

**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 407/BROCK ROAD INTERCHANGE CONNECTION
STRUCTURE M-9
REALIGNED HWY 7
OVER BROUGHAM CREEK TRIBUTARY 'B' AND HWY 407
Contract No: E2-2012**

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the proposed location of a new bridge (and associated approach fills and retaining wall) that will carry the realigned Highway 7 over Brougham Creek Tributary 'B' and the new Highway 407, in The City of Pickering, Ontario. The new bridge, approach fills, and retaining wall are planned as part of the Highway 407 east extension and is to be completed as part of the Highway 407/Brock Road Interchange Connection project.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile and sections, laboratory test results and written descriptions of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

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 bridge site is located just east of Sideline 16 and extends from Highway 7 to north of Highway 7 at Brougham Creek Tributary 'B'. The community of Brougham is located approximately 1.1 km west of the proposed bridge site.

At the location of the proposed bridge, Brougham Creek Tributary 'B' flows from north to south. The creek flows in a valley that is approximately 6 m below the existing highway grade. Lands surrounding the bridge site consist primarily of agricultural fields and undeveloped areas within the Highway 407/Highway 7 right-of-way. Selected site photographs are included in Appendix D.

The site is situated in the physiographic region known as the South Slope, which lies between the Oak Ridges Moraine and the Iroquois Plain and typically is characterized by overburden deposits

consisting of sand and silt, overlying glacial till sheets. Lacustrine clay deposited by Lake Iroquois, is often encountered between or overlying the till sheets.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this bridge and associated high fills and retaining wall were carried out from October 10 to 24 and November 29 to December 13, 2012 and on January 9, 2013 and consisted of drilling and sampling a total of fifteen boreholes (identified as SM9-01 to SM9-10, RW-03 to RW-06, and BH-F4). Two boreholes were drilled near each of the east and west abutments (SM9-08 & SM9-09 and SM9-02 & SM9-03) and the two piers (SM9-04 to SM9-07) and one borehole was drilled at the east and west approaches (SM9-10 and SM9-01). Four boreholes were drilled along the proposed retaining wall alignment (RW-03 to RW-06) and one borehole (BH-F4) was drilled at the west end of the high fill approaching the west abutment. The boreholes were advanced to depths ranging from 5.2 to 32.0 m below the existing ground surface (Elevation 169.6 to 134.4 m). The Record of Borehole sheets are included in Appendix A.

The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawings included in Appendix F.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling. Double row silt fencing with straw bales was installed at each drilling location that was located within the protected zone identified by The Ministry of Natural Resources (MNR) to prevent sediment laden water from entering Brougham Creek Tributary 'B'.

Drilling was carried out using various track mounted drill rigs (and a truck-mounted drill rig for Boreholes SM9-09 and RW-03 to RW-06). A combination of solid stem augers, hollow stem augers, and tricone methods were used to advance the boreholes. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (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.

Where practical, groundwater conditions were observed in the open boreholes upon completion of the drilling operations. Standpipe piezometers (consisting of 25 mm diameter PVC pipe with a 1.5 m long slotted screen) and monitoring wells (consisting of 50 mm diameter PVC pipe with a 3.0 m long screen) were installed in selected boreholes at this site. The completion details of the piezometers/monitoring wells and boreholes are summarized in Table 3.1. The boreholes were backfilled in general accordance with O.Reg. 903.

