | | | | | | | | | | | | | |
| | Moist to wet | | | | | | | | | | | | | | | | |
| 96.8 | CLAYEY SILT | | 4 | SS | 100/0.13 | | | | | | | | | | | | |
| 2.1 | Hard | | | | | | | | | | | | | | | | |
| | Brown to grey | | | | | | | | | | | | | | | | |
| | Moist | | | | | | | | | | | | | | | | |
| | SHALE (BEDROCK) | | | | | | | | | | | | | | | | |
| | Grey | | | | | | | | | | | | | | | | |
| | END OF BOREHOLE | | | | | | | | | | | | | | | | |
| NOTE: 1. Borehole dry upon completion of drilling. | | | | | | | | | | | | | | | | | |

GTA-MTO 001 \GOLDER\GDS\GAL\MISSISSAUGA\CLIENTS\IMTO\QEW-CREDIT_RIVER\02_DATA\GINTQEW-CREDIT_RIVER.GPJ GAL-GTA.GDT 5/7/18

| PROJECT | | RECORD OF BOREHOLE | | | | No SWMW-03 | | SHEET 1 OF 1 | | METRIC | | | | |
|----------------------|---|--------------------|---------|---|------------|-------------------------|-----------------|--|--|---------------------------------|-------------------------------|--------------------------------|---------------------------------------|---------------------------------------|
| G.W.P. 1662333 | | LOCATION | | N 4823513.7; E 295424.7 MTM NAD 83 ZONE 10 (LAT. 43.551490; LONG. -79.616000) | | | | ORIGINATED BY FC | | | | | | |
| DIST Central HWY QEW | | BOREHOLE TYPE | | CME 55, 152 mm O.D., Solid Stem Augers (Auto Hammer) | | | | COMPILED BY KN | | | | | | |
| DATUM Geodetic | | DATE | | August 14, 2017 | | | | CHECKED BY MWK | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | |
| 99.4 | GROUND SURFACE | | | | | | | | | | | | | |
| 0.9 | TOPSOIL (80mm) | | 1 | SS | 9 | | | | | | | | | 1 14 51 34 |
| 98.7 | SILTY CLAY, some sand, trace gravel, trace rootlets | | 2 | SS | 18 | | | | | | | | | |
| 0.7 | Stiff Brown Moist | | 3 | SS | 55 | | | | | | | | | |
| 97.2 | SANDY CLAYEY SILT, contains shale fragments (RESIDUAL SOIL) | | 4 | SS | 100/0.08 | | | | | | | | | |
| | Very stiff to hard Brown Moist | | 1 | RC | REC 100% | | | | | | | | | RQD = 67% |
| 2.2 | SHALE (BEDROCK) | | 2 | RC | REC 100% | | | | | | | | | RQD = 92% |
| | Grey | | 3 | RC | REC 100% | | | | | | | | | RQD = 93% |
| | Bedrock cored from depths of 2.4 m to 6.9 m | | 4 | RC | REC 100% | | | | | | | | | RQD = 100% |
| | For bedrock coring details refer to Record of Drillhole SWMW-03 | | | | | | | | | | | | | |
| 92.5 | END OF BOREHOLE | | | | | | | | | | | | | |
| 6.9 | NOTES: 1. Borehole dry prior to rock coring. | | | | | | | | | | | | | |

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Aardvark Drilling

[illegible]

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50



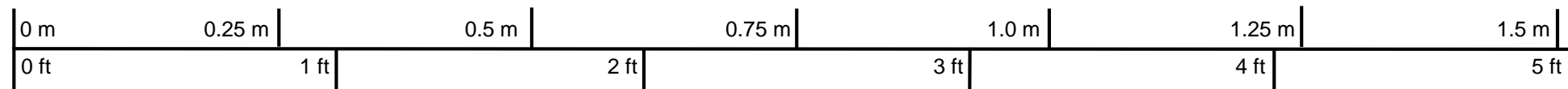
GOLDER

LOGGED: FC


CHECKED: AC

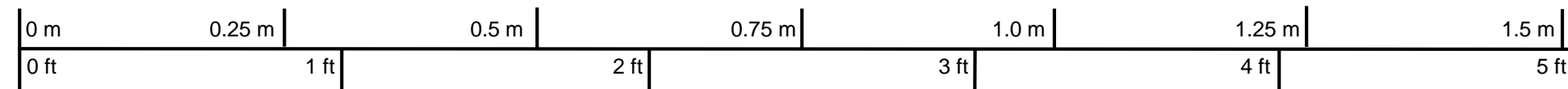
GTARCK 054 S:\CLIENTS\MTQ\QEW-CREDIT RIVER\02 DATA\GINT\QEW-CREDIT RIVER.GPJ GAL-MISS.GDT 12/14/18

| PROJECT | | 1662333 | | RECORD OF BOREHOLE | | No NRW7-1 | | SHEET 1 OF 1 | | METRIC | | | | | | | |
|--|--|-----------------|---------|--------------------|------------|---|-----------------|--|--|--------|--|--|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. | | 2002-13-00 | | LOCATION | | N 4824601.8; E 296209.0 MTM NAD 83 ZONE 10 (LAT. 43.561304; LONG. -79.606346) | | ORIGINATED BY | | CC | | | | | | | |
| DIST | | Central HWY QEW | | BOREHOLE TYPE | | CME 75, 76 mm I.D., 190 mm O.D., Hollow Stem Augers | | COMPILED BY | | SK | | | | | | | |
| DATUM | | Geodetic | | DATE | | July 12, 2018 | | CHECKED BY | | SMM | | | | | | | |
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| 95.0 | GROUND SURFACE | | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT (200 mm) | | | | | | | | | | | | | | | | |
| | CONCRETE (200 mm) | | | | | | | | | | | | | | | | |
| 0.4 | Gravelly sand (FILL) | | 1 | SS | 32 | | | | | | | | | | | | |
| 94.1 | Dense Brown Moist | | | | | | | | | | | | | | | | |
| 0.9 | Silty sand to sand, trace clay (FILL) | | 2 | SS | 27 | | | | | | | | | | | | |
| | Very loose to compact Brown Moist to wet | | 3 | SS | 5 | | | | | | | | | | | | |
| | - Wet below 2.3 m | | 4 | SS | 4 | | | | | | | | | | | | |
| 92.0 | | | | | | | | | | | | | | | | | |
| 3.0 | Sandy silt, some organics, trace to some clay, topsoil leaves, rootlets (FILL) | | 5 | SS | 1 | | | | | | | | | | | | |
| 91.3 | Very loose Brown / grey Wet | | | | | | | | | | | | | | | | |
| 3.7 | Silt, some sand, trace clay (FILL) | | 6 | SS | 4 | | | | | | | | | | | | |
| 90.5 | Very loose to loose Brown Wet | | | | | | | | | | | | | | | | |
| 4.5 | Sandy CLAYEY SILT, trace to some gravel, trace organics to 5.2 m depth (TILL) | | 7 | SS | 5 | | | | | | | | | | | | |
| | Firm to hard Brown to grey Moist to wet below 4.9 m | | | | | | | | | | | | | | | | |
| | | | 8 | SS | 12 | | | | | | | | | | | | |
| | - Cobbles at 6.7 m | | | | | | | | | | | | | | | | |
| 87.8 | | | | | | | | | | | | | | | | | |
| 7.2 | SILT and SAND, some gravel, trace clay (TILL) | | 9 | SS | 50/0.06 | | | | | | | | | | | | |
| | Very dense Grey Moist | | | | | | | | | | | | | | | | |
| | - Cobbles within Till matrix between 7.2 m and 10.2 m depth | | 10 | SS | 50/0.06 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 84.8 | | | | | | | | | | | | | | | | | |
| 10.2 | SAND, some cobble fragments | | | | | | | | | | | | | | | | |
| | Very dense Grey Moist | | 11 | SS | 60 | | | | | | | | | | | | |
| 83.7 | | | | | | | | | | | | | | | | | |
| 11.3 | END OF BOREHOLE | | | | | | | | | | | | | | | | |
| NOTES: | | | | | | | | | | | | | | | | | |
| 1. Borehole caved to a depth of 10.1 m below ground surface upon removal of augers. | | | | | | | | | | | | | | | | | |
| 2. Water level measured at a depth of about 8.5 m below ground surface (Elev. 86.5 m) upon completion of drilling. | | | | | | | | | | | | | | | | | |




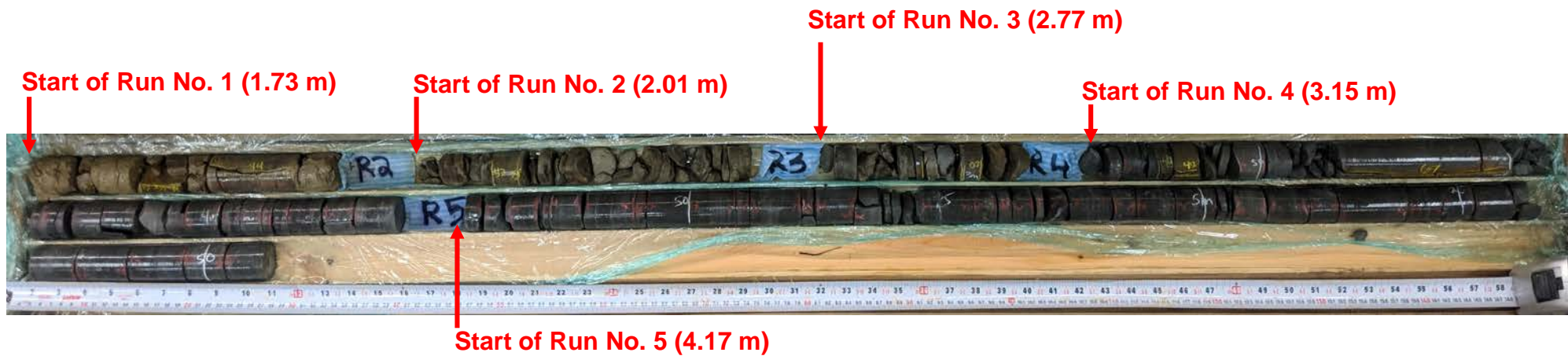
Scale

| | | | | | |
|---|--|--|------|---------------|----------------|
| PROJECT | | MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street | | | |
| TITLE | | Bedrock Core Photograph Borehole OHS-1 (3.61 m to 7.26 m) | | | |
|  | | PROJECT No. 1662333 | | FILE No. ---- | |
| | | DRAFT | SE | 20180821 | SCALE AS SHOWN |
| | | CADD | -- | | VER. 1. |
| | | CHECK | SMM | 20181120 | FIGURE B-1 |
| | | REVIEW | JMAC | 20181120 | |




Scale

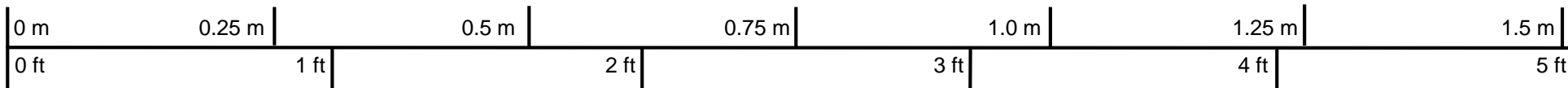
| | | | | | |
|--|--|--|---------------------|----------|---------------|
| PROJECT | | | | | |
| MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street | | | | | |
| TITLE | | | | | |
| Bedrock Core Photograph Borehole OHS-2 (3.81 m to 7.47 m) | | | | | |
|  | | | PROJECT No. 1662333 | | FILE No. ---- |
| | | | DRAFT | SE | 20180821 |
| | | | CADD | -- | |
| | | | CHECK | SMM | 20181120 |
| | | | REVIEW | JMAC | 20181120 |
| | | | SCALE | AS SHOWN | VER. 1. |
| FIGURE B-2 | | | | | |




| | | | | | | |
|------|--------|-------|--------|-------|--------|-------|
| 0 m | 0.25 m | 0.5 m | 0.75 m | 1.0 m | 1.25 m | 1.5 m |
| 0 ft | 1 ft | 2 ft | 3 ft | 4 ft | 5 ft | |

