



July 2015

## REPORT ON

# Foundation Investigation and Design Proposed Replacement of Noise Barrier Wall Highway 417 Westbound from Maitland Avenue to about 350 metres East of Maitland Avenue Ottawa, Ontario GWP 4058-01-00

**Submitted to:**  
MMM Group Limited  
1145 Hunt Club Road, Suite 300  
Ottawa, Ontario  
K1V 0Y3

REPORT



**Geocres Number:** 31G5-267

**Report Number:** 05-1120-210-8000

**Distribution:**

2 copies	-	MMM Group Limited
3 copies	-	Ministry of Transportation, Kingston
1 copy	-	Ministry of Transportation, Downsview
1 copy	-	Golder Associates Ltd.







## Table of Contents

### PART A – FOUNDATION INVESTIGATION REPORT

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION.....</b>	<b>2</b>
<b>3.0 INVESTIGATION PROCEDURES .....</b>	<b>3</b>
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS .....</b>	<b>5</b>
4.1 Regional Geology .....	5
4.2 Site Stratigraphy .....	5
4.2.1 Topsoil and Fill.....	5
4.2.2 Silty Sand and Sand.....	6
4.2.3 Silty Clay to Clay.....	6
4.2.4 Till .....	6
4.2.5 Bedrock.....	7
4.3 Groundwater Conditions .....	7
<b>5.0 CLOSURE.....</b>	<b>8</b>
<b>6.0 ENGINEERING RECOMMENDATIONS.....</b>	<b>9</b>
6.1 General.....	9
6.2 Noise Barrier Wall Foundations .....	9
6.2.1 Construction Considerations .....	10
<b>7.0 CLOSURE.....</b>	<b>11</b>

### LIST OF TABLES

Table 1 – Geotechnical Design Parameters for Noise Barrier Wall

### LIST OF DRAWINGS

Drawing 1 – Noise Barrier Wall Borehole Locations and Soil Strata



---

## FOUNDATION INVESTIGATION AND DESIGN REPORT HIGHWAY 417 NOISE BARRIER WALL - GWP 4058-01-00

---

### APPENDICES

#### APPENDIX A    **Borehole and Drillhole Records, Current Investigation**

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Records of Borehole and Drillhole Sheets 14-1 to 14-5

#### APPENDIX B    **Laboratory Test Results**

Figure B1 – Grain Size Distribution – Fill

Figure B2 – Grain Size Distribution – Weathered Silty Clay to Clay

Figure B3 – Plasticity Chart – Unweathered Silty Clay to Clay

Figure B4 – Grain Size Distribution – Till

#### APPENDIX C    **Record of Borehole, Previous Investigation – GEOCRETS No. 31G5-22**

Records of Borehole 6

#### APPENDIX D    **Non Standard Special Provisions**

Control of Overburden Soils

Socketting Caissons into Bedrock

Boulders/Obstructions during Excavation



# **PART A**

**FOUNDATION INVESTIGATION**

**PROPOSED REPLACEMENT OF NOISE BARRIER WALL**

**HIGHWAY 417 WESTBOUND FROM MAITLAND AVENUE TO ABOUT  
350 METRES EAST OF MAITLAND AVENUE**

**OTTAWA, ONTARIO**

**GWP 4058-01-00**





## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by MMM Group Limited (MMM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services associated with the replacement of a noise barrier wall along Highway 417 in Ottawa, Ontario (GWP 4058-01-00).

This foundation investigation report addresses the proposed replacement of the existing noise barrier wall along the westbound lanes (the north side) of Highway 417 from Maitland Avenue to about 350 m east of Maitland Avenue at the location shown on Drawing 1.

The purpose of the foundation investigation was to assess the subsurface conditions along the alignment of the proposed noise barrier wall replacement based on 5 new boreholes along with one existing borehole.

The Scope of Work for the foundation engineering services is presented in Golder Associates' proposal number 05-1121-210-8000, dated August 28, 2014.



## **2.0 SITE DESCRIPTION**

The noise barrier wall site is located east of the existing Maitland Avenue underpass and along the north side of Highway 417 between about Stations 22+000 and 22+350 in Ottawa, Ontario. Based on information provided by MMM, the roughly 350 m long noise wall will replace the existing wall that has been constructed to separate the south property line of the adjacent residential properties and Highway 417 east of Maitland Avenue. The existing noise barrier consists of a post and panel wall.

The results of a previous geotechnical investigation for the Maitland Avenue overpass at the west end of this site were provided in a report by McRostie Genest St-Louis to De Leuw, Cather and Co. titled 'Foundation Investigation at Queensway and Maitland Avenue, Bridge No. 3', dated July 1958 (GEOCRE number 31G5-22).





### **3.0 INVESTIGATION PROCEDURES**

The field work for this subsurface investigation was carried out between November 25 and 27, 2014, during which time five boreholes (designated as Boreholes 14-1 to 14-5) were advanced along this alignment.

An additional borehole, numbered 14-4A, was initially advanced in the area of Borehole 14-4; however rigid insulation (polystyrene) and fine sand fill were encountered within the first spoon advanced at this location, which were inferred to possibly indicate the close proximity of an existing sewer pipe or other unknown utility. This borehole was therefore terminated and a new borehole, numbered 14-4, was advanced about 1.5 m southwest of the original location. Borehole 14-4A is not discussed further in this report, but the Record of Borehole sheet is provided in Appendix A for general information purposes, and its location is shown on Drawing 1.

The boreholes were advanced using a CME-55 truck-mounted drill rig, supplied and operated by Marathon Drilling of Ottawa, Ontario. Boreholes 14-1, 14-2, and 14-3 were located on the north side of the proposed noise barrier alignment and accessed from private property, while boreholes 14-4 and 14-5 were located on the south side of the proposed alignment and accessed from Highway 417.

The boreholes were advanced to depths ranging from about 6.1 to 8.8 m below the existing ground surface. Soil samples were typically obtained at 0.6 m intervals of depth using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586-08a). In situ vane testing using the MTO “N” vane was carried out where possible in the silty clay to measure the undrained shear strength of this soil. Bedrock was cored in NQ size in Boreholes 14-1, 14-2, 14-4, and 14-5. Borehole 14-3 was terminated at its target depth of 6.1 m without encountering refusal to augering.

Two standpipe piezometers were installed, one in each of Boreholes 14-1 and 14-3, to permit monitoring of the stabilized groundwater levels. The standpipe piezometers each consist of a 32 mm diameter PVC pipe, with a slotted screen sealed within a sand filter pack at a selected depth interval within the boreholes. Above the sand filter pack and piezometer screen, the annulus surrounding the piezometer pipe was backfilled to the ground surface with a mixture of bentonite pellets and native cuttings. The standpipe piezometer installation details and water level readings are indicated on the borehole records contained in Appendix A. All remaining boreholes were backfilled with bentonite and soil cuttings upon completion.

The field work was supervised on a full-time basis by a member of Golder’s technical staff who located the boreholes in the field, observed the drilling, sampling, and in situ testing operations, and logged the subsurface conditions encountered in the boreholes. The soil and bedrock samples were identified in the field, placed in labelled containers and transported to Golder’s laboratory in Ottawa for further examination and laboratory testing. Index and classification tests consisting of water content determinations, Atterberg Limit testing, and grain size distribution analyses were carried out on selected soil samples.

The borehole locations and ground surface elevations (for the current investigation) were surveyed by Golder Associates Ltd. using a Trimble R8 GPS unit. The borehole locations, including MTM NAD83 northing and easting coordinates, and ground surface elevations referenced to Geodetic datum are summarized in the following table and are shown on Drawing 1.



## FOUNDATION INVESTIGATION AND DESIGN REPORT HIGHWAY 417 NOISE BARRIER WALL - GWP 4058-01-00

Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
14-1	5025958.5	363211.3	82.3	8.6
14-2	5026033.5	363271.1	82.1	8.8
14-3	5026093.6	363309.6	82.1	6.1
14-4	5026151.2	363368.8	80.0	7.5
14-4A	5026152.7	363369.3	80.0	1.4
14-5	5026205.3	363412.3	79.9	6.8



## **4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS**

### **4.1 Regional Geology**

The study area for this assignment lies within the minor physiographic region known as the Ottawa Valley Clay Plain, as delineated in *The Physiography of Southern Ontario*<sup>1</sup>, within the major physiographic region of the Ottawa-St. Lawrence Lowland.

