

**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 407/BROCK ROAD INTERCHANGE CONNECTION
OVERHEAD AND DUTCHMASTER SIGN SUPPORTS**

Contract No: E2-2012

Report to

MMM Group Limited

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation carried out by Thurber Engineering Ltd (Thurber) for the detailed design of the supports for four (4) overhead signs and one (1) Dutchmaster sign located in the vicinity of the intersection of Highway 407/Highway 7 from Brock Road to Sideline 16 in Pickering, Ontario. These signs are planned as part of the Highway 407/Brock Road Interchange Connection project.

The purpose of this investigation was to explore the subsurface conditions at the proposed locations of the overhead sign supports and, based on the data obtained, to provide borehole location plans, records of boreholes, laboratory test results and written descriptions of the subsurface conditions.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited, under the Highway 407 ETR Contract Number E2-2012 (Design).

2 SITE DESCRIPTION

The four overhead signs (OHS) addressed in this report are to be located within the vicinity of the existing Highway 407/Highway 7 from Brock to Sideline 16 near the community of Brougham, in The City of Pickering. The OHS locations and other relevant details are summarized in Table 2.1 below.

Table 2.1 – Overhead Sign Details

Overhead Sign	Approximate Location	Station	Offset (m)
OH-1	305 m west of existing Brock Road just south of existing Hwy 407	16+841	Left Leg: 0.0 Right Leg: 26.6
OH-2	110 m east of existing Brock Road at existing Hwy 407	17+300	Left leg: 0.0 Right Leg: 36.6
OH-3	50 m north of existing Hwy 7 and 140 m east of existing Sideline 16 (just west of proposed Structure M-10)	18+421	Left Leg: -35.5 Right Leg: 0.0
OH-4	310 m north of Highway 7 and 300 m west of Sideline 14	18+881	Left Leg: -28.4 Right Leg: 0.0

In addition, a Dutchmaster sign is to be located some 40 m to the west of the west abutment of the proposed M9 bridge on the north side of the realigned Highway 7.

Lands surrounding the proposed OHS locations consist primarily of agricultural fields and undeveloped grass areas near the existing Highway 407.

The proposed overhead signs are located in the physiographic region known as the South Slope, which lies between the Oak Ridges Moraine and the Iroquois Plain, and is typically characterized by overburden deposits consisting of sands and silts overlying glacial till sheets. ‘Surficial Geology of Southern Ontario’ published by The Ontario Geological Survey shows that the overhead signs are located in an area underlain by sandy silt to silty sand till.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for the overhead signs were carried out between December 3 and 17, 2012. Two boreholes were drilled at each proposed overhead sign location, one borehole per sign support, for a total of eight boreholes (identified as OHS-01 to OHS-08). The locations of the boreholes were determined based on information provided by MMM Group. The borehole locations are shown on the Borehole Locations Plans (2 sheets), included immediately following the text and tables of this report. Boreholes were drilled to depths of 7.7 to 8.2 m (Elevations 160.5 to 187.7 m).

The borehole locations were marked in the field and utility clearances were obtained prior to drilling. As well, Permission to Enter was obtained by MTO for the private properties accessed by this investigation.

The boreholes were drilled using a CME-55 track-mounted drill rig or a D-90 truck-mounted drill rig. Solid stem augers (SSA) were generally used to advance the boreholes. In some boreholes (OHS-07 and OHS-08), hollow stem augers (HSA) were initially used and followed by SSAs to further advance the boreholes. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with the Standard Penetration Test (SPT).

The drilling and sampling operations were supervised on a full time basis by a member of Thurber’s technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber’s laboratory for further examination and testing.

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. A standpipe piezometer was installed in selected boreholes for subsequent monitoring of groundwater levels. The installation details of the standpipe piezometers and completion details for the boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion and Piezometer Installation Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Completion / Installation Details
OHS-1	None installed	Backfilled with bentonite holeplug to 1.9 m, cuttings from 1.9 to 0.1 m, the asphalt to surface.
OHS-2	6.1 / 189.8	25 mm diameter PVC pipe with 1.5 m slotted screen installed with filter sand to 4.3 m and bentonite holeplug from 4.3 m to surface.
OHS-3	6.1 / 182.8	25 mm diameter PVC pipe with 1.5 m slotted screen installed with filter sand to 4.3 m and bentonite holeplug from 4.3 m to surface.
OHS-4	None installed	Backfilled with bentonite holeplug to 1.7 m, cuttings from 1.7 to 0.2 m, the asphalt to surface.
OHS-5	4.6 / 164.9	25 mm diameter PVC pipe with 1.5 m slotted screen installed with filter sand to 2.7 m and bentonite holeplug from 2.7 m to surface.
OHS-6	None installed	Borehole caved to 4.9 m, then backfilled with bentonite holeplug from 4.9 m to surface.
OHS-7	None installed	Backfilled with bentonite holeplug to surface.
OHS-8	4.6 / 173.0	25 mm diameter PVC pipe with 1.5 m slotted screen installed with filter sand to 2.7 m and bentonite holeplug from 2.7 m to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to visual identification and natural moisture content determination. Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and on the figures included in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. An overall description of the stratigraphy encountered in the boreholes drilled for the overhead sign supports is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

5.1 Topsoil

A layer of topsoil was encountered surficially in Boreholes OHS-02, OHS-03, OHS-05, and OHS-06. The thickness of the topsoil ranged from 75 to 150 mm in these boreholes.

5.2 Pavement Structure

Pavement structure consisting of asphalt overlying granular fill materials (sand fill) was encountered in Boreholes OHS-01 and OHS-04, which were drilled on the shoulder of the existing Highway 407. The asphalt was 100 mm thick in both boreholes.

The granular fill consists of sand with trace to some gravel and trace to some silt. The thickness of the granular fill ranged from 1.3 to 1.5 m with a lower boundary at depths of 1.4 and 1.6 m in Boreholes OHS-01 and OHS-04, respectively (Elevation 194.0 and 189.5 m).

Two SPT N-values recorded in the granular fill were 25 and 48 blows for 0.3 m penetration, indicating a compact to dense state. Measured moisture contents of the sand fill ranged from 2 to 5%.

One sample of the sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the corresponding Record of Borehole sheet included in Appendix A. The grain size distribution curve for this sample is plotted on Figure B1, Appendix B.

Soil Particles	Percentage (%)
Gravel	6
Sand	81
Silt and Clay	13

5.3 Clayey Silt and Sand

A layer of clayey silt and sand containing trace gravel was encountered below the topsoil in Boreholes OHS-02, OHS-05, and OHS-06. This layer typically contained organics, rootlets and occasional peat pockets (in Borehole OHS-05).

The thickness of this layer ranged from 0.4 to 2.9 m with a lower boundary at depths of 0.6 to 3.0 m (Elevation 195.3 to 166.5 m).

SPT N-values recorded in this layer ranged from 2 to 12 blows for 0.3 m penetration, indicating a very soft to stiff consistency. Measured moisture contents ranged from 10 to 35%.

Two samples of the clayey silt and sand were selected for laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the corresponding Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure B2, Appendix B.

Soil Particles	Percentage (%)
Gravel	0 to 3
Sand	40 to 43
Silt	41 to 45
Clay	13 to 15

5.4 Sand and Silt to Sand

A sand and silt to sand deposit was encountered in Boreholes OHS-01 to OHS-06. This deposit was encountered below the granular fill in Borehole OHS-01, below a thin localized layer of clayey silt and sand in Borehole OHS-02, below the tills (described in later sub-sections) in Boreholes OHS-03 and OHS-04, and below a gravelly sand layer in Boreholes OHS-05 and OHS-06. The silty sand to sand was brown in colour becoming grey with increasing depth and contained trace gravel at some locations.

The sand and silt to sand deposit was not fully penetrated in any of these boreholes. The boreholes were advanced 0.9 to 7.6 m into this deposit and were all terminated at a depth of 8.2 m (Elevation 187.7 to 160.5 m).

SPT N-values recorded in the sand and silt to sand ranged from 14 to 62 blows for 0.3 m penetration, indicating a compact to very dense state. SPT N-values generally increased with depth, except in Borehole OHS-03. Measured moisture contents measured in samples of the sand and silt to sand ranged from 5 to 22%, typically between 15 and 20% for samples below the water table.

Four samples of the sand and silt to sand underwent laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the corresponding Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure B3.

Soil Particles	Percentage (%)
Gravel	0
Sand	50 to 85
Silt	36 to 42
Clay	3 to 8
Silt and Clay	15

In Borehole OHS-02, a 1.6 m thick layer of silt was encountered within the sand deposit. This silt layer was encountered at a depth of 4.5 with the lower boundary at a depth of 6.1 m

(Elevation 189.8). An SPT N-value of 54 blows for 0.3 m penetration was recorded in the silt (very dense) and a moisture content of 18% was measured in one sample of the silt.

5.5 Gravelly Sand

A layer of gravelly sand was encountered below the clayey silt and sand in Boreholes OHS-05 and OHS-06. The gravelly sand was grey and contained trace to some silt.