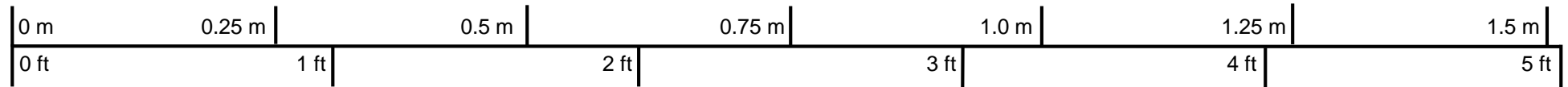
Scale

| | | | | | |
|---|--|--|---------------------|----------|---------------|
| PROJECT | | | | | |
| MTO Assignment 2015-E-0033 | | | | | |
| QEW Widening Between | | | | | |
| Mississauga Road and Hurontario Street | | | | | |
| TITLE | | | | | |
| Bedrock Core Photograph | | | | | |
| Borehole OHS-4 (1.73 m to 5.56 m) | | | | | |
|  | | | PROJECT No. 1662333 | | FILE No. ---- |
| | | | DRAFT | JIL | 20181112 |
| | | | CADD | -- | |
| | | | CHECK | SMM | 20181120 |
| | | | REVIEW | JMAC | 20181120 |
| | | | SCALE | AS SHOWN | VER. 1. |
| FIGURE B-3 | | | | | |




Scale

| | | | | | |
|---|--|--|------|---------------|----------------|
| PROJECT | | MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street | | | |
| TITLE | | Bedrock Core Photograph Borehole OHS-5 (4.06 m to 7.95 m) | | | |
|  | | PROJECT No. 1662333 | | FILE No. ---- | |
| | | DRAFT | SE | 20180821 | SCALE AS SHOWN |
| | | CADD | -- | | VER. 1. |
| | | CHECK | SMM | 20181120 | FIGURE B-4 |
| | | REVIEW | JMAC | 20181120 | |



Scale

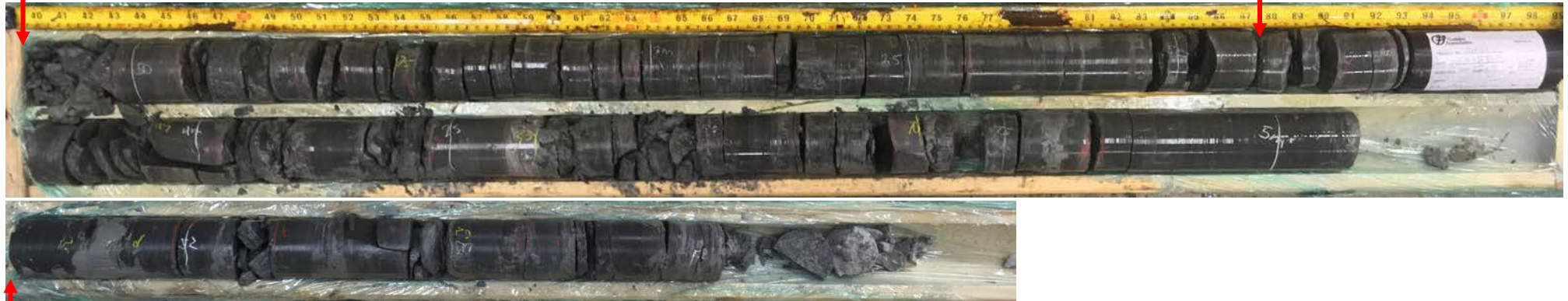
| | | | | | |
|---|---------------------|--|----------|---------------|----------|
| PROJECT | | MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street | | | |
| TITLE | | Bedrock Core Photograph Borehole HMLP-1 (3.05 m to 6.53 m) | | | |
|  | PROJECT No. 1662333 | | | FILE No. ---- | |
| | DRAFT | SE | 20180821 | SCALE | AS SHOWN |
| | CADD | -- | | FIGURE B-5 | |
| | CHECK | SMM | 20181120 | | |
| | REVIEW | JMAC | 20181120 | | |
| | | | VER. 1. | | |

Broken Core due to Split-spoon sampling

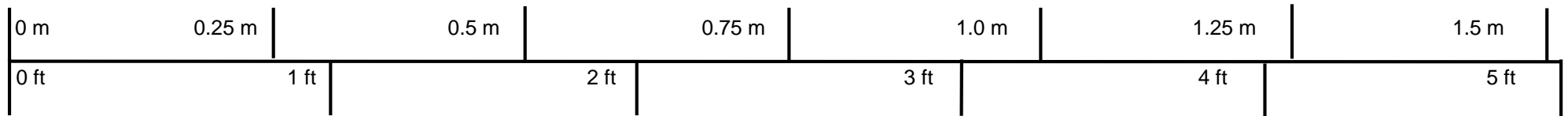


Start of Run No. 1 (2.29 m)


Start of Run No. 2 (3.58 m)

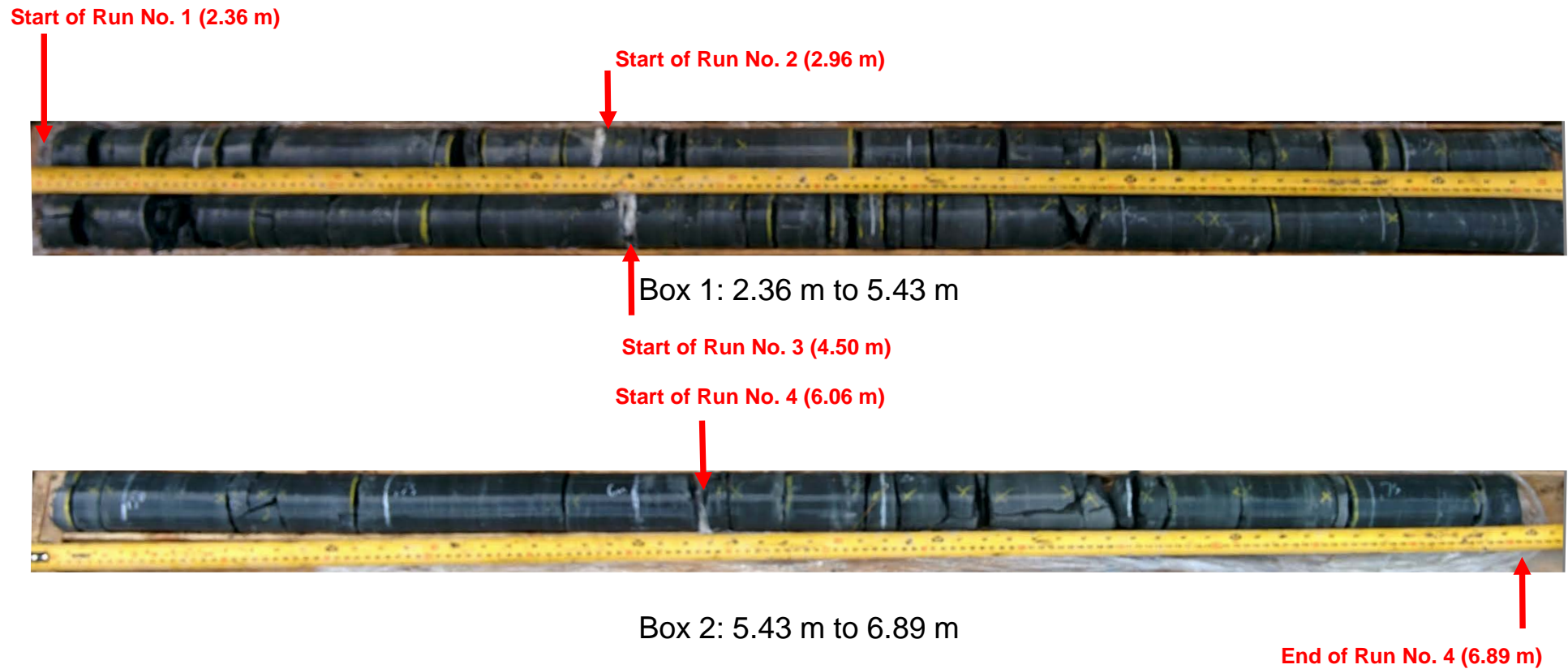



Start of Run No. 3 (5.08 m)



Scale

| | | | | | |
|---|--|--|------|---------------|----------------|
| PROJECT | | MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street | | | |
| TITLE | | Bedrock Core Photograph Borehole HMLP-2 (2.29 m to 5.77 m) | | | |
|  | | PROJECT No. 1662333 | | FILE No. ---- | |
| | | DRAFT | JIL | 20181112 | SCALE AS SHOWN |
| | | CADD | -- | | VER. 1. |
| | | CHECK | SMM | 20181120 | FIGURE B-6 |
| | | REVIEW | JMAC | 20181120 | |



| | | | | | |
|---|---------------------|--|---------------|------------|-----|
| PROJECT | | MTO Assignment 2015-E-0033 QEW Widening Between Mississauga Road and Hurontario Street | | | |
| TITLE | | Bedrock Core Photographs Borehole SWMW-03 (2.36 m to 6.89 m) | | | |
|  | PROJECT No. 1662333 | | FILE No. ---- | | |
| | DESIGN | AC | 20171003 | SCALE | NTS |
| | CADD | -- | | FIGURE B-7 | |
| | CHECK | SMM | 20181120 | | |
| | REVIEW | JMAC | 20181120 | | |

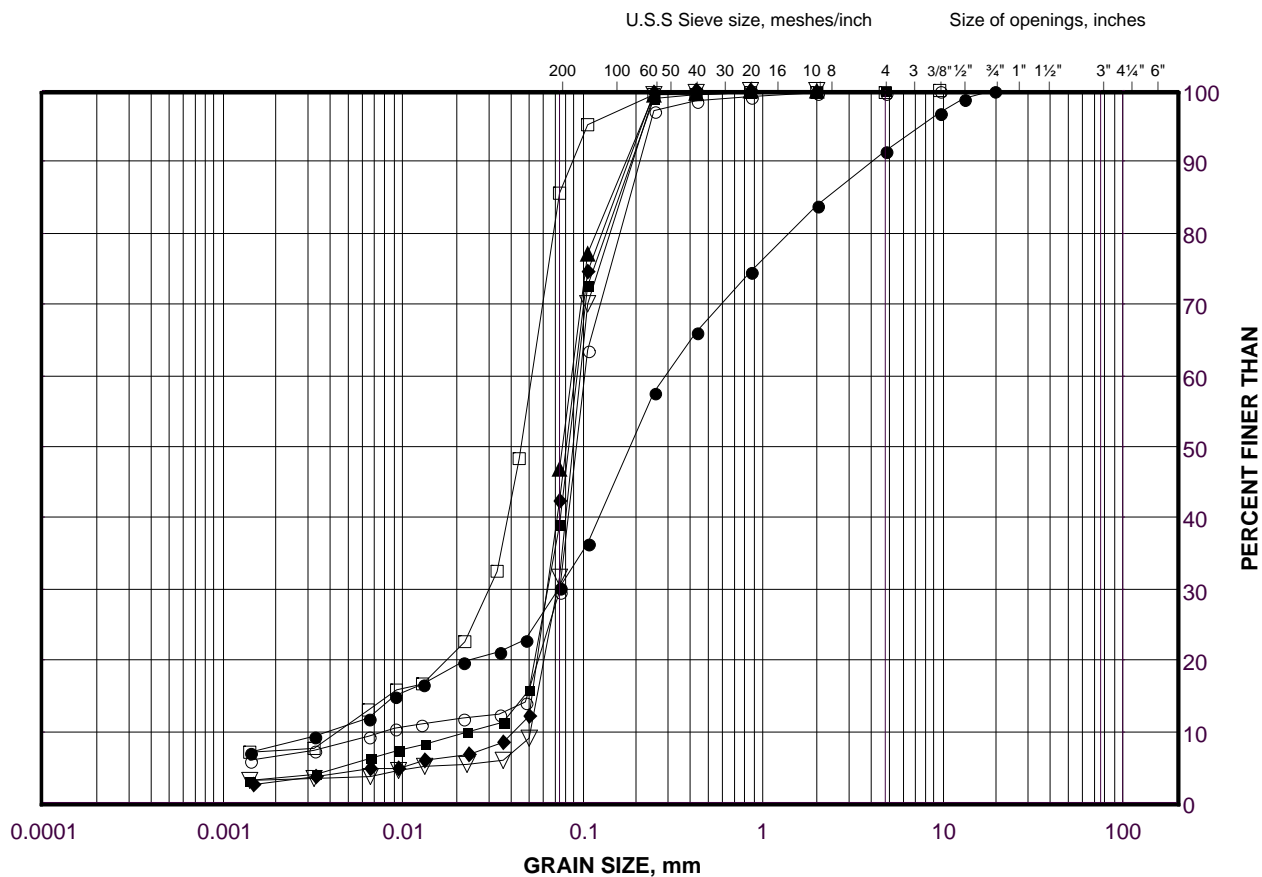
APPENDIX C

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Silt / Silt and Sand / Silty Sand (Fill)