The Ottawa Valley Clay Plain region is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock.<sup>2</sup> This region is underlain by a series of sedimentary rocks, consisting of sandstones, dolostones, limestones and shales that are, in turn, underlain by igneous and metamorphic bedrock of the Precambrian Shield.

### **4.2 Site Stratigraphy**

The detailed subsurface stratigraphic conditions encountered in the boreholes advanced during the current investigation, and the results of in situ testing and laboratory index testing are provided on the Record of Borehole and Drillhole sheets contained in Appendix A. The results of the current geotechnical laboratory testing are also presented on Figures B1 to B4 contained in Appendix B. The Record of Borehole sheet for Borehole 6 from a previous investigation (GEOCREC No. 31G5-22) is provided in Appendix C.

An interpreted stratigraphic profile projected along the centreline of the proposed noise barrier wall alignment is shown on Drawing 1. The stratigraphic boundaries shown on the profile and borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions at the location of the proposed Highway 417 noise barrier wall replacement consists of topsoil and fill overlying a discontinuous layer of sand over silty clay and glacial till, which is underlain by limestone bedrock at about 4 to 6 m depth.

A more detailed description of the subsurface conditions encountered in the boreholes advanced at this site is provided in the following sections.

#### **4.2.1 Topsoil and Fill**

A 0.11 to 0.4 m thick surficial layer of topsoil was encountered at all of the borehole locations.

A layer of fill was encountered beneath the topsoil in Boreholes 14-4 and 14-5, about 2.3 and 0.7 m in thickness, respectively. The fill predominantly consists of sand with varying amounts of gravel. The recorded Standard Penetration Test (SPT) 'N' values for this material were 4 and 6 blows per 0.3 m of penetration indicating a loose state of packing.

The results of grain size distribution testing carried out on one sample of the sand and gravel fill from Borehole 14-4 are provided on Figure B1 in Appendix B.

The measured natural water contents of two selected samples of the fill are about 7 and 25 percent.

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

<sup>2</sup> Belanger, J.R. "Urban Geology of Canada's National Capital Area", in *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White, 1998.



#### **4.2.2 Silty Sand and Sand**

A deposit of layered silty sand and sand was encountered below the topsoil in Boreholes 14-1 to 14-3, inclusive. The layered sandy deposit ranges in thickness from about 0.3 to 1.1 m.

The recorded SPT 'N' values for this material were 8 and 14 blows per 0.3 m of penetration indicating a loose to compact state of packing.

The measured natural water contents of one sample of the silty sand and the sand each are about 15 and 3 percent, respectively.

#### **4.2.3 Silty Clay to Clay**

The topsoil, fill, and silty sand to sand, where encountered, are underlain by a deposit of silty clay to clay.

The upper portion of the deposit in Boreholes 14-1, 14-2, 14-3, and 14-5 has been weathered to a grey brown crust that is about 1.2 to 2.5 m thick. The entire 3.2 m thickness of the silty clay encountered in Borehole 6 is also weathered. The recorded SPT 'N' values for this material range from about 'weight of hammer' to 18 blows per 0.3 m of penetration. In situ vane testing in this material measured undrained shear strengths ranging from about 86 to 'in excess of 100' kilopascals in Borehole 6. These results indicate that the weathered silty clay to clay generally has a stiff to very stiff consistency.

The results of grain size distribution testing carried out on one sample of the weathered silty clay to clay from Borehole 14-3 are provided on Figure B2 in Appendix B. The measured natural water contents of two selected samples of the weathered silty clay to clay range between 35 and 40 percent.

The silty clay to clay below the depth of weathering, and the full depth of the clayey deposit in Borehole 14-4, is grey in colour. The grey clay deposit was fully penetrated in Boreholes 14-1, 14-2, 14-4, and 14-5 and extends to depths of about 3.5 to 4.7 m below the existing ground surface (i.e., Elevations of 77.9 to 76.4 m). The unweathered portion of this deposit was not fully penetrated in Borehole 14-3 but was proven to a depth of about 6.1 m below the ground surface (i.e., Elevation 76.0 m).

In situ vane testing in this material measured undrained shear strengths ranging from about 38 to 90 kilopascals. These results indicate that the unweathered silty clay to clay generally has a firm to stiff consistency.

The results of Atterberg limit testing on three samples of the silty clay to clay indicate a plasticity index which ranges from about 26 to 43 percent and liquid limits ranging from about 45 to 62 percent. These results are provided on Figure B3 in Appendix B and indicate that the deposit is a silty clay to clay of intermediate to high plasticity.

The measured natural water contents of selected samples of the grey silty clay to clay range from about 50 to 57 percent which is generally near the measured liquid limit.

#### **4.2.4 Till**

At Boreholes 14-1, 14-2, 14-4, 14-5, and 6 the silty clay is underlain by a thin deposit of glacial till. The till in the area generally consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of silty sand, with trace to some clay, to clayey silt. The till was fully penetrated in the boreholes, where encountered, and ranges in thickness from about 0.3 to 1.2 m.



## FOUNDATION INVESTIGATION AND DESIGN REPORT HIGHWAY 417 NOISE BARRIER WALL - GWP 4058-01-00

The recorded SPT 'N' values in the till range from about 1 to 'greater than 100' blows per 0.3 m of penetration indicating a very loose to very dense state of packing. The higher blow counts may reflect the presence of cobbles and boulders in the glacial till rather than the state of packing of the soil matrix.

The results of grain size distribution testing carried out on two samples of the till, one each from Boreholes 14-1 and 14-4, are provided on Figure B4 in Appendix B. The measured natural water contents of two select samples of the till are about 6 and 9 percent.

### 4.2.5 Bedrock

Bedrock was encountered beneath the till deposit at Boreholes 14-1, 14-2, 14-4, 14-5, and 6. The bedrock was cored for lengths between 3.0 and 3.3 m. The following table summarizes the bedrock surface depths and elevations as encountered at the borehole locations.

Borehole Number	Existing Ground Surface Elevation (m)	Depth to Bedrock (m)	Bedrock Surface Elevation (m)
14-1	82.3	5.6	76.7
14-2	82.1	5.5	76.6
14-4	80.0	4.4	75.6
14-5	79.9	3.8	76.1
6	82.3	4.9	77.4

The bedrock encountered in the boreholes generally consists of fresh, grey, medium strong, limestone with calcite and shale partings. The Rock Quality Designation (RQD) values measured on the recovered limestone bedrock core samples range from about 57 to 100 percent, indicating fair to excellent quality rock.

### 4.3 Groundwater Conditions

The water levels measured in the standpipe piezometers are summarized in the table below. In addition, measurements taken within Borehole 6 from the previous investigation are also shown.

Borehole Number	Existing Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)	Type of Reading	Date of Reading
14-1	82.3	3.2	79.1	Standpipe Piezometer	December 18, 2014
14-3	82.1	3.9	78.2	Standpipe Piezometer	December 18, 2014
6	82.3	0.9	81.4	Open hole	May 14, 1958

It should be noted that groundwater levels in the area are expected to fluctuate both seasonally and with precipitation events.



## 5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Kim Lesage, P.Eng., and reviewed by Mr. Bill Cavers, P.Eng., a senior geotechnical engineer and Associate with Golder. Mr. Fin Heffernan, P.Eng., Golder's Designated MTO Foundations Contact for this project, conducted an independent quality review of the report.

### GOLDER ASSOCIATES LTD.



Bill Cavers, P.Eng.  
Associate, Geotechnical Engineering



Fintan Heffernan, P.Eng.  
Designated MTO Contact

WAM/KSL/WC/FJH/ob

n:\active\2005\1120\geotechnical\05-1120-210 mrc hwy 417 bridges mailand to island park drive\phase 8000 noise barrier wall - signs - trenchless\report\final\05-1120-210-8000 rpt-001 draft april 2015.docx



# **PART B**

## **FOUNDATION DESIGN**

### **PROPOSED REPLACEMENT OF NOISE BARRIER WALL**

#### **HIGHWAY 417 WESTBOUND FROM MAITLAND AVENUE TO ABOUT 350 METRES EAST OF MAITLAND AVENUE**

#### **OTTAWA, ONTARIO**

#### **GWP 4058-01-00**







## **6.0 ENGINEERING RECOMMENDATIONS**

### **6.1 General**

This section of the report provides foundation design recommendations for the proposed noise barrier wall replacement along and north of Highway 417 and east of Maitland Avenue, between about Stations 22+000 and 22+350, in Ottawa, Ontario. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the current and previous subsurface investigations in the vicinity of the proposed noise barrier wall alignment.