The gravelly sand layer was 4.3 m thick in Borehole OHS-05 and 2.8 m thick in Borehole OHS-06, with a lower boundary at depths of 7.3 and 5.8 m, respectively (Elevation 162.2 and 162.9 m).

SPT N-values recorded in the gravelly sand layer ranged from 11 to 26 blows for 0.3 m penetration indicating a compact state. Measured moisture contents measured in the gravelly sand samples ranged from 8 to 18%.

Two samples of the gravelly sand were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are presented on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are presented on Figure B4, Appendix B.

Soil Particles	Percentage (%)
Gravel	18 to 27
Sand	62 to 75
Silt and Clay	7 to 11

5.6 Sand and Silt to Silty Sand Till

Sand and silt to silty sand till deposits were encountered in Boreholes OHS-04 and OHS-06. The till was encountered below the sand fill in Borehole OHS-04 and below the clayey silt and sand in Borehole OHS-06. The till was typically brown in colour and contained some clay, trace to some gravel. The presence of occasional cobbles was inferred during the drilling process.

In Borehole OHS-04, the till was 2.5 m thick with a lower boundary at a depth of 4.1 m (Elevation 187.0 m). In Borehole OHS-06, only a 0.8 m thick layer of till was encountered with a lower boundary at a depth of 3.0 m (Elevation 165.7 m).

SPT N-values recorded in the till ranged from 18 blows for 0.3 m penetration to 50 blows for 0.15 m penetration indicating a compact to very dense state. Measured moisture contents of the till samples ranged from 5 to 10%.

Two samples of the till were selected for laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the corresponding Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure B5, Appendix B.

Soil Particles	Percentage (%)
Gravel	8 to 15
Sand	43 to 54
Silt	21 to 43
Clay	6 to 10

Glacial tills inherently contain cobbles and boulders.

5.7 Clayey Silt and Sand Till

Deposits of clayey silt and sand till were encountered below the topsoil in Borehole OHS-03 and at ground surface in Boreholes OHS-07 and OHS-08. The till was typically brown in colour becoming grey with depth and contained trace gravel. The presence of occasional cobbles was inferred during the drilling process.

Borehole OHS-03 fully penetrated the till which was 2.3 m thick with a lower boundary at a depth of 2.4 m (Elevation 186.4 m). Boreholes OHS-07 and OHS-08 were terminated within this till at a depth of 7.7 m (Elevation 169.9 m).

Within the upper 3 m, SPT N-values recorded in this till ranged from 6 blows at ground surface to 86 blows for 0.3 m penetration indicating a firm to hard consistency. Below 3 m depth, N-values were greater than 100 blows for less than 0.3 m penetration indicating a hard consistency throughout and inferred the presence of cobbles and/or boulders. Measured moisture contents of the till samples ranged from 11 to 20%.

Five samples of this till were selected for laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the corresponding Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure B6, Appendix B. One sample was subjected to Atterberg Limits testing and the results are plotted on a plasticity chart shown on Figure B7, Appendix B.

Soil Particles	Percentage (%)
Gravel	3 to 9
Sand	38 to 41
Silt	33 to 47
Clay	10 to 20

Soil Property	Percentage (%)
Liquid Limit	19
Plasticity Index	8

Results of the Atterberg Limits testing indicate that the clayey silt and sand till has a low plasticity (group symbol CL). Glacial tills inherently contain cobbles and boulders.

5.8 Groundwater Conditions

Water levels were observed in the open boreholes during and upon completion of drilling. One standpipe piezometer was installed in a selected borehole at each overhead sign location to monitor water levels after completion of drilling. The water levels measured in the piezometer are summarized in Table 5.1, along with the measurements in the open boreholes upon completion of drilling.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
OHS-01	Dec. 12, 2012	4.1	191.3	Open borehole
OHS-02	Dec. 17, 2012	6.1	189.8	Open borehole
	Dec. 18, 2012	5.0	190.9	Piezometer
	Jan. 2, 2013	4.9	191.0	
	Jan. 9, 2013	4.9	191.0	
OHS-03	Dec. 14, 2012	3.0	185.9	Open borehole
	Dec. 18, 2012	2.9	186.0	Piezometer
	Jan. 2, 2012	0.9	188.0	
	Jan. 9, 2013	2.5	186.4	
OHS-04	Dec. 12, 2012	5.9	185.2	Open borehole
OHS-05	Dec. 6, 2012	4.0	165.5	Open borehole
	Jan. 2, 2012	1.3	168.2	Piezometer
OHS-06	Dec. 6, 2012	3.0	165.7	Open borehole
OHS-07	Dec. 3, 2012	Dry		Open borehole
OHS-08	Dec. 3, 2012	1.2	176.4	Open borehole
	Jan. 2, 2012	0.8	176.8	Piezometer

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

The proposed borehole locations were selected by MMM and the drillable locations were staked in the field by Thurber using a Trimble Pathfinder ProXRT differential GPS prior to drilling. The co-ordinates and ground surface elevations at the boreholes were surveyed by MMM upon completion of drilling.

Thurber obtained utility clearances for the borehole locations prior to drilling.

DBW Drilling of Ajax, Ontario supplied both truck-mounted and track-mounted drill rigs for these boreholes and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised by Mr. Stephane Loranger, C.E.T. and Mr. George Azzopardi of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall supervision of the field program was conducted by Ms. Lindsey Blaine, E.I.T. Interpretation of the data and preparation of the report were carried out by Ms. Lindsey Blaine, E.I.T and Mr. Sydney Pang, P.Eng.

Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

THURBER ENGINEERING LTD.

L. Blaine
Jan. 25/13

Lindsey Blaine, E.I.T.
Project Manager



Sydney Pang, P.Eng.
Associate, Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.,
Review Principal

**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 407/BROCK ROAD INTERCHANGE CONNECTION
OVERHEAD AND DUTCHMASTER SIGN SUPPORTS**

Contract No: E2-2012

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 SIGN SUPPORT DESIGN RECOMMENDATIONS

7.1 General

This section of the report presents foundation recommendations for the design of the proposed overhead sign supports.

Information on the proposed locations of the signs was provided to Thurber by MMM Group Limited. One borehole was drilled at the location of each of the two proposed supports for each sign. The Record of Borehole sheets for these boreholes are included in Appendix A. Records of Boreholes SM9-01 and SM9-02 closest to the Dutchmaster sign are also attached in Appendix A. Table 1 immediately following the text of this report indicates the relevant boreholes that are used for the recommended geotechnical parameters for design of the sign supports.

7.2 Foundation Design Parameters

Design of the sign support foundations should be carried out in accordance with the following document.

- Ministry of Transportation, Ontario (2007) "Sign Support Manual", Policy, Planning and Standards Division, Bridge Office (Reference 1).

Reference should also be made to the following documents:

- Ministry of Transportation, Ontario (2003) "Guidelines for the Design of High Mast Pole Foundations", Third Edition, BRO-006, Engineering Standards Branch, Bridge Office (Reference 2).
- Canadian Highway Bridge Design Code and Commentary (2006). CAN/CSA-S6-00 and S6.1-00 (Reference 3).

It is noted that Reference 2 is based on caisson design recommendations from the following:

- Broms, B.B. (1964a). Lateral Resistance of Piles in Cohesive Soils. Journal for Soil Mech. and Found. Engrg., ASCE, Vol.90, SM2, pp. 27-64 (Reference 4).
- Broms, B.B. (1964b). Lateral Resistance of Piles in Cohesionless Soils. Journal for Soil Mech. and Found. Engrg., ASCE, Vol.90, SM3, pp. 123-156 (Reference 5).

It is understood that a sign support foundation typically consists of a conventional augered caisson (drilled shaft). Table 1 following the text of this report presents the recommended foundation design parameters for the design of such caissons.

It is recommended that MTO's standard drawings SS 118-3, 4 and 5 and other relevant foundation design recommendations in Reference 1 be used as a basis for the sign support designs. The foundation design parameters in Table 1 should be used in conjunction with Reference 2 to confirm that the standard designs are adequate.

For the Dutchmaster sign, the two closest boreholes, SM9-01 and SM9-02, are some 40 m away from the sign location, and the latter is several metres higher in topographic elevation. By extrapolating from these boreholes, the design parameters in Table 1 should be used in conjunction with Reference 2 for foundation design.

In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of a caisson within the upper 1.2 m below final grade should be neglected in the foundation design. It is recommended that all topsoil and organics be neglected in determining lateral resistance.

Where downward sloping fill or native soil exists in front of a caisson, reduction of lateral passive resistance should be taken into account during design. For foundation design at the caissons, it must be assumed that full lateral resistance can only be mobilized where the extent of the soil in front of or behind the caisson is equal to or greater than approximately four (4) times the diameter of the caissons. For sloping ground in front of a caisson, the magnitude of the mobilized passive resistance can be estimated by interpolating between zero passive resistance at the level where the slope face intersects the pile, and full passive resistance at the level where the horizontal distance from the slope face is equal to or greater than four (4) times the diameter of the caisson.

Where an unconfined compressive strength, q_u , ($q_u = 2 \times C_u$, undrained shear strength) is provided for a cohesive soil (clayey silt and clayey silt till), the ultimate lateral passive resistance should be calculated in conjunction with the total soil unit weight. When designing for portions of the caissons below the groundwater level in cohesionless sands and silts, the submerged soil unit weight, γ' , should be used. The required depth of the drilled shaft will be

governed by lateral loads, including wind loads, acting on the sign. The length of the caisson should also be sufficient to counteract frost jacking (upward) forces.