FIGURE C-1



| | | | | | | |
|---------------------|-----------|--------|--------|-------------|--------|--------|
| SILT AND CLAY SIZES | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE |
| FINE GRAINED | SAND SIZE | | | GRAVEL SIZE | | SIZE |

LEGEND

| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|-----------|--------------|
| ● | HMLP-1 | 2 | 99.4 |
| ■ | OHS-3 | 2 | 93.8 |
| ◆ | OHS-1 | 2 | 100.4 |
| ▲ | OHS-5 | 2B (LENS) | 99.4 |
| ▽ | NRW7-1 | 3 | 93.1 |
| ○ | MO-08B | 3A | 97.7 |
| □ | NRW7-1 | 6 | 90.8 |

Project Number: 1662333

Checked By: SMM

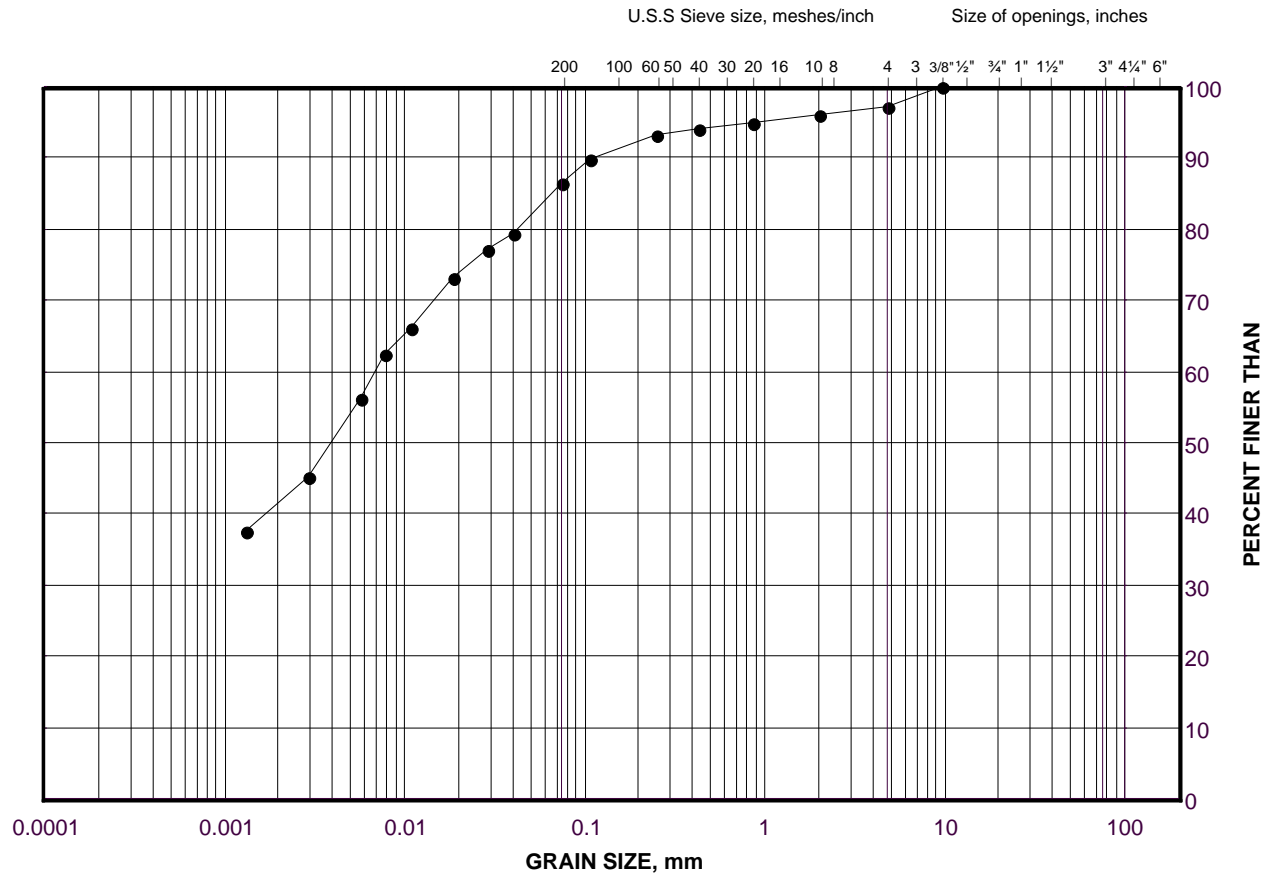
Golder Associates

Date: 12-Nov-18

GRAIN SIZE DISTRIBUTION

Silty Clay (Fill)

FIGURE C-2



| | | | | | | | |
|---------------------|--|-----------|--------|--------|-------------|--------|--------|
| SILT AND CLAY SIZES | | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE |
| FINE GRAINED | | SAND SIZE | | | GRAVEL SIZE | | SIZE |

LEGEND

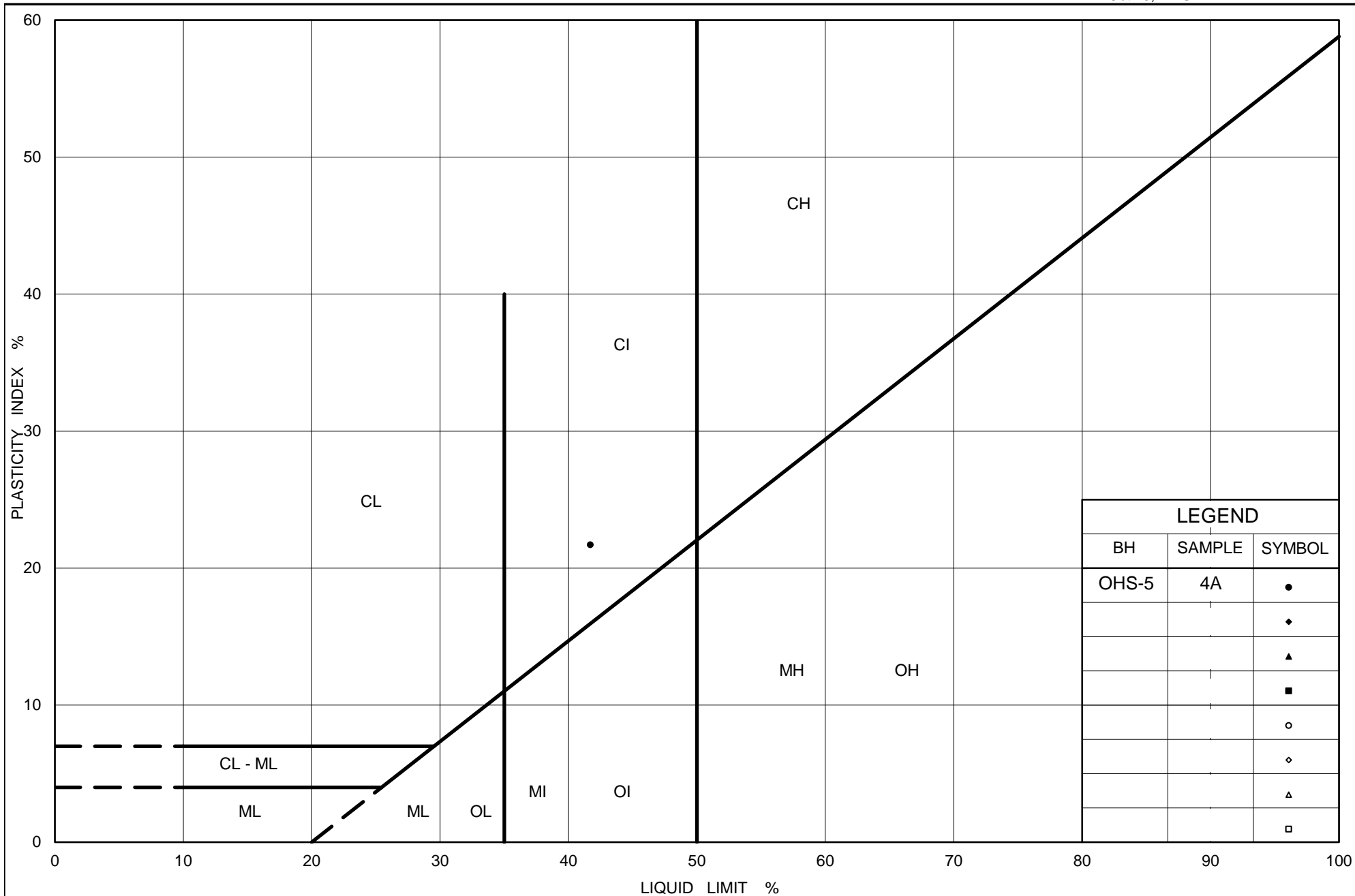
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| • | OHS-5 | 4A | 98.1 |

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 12-Nov-18



Ministry of Transportation

Ontario

PLASTICITY CHART

Silty Clay (Fill)

Figure No. C-3

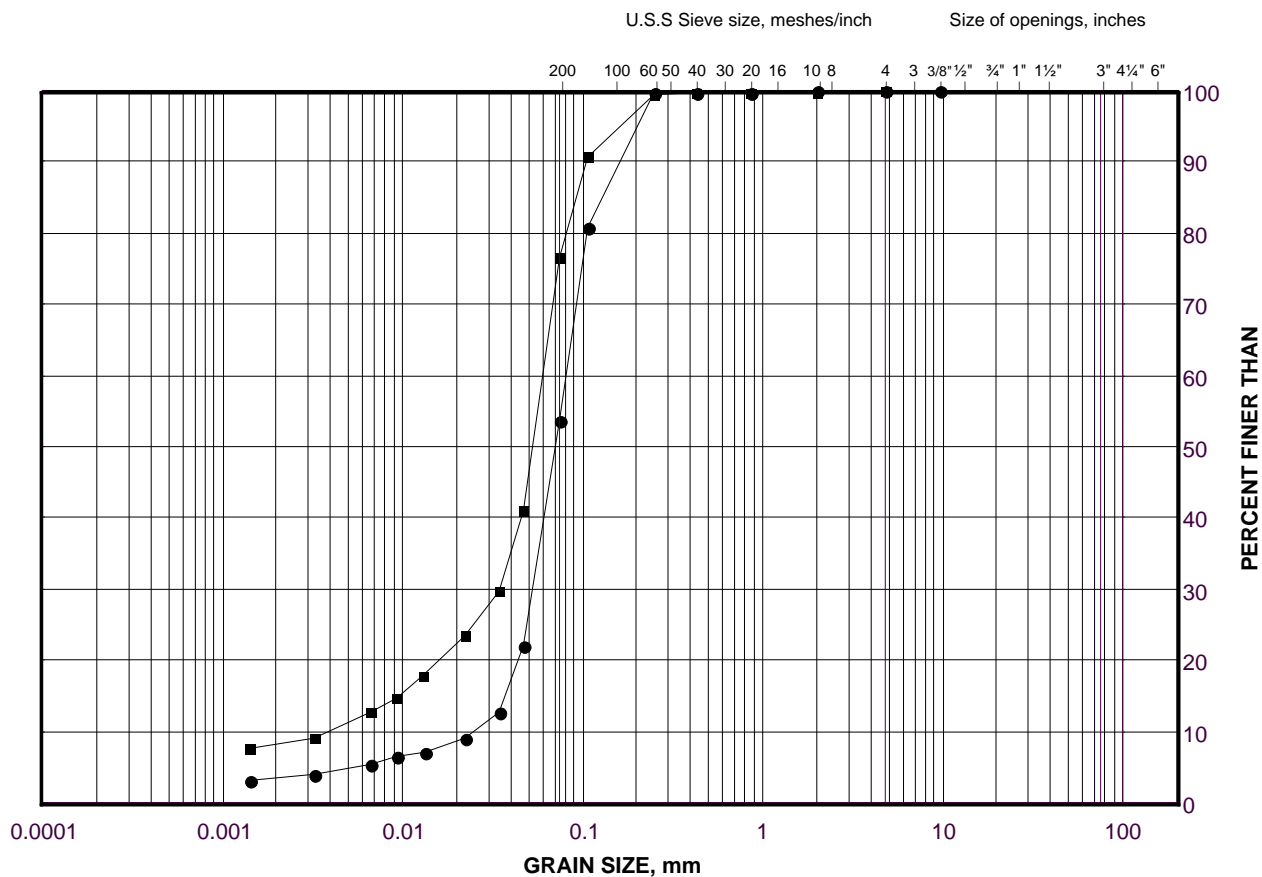
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sandy Silt to Silt and Sand