The interpretation and recommendations herein are intended to provide the designers with sufficient information to assess the feasible foundation alternatives and to design the proposed structure foundations. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project and for which special provisions or operational constraints 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 it may affect equipment selection, proposed construction methods, scheduling and the like.

### **6.2 Noise Barrier Wall Foundations**

The current plans for this project are to construct a new, roughly 350 m long noise barrier wall on the north side of Highway 417, from Maitland Avenue to about 350 m east of Maitland Avenue. Given the subsurface conditions encountered at the site and the variable bedrock surface elevation (i.e., between 75.6 and 77.4 m), it is understood that the noise barrier wall will be supported using augered caissons, typically 0.6 m to 0.9 m in diameter.

The noise barrier wall foundations should be designed and constructed in accordance with Ontario Provincial Standard Specification (OPSS) 760 (Noise Barrier Systems). As specified in Section 760.04.01.01 of OPSS 760, the depth of footings shall be in accordance to CAN/CSA-S6, Canadian Highway Bridge Design Code. Geotechnical design parameters for design of the caisson foundations are provided in Table 1 following the text of this report, based on the soil conditions encountered along the proposed noise barrier wall alignment. The stratigraphy presented in Table 1 has been simplified for the purposes of the noise barrier wall foundation design.

Where both an undrained shear strength,  $c_u$ , and an effective friction angle,  $\phi'$ , have been given for a specific stratum, the caisson design should be checked for both the drained and the undrained condition, and the larger of the two calculated caisson depths shall govern. The effective unit weight,  $\gamma'$ , should be used below the groundwater table, where:

$$\gamma' = \gamma - 10 \text{ kN/m}^3$$

For foundation design, full passive resistance will be mobilized only where the width of soil in front or behind the caissons is equal to or greater than eight caisson diameters. This condition may not be met in the case where downward sloping ground is present adjacent to the noise barrier wall. If there is lesser width of soil for development of passive resistance, the magnitude of the passive resistance may be determined by interpolating between zero passive resistance at ground surface and full passive resistance at the depth where the highway



embankment slope face is greater than eight caisson diameters away from the face of the caisson. In addition, the passive resistance in front of the caisson within the upper 1.8 m below ground surface should be neglected to account for frost action.

Where limestone is present, design parameters have been provided similar to that for the overlying till. The use of churn drilling and / or coring will be required to form the socket for caissons installed in the limestone bedrock.

Auger holes for the noise barrier wall foundations will be advanced through fill and cohesionless soils which may be unstable below the groundwater level. The holes should be advanced through these deposits using a liner or fluid support in order to maintain the open hole for the full caisson depth.

In addition, the Contractor's proposed excavation techniques should be able to accommodate removal or breaking up of cobbles, boulders, and/or other obstructions which may be encountered in both the fill and native soils.

Existing utilities should be considered in the design of the noise barrier wall foundations with respect to lateral loading from the caisson foundation at the utility level. Available utility plans indicate that a 900 mm diameter concrete storm sewer is present parallel to and in close proximity to the proposed noise barrier wall alignment east of approximately Station 22+300. Furthermore, rigid insulation (polystyrene) and fine sand fill were encountered at about Station 22+275, which were inferred to possibly indicate the close proximity of an existing sewer pipe or other unknown utility. The presence or absence of existing utilities in that area should be confirmed during design to assess any potential impacts. If required, provision could be made for deepening of the caisson foundations, protection of the utility, and/or realignment of the utility (if present) or noise barrier wall.

### **6.2.1 Construction Considerations**

Caisson construction for the noise barrier wall foundations will generally require excavation through topsoil, fill, silty sand to sand, silty clay to clay, and till, into the underlying limestone bedrock. The overburden soils could be susceptible to disturbance during caisson excavation and construction. The use of a temporary liner to advance the holes within overburden soils is recommended, in order to minimize caving and protect the integrity of the caisson excavations during drilling and concrete placement. It is recommended that a Non Standard Special Provision (NSSP) be included in the Contract Documents to advise the Contractor of this condition since it may affect the installation of the noise barrier wall foundations. A sample NSSP is provided in Appendix D.

The limestone bedrock will be resistant to auger advance. The use of churn drilling and/or coring will be required to form the socket for caissons installed in the rock. In addition, the Contractor should have appropriate equipment and methods to penetrate through cobbles, boulders and/or other obstructions which may be present in the fill and native soils, if encountered. It is recommended that an NSSP be included in the Contract Documents to warn the Contractor of these conditions since they may affect the installation of the noise barrier wall foundations. A sample NSSP for each condition is provided in Appendix D.

In accordance with OPSS 760, following construction the Quality Verification Engineer shall submit a Certificate of Conformance confirming that the noise barrier wall foundations have been constructed in general conformance with the contract documents.



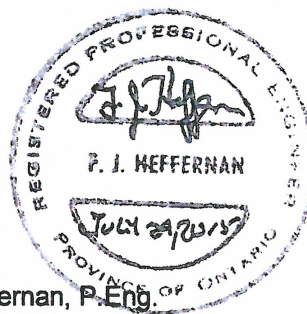
## 7.0 CLOSURE

This Foundation Design Report was prepared by Ms. Kim Lesage, P.Eng., and reviewed by Mr. Bill Cavers, P.Eng., a senior geotechnical engineer and Associate with Golder. Mr. Fin Heffernan, P.Eng., Golder's Designated MTO Foundations Contact for this project, conducted an independent quality review of the report.

### GOLDER ASSOCIATES LTD.



Bill Cavers, P.Eng.  
Associate, Geotechnical Engineer



Fintan Heffernan, P.Eng.  
Designated MTO Contact

WAM/KSL/WC/FJH/ob

n:\active\2005\1120\geotechnical\05-1120-210 mrc hwy 417 bridges maitland to island park drive\phase 8000 noise barrier wall - signs - trenchless\reports\final\05-1120-210-8000 rpt-001 draft april 2015.docx





**FOUNDATION INVESTIGATION AND DESIGN REPORT**  
**HIGHWAY 417 NOISE BARRIER WALL - GWP 4058-01-00**

**Table 1 – Geotechnical Design Parameters for Noise Barrier Wall**  
**Highway 417 – GWP 4058-01-00**

Approximate Station	Approximate Existing Ground Surface Elevation (m)	Reference Boreholes	Stratum	Elevation Interval (m)	Design Parameters <sup>3</sup>					Water Level Elevation (m)
					$c_u$ <sup>1</sup>	$c'$	$\phi'$ <sup>1</sup>	$K_p$ <sup>2</sup>	$\gamma$	
22+000 to 22+120	82.2	6 14-1 14-2	Loose silty sand to sand	Above 80.4	-	-	28	2.8	19	Below 79.1
			Stiff to very stiff silty clay to clay	79.3 to 80.4	75	5	32	3.3	17	
			Firm silty clay to clay	77.4 to 79.3	50	7.5	30	3.0	16.5	
			Loose to Dense Till	76.6 to 77.4	-	-	35	3.7	21	
			Limestone bedrock	Below 76.6	-	-	40	3.7	21	
22+120 to 22+270	82.1	14-3	Compact sand	Above 80.6	-	-	28	2.8	19	
			Very stiff silty clay to clay	78.4 to 80.6	75	5	32	3.3	17	
			Firm silty clay to clay	Below 78.4	50	7.5	30	3.0	16.5	
22+270 to 22+350	80.0	14-4 14-5	Loose sand and gravel fill	Above 77.6	-	-	28	2.8	19	
			Firm silty clay to clay	76.4 to 77.6	50	7.5	30	3.0	16.5	
			Loose Till	75.6 to 76.4	-	-	35	3.7	21	
			Limestone bedrock	Below 75.6	-	-	40	3.7	21	

**Notes:**  $c_u$  = Undrained shear strength of soil (kPa);

$c'$  = Cohesion (kPa);

$\phi'$  = Effective angle of friction in soil (degrees), internal angle of friction in rock (degrees);