An equivalent caisson width equal to 2 times the caisson diameter may be assumed for lateral resistance calculations. Appropriate load and resistance factors should be applied for caisson design.

7.3 Caisson Installation

Caisson installation should generally be carried out in accordance with OPSS 903.

The contract documents should contain an NSSP alerting the contract bidders of the specific aspects relating to caisson construction for OHS foundation supports at this site. Suggested wordings for this NSSP are provided in Appendix C.

Caisson installation equipment must be able to dislodge, handle, remove cobbles and boulders, to penetrate obstructions within the fill and tills, and to drill through hard or very dense layers, where encountered.

The short term groundwater levels were measured at between 1 and 4 m depths below existing ground surface. The stabilized groundwater levels may be higher. Soil sloughing and water seepage will occur in unsupported holes especially in gravelly sands, sands and silts below the groundwater level. Temporary liners must be available to support the caisson sidewalls and to provide seepage cut-off where required. Any accumulated water may have to be pumped out from the hole prior to placing concrete. Should it be considered impractical to remove the accumulated water inside the hole or be required to maintain a head of water inside the liner to maintain basal stability (against “boiling”), it is recommended that the concrete be placed by the tremie method.

7.4 Construction Concerns

Concerns during caisson construction mainly involve the handling and removal of cobbles or boulders, or other obstructions in the fill and till, drilling through hard/very dense soils, soil sloughing and water seepage from caisson sidewalls, and basal instability. Recommendations on how to address these issues have been outlined in the previous section.

7.5 Construction Inspection and Testing

Caisson construction should be monitored by qualified geotechnical personnel (as per OPSS 903) to verify the soil conditions and to confirm that those conditions are consistent with the design assumptions in this report.

THURBER ENGINEERING LTD.



Sydney Pang, P.Eng.
Associate, Senior Geotechnical Engineer



Alastair Gorman, P.Eng.
Associate, Senior Foundations Engineer



P.K. Chatterji, P.Eng.
Review Principal

TABLE 1
FOUNDATION DESIGN PARAMETERS
HIGHWAY 407/BROCK ROAD INTERCHANGE CONNECTION
OVERHEAD AND DUTCHMASTER SIGN SUPPORTS
Contract No: E2-2012

Sign Number and Location (Station)	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters						
				q _u (kPa)	φ' (deg.)	n _h (MN/m ³)	K _p	γ (kN/m ³)	γ' (kN/m ³)	Groundwater Depth (m)
OH-1 (16+841)	OHS-01	Sand (Fill) Sand	0.1 to 1.4 1.4 to 8.2	- -	30 33	3.0 5.0	3.0 3.3	20 20	- 10	4 (below existing grade)
	OHS-02	Sand Sand / Silt	0.2 to 2.0 2.0 to 8.2	- -	30 34	3.0 5.5	3.0 3.5	20 21	- 11	5 (below existing grade)
OH-2 (17+300)	OHS-03	Clayey Silt and Sand Till Sand Sand	0.1 to 2.4 2.4 to 6.0 6.0 to 8.2	200 - -	- 34 30	- 5.5 3.0	- 3.5 3.0	21 21 20	- 11 10	2 (below existing grade)
	OHS-04	Sand (Fill) Silty Sand Till Sand and Silt	0.1 to 1.6 1.6 to 4.1 4.1 to 8.2	- - -	30 32 34	3.0 4.0 5.5	3.0 3.2 3.5	20 20 21	- 10 11	3 (below existing grade)
OH-3 (18+421)	OHS-05	Clayey Silt and Sand Gravelly Sand Sand	0.1 to 3.0 3.0 to 7.3 7.3 to 8.2	40 - -	- 30 34	- 3.0 5.5	- 3.0 3.5	19 20 21	- 10 11	1 (below existing grade)
	OHS-06	Clayey Silt and Sand Gravelly Sand Sand	0.1 to 2.2 2.2 to 5.8 5.8 to 8.2	100 - -	- 30 33	- 3.0 5.0	- 3.0 3.3	20 20 21	- 10 11	1 (below existing grade)

Notes: 1. This table must be read in conjunction with the text of this report.

2. In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.2 m below final grade should be neglected in the foundation design.

Highway 407/Brock Road Interchange Connection
Overhead and Dutchmaster Sign Supports

Sign Number and Location (Station)	Reference Borehole	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters						
				q _u (kPa)	φ' (deg.)	n _h (MN/m ³)	K _p	γ (kN/m ³)	γ' (kN/m ³)	Groundwater Depth (m)
OH-4 (18+881)	OHS-07	Clayey Silt and Sand Till Clayey Silt & Sand Till	0.0 to 1.4 1.4 to 7.7	80 300	- -	- -	- -	20 22	- -	1 (below existing grade)
	OHS-08	Clayey Silt and Sand Till Clayey Silt and Sand Till	0.0 to 2.2 2.2 to 7.7	150 300	- -	- -	- -	20 22	- -	1 (below existing grade)
Dutchmaster Sign	SM9-01 and SM9-02	Sand	0.2 to 8.0	-	32	3.5	3.2	20	10	0 (at existing grade)

LEGEND

q_u	=	Unconfined Compressive Strength ($= 2 \times C_u$, undrained shear strength) (kPa)
ϕ'	=	Angle of Internal Friction (degrees)
n_h	=	Coefficient of Horizontal Subgrade Reaction (MN/m ³ or $\times 10^3$ kN/m ³)
K_p	=	Coefficient of Passive Earth Pressure
γ	=	Soil Unit Weight (kN/m ³)
γ'	=	Submerged Soil Unit Weight (kN/m ³) – to be used only for cohesionless soils below the groundwater table

Notes: 1.

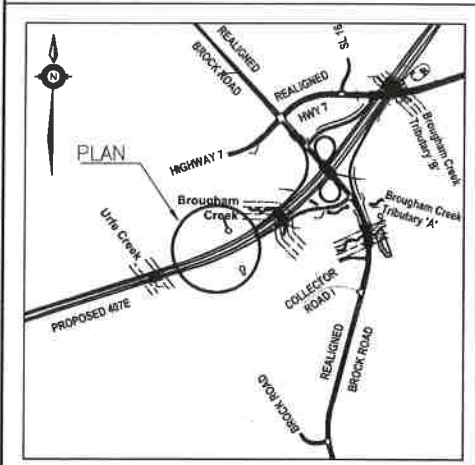
2. This table must be read in conjunction with the text of this report.
In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.2 m below final grade should be neglected in the foundation design.

NO.	DATE	REVISIONS	BY	CHK	LEAD	PROJ.