FIGURE C-4



| | | | | | | | |
|---------------------|--|-----------|--------|--------|-------------|--------|--------|
| SILT AND CLAY SIZES | | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE |
| FINE GRAINED | | SAND SIZE | | | GRAVEL SIZE | | SIZE |

LEGEND

| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | OHS-3 | 5 | 91.6 |
| ■ | OHS-3 | 7 | 90.1 |

Project Number: 1662333

Checked By: SMM

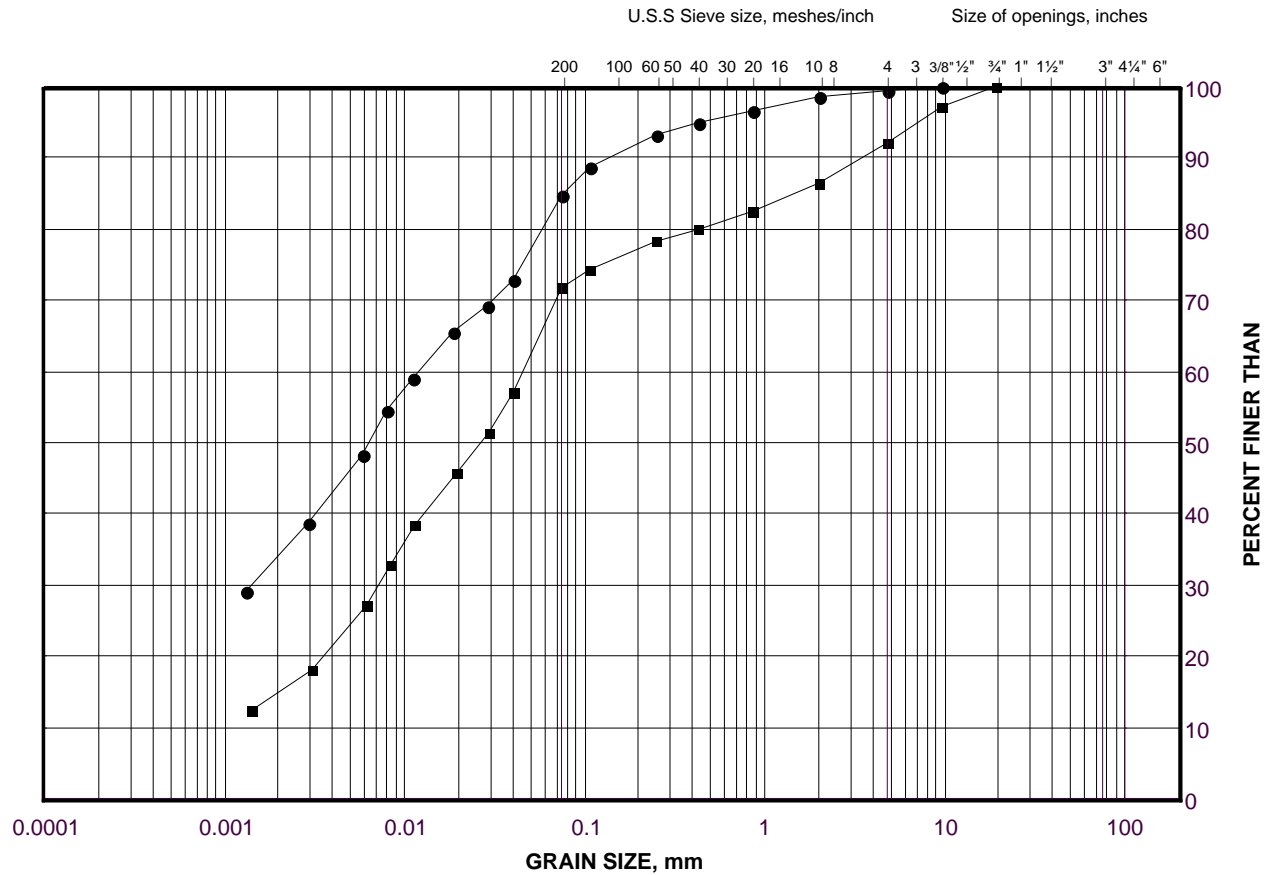
Golder Associates

Date: 12-Nov-18

GRAIN SIZE DISTRIBUTION

Clayey Silt to Silty Clay

FIGURE C-5



| | | | | | | | |
|---------------------|--|-----------|--------|--------|-------------|--------|----------------|
| | | | | | | | |
| SILT AND CLAY SIZES | | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | | SAND SIZE | | | GRAVEL SIZE | | |

LEGEND

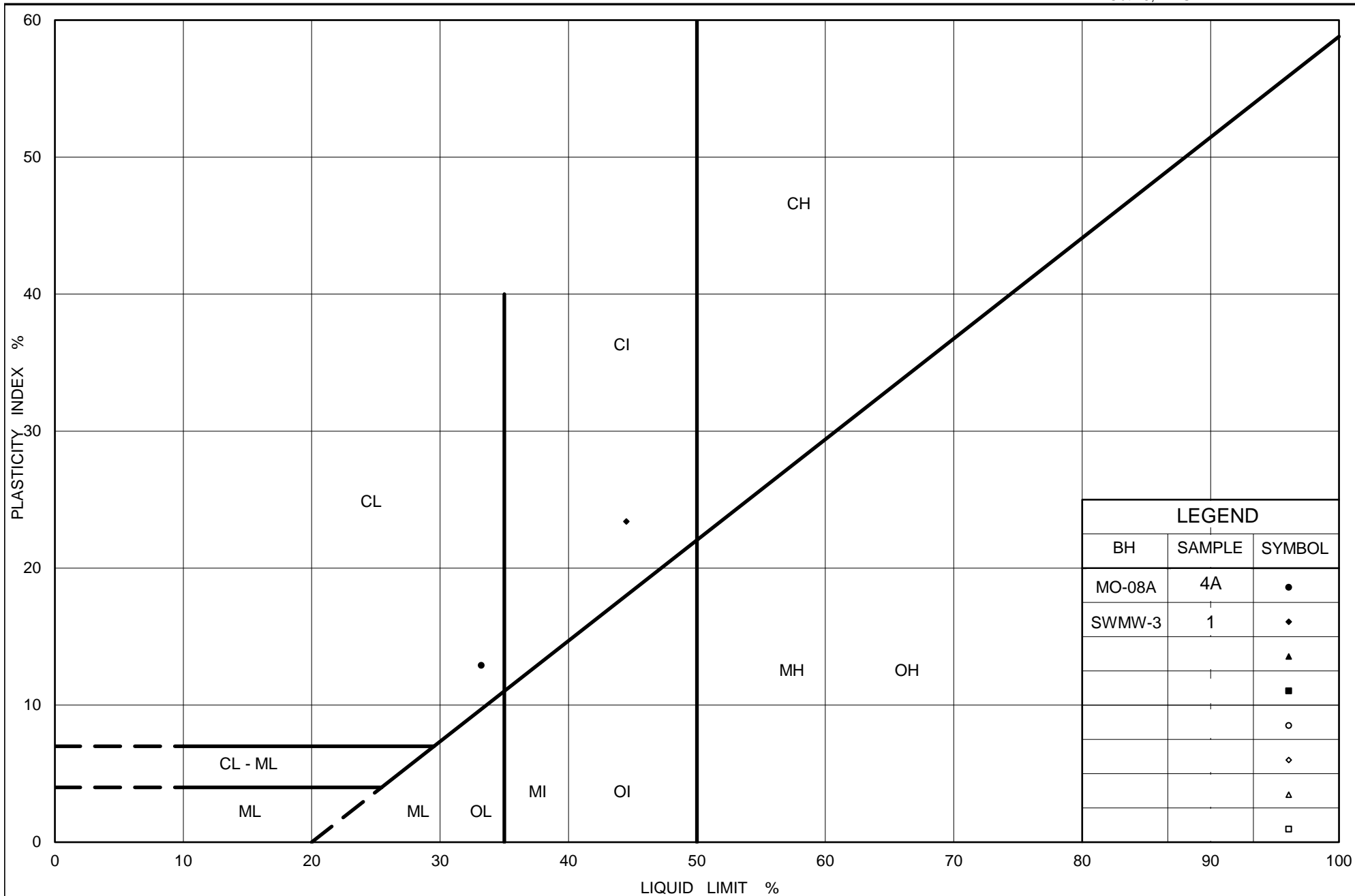
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | SWMW-3 | 1 | 99.1 |
| ■ | MO-08A | 4A | 96.9 |