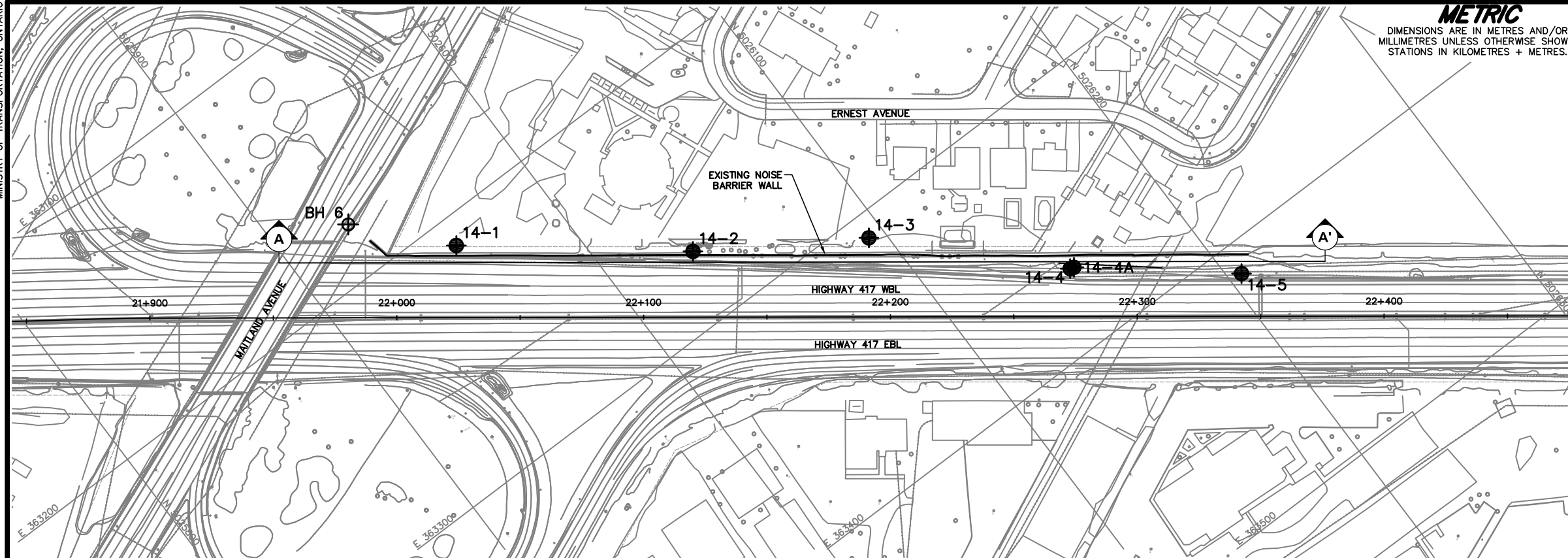
$K_p$  = Coefficient of passive earth pressure; and,

$\gamma$  = Bulk unit weight of soil (kN/m<sup>3</sup>).

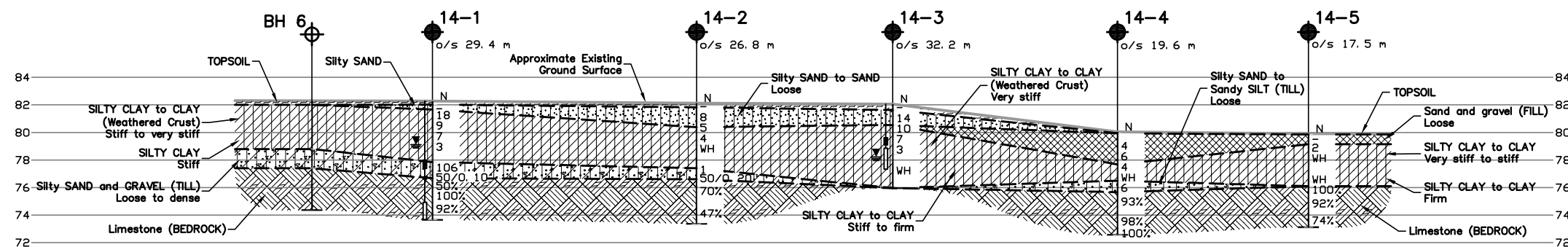
- Where both  $c_u$  and  $\phi'$  have been given for a specific stratum, the foundation design should be checked for both the undrained and the drained conditions, and the larger of the two calculated foundation depths shall govern.
- Passive earth pressure coefficient ( $K_p$ ) values are provided for level ground in front of or behind caissons for a distance  $\geq 8$  diameters. Where downward sloping ground is present adjacent to the composite retaining/noise barrier wall, adjusted  $K_p$  values must be used in the foundation design.
- The passive resistance in front of the caisson within the upper 1.8 m below ground surface should be neglected to account for frost action.







**PLAN**  
SCALE  
20 0 20 40 m



**SECTION A-A'**  
HORIZ. SCALE 20 0 20 40 m  
VERT. SCALE 4 0 4 8 m

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

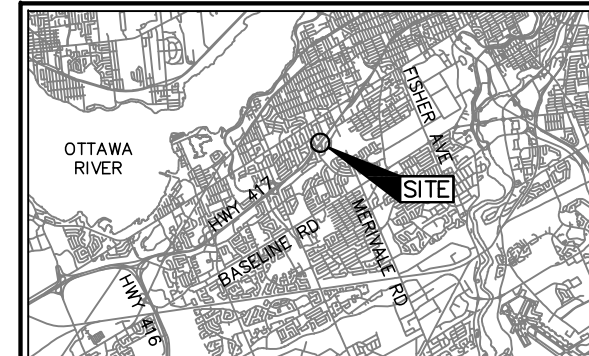
**CONT No.**  
**WP No. 4058-01-00**



**SHEET**



**Golder Associates Ltd.**  
OTTAWA, ONTARIO, CANADA



### LEGEND

- Borehole - Current Investigation
- ⊕ Borehole - Previous Investigation (Geocres No. 31G5-22)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer
- 100% Total Core Recovery (REC)
- ⬮ Seal
- ⬮ Piezometer

### BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
14-1	82.3	5025958.5	363211.3
14-2	82.1	5026033.5	363271.1
14-3	82.1	5026093.6	363309.6
14-4	80.0	5026151.2	363368.8
14-4A	80.0	5026152.7	363369.3
14-5	79.9	5026205.3	363412.3
BH 6	82.3	5025928.7	363178.1

### NOTES

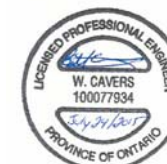
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

### REFERENCE

Base plan provided in digital format by MMM Group, drawing file No. 06320-C5-XB1.dwg, received December 19, 2014.



NO.	DATE	BY	REVISION
1	12/19/14	JM	Base plan provided in digital format by MMM Group, drawing file No. 06320-C5-XB1.dwg, received December 19, 2014.
2	07/24/15	JM	Revised borehole locations and soil strata data.

Geocres No. 31G5-267

HWY. 417	PROJECT NO. 05-1120-210	DIST.
SUBM'D. KSL	CHKD. KSL	DATE: 4/13/2015
DRAWN: JM	CHKD. WC	APPD. FJH
DWG. 1		







# **APPENDIX A**

**Lists of Abbreviations and Symbols**

**Lithological and Geotechnical Rock Description Terminology**

**Records of Borehole and Drillhole Sheets, Current Investigation**



## 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		III. SOIL DESCRIPTION		
AS	Auger sample	(a) Cohesionless Soils		
BS	Block sample	Density Index (Relative Density)	N	
CS	Chunk sample		Blows/300 mm	
DO or DP	Seamless open-ended, driven or pushed tube samplers		Or Blows/ft.	
DS	Denison type sample		0 to 4	
FS	Foil sample		4 to 10	
RC	Rock core		10 to 30	
SC	Soil core		30 to 50	
SS	Split spoon sampler		over 50	
ST	Slotted tube	(b) Cohesive Soils C <sub>u</sub> or S <sub>u</sub>		
TO	Thin-walled, open			
TP	Thin-walled, piston			
WS	Wash sample			
DT	Dual tube sample			
DD	Diamond drilling			
II. PENETRATION RESISTANCE			Consistency	
				kPa
		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 <sub>p</sub> or PL	Plastic limited	
		w <sub>l</sub> or LL	Liquid limit	
		C	Consolidaiton (oedometer) test	
		CHEM	Chemical analysis (refer to text)	
		CID	Consolidated isotropically drained triaxial test <sup>1</sup>	
		CIU	Consolidated isotropically undrained triaxial tes with porewater pressure measurement <sup>1</sup>	
		D <sub>R</sub>	Relative density	
		DS	Direct shear test	
		G <sub>s</sub>	Specific gravity	
		M	Sieve analysis for particle size	
		MH	Combined sieve and hydrometer (H) analysis	
		MPC	Modified Proctor compaction test	
		SPC	Standard Proctor compaction test	
		OC	Organic content test	
		SO <sub>4</sub>	Concentration of water-soluble sulphates	
		UC	Unconfined compression test	
		UU	Unconsolidated undrained triaxial test	
		V	Field vane test (LV-laboratory vane test)	
		γ	Unit weight	
		Note: <sup>1</sup> Tests which are anisotropically consolidated prior shear are shown as CAD, CAU.		