CONTRACT No. E2-2013
HWY 407/BROCK ROAD
INTERCHANGE

HWY 407-BROCK RD.
INTERCHANGE CONNECTION
OVERHEAD SIGNS
BOREHOLE LOCATIONS PLAN

SHEET



KEYPLAN

LEGEND	
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

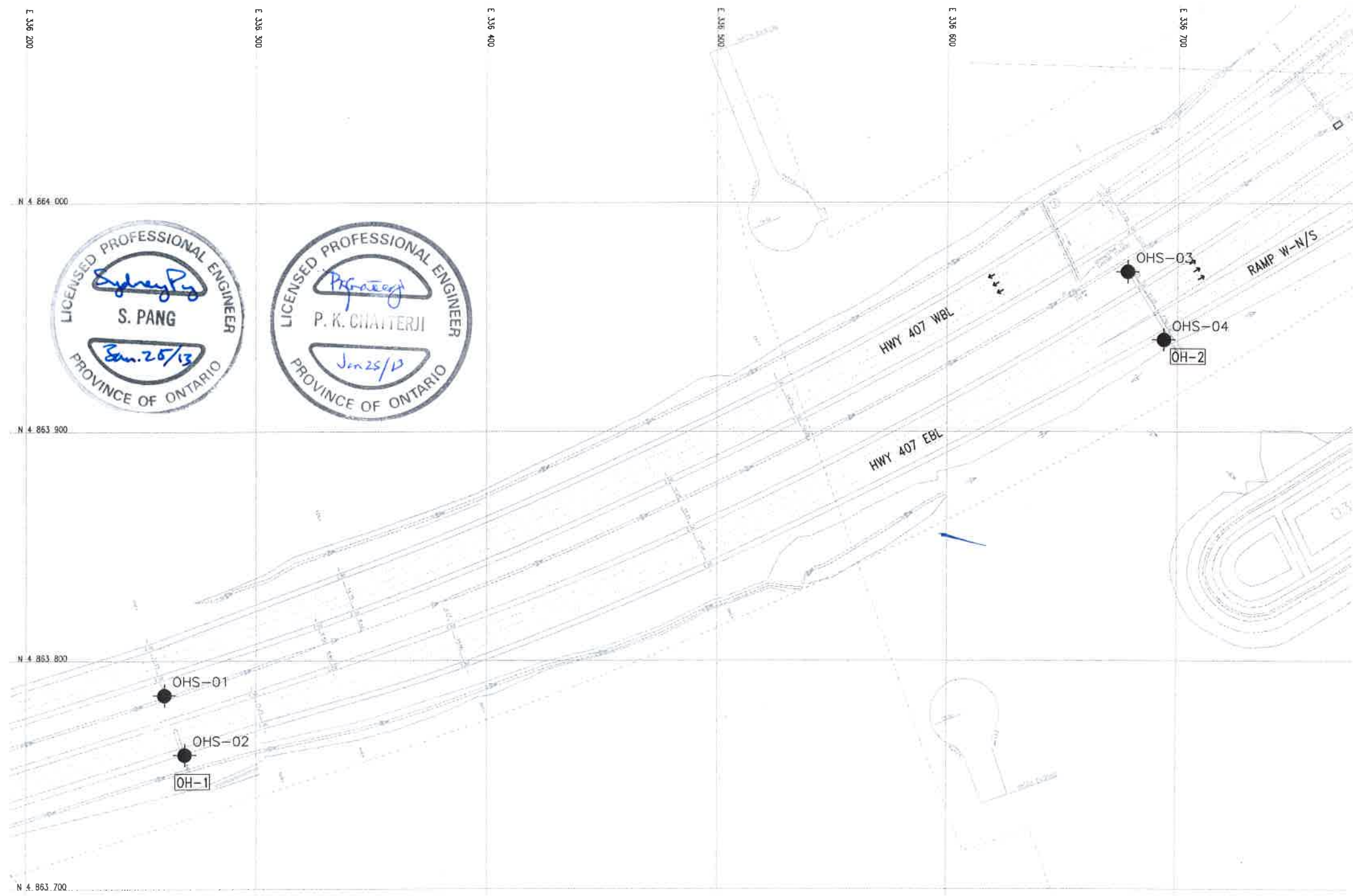
NO	ELEVATION	NORTHING	EASTING
OHS-01	195.4	4 863 785.0	336 260.2
OHS-02	195.9	4 863 759.0	336 269.0
OHS-03	188.9	4 863 969.9	336 678.3
OHS-04	191.1	4 863 940.2	336 694.1
OHS-05	169.5	4 864 816.9	337 396.5
OHS-06	168.7	4 864 795.0	337 424.6
OHS-07	177.6	4 865 184.9	337 676.4
OHS-08	177.6	4 865 169.1	337 693.8

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

DESIGN LRB	CHK LRB	CODE	LOAD	DATE	JAN 2013
DRAWN AN	CHK SKP	SITE	STRUCT	DWG	1

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



PLAN



DRAWING NAME: H:\Drafting\19\5161\130\led1130-Hwy407-BrockRoad-Plan.dwg
CREATED: November 21, 2012
MODIFIED: January 18, 2013

NO.	DATE	REVISIONS	BY	CHK	LEAD	INCH	MM

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONTRACT No. E2-2013
HWY 407/BROCK ROAD
INTERCHANGE
HWY 407-BROCK RD.
INTERCHANGE CONNECTION
OVERHEAD SIGNS
BOREHOLE LOCATIONS PLAN



KEYPLAN
LEGEND

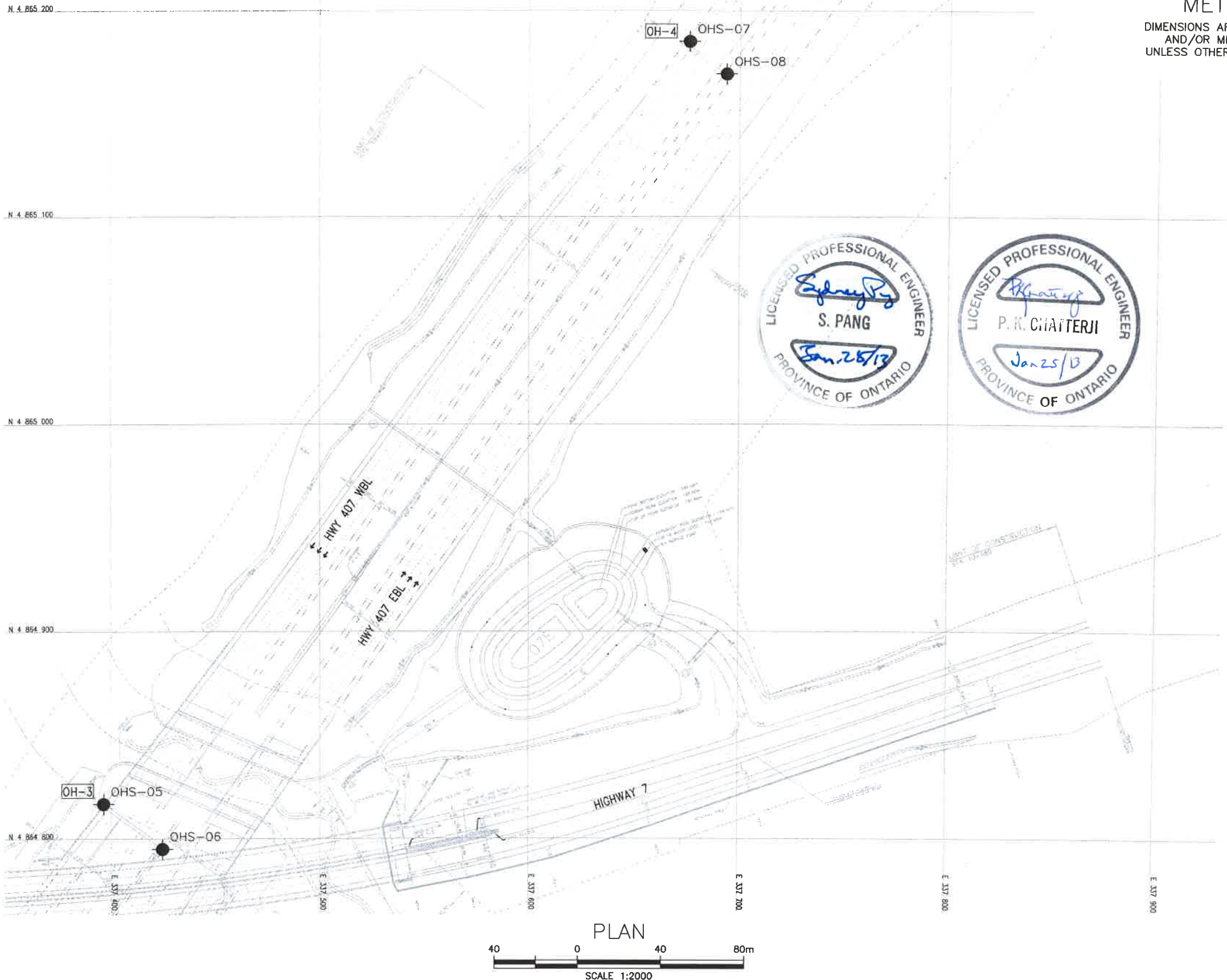
- Borehole
- ⊕ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- HA Head Artesian Water
- P Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
OHS-01	195.4	4 863 785.0	336 260.2
OHS-02	195.9	4 863 759.0	336 269.0
OHS-03	188.9	4 863 969.9	336 678.3
OHS-04	191.1	4 863 940.2	336 694.1
OHS-05	169.5	4 864 816.9	337 396.5
OHS-06	168.7	4 864 795.0	337 424.6
OHS-07	177.6	4 865 184.9	337 676.4
OHS-08	177.6	4 865 169.1	337 693.8

NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

DESIGN	LRB	CHK	LRB	CODE	LOAD	DATE	JAN 2013
DRAWN	AN	CHK	SKP	SITE	STRUCT	DWG	2



DRAWING NAME: H:\Drafting\19\3161\130\407-BrockRoad-Plan.dwg
CREATED: November 21, 2012
MODIFIED: January 18, 2013

Appendix A
Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT 'N' VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$



Water Level

C_{pen}





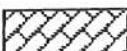
Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>		
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	Field Estimation of Hardness*
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m			
Medium bedded	0.2 to 0.6m	Very Strong	100-250	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m			
Very thinly bedded	20 to 60mm	Strong	50-100	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm			
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	Indented by thumbnail

<u>TERMS</u>	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

RECORD OF BOREHOLE No OHS-01

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 863 785.0 E 336 260.2 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.12.12 - 2012.12.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
195.4													
0.0	ASPHALT: (100mm)												
0.1	SAND, trace to some gravel, trace to some silt Compact Brown Moist (FILL)		1	GS			195						
			2	GS									
			3	SS	25								6 81 13 (SI+CL)
194.0							194						
1.4	SAND, trace to some silt, trace gravel Compact to Dense Brown Moist		4	SS	23								
			5	SS	37		193						
	Becoming wet		6	SS	28		192						
							191						
			7	SS	25								0 85 15 (SI+CL)
							190						
			8	SS	32		189						
							188						
	With clayey silt seams Grey		9	SS	44								
187.2													
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 5.0m AND WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.9m, CUTTINGS TO 0.1m THEN ASPHALT TO SURFACE.												