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 12-Nov-18



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt to Silty Clay

Figure No. C-6

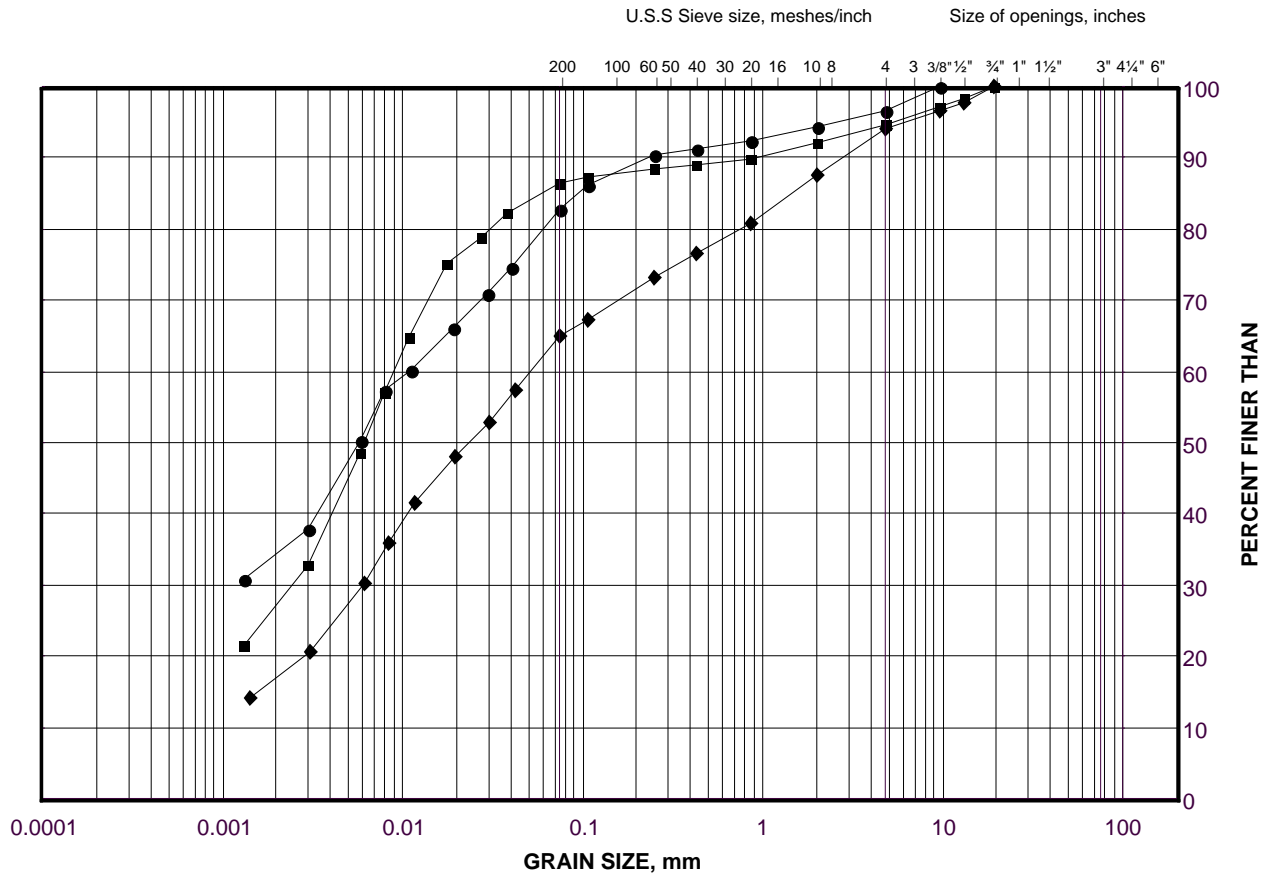
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Silty Clay (Till)

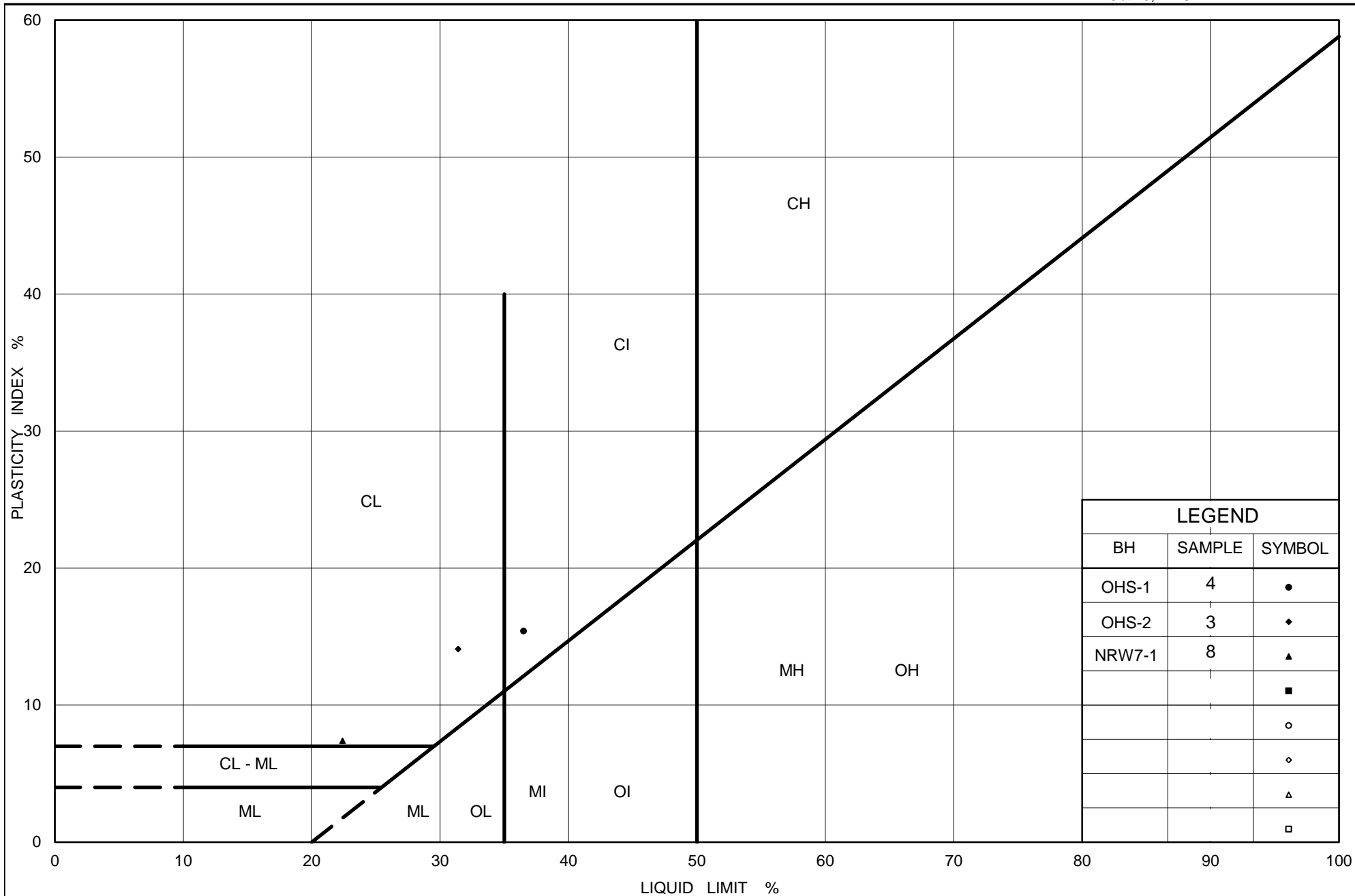
FIGURE C-7



| | | | | | | | |
|---------------------|--|-----------|--------|--------|-------------|--------|--------|
| SILT AND CLAY SIZES | | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE |
| FINE GRAINED | | SAND SIZE | | | GRAVEL SIZE | | SIZE |

LEGEND

| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | OHS-2 | 3 | 98.8 |
| ■ | OHS-1 | 4 | 99.0 |
| ◆ | NRW7-1 | 8 | 88.5 |



Ministry of Transportation

Ontario

PLASTICITY CHART Sandy Clayey Silt to Silty Clay (Till)

Figure No. C-8

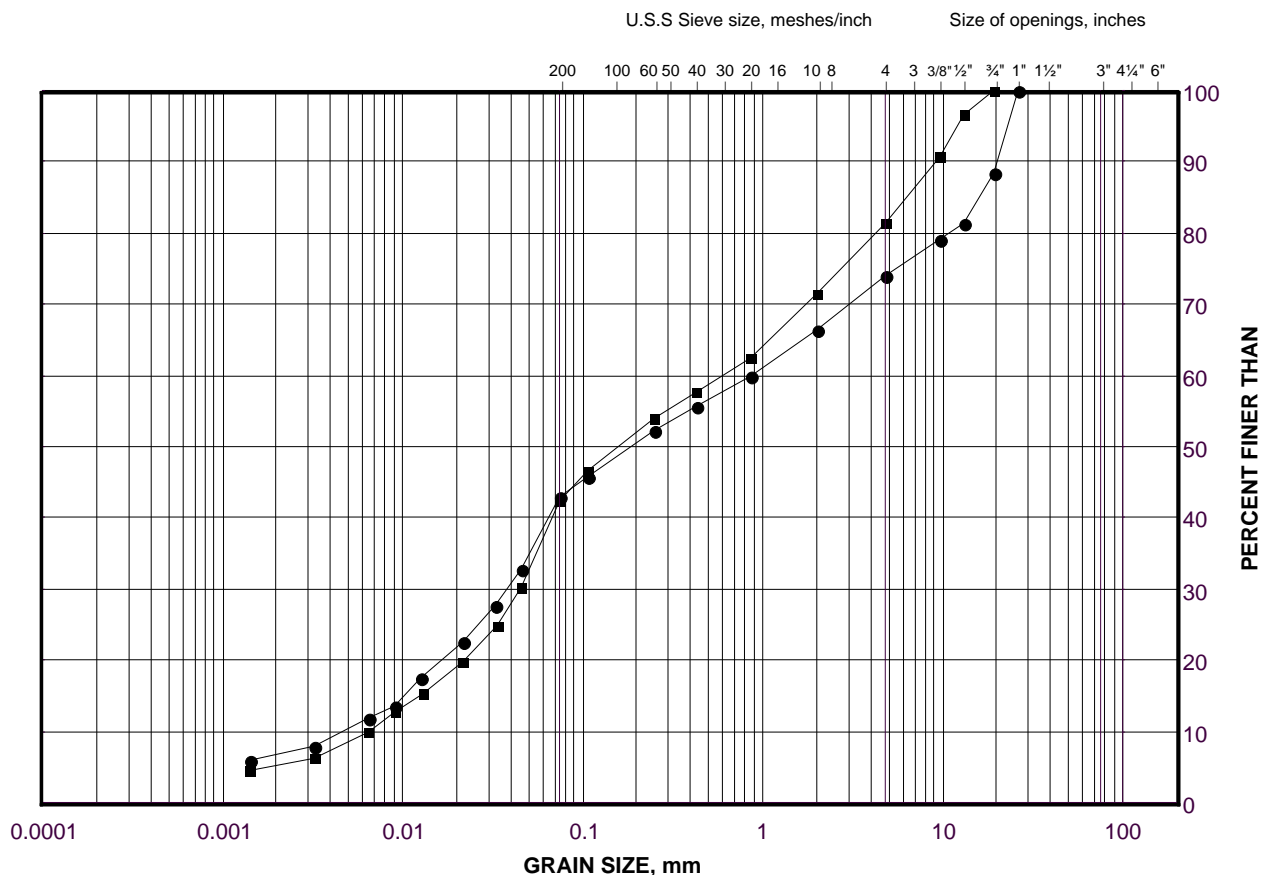
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Silt and Sand to Gravelly Silt and Sand (Till)

FIGURE C-9



| | | | | | | | |
|---------------------|--|-----------|--------|--------|-------------|--------|--------|
| SILT AND CLAY SIZES | | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE |
| FINE GRAINED | | SAND SIZE | | | GRAVEL SIZE | | SIZE |