Standard Penetration Resistance (SPT), N:				
The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split spoon sampler for a distance of 300 mm (12 in.).				
Dynamic Cone Penetration Resistance (DCPT); N<sub>d</sub>:				
The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive an uncased 50 mm (2 in.) diameter, 60<sup>0</sup> 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			
Cone Penetration Test (CPT):				
An electronic cone penetrometer with a 60<sup>0</sup> conical tip and a projected end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q<sub>t</sub>), porewater pressure (u) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.				

## LIST OF SYMBOLS

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

### I. GENERAL

$\pi$	3.1416
$\ln x$	natural logarithm of x
$\log_{10} x$ or $\log x$	logarithm of x to base 10
$g$	acceleration due to gravity
$t$	time
FOS	factor of safety
V	volume
W	weight

### II. STRESS AND STRAIN

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

### III. SOIL PROPERTIES

#### (a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
$\gamma'$	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )
$D_R$	relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) formerly ( $G_s$ )
$e$	void ratio
$n$	porosity
$S$	degree of saturation
*	Density symbol is $\rho$ . Unit weight symbol is $\gamma$ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

#### (a) Index Properties (continued)

$w$	water content
$w_L$ or $LL$	liquid limit
$w_p$ or $PL$	plastic limit
$I_p$ or $PI$	plasticity Index $= (w_L - w_p)$
$w_s$	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 (overconsolidated range)
$C_s$	swelling index
$C_\alpha$	coefficient of secondary consolidation
$m_v$	coefficient of volume change
$c_v$	coefficient of consolidation (vertical direction)
$T_v$	time factor (vertical direction)
$U$	degree of consolidation
$\sigma'_p$	pre-consolidation stress
OCR	overconsolidation ratio $= \sigma'_p / \sigma'_{vo}$

#### (d) Shear Strength

$\tau_p$ or $\tau_r$	peak and residual shear strength
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	coefficient of friction $= \tan \delta$
$c'$	effective cohesion
$c_u$ or $s_u$	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:

<sup>1</sup>  $\tau = c' + \sigma' \tan \phi'$

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

# LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

## WEATHERING STATE

**Fresh:** no visible sign of rock material 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 texture and structure are preserved.

## BEDDING THICKNESS

<u>Description</u>	<u>Bedding Plane Spacing</u>
Very Thickly Bedded	> 2 m
Thickly Bedded	0.6 m to 2m
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	< 6 mm

## JOINT OR FOLIATION SPACING

<u>Description</u>	<u>Spacing</u>
Very Wide	> 3 m
Wide	1 – 3 m
Moderately Close	0.3 – 1 m
Close	50 – 300 mm
Very Close	< 50 mm

## GRAIN SIZE

<u>Term</u>	<u>Size*</u>
Very Coarse Grained	> 60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns – 2mm
Fine Grained	2 – 60 microns
Very Fine Grained	< 2 microns

Note: \*Grains > 60 microns diameter are visible to the naked eye.

## CORE CONDITION

### Total Core Recovery

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 varies from 0% for completely broken core 100% for core in solid sticks.

## DISCONTINUITY DATA

### Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including naturally occurring fractures but not including mechanically induced breaks caused by drilling.

### Dip with Respect to (W.R.T.) 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 abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature information concerning the nature of fracture surfaces and infillings are also noted.

### Abbreviations

BD -	Bedding	PY -	Pyrite
FO -	Foliation/Schistosity	Ca -	Calcite
CL -	Clean	PO -	Polished
SH -	Shear Plane/Zone	K -	Slickensided
VN -	Vein	SM -	Smooth
FLT -	Fault	RO -	Ridged/Rough
CO -	Contact	ST -	Stepped
JN -	Joint	PL -	Planar
FR -	Fracture	IR -	Irregular
MB -	Mechanical Break	UN -	Undulating
BR -	Broken Rock	CU -	Curved
BL -	Blast Induced	TCA -	To Core Axis
Il -	Parallel To	STR -	Stress Induced
OR -	Orthogonal		



PROJECT 05-1120-210/8000		<b>RECORD OF BOREHOLE No 14-1</b>		SHEET 1 OF 2		<b>METRIC</b>																											
G.W.P. 4058-01-00		LOCATION N 5025958.5 ; E 363211.3		ORIGINATED BY PAH																													
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 200 mm Diam. (Hollow Stem), Rotary Drill NQ Core		COMPILED BY JM																													
DATUM Geodetic		DATE November 26, 2014		CHECKED BY KSL																													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																											
82.3	0.0	GROUND SURFACE																															
82.0	0.3	TOPSOIL																															
81.7	0.6	Silty SAND, trace gravel Red-brown Moist		1	AS	-																											
		SILTY CLAY to CLAY, some silty sand seams (Weathered Crust) Very stiff Grey-brown Moist		2	SS	18																											
				3	SS	9																											
				4	SS	7																											
79.3	3.1	SILTY CLAY to CLAY, some silty sand layers Stiff Grey Very moist		5	SS	3																											
77.9	4.4	Silty SAND and GRAVEL, trace clay, with probable cobbles and boulders (TILL) Very dense Grey Very moist		6	SS	106																											
				7	SS	50/0.10																											
76.7	5.6	Limestone (BEDROCK)																															
		Bedrock cored from depths of 5.6 m to 8.6 m																															
		For bedrock coring details refer to Record of Drillhole 14-1.		1	RC	REC 98%																											
				2	RC	REC 100%																											
				3	RC	REC 100%																											
73.7	8.6	END OF BOREHOLE																															
		NOTES:																															
		1. Water level in well screen at a depth of 3.2 m below ground surface (Elev. 79.1 m), measured on Dec. 18, 2014.																															

GTA-MTO 001 N:\ACTIVE\2005\1120\GEOTECHNICAL\05-1120-210 MRC HWY 417 BRIDGES MAINTLAND TO ISLAND PARK DRIVE\GINT\051120210.GPJ GAL-GTA.GDT 07/24/15 JM

SHEET 1 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

[illegible]

DEPTH SCALE

1 : 50


**Golder  
Associates**

LOGGED:

CHECKED: KSL



PROJECT		05-1120-210/8000		RECORD OF BOREHOLE No 14-2		SHEET 1 OF 2		METRIC									
G.W.P.		4058-01-00		LOCATION		N 5026033.5; E 363271.1		ORIGINATED BY PAH									
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger 200 mm Diam. (Hollow Stem), Rotary Drill NQ Core		COMPILED BY JM									
DATUM		Geodetic		DATE		November 25, 2014		CHECKED BY KSL									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
82.1	GROUND SURFACE																
0.0	TOPSOIL		1	AS	-												
81.8																	
0.3	Silty SAND Loose Red-brown to grey-brown Moist		2	SS	8												
80.7																	
1.4	SAND, trace gravel Loose Grey-brown Moist																
80.4																	
1.7	SILTY CLAY to CLAY, some silty sand seams (Weathered Crust) Very stiff Grey-brown Very moist		3	SS	5												
			4	SS	4												
79.0																	
3.1	SILTY CLAY to CLAY Stiff to firm Grey Wet		5	SS	WH												
77.4																	
4.7	Silty SAND, some gravel, trace clay (TILL) Very loose Grey Wet		6	SS	1												
76.6			7	SS	50/0.20												
5.5	Limestone (BEDROCK)  Bedrock cored from depths of 5.5 m to 8.8 m  For bedrock coring details refer to Record of Drillhole 14-2.		1	RC	REC 100%												RQD = 70%
			2	RC	REC 100%												RQD = 47%
73.3																	
8.8	END OF BOREHOLE																

GTA-MTO 001 N:\ACTIVE\2005\1120\GEOTECHNICAL\05-1120-210 MRC HWY 417 BRIDGES MAINTLAND TO ISLAND PARK DRIVE\GINT05\1120210.GPJ GAL-GTA.GDT 07/24/15 JM

SHEET 1 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

[illegible]

DEPTH SCALE

1 : 50


**Golder  
Associates**

LOGGED:

CHECKED: KSL

PROJECT		RECORD OF BOREHOLE No 14-3		SHEET 1 OF 1		METRIC											
G.W.P. 05-1120-210/8000		LOCATION N 5026093.6 ; E 363309.6		ORIGINATED BY PAH													
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 200 mm Diam. (Hollow Stem)		COMPILED BY JM													
DATUM Geodetic		DATE November 25, 2014		CHECKED BY KSL													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	25 50 75				
82.1	GROUND SURFACE						82										
0.0	TOPSOIL		1	AS	-												
81.7																	
0.4	SAND Compact Red-brown to grey-brown Moist		2	SS	14		81										
80.6																	
1.5	SILTY CLAY to CLAY, some silty sand seams (Weathered Crust) Very stiff Grey-brown Moist to wet		3	SS	10		80										
			4	SS	7		79										
			5	SS	3		78										
78.4																	
3.7	SILTY CLAY to CLAY, some silty sand seams Stiff to firm Grey Wet						78										
			6	SS	WH		77										
76.0							76										
6.1	END OF BOREHOLE																
NOTES:																	
1. Water level in well screen at a depth of 3.9 m below ground surface (Elev. 78.2 m), measured on Dec. 18, 2014.																	