ONTMT4S 1130A.GPJ 1/8/13

RECORD OF BOREHOLE No OHS-02

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 863 759.0 E 336 269.0 ORIGINATED BY GA
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.12.17 - 2012.12.17 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
195.9							20 40 60 80 100	20 40 60						
0.0	TOPSOIL: (150mm)													
0.2	Clayey SILT and SAND, occasional rootlets		1	SS	12								0 40 45 15	
195.3	Stiff													
0.6	Brown													
	Moist													
	SAND, some silt		2	SS	14									
	Compact to Dense													
	Brown													
	Moist													
			3	SS	23									
			4	SS	46									
			5	SS	39								0 61 36 3	
	Becoming silty													
191.4														
4.5	SILT, some sand		6	SS	54									
	Very Dense													
	Brown													
	Wet													
189.8														
6.1	SAND		7	SS	43									
	Dense													
	Brown													
	Wet													
			8	SS	47									
187.7														
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 6.1m AND WATER LEVEL AT 6.1m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec. 18/12 5.0 190.9 Jan. 02/13 4.9 191.0 Jan. 09/13 4.9 191.0													

ONTWT4S 1130A.GPJ 1/18/13

+ 3, X 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS-03

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 863 969.9 E 336 678.3 ORIGINATED BY GA
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.12.14 - 2012.12.14 CHECKED BY LRB

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						
188.9								20 40 60 80 100						
0.0								○ UNCONFINED + FIELD VANE						
0.1	TOPSOIL: (100mm)							● QUICK TRIAXIAL × LAB VANE						
	Clayey SILT and SAND, trace gravel Stiff to Hard Brown Moist (TILL)		1	SS	8									
			2	SS	32		188							3 43 38 16
			3	SS	82		187							
186.4														
2.4	SAND, some silt Dense to Very Dense Brown Moist to Wet		4	SS	62		186							
			5	SS	38									
							185							
			6	SS	38		184							0 85 15 (SI+CL)
							183							
	Compact		7	SS	16		182							
							181							
180.6			8	SS	22									
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 6.1m AND WATER LEVEL AT 3.0m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec. 18/12 2.9 186.0 Jan. 02/13 0.9 188.0 Jan. 09/13 2.5 186.4													

ONTMT4S 1130A GPJ 1/18/13

+ 3, × 3: Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No OHS-04

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 863 940.2 E 336 694.1 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.12.12 - 2012.12.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
191.1												
0.0	ASPHALT: (100mm)											
0.1	SAND, some gravel, trace silt Brown Moist (FILL)		1	GS			191					
	Dense		2	SS	48		190					
189.5												
1.6	Silty SAND, some gravel, trace to some clay Compact Brown Moist (TILL)		3	SS	44		189					15 54 21 10
			4	SS	18		188					
			5	SS	26		187					
187.0												
4.1	SAND and SILT, trace clay Dense Brown Wet		6	SS	36		186					0 50 42 8
							185					
			7	SS	36		184					
	Trace gravel Grey		8	SS	43		183					
182.8												
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 5.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.7m, CUTTINGS TO 0.2m, THEN ASPALT TO SURFACE.											

ONTMT4S 1130A.GPJ 1/8/13

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No OHS-06

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 864 795.0 E 337 424.6 ORIGINATED BY RA
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.12.06 - 2012.12.06 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W P	W	W L		
168.7								20 40 60 80 100						GR SA SI CL
0.0	TOPSOIL: (125mm)							20 40 60 80 100						
0.1	Clayey SILT and SAND, trace gravel, some organics Stiff Brown Moist Wet sand layer (150mm) at 0.8m		1	SS	10		168							
			2	SS	10									
			3	SS	7		167							
166.5														
2.2	SAND and SILT, trace gravel, trace clay Very Dense Brown Wet (TILL)		4	SS	50/ 0.150		166							8 43 43 6
165.7														
3.0	Gravelly SAND, trace to some silt Compact Grey Wet		5	SS	25		165							
			6	SS	20		164							18 75 7 (SI+CL)
162.9							163							
5.8	SAND, trace silt Compact to Dense Grey Wet		7	SS	42		162							
			8	SS	24		161							
160.5														
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 4.9m AND WATER LEVEL AT 3.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.													

ONTMT4S 1130A GPJ 1/18/13

RECORD OF BOREHOLE No OHS-07

1 of 1

METRIC

WP# E2-2012 LOCATION N 4 865 184.9 E 337 676.4 ORIGINATED BY GA
 HWY 407 BOREHOLE TYPE Hollow Stem Augers/Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.12.03 - 2012.12.04 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE						w _p — w — w _L		
								● QUICK TRIAXIAL × LAB VANE								
177.6						20 40 60 80 100	20 40 60									
0.0	Clayey SILT and SAND, trace gravel Firm to Stiff Brown Moist (TILL)		1	SS	6											
			2	SS	12								4 39 47 10			
176.2																
1.4	Hard		3	SS	79											
			4	SS	75											
			5	SS	50/ 0.150											
			6	SS	110/ 0.150								4 41 36 19			
	Grey Sampler wet		7	SS	118/ 0.150											
169.9			8	SS	100/ 0.100											
7.7	END OF BOREHOLE AT 7.7m. BOREHOLE OPEN TO 7.7m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															





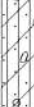
ONTMT4S 1130A GPJ 1/18/13

RECORD OF BOREHOLE No OHS-08

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 865 169.1 E 337 693.8 ORIGINATED BY GA
 HWY 407 BOREHOLE TYPE Hollow Stem Augers/Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.12.03 - 2012.12.04 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE					
177.6								20 40 60 80 100						
0.0	Clayey SILT and SAND, trace gravel Stiff to Very Stiff Brown Moist (TILL)		1	SS	11									
			2	SS	15									
			3	SS	16									
175.4														
2.2	Hard		4	SS	61									3 40 40 18
	Sampler wet		5	SS	86									
	Occasional cobbles													
			6	SS	100/ 0.150									
	Refusal at 4.7m with hollow stem augers. Installed piezometer. Moved 1 m south and continued with solid stem augers.													
			7	SS	100/ 0.150									9 38 33 20
169.9			8	SS	100/ 0.125									
7.7	END OF BOREHOLE AT 7.7m. BOREHOLE OPEN TO 7.7m AND WATER LEVEL AT 1.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jan. 02/13 0.8 176.8													

ONTMT4S 1130A GPJ 1/18/13

RECORD OF BOREHOLE No SM9-01

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 773.4 E 337 332.2 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2012.10.24 - 2012.10.24 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
172.6												
0.0	ORGANICS , with roots and rootlets: (200mm)											
0.2	SAND , some silt to silty, trace to some gravel Dense Brown Moist		1	SS	36		172					
			2	SS	33		171					3 71 26 (SI+CL)
	Gravelly		3	SS	45		170					
	Coarse grained Wet		4	SS	35		169					
			5	SS	46		168					
167.6	Sandy SILT Dense Brown Wet						167					
166.5												
6.1	SAND , some gravel, some silt Dense Brown Wet		6	SS	66		166					
166.2												
6.4	Silty SAND , some gravel Very Dense to Dense Brown to Grey Wet						165					11 69 20 (SI+CL)
	Grey		7	SS	59		164					
			8	SS	42		163					
162.8												
9.8	END OF BOREHOLE AT 9.8m.											

Continued Next Page

+ 3 x 3 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-01

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 773.4 E 337 332.2 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2012.10.24 - 2012.10.24 CHECKED BY LRB

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
	Continued From Previous Page BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, THEN CUTTINGS TO SURFACE.						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60					

RECORD OF BOREHOLE No SM9-02

1 OF 3

METRIC

WP# E2-2012 LOCATION N 4 864 785.9 E 337 346.3 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.10.10 - 2012.10.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60 80 100	20 40 60				
172.1														
0.0														
0.2	<div>ORGANICS, sandy, trace roots and rootlets Dark Brown Wet (200mm)</div> <div>Clayey SILT, some sand, trace gravel Very Stiff Brown (TILL)</div>													
170.7			1	SS	28									
1.4	<div>SAND, trace to some gravel, trace silt Dense Brown Moist</div> <div>Wet</div>		2	SS	41									
			3	SS	35									
			4	SS	31									
167.8														
4.3	<div>Gravelly SAND, trace to some silt Very Dense to Dense Brown Moist</div> <div>Wet</div> <div>Grey</div>		5	SS	100/ 0.125									
			6	SS	41									
			7	SS	37									
163.4														
8.7	<div>SAND, some silt to silty Dense to Very Dense Grey Wet</div>		8	SS	46									

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity
20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-02

2 OF 3

METRIC

WP# E2-2012 LOCATION N 4 864 785.9 E 337 346.3 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.10.10 - 2012.10.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page												
160.2	SAND, some silt to silty Dense to Very Dense Grey Wet		9	SS	58		162						
11.9	SILT and SAND, trace clay Very Dense Grey Wet		10	SS	63		161						
158.8	SAND, trace to some gravel, some silt Dense to Very Dense Grey Wet		11	SS	46		160						0 54 41 5
13.3	Silty		12	SS	38		159						
154.1	SILT and SAND, some clay, trace gravel Very Dense Grey Moist (TILL)		13	SS	78		158						
18.0			14	SS	73		157						7 44 38 11
							156						
							155						
							154						
							153						