LEGEND

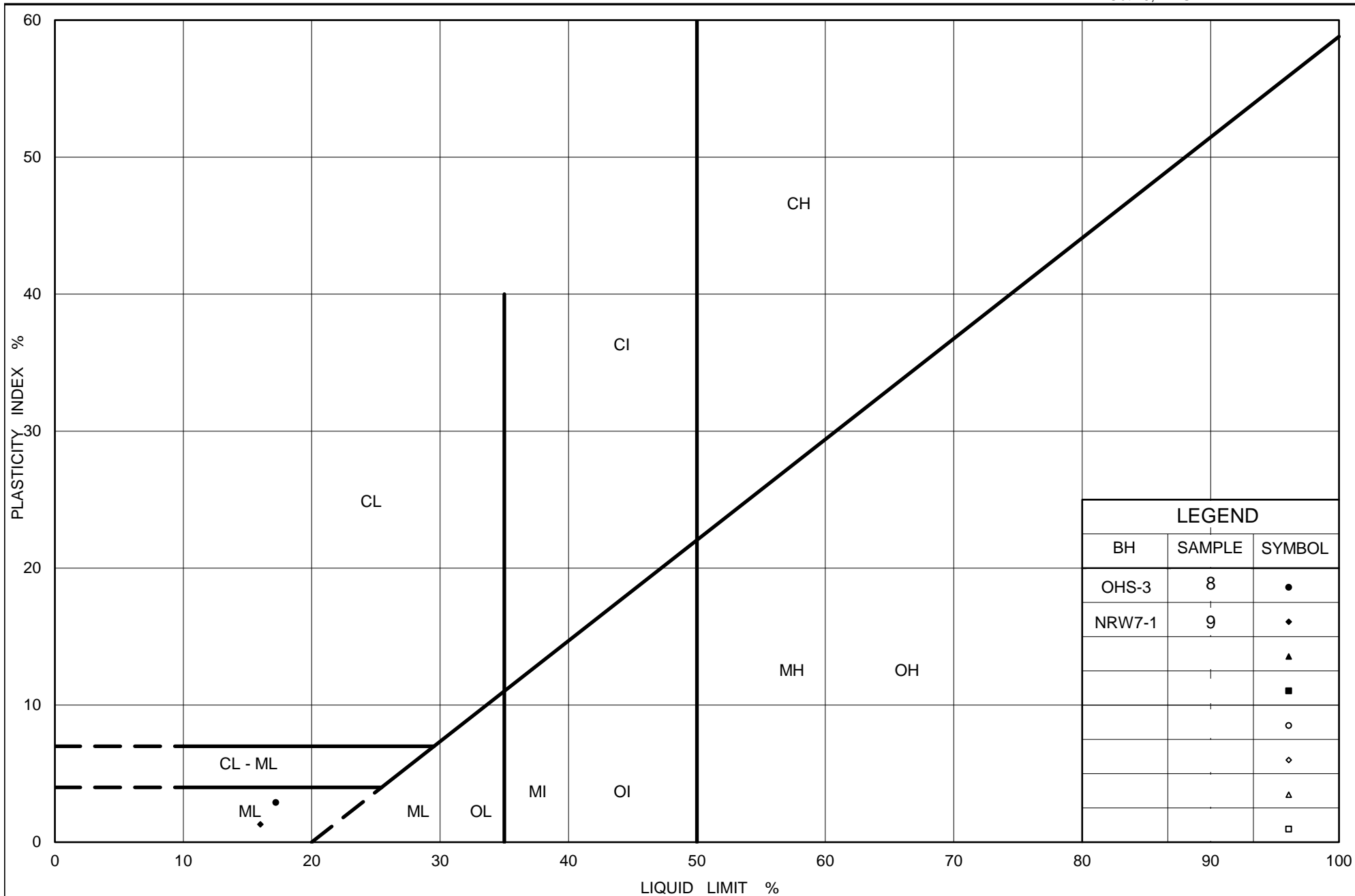
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | OHS-3 | 8 | 88.6 |
| ■ | NRW7-1 | 9 | 87.3 |

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 12-Nov-18



Ministry of Transportation

Ontario

PLASTICITY CHART Silt and Sand to Gravelly Silt and Sand (Till)

Figure No. C-10

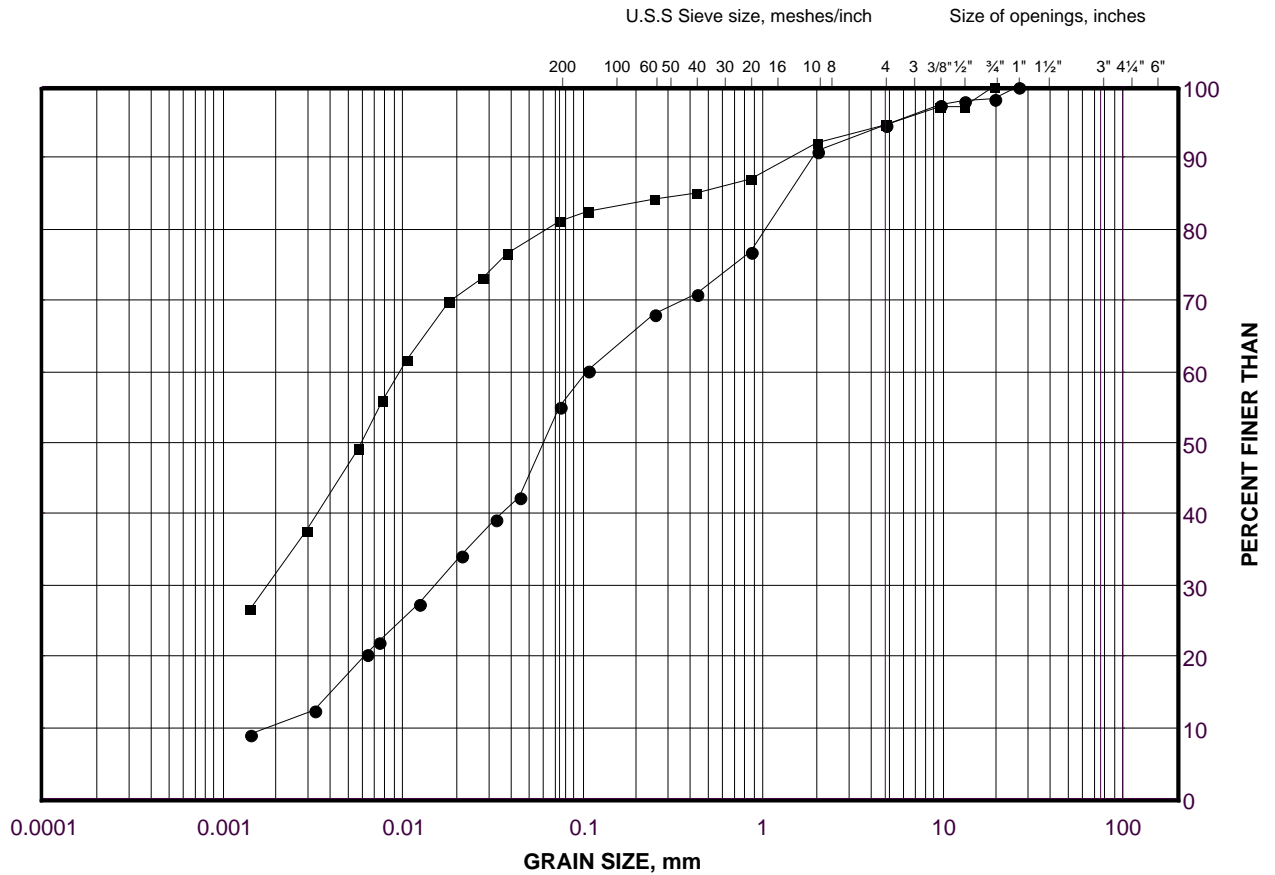
Project No. 1662333

Checked By: SMM

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand to Silty Clay (Residual Soil)

FIGURE C-11



| | | | | | | | |
|---------------------|--|-----------|--------|--------|-------------|--------|----------------|
| | | | | | | | |
| SILT AND CLAY SIZES | | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | | SAND SIZE | | | GRAVEL SIZE | | |

LEGEND

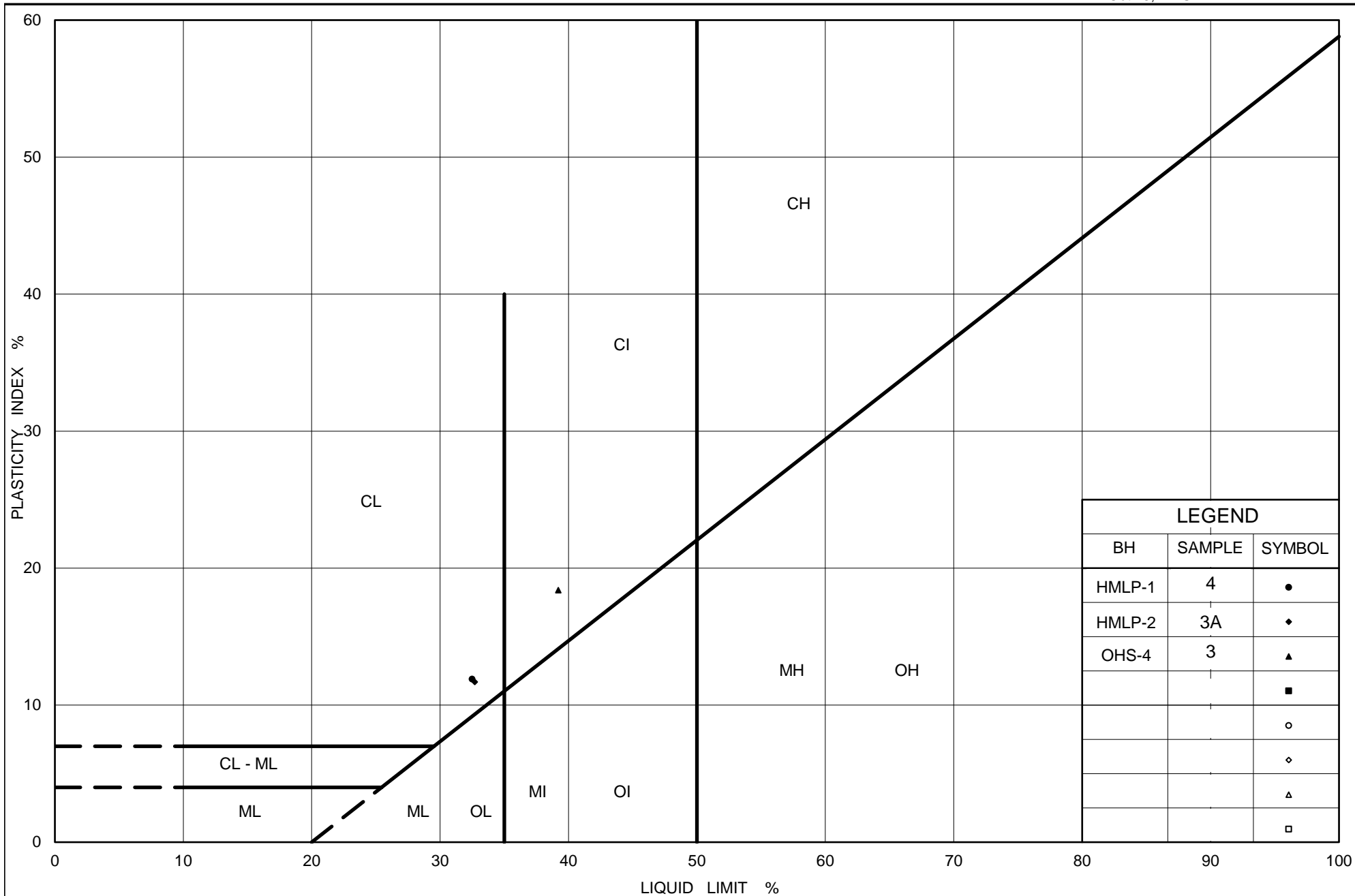
| SYMBOL | Borehole | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| ● | HMPL-2 | 2B/2C | 97.9 |
| ■ | OHS-4 | 3 | 95.8 |

Project Number: 1662333

Checked By: SMM

Golder Associates

Date: 12-Nov-18



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt with Sand to Silty Clay(Residual Soil)

Figure No. C-12

Project No. 1662333

Checked By: SMM

August 27, 2018

Mr. David Marmor
Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario
Canada L5N 7K2

Re: UCS only and UCS + E testing
(Golder Project No. 1662333)

Dear Mr. Marmor:

On July 31, 2018 and August 17, 2018 seven (7) and six (6) HQ-sized core samples were received by Geomechanica Inc. via drop-off by Golder personnel, respectively. These samples were identified as being from boreholes drilled as part of Golder project 1662333. A total of 13 uniaxial compressive strength (UCS) specimens were prepared and tested from these samples. The tangent elastic modulus was measured for 5 of these 13 tests.

Details regarding the steps of specimen preparation and testing along with the test results and specimen photographs before and after testing are presented in the accompanying laboratory report.

Sincerely,



Bryan Tatone Ph.D., P. Eng.

Geomechanica Inc.
Tel: (647) 478-9767
Email: bryan.tatone@geomechanica.com

Rock Laboratory Testing Results

A report submitted to:

David Marmor
Golder Associates Limited
6925 Century Avenue, Suite #100
Mississauga, Ontario
Canada L5N 7K2

Prepared by:

Bryan Tatone, PhD, PEng
Omid Mahabadi, PhD, PEng
Geomechanica Inc
#900-390 Bay St
Toronto ON
M5H 2Y2 Canada
Tel: +1-647-478-9767
info@geomechanica.com

August 27, 2018

Project number: 1662333

Abstract

This document summarizes the results of rock laboratory testing of 13 uniaxial compressive strength (UCS) tests. Results, including uniaxial compressive strength (UCS) and Young's modulus (for select samples) along with photographs of samples before and after testing are presented. Additional specimen information is included in an accompanying summary spreadsheet.