PROJECT 05-1120-210/8000		<b>RECORD OF BOREHOLE No 14-4</b>				SHEET 1 OF 2		<b>METRIC</b>									
G.W.P. 4058-01-00		LOCATION N 5026151.2; E 363368.8				ORIGINATED BY PAH											
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 200 mm Diam. (Hollow Stem), Rotary Drill NQ Core				COMPILED BY JM											
DATUM Geodetic		DATE November 27, 2014				CHECKED BY KSL											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
80.0	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL																
0.1	Sand (FILL) Loose Grey-brown Moist		1	SS	4		79										
78.5	Crushed sand and gravel, trace silt and clay (FILL) Loose Grey Moist		2	SS	6		78										
77.6	SILTY CLAY to CLAY Stiff to firm Grey Wet		3	SS	4		77										
76.5	Silty SAND, some gravel, trace clay (TILL) Loose Grey Wet		4	SS	WH												
75.6			5	SS	6		76										
4.4	Limestone (BEDROCK)  Bedrock cored from depths of 4.4 m to 7.5 m  For bedrock coring details refer to Record of Drillhole 14-4.		1	RC	REC 100%		75										RQD = 93%
			2	RC	REC 100%		74										RQD = 98%
			3	RC	REC 100%		73										RQD = 100%
72.5	END OF BOREHOLE																
7.5																	

GTA-MTO 001 N:\ACTIVE\2005\1120\GEOTECHNICAL\05-1120-210 MRC HWY 417 BRIDGES MAINTLAND TO ISLAND PARK DRIVE\GINT051120210.GPJ GAL-GTA.GDT 07/24/15 JM

[illegible]

DEPTH SCALE

1 : 50


**Golder  
Associates**

LOGGED:

CHECKED: KSL

PROJECT <u>05-1120-210/8000</u>		<b>RECORD OF BOREHOLE No 14-4A</b>		SHEET 1 OF 1		<b>METRIC</b>	
G.W.P. <u>4058-01-00</u>		LOCATION <u>N 5026152.7 ; E 363369.3</u>		ORIGINATED BY <u>PAH</u>			
DIST <u>Eastern</u> HWY <u>417</u>		BOREHOLE TYPE <u>Power Auger 200 mm Diam. (Hollow Stem)</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>November 27, 2014</u>		CHECKED BY <u>KSL</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W <sub>p</sub>	W	W <sub>L</sub>		
								○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED					WATER CONTENT (%)				
							20	40	60	80	100	25	50	75			
80.0	GROUND SURFACE																
0.0	FILL																
79.1																	
0.9	Polystyrene Insulation																
	Sand (FILL)		1	SS	7												
78.6	Loose Moist																
1.4	END OF BOREHOLE																

GTA-MTO 001 N:\ACTIVE\2005\1120\GEOTECHNICAL\05-1120-210 MRC HWY 417 BRIDGES MAITLAND TO ISLAND PARK DRIVE\GINT051120210.GPJ GAL-GTA.GDT 07/24/15 JM

PROJECT 05-1120-210/8000		<b>RECORD OF BOREHOLE No 14-5</b>		SHEET 1 OF 2		<b>METRIC</b>											
G.W.P. 4058-01-00		LOCATION N 5026205.3;E 363412.3		ORIGINATED BY PAH													
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger 200 mm Diam. (Hollow Stem), Rotary Drill NQ Core		COMPILED BY JM													
DATUM Geodetic		DATE November 27, 2014		CHECKED BY KSL													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m <sup>3</sup>	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>				
79.9	GROUND SURFACE																
0.7	TOPSOIL																
	Sand, some gravel, with silty clay pockets (FILL)		1	AS	-												
	Loose																
	Grey-brown																
	Moist																
79.1	SILTY CLAY to CLAY, some silty sand seams (Weathered Crust)		2	SS	2		79										
0.8	Very stiff to firm																
	Grey-brown																
	Wet																
			3	SS	WH		78										
77.9	SILTY CLAY to CLAY																
2.0	Firm																
	Grey																
	Wet																
			4	SS	WH		77										
76.4	CLAYEY SILT and Sandy SILT, some gravel (TILL)																
3.5	Grey																
76.1	Wet																
3.8	Limestone (BEDROCK)		1	RC	REC 100%		76										RQD = 100%
	Bedrock cored from depths of 3.8 m to 6.8 m																
	For bedrock coring details refer to Record of Drillhole 14-5.		2	RC	REC 100%		75										RQD = 92%
			3	RC	REC 100%		74										RQD = 74%
73.1																	
6.8																	

SHEET 1 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

[illegible]

DEPTH SCALE

1 : 50


**Golder  
Associates**

LOGGED:

CHECKED: KSL





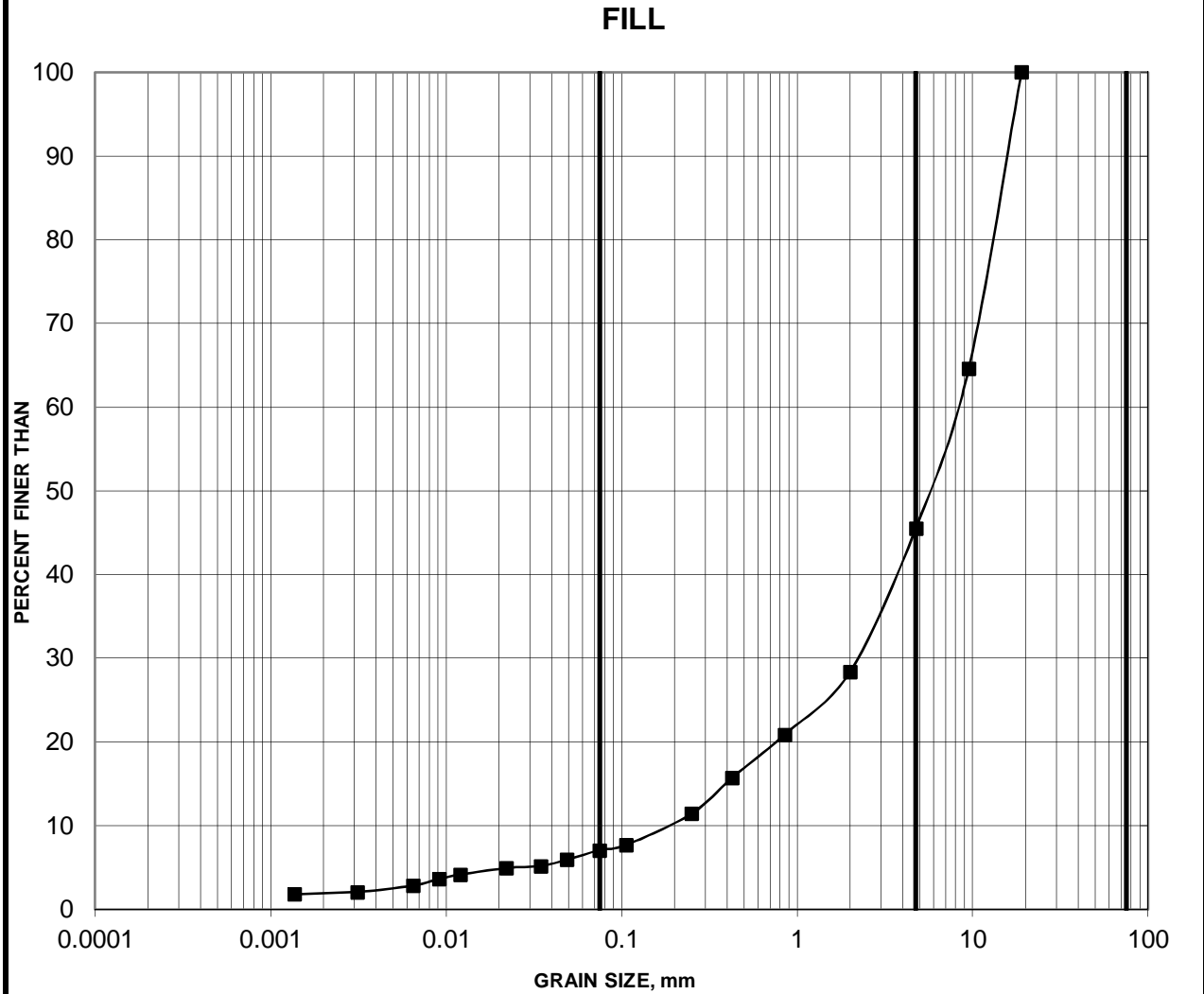
# **APPENDIX B**

## **Laboratory Test Results**



# GRAIN SIZE DISTRIBUTION

FIGURE B1

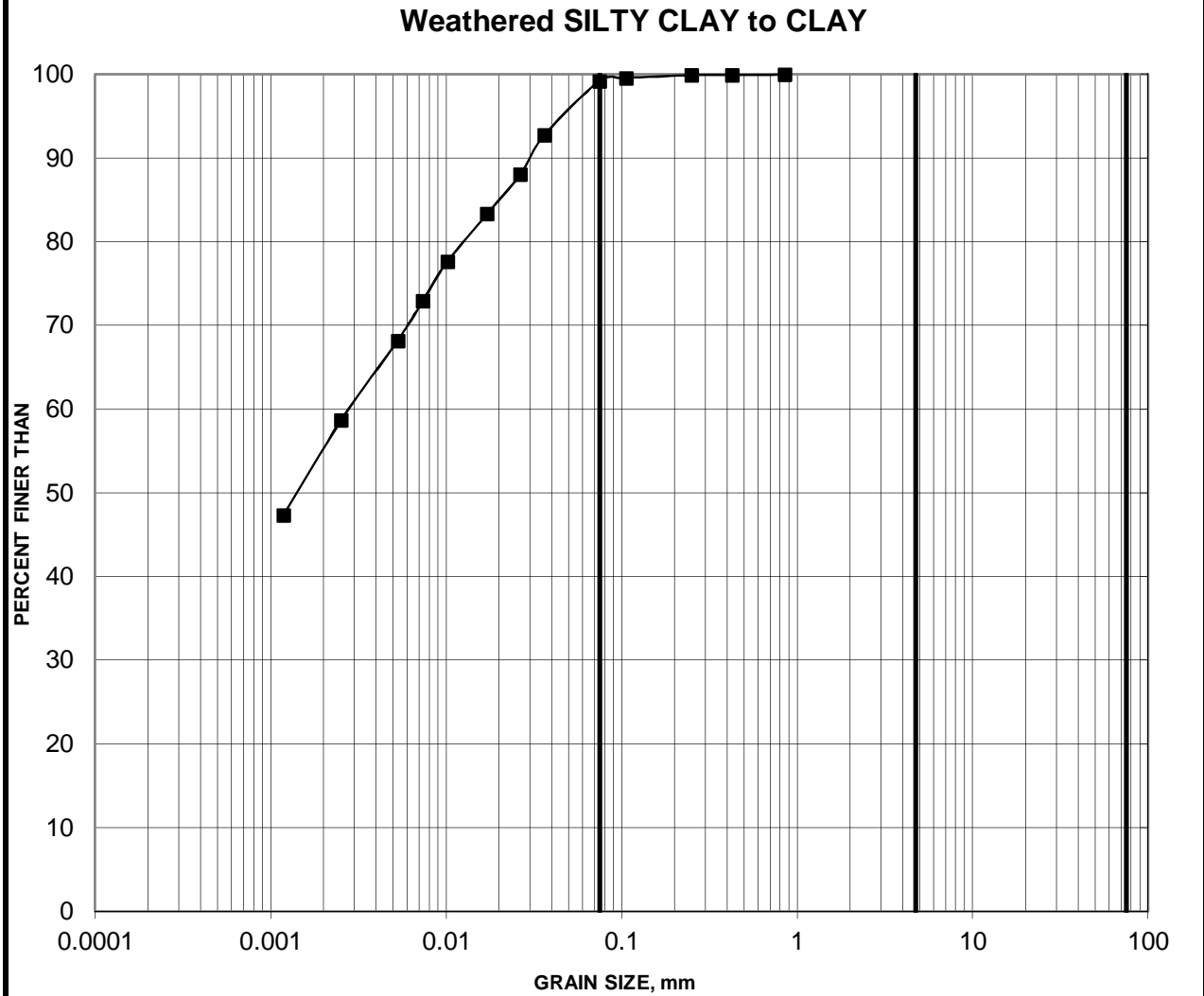


SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
14-4	2	1.52-2.13

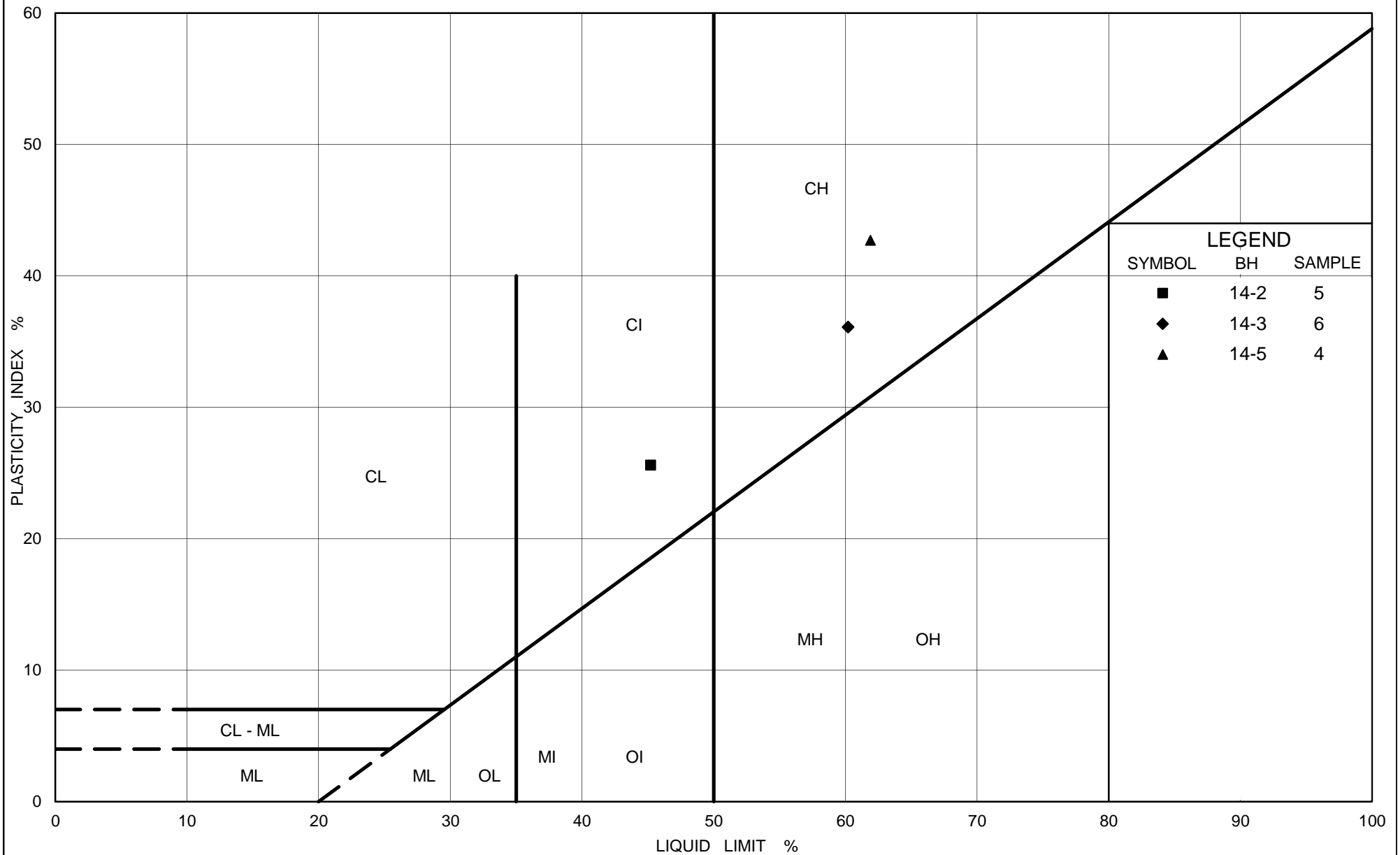
# GRAIN SIZE DISTRIBUTION

FIGURE B2



SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
—■ 14-3	4	2.29-2.90



Ontario

Ministry of Transportation

# PLASTICITY CHART SILTY CLAY TO CLAY

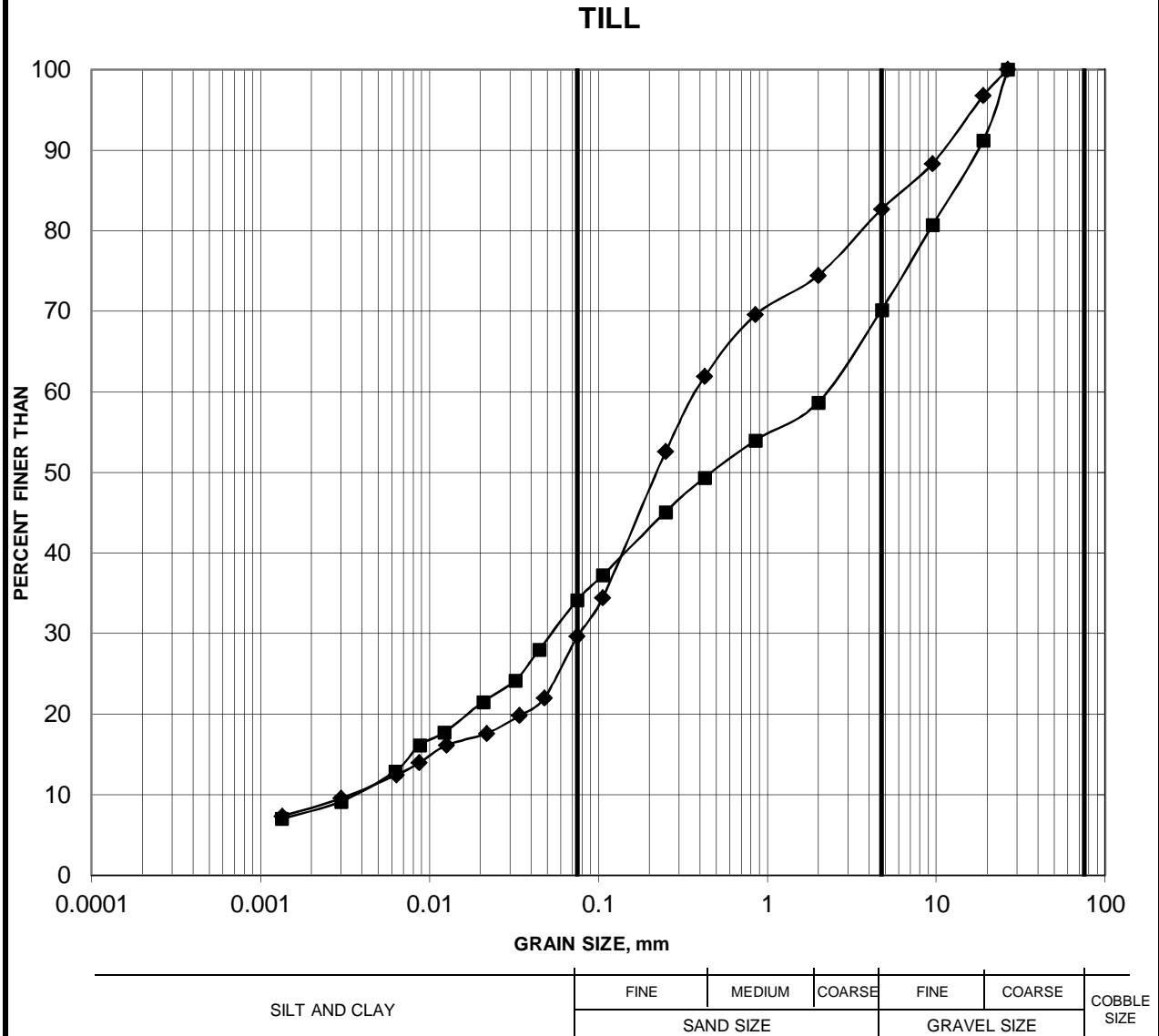
FIG No. B3

Project No. 05-1120-210/8000

Compiled By : MI      Checked By : CNM

# GRAIN SIZE DISTRIBUTION

FIGURE B4



Borehole	Sample	Depth (m)
■ 14-1	6	4.57-4.88
◆ 14-4	5	3.81-4.42



# **APPENDIX C**

**Record of Borehole**

**Previous Investigation – GEOCRES No. 31G5-22**





**McROSTIE & ASSOCIATES**  
**CONSULTING ENGINEERS**  
**OTTAWA CANADA**

## SOIL PROFILE AND SUMMARY OF LABORATORY TESTS

QUEENSWAY AT MAITLAND AVE.  
BRIDGE No. 3

ELEVATION OF GROUND SURFACE (ZERO DEPTH) 270.0 - GEODETIC  
REMARKS SEE PLATE 2

HOLE No.

DATE MAY 13-14, 1958

UNCONFINED COMPRESSIVE STRENGTH Kips/Ft. <sup>2</sup>	SMALL SCALE PENETROMETER KIPS/FT. <sup>2</sup>	STANDARD PENETRATION BLOWS/FT.	SAMPLE NUMBER	DESCRIPTION OF SOIL	DEPTH IN FEET	ELEVATION	PENETRATION TEST					
							.....ANVIL.....		.....NO CASING.....		.....INCH DIA. ROD.....	BLOWS PER FOOT
							.....INCH DRAIN.....		.....INCH DIA. ROD.....			
				GROUND SURFACE								
				TOP SOIL	0	270.0						
					1.0	269.0						
				HARD, FISSURED, SILTY	2							
2.5	84 78 74 90 90 90 90 90 90		6-1	BROWNISH-GRAY CLAY	4							
					4.5	265.5						
4.7	62 72 80 74 76 70 80 80 80		6-2	VERY STIFF, FISSURED SILTY BROWNISH-GRAY CLAY	6							
					7.0	263.0						
1.8	36 34 32 32 35 38 40 37 34		6-3	STIFF, FISSURED, SILTY	8							