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-02

3 OF 3

METRIC

WP# E2-2012 LOCATION N 4 864 785.9 E 337 346.3 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.10.10 - 2012.10.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
	Continued From Previous Page												
151.4	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL) Cobbles grinding at 20.5m		15	SS	100/ 0.175		152						
20.7	Silty SAND Very Dense Grey Moist to Wet		16	SS	100/ 0.175		151						0 63 32 5
149.2							150						
22.9	END OF BOREHOLE AT 22.9m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		17	SS	100/ 0.075								
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 16/12 2.8 169.3 Oct. 19/12 2.8 169.3 Oct. 22/12 2.8 169.3 Nov. 29/12 2.7 169.4 Dec. 12/12 3.2 168.9												

+³, ×³: Numbers refer to
Sensitivity

20
15
10

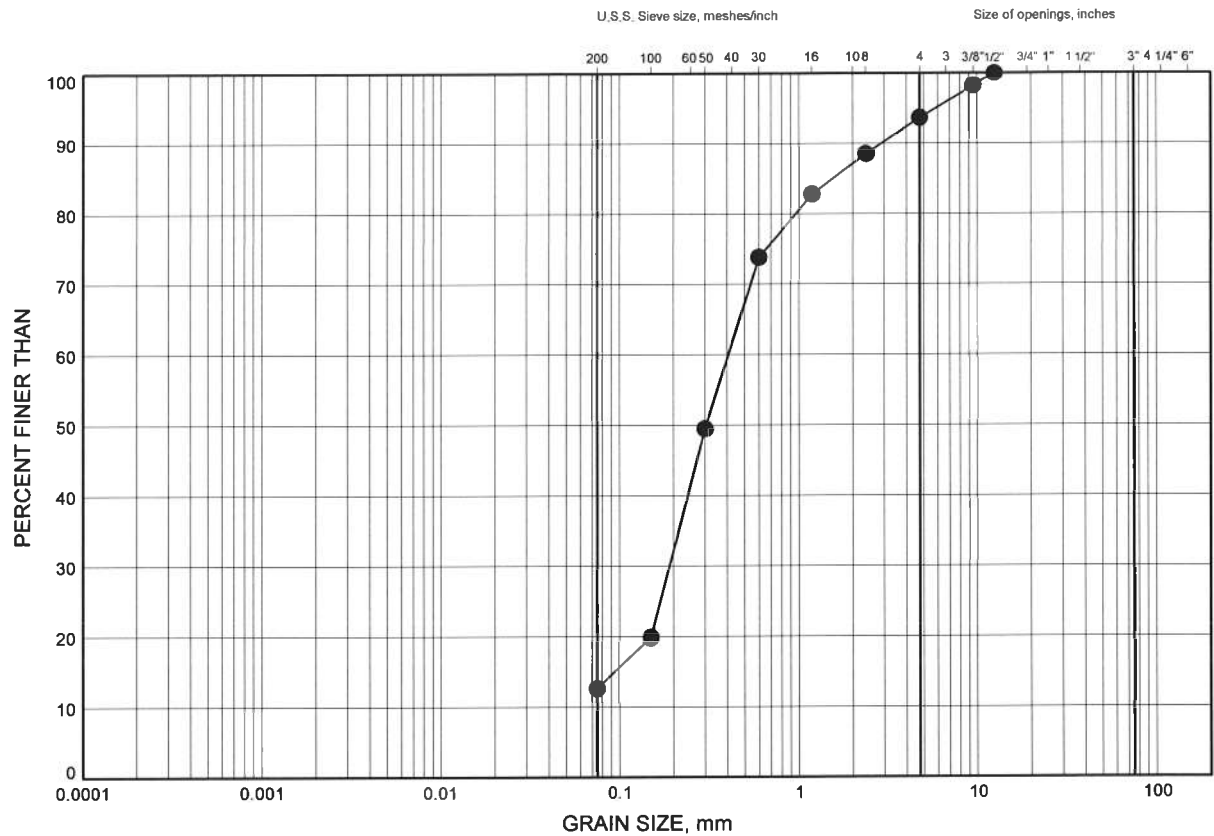
(%) STRAIN AT FAILURE

Appendix B
Geotechnical Laboratory Test Results

Hwy 407 Brock Road Connection - Foundations
GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-01	1.07	194.34

GRAIN SIZE DISTRIBUTION - THURBER 1130A.GPJ 1/8/13

Date January 2013
 WP# E2-2012



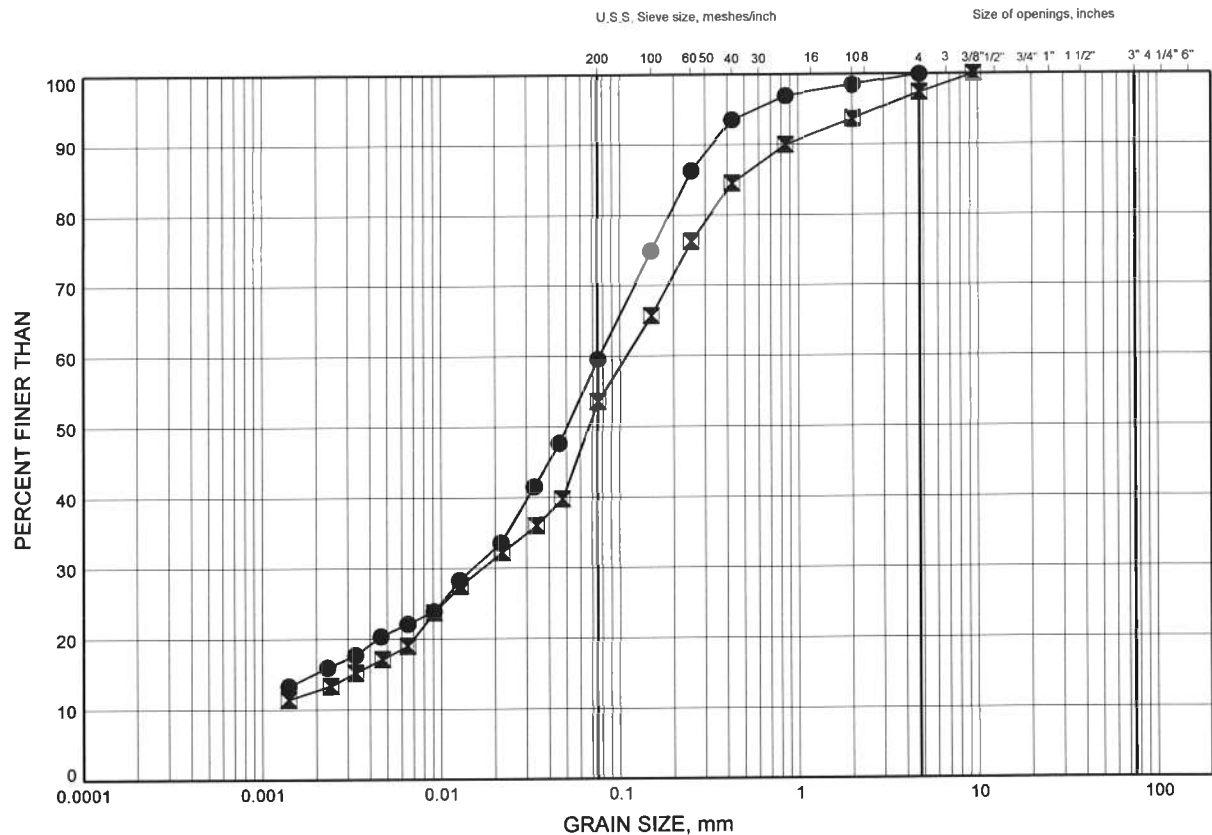
Prep'd AN
 Chkd. LRB

Hwy 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B2

CLAYEY SILT & SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-02	0.30	195.64
■	OHS-05	1.07	168.44