In this document:

| | | |
|---|---|---|
| 1 | Uniaxial Compressive Strength (UCS) testing | 1 |
|---|---|---|

1 Uniaxial Compressive Strength (UCS) testing

This report summarizes the results of 13 uniaxial compressive strength (UCS) tests. The testing was performed in Geomechanica's rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.15 mm/min for shale and 0.075 mm/min for limestone samples (Figure 1). This displacement rate was selected to target specimen failure to occur within 2 - 15 minutes.

The specimen preparation and testing procedure included the following:

1. Unwrapping of the core sample, inspecting it for damage, and re-wrapping it in electrical tape to minimize exposure to moisture during subsequent specimen preparation.
2. Diamond cutting of core sample to obtain a cylindrical specimen with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding of specimen to obtain flat (within ± 0.025 mm) and parallel end faces (within 0.25°).
4. Placement of the specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axial loading to rupture while continuously recording axial force and axial deformation to determine the peak strength (UCS) and (tangent) Young's modulus (E) for select samples.



Figure 1: UCS test setup.

1.1 Results

The results of the tests are summarized in Table 1. The corresponding stress-strain curves for the uniaxial compression tests are presented in Figure 2 and 3. Young's modulus is the tangent modulus, calculated as the slope of the best fit line through ± 300 data points on either side of the point representing 50.0% of the peak strength. Additional specimen information is included in the accompanying summary spreadsheet.

Table 1: Summary of laboratory test results.

| Sample | Depth (m) | Lithology description | Bulk density ρ (g/cm ³) | UCS (MPa) | Young's Modulus E (GPa) | Failure description |
|--------------|---------------|---|---|--------------|------------------------------|--------------------------------------|
| NRW3-7, SA-1 | 9.57 - 9.71 | Georgian Bay Formation - Shale | 2.596 | 14.4 | 0.68 | Axial splitting ^{1, 2} |
| NWI-2, SA-1 | 5.06 - 5.31 | Georgian Bay Formation - Shale | 2.619 | 23.3 | 1.26 | Inclined shear fracture ² |
| NWI-3, SA-1 | 4.29 - 4.44 | Georgian Bay Formation - Shale with several limestone lenses < 5 mm | 2.601 | 16.8 | - | Localized crushing ² |
| NW5-4, SA-1 | 5.47 - 5.61 | Georgian Bay Formation - Limestone | 2.732 | 196.3 | 60.84 | Inclined shear fracture |
| OHS-1, SA-1 | 5.26 - 5.44 | Georgian Bay Formation - Shale | 2.591 | 13.0 | - | Inclined shear fracture ² |
| OHS-2, SA-1 | 5.38 - 5.49 | Georgian Bay Formation - Shale with 2 limestone layers ≈ 5 mm thick | 2.449 | 23.4 | - | Hourglass failure ^{1, 2} |
| OHS-5, SA-1 | 6.13 - 6.27 | Georgian Bay Formation - Shale | 2.603 | 16.7 | - | Axial splitting ² |
| AR-2, SA-1 | 5.92 - 6.12 | Georgian Bay Formation - Shale | 2.574 | 9.1 | - | Axial splitting ² |
| AR-2, SA-2 | 8.60 - 8.82 | Georgian Bay Formation - Shale | 2.588 | 11.5 | - | Axial splitting ² |
| NW5-1, SA-1 | 4.29 - 4.45 | Georgian Bay Formation - Shale | 2.593 | 13.6 | - | Hourglass failure ² |
| SWME-4, SA-1 | 10.40 - 10.54 | Georgian Bay Formation - Shale | 2.586 | 13.5 | - | Axial splitting ² |
| HMPL-1, SA-1 | 4.81 - 4.96 | Georgian Bay Formation - Shale | 2.573 | 11.8 | 0.50 | Localized crushing ² |
| HMPL-2, SA-1 | 3.70 - 3.85 | Georgian Bay Formation - Shale | 2.594 | 13.7 | 0.88 | Axial splitting ² |

¹ Specimen Length:Diameter ratio < 2 due to short sample length

² Specimen emitted pore water upon loading

1.2 Specimen photographs

Photographs of the specimens before and after testing are presented in Figures 4 to 6.

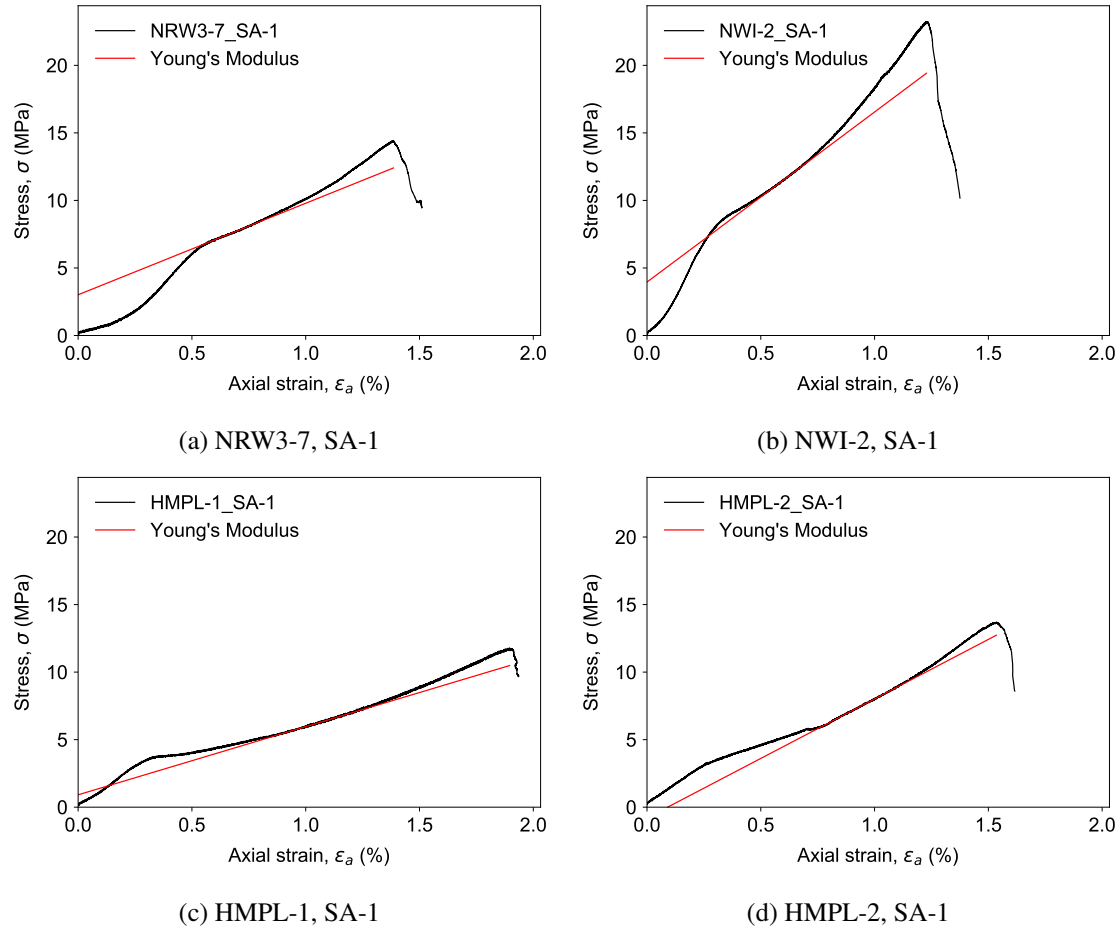
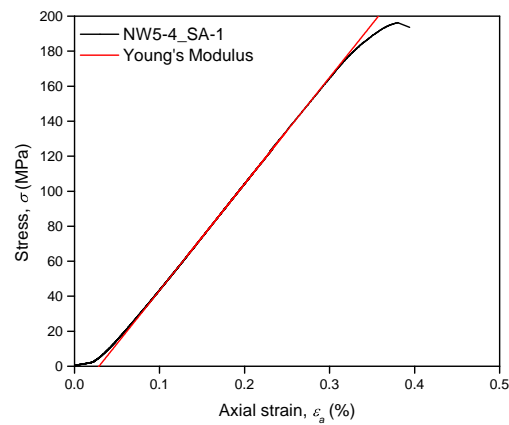


Figure 2: Measured stress-strain curves for shale samples.



(a) NRW5-4, SA-1

Figure 3: Measured stress-strain curves for limestone samples.

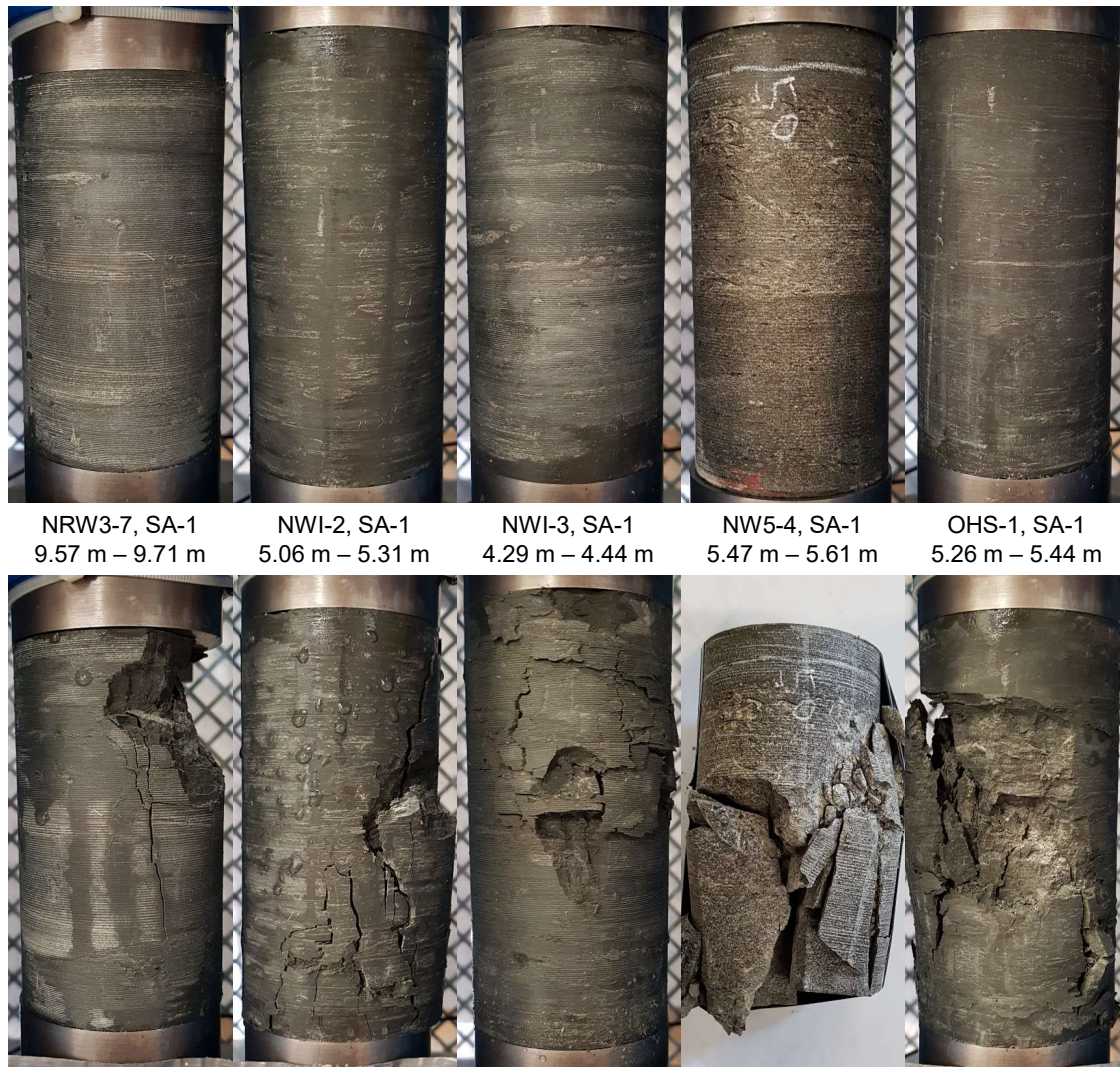


Figure 4: Photographs of specimens before and after testing.