				BROWNISH-GRAY CLAY	10							
2.0	34 36 34 36 40 38		6-4		11.5	258.5						
				LOOSE TILL	12							
		7	6-5		13.5	256.5						
		33 for 6"		DENSE TILL	14							
		44 for 3'	6-6		16.2	253.8						
				LIMESTONE (DRILLED)	18							
				CORE RECOVERY 93%	19.7	250.3						
				BEDDING THICKNESS 2"	20							
				LIMESTONE (DRILLED)	22							
				CORE RECOVERY 94%	24.2	245.8						
				BEDDING THICKNESS 3"	26.2	243.8						
				BOTTOM OF HOLE								





# **APPENDIX D**

## **Non Standard Special Provisions**



**CAISSON SOCKETS IN BEDROCK FOR NOISE BARRIER WALL FOUNDATIONS -**  
**Item No.**

---

Special Provision

---

The limestone at the proposed noise barrier wall foundation areas, where present, is medium strong. Appropriate construction equipment and procedures will be required for construction of caisson foundation sockets within the bedrock.

**Basis of Payment**

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

END OF SECTION

**BOULDERS/OBSTRUCTIONS DURING EXCAVATION FOR NOISE BARRIER WALL  
FOUNDATIONS – Item No.**

---

**Special Provision**

---

The soils at the site are glacially-derived and should be expected to contain cobbles and boulders. Appropriate equipment and procedures will be required to penetrate obstructions (cobbles and boulders) that are encountered during excavation for noise barrier wall foundations.

**Basis of Payment**

Payment at the contract price for the above tender item shall include full compensation for all labour and materials to complete the work.

**END OF SECTION**



At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

[solutions@golder.com](mailto:solutions@golder.com)  
[www.golder.com](http://www.golder.com)

**Golder Associates Ltd.**  
**1931 Robertson Road**  
**Ottawa, Ontario, K2H 5B7**  
**Canada**  
**T: +1 (613) 592 9600**