GRAIN SIZE DISTRIBUTION - THURBER 1130A.GPJ 1/8/13

Date January 2013
WP# E2-2012

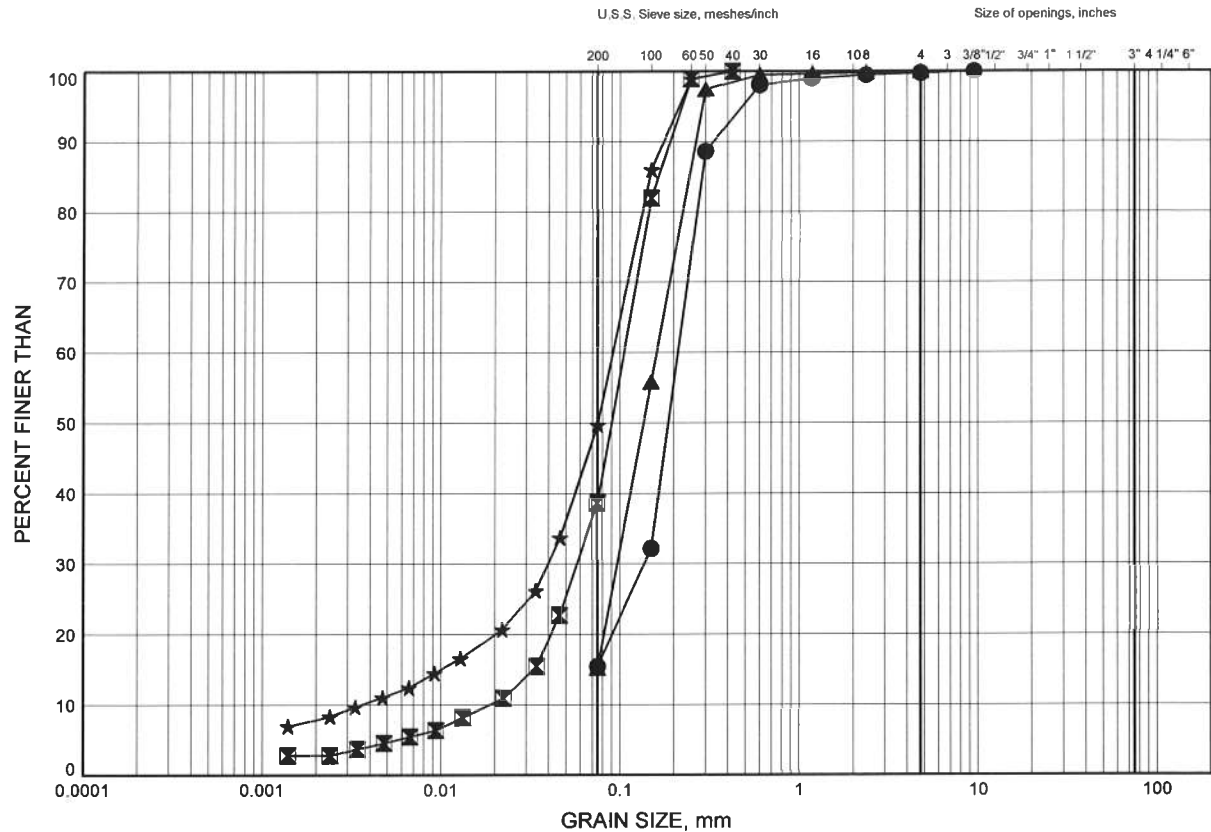


Prep'd AN
Chkd. LRB

Hwy 407 Brock Road Connection - Foundations
GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND & SILT to SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-01	4.88	190.53
⊠	OHS-02	3.35	192.59
▲	OHS-03	4.88	183.98
★	OHS-04	4.88	186.20

Date January 2013
 WP# E2-2012

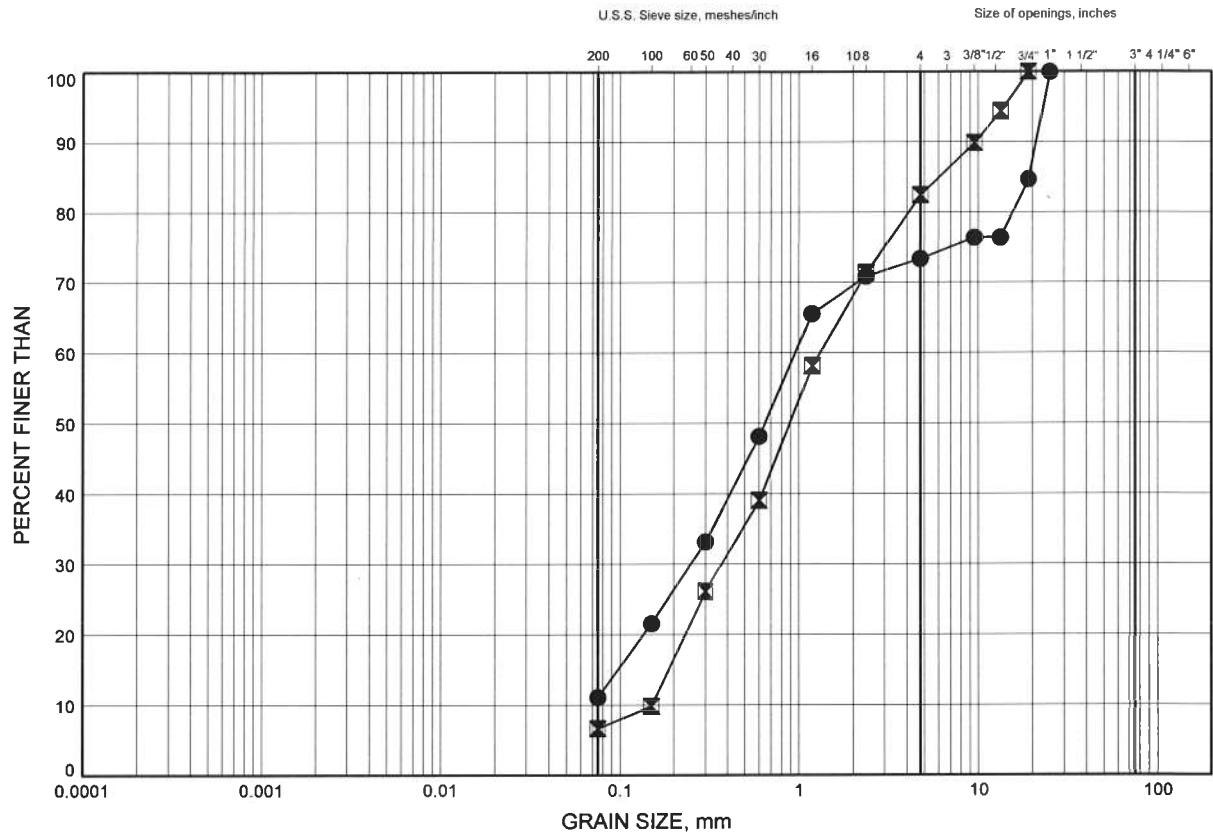


Prep'd AN
 Chkd. LRB

Hwy 407 Brock Road Connection - Foundations
GRAIN SIZE DISTRIBUTION

FIGURE B4

GRAVELLY SAND



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-05	6.40	163.10
⊠	OHS-06	4.88	163.85

GRAIN SIZE DISTRIBUTION - THURBER 1130A.GPJ 1/8/13

Date January 2013
 WP# E2-2012

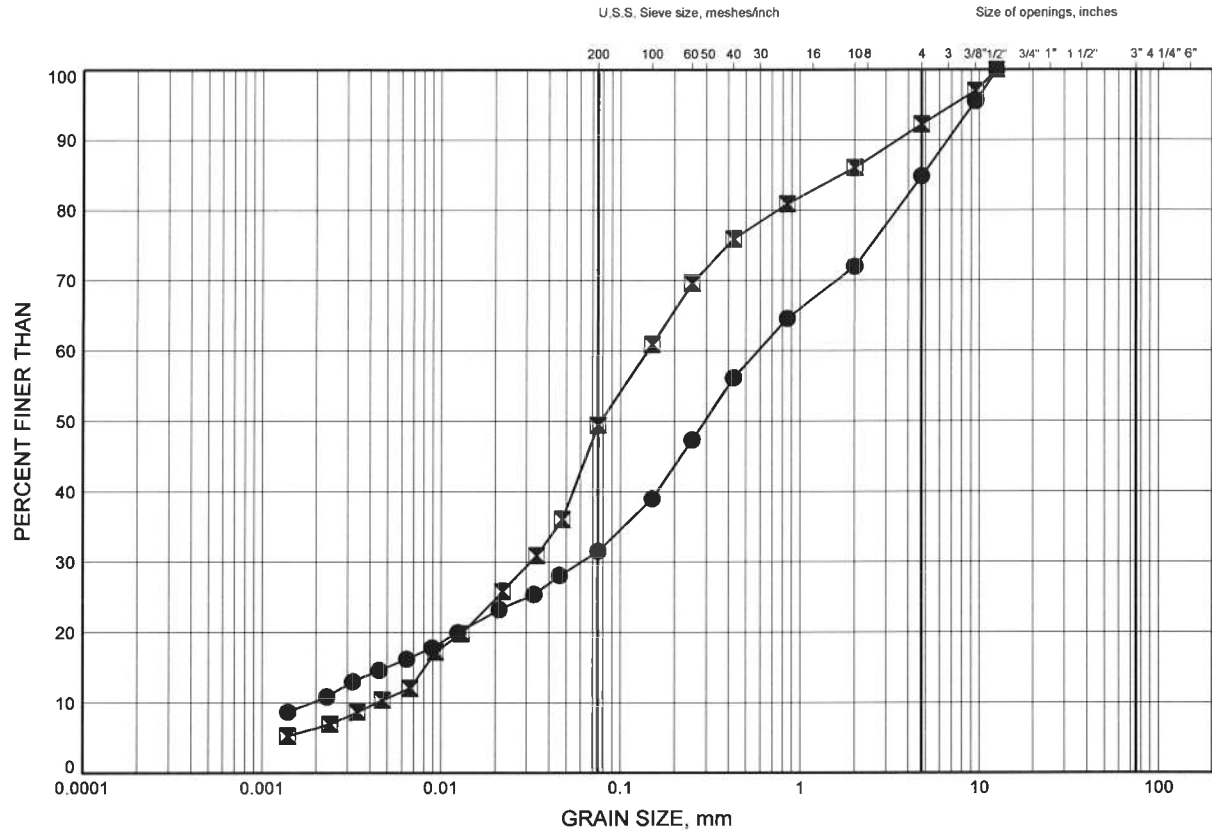


Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND & SILT to SILTY SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-04	1.83	189.25
■	OHS-06	2.59	166.14