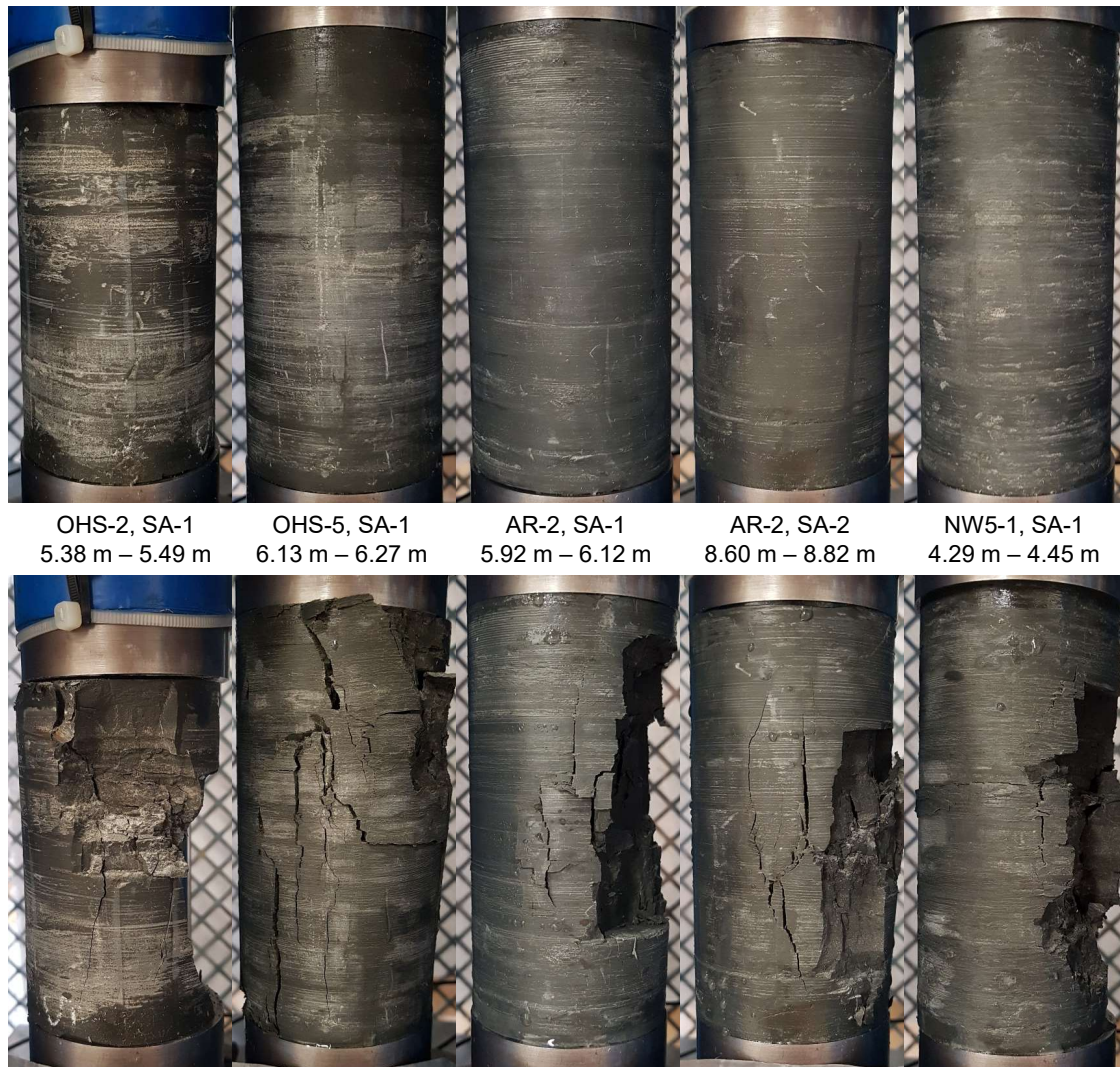


Figure 5: Photographs of failed specimens before and after testing (continued).

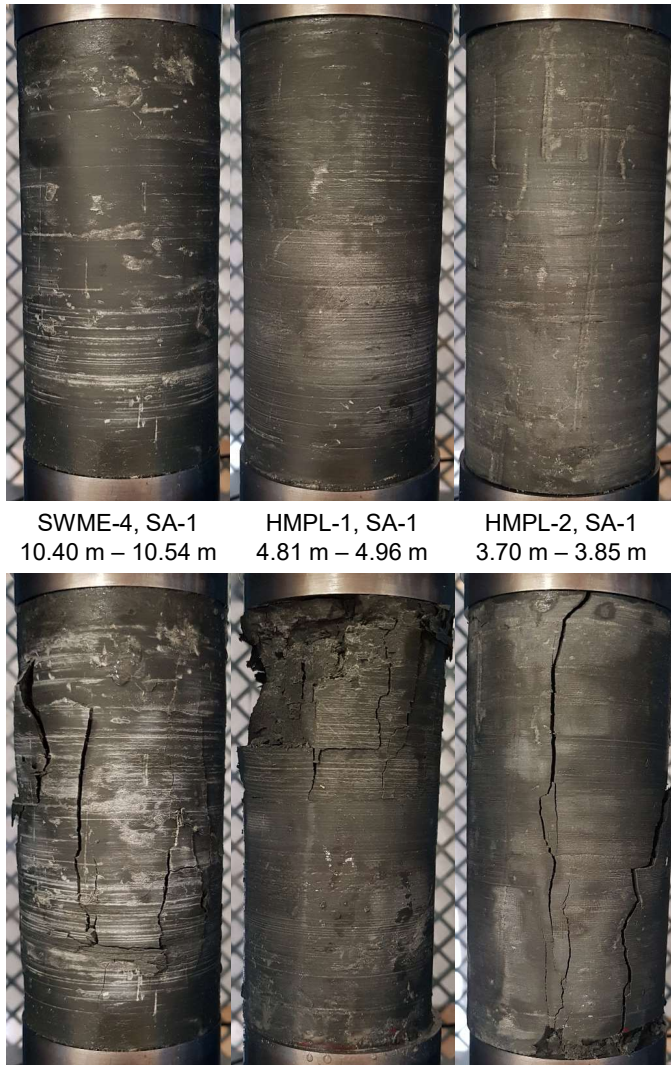


Figure 6: Photographs of failed specimens before and after testing (continued).

APPENDIX D

**Non-Standard Special Provisions
and Notice to Contractor**

DEEP FOUNDATIONS - Item No.

Non-Standard Special Provision

Amendment to OPSS.PROV 903, April 2016

903.01 SCOPE

Section 903.01 of OPSS.PROV 903 is deleted in its entirety and replaced with the following:

This specification covers the requirements for the supply and installation of caisson foundations for the west pier and east pier foundations of the QEW-Credit River bridge, the west abutment of the East-West Active Transport (E-W AT) bridge, the overhead sign supports, high mast light pole foundations and the noise barrier walls foundations.

903.07 CONSTRUCTION

Section 903.07.03.02.01 of OPSS.PROV 903 is amended by the addition of the following:

Section 903.07.03.02.01 General

Pre-augering/pre-coring for caissons for the west abutment for the E-W AT bridge, overhead sign supports, high mast light pole foundations and noise barrier walls will extend through granular and cohesive fills, native soils and into the shale bedrock at some locations. The overburden soil could slough (if dry) or flow (if water-bearing) into unsupported augers holes during caissons installation. The shale bedrock, which is weak, contains clay seams and contains strong to very strong interlayers of limestone at varying depths/elevations, may fall into the caisson. Appropriate equipment and construction procedures will be required to penetrate the overburden and penetrate these harder layers of bedrock and advance the caissons to reach the design founding level including the use of temporary or permanent liner to provide support to the overburden soils and minimise ground loss during drilling, caisson installation and concrete placement.

Where caisson foundations are used for support of the Credit River bridge foundation elements, the foundations will extend through the overburden into the shale bedrock, which is weak and which contains clay seams and strong to very strong limestone interlayers at varying depths/elevations. Appropriate equipment and construction procedures will be required to penetrate the overburden and advance sockets into the bedrock to reach the design founding level including the use of permanent liners to provide support to the overburden soils and the weathered bedrock just below the bedrock surface.

The caissons and rock sockets at the Credit River bridge must be constructed in the wet at all times and the rock socket must be maintained in a wet condition up until the time of concreting using tremie methods.

The temporary and permanent liners must be advanced sufficiently into bedrock to prevent the overburden and shale bedrock from falling into the to caisson/rock socket.

Section 903.07.03.03 of OPSS.PROV 903 is amended by the addition of the following:

Section 903.07.03.03 Inspection of the Excavation

Immediately following the completion of the excavation for each caisson (including construction of the rock socket below the bottom of the liner) the wall and base of each caisson shall be thoroughly cleaned by airlift or

other means such that the water issuing from the caisson on pumping is clean and free from silt, rock cuttings and any other material. Every reasonable step shall be taken to remove all loose, clayey/silty/sandy soil and all cuttings and other materials from the caisson and from the walls and base of the rock socket.

Prior to placing concrete using tremie methods the Contractor shall provide the Contract Administrator with conclusive evidence that the wall and base of the rock sockets are free of debris, by a method satisfactory to the Foundation Engineer retained by the Contract Administrator.

Section 903.07.03.07.02 of OPSS.PROV 903 first paragraph is deleted and replaced by the addition of the following:

Section 903.07.03.07.02 Concrete Placed in the Dry

At sites other than the QEW-Credit River bridge and the E-W AT, the caissons shall be advanced / constructed in the dry provided the concrete is placed within the same day that the caisson is cleaned, inspected, otherwise the caisson must be protected and approved, otherwise the caisson must be protected by filling with water on the same day that it is advanced.

Section 903.07.03.07.03 of OPSS.PROV 903 is amended by the addition of the following:

Section 903.07.03.07.03 Concrete Placed Under Water or Under Slurry

Immediately following drilling, cleaning and inspection/approval of the rock socket by a Foundation Engineer the required reinforcement shall be placed and the rock socket shall be concreted using tremie methods not longer than 24 hours following cleaning of the rock socket.

Construction of a rock socket or driving or seating of a steel liner shall not be permitted within 5 m of any caisson concrete which has been placed within the preceding 24 hours.

Section 903.07.03.07.04 of OPSS.PROV 903 is amended by the addition of the following:

Section 903.07.03.07.04 Withdrawal of Liners

The liners at the piers for the Credit River bridge shall not be removed.

OBSTRUCTIONS – Item No.

Notice to Contractor

The Contactor shall be alerted to the potential presence of cobbles, boulders and limestone and shale fragments in the fill and native soils, glacially derived soils and residual soils. Consideration of the presence of these obstructions must be made in the selection of appropriate equipment and procedures for advancing caissons, excavations for shallow foundations, stormwater management pond, overhead sign supports, high mast light pole foundations and culverts, and installation of any temporary protection systems that may be required.

The Contactor is hereby notified that in some areas of the site, and in particular in the general vicinity of the east pier for the Credit River bridge, rip-rap and other cobble and boulder size obstructions are present at and below ground surface. These obstructions may impede or prevent excavation, grading, construction of access roads and/or crane pads and lay-down areas, and the installation of some types of protection systems/cofferdams.

The presence of the above-noted near surface conditions shall be considered by the Contractor in the selection of appropriate equipment and procedures for various activities, including but not limited to excavation, grading, installation of the foundations and installation of cofferdams/protection systems.



golder.com