Date January 2013
 WP# E2-2012



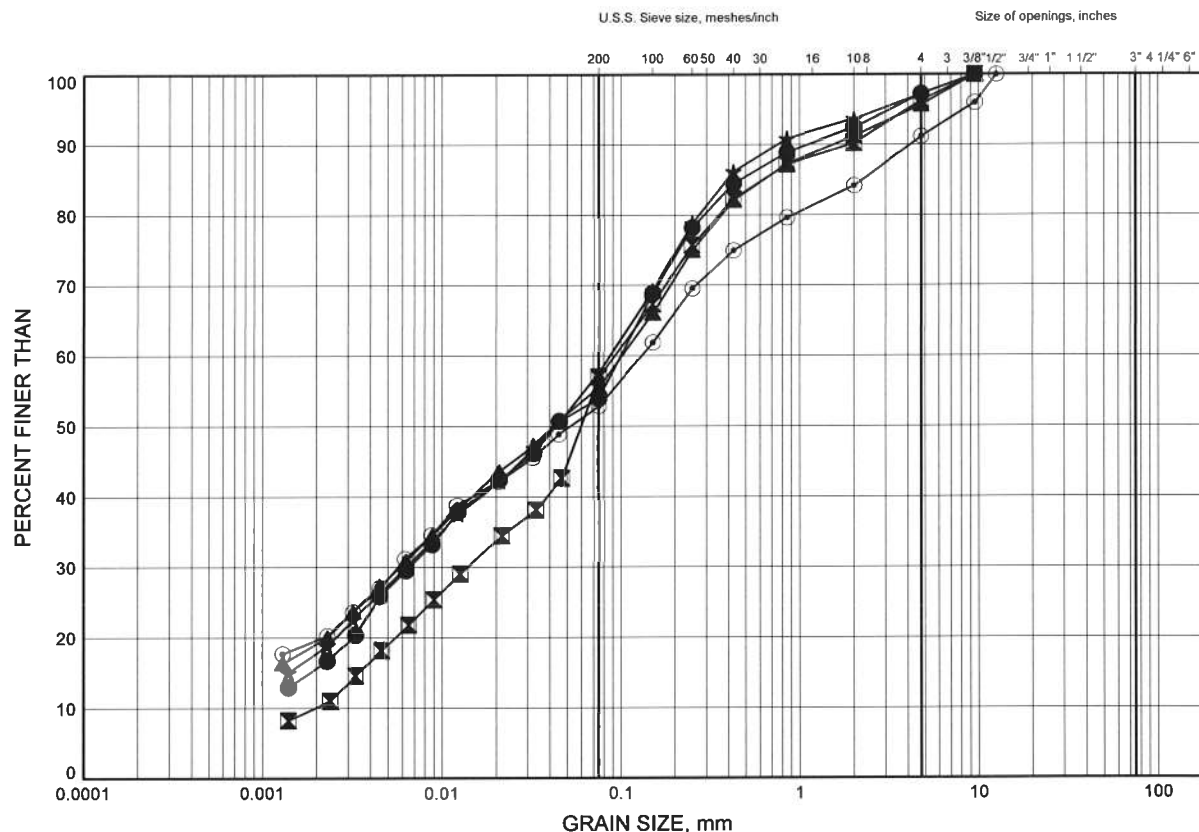
Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B6

CLAYEY SILT & SAND TILL



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND			GRAVEL		SIZE

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-03	1.07	187.79
⊠	OHS-07	1.07	176.52
▲	OHS-07	4.88	172.71
★	OHS-08	2.59	175.01
⊙	OHS-08	6.40	171.20

GRAIN SIZE DISTRIBUTION - THURBER 1130A GPJ 1/18/13

Date January 2013
WP# E2-2012

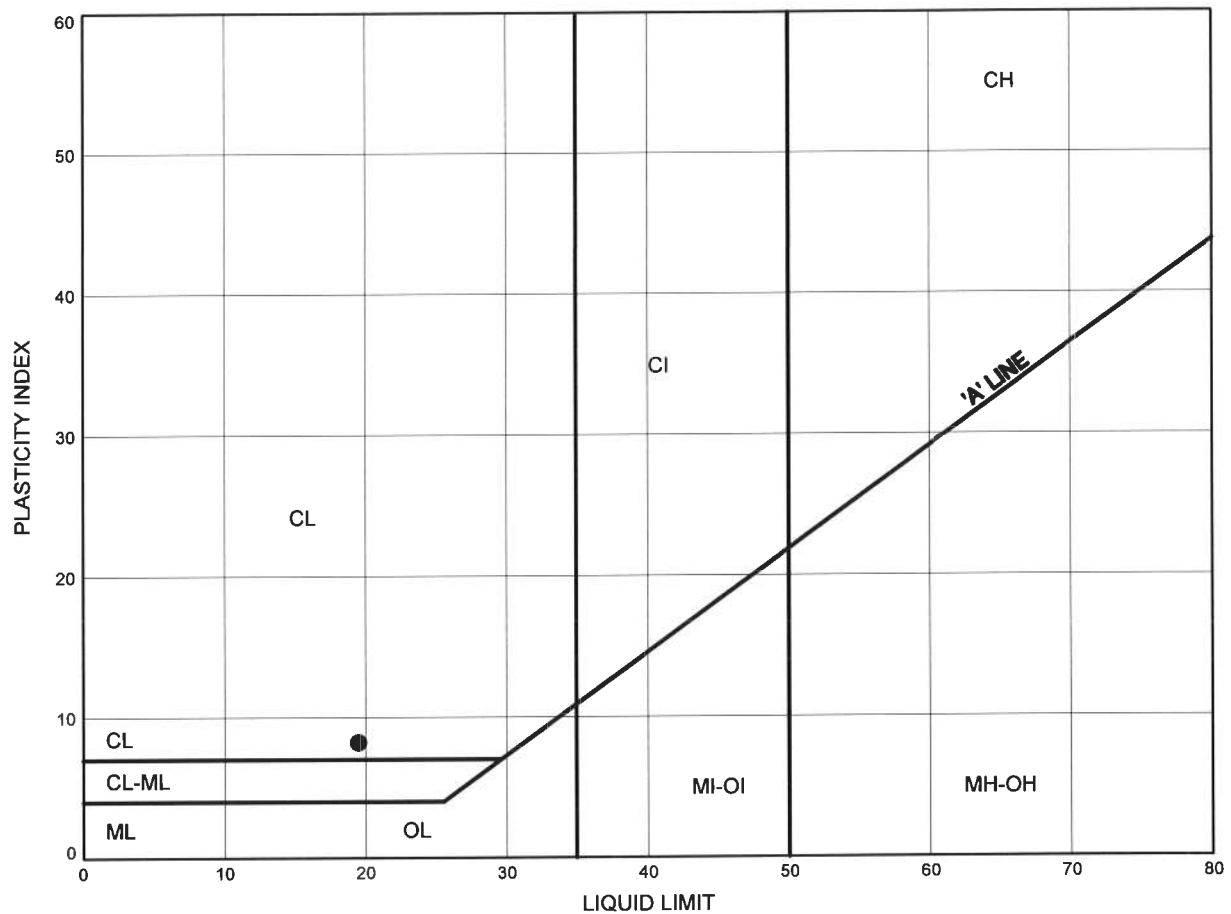


Prep'd AN
Chkd. LRB

Hwy 407 Brock Road Connection - Foundations
ATTERBERG LIMITS TEST RESULTS

FIGURE B7

CLAYEY SILT & SAND TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	OHS-07	1.07	176.52

Appendix C
List of SPs and NSSPs
Suggest Wordings for NSSP

List of Special Provisions Referenced in this Report

OPSS 903

Suggested Text for NSSP on:

“Augered Caisson Construction for Overhead and Dutchmaster Sign Support Foundations”

The Contractor is advised that variable types of subsurface materials may be encountered at the locations of the sign support foundations. For additional information regarding subsurface conditions, the Contractor is referred to the Foundation Investigation Report.

For bidding purposes, the Contractor shall assume the following:

1. The subsurface conditions at an augered caisson location are the same as those encountered in the borehole closest to the subject caisson location.
2. Cobbles, boulders and rock fragments may be encountered within the glacial till deposits. Obstructions including rubble, cobbles and boulders may also be present within the fills. The soil matrix is anticipated to become harder or denser with depth. Caisson installation equipment must be able to dislodge, handle, remove or otherwise penetrate these obstructions and hard/very dense layers.
3. Water seepage and/or soil sloughing into the caisson hole will occur from existing fill and cohesionless soils at some locations. The cohesionless soils would be susceptible to disturbance under conditions of unbalanced hydrostatic head. Temporary liners shall be available on site to support the caisson sidewalls and provide seepage cut-off where required. The tremie technique may be required to place the concrete.

The Contractor is responsible for constructing the sign support foundations without disturbing the material at the sides or bases of the foundations.