Table 3-1. Borehole Completion and Piezometer Installation Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Borehole Backfilling Details
BH-F4	None installed	Backfilled with bentonite holeplug to 1.6 m, then cuttings to surface.
SM9-01	None installed	Backfilled with bentonite holeplug to 0.6 m, then cuttings to surface.
SM9-02	22.8 / 149.3	Piezometer with 1.5 m slotted screen installed with sand filter to 20.5 m, bentonite from 20.5 to 0.8 m, then sand to surface.
SM9-03	None installed	Backfilled with bentonite holeplug to surface.
SM9-04	13.3 / 155.7	50 mm well with 1.5 m screen installed with sand filter to 10.8 m and bentonite from 10.8 m to surface.
	6.6 / 162.4	50 mm well with 1.5 m screen installed with filter sand to 4.0 m and bentonite from 4.0 m to surface.
SM9-05	None installed	Backfilled with bentonite holeplug to surface.
SM9-06	11.9 / 152.7	Piezometer with 1.5 m slotted screen installed with sand filter to 10.1 m then bentonite from 10.1 to surface.
SM9-07	None installed	Backfilled with bentonite holeplug to 0.3 m, then sand and gravel to surface.
SM9-08	15.2 / 151.0	50 mm well with 3.0 m screen installed with sand filter to 11.9 m and bentonite from 11.9 m to surface.
SM9-09	None installed	Borehole grouted upon completion.
SM9-10	None installed	Borehole sloughed to 4.3 m. Backfilled with bentonite holeplug from 4.3 to 2.7 m, cuttings from 2.7 to 0.6 m, then bentonite to surface.
RW-03	None installed	Backfilled with bentonite holeplug to 2.3 m, cuttings from 2.3 to 0.2 m, then asphalt to surface.
RW-04	7.6 / 159.4	Piezometer with 1.5 m slotted screen installed with filter sand to 5.6 m, bentonite holeplug from 5.6 to 1.5 m, cutting from 1.5 to 0.2 m, then cement to surface.
RW-05	None installed	Backfilled with bentonite holeplug to 2.4 m, cuttings from 2.4 to 0.15 m, then asphalt to surface.
RW-06	5.2 / 163.4	Piezometer with 1.5 m slotted screen installed with filter sand to 3.3 m, bentonite holeplug from 3.3 to 1.2 m, cutting from 1.2 to 0.2 m, then concrete to surface.

The piezometers and monitoring wells will be decommissioned in accordance with O.Reg. 903 after a period of groundwater monitoring.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to 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 are presented on the figures included in Appendix B.

Selected soil samples were submitted to a qualified laboratory for pH and soluble sulphate testing. The laboratory Certificate of Analysis is provided in Appendix B, following the figures.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy at the proposed bridge site are presented on the "Borehole Locations and Soil Strata" drawings included in Appendix F. An overall description of the stratigraphy encountered at the proposed bridge site 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 Asphalt

Asphalt was encountered at the surface in Boreholes RW-03 to RW-06, which were drilled through the existing Highway 7 embankment, east of Sideline 16. The asphalt was 260 to 300 mm thick in these boreholes.

5.2 Organics and Peat

A thin layer of organics was encountered at surface in Boreholes BH-F4, SM9-01 to SM9-03 and SM9-05 and a layer of peat was encountered at surface in Borehole SM9-06.

The thickness of the organic layer ranged from 150 to 225 mm.

The peat in Borehole SM9-06 was 1.2 m thick, with the lower boundary of the peat encountered at Elevation 163.4 m. SPT N-values recorded in the peat layer ranged from 0 to 2 blows for 0.3 m penetration, indicating a very soft consistency. Moisture contents of 160 to 287% were measured in samples of the peat.

A layer of organics with sand and silt was also encountered below the sand fill in Borehole SM9-10. This layer of organics was 0.9 m thick with the lower boundary of this layer encountered at a depth of 3.0 m (Elevation 163.3 m). An SPT N-value of 3 blows for 0.3 m penetration was recorded in this layer, indicating a very loose relative density. A moisture content of 22% was measured in this layer.

The presence and thickness of the organic layer and peat deposits may vary between and beyond the borehole locations.

5.3 Sand Fill

A layer of sand fill was encountered in Boreholes RW-03 to RW-06 and SM9-07, SM9-09, and SM9-10, all of which were drilled through the new Highway 7 embankment. The sand fill was brown and contained trace silt to silty, trace to some gravel, occasional gravelly zones, occasional asphalt fragments, and occasional clay pockets. Occasional cobbles were inferred during drilling.

The thickness of the fill ranged from 1.1 to 4.3 m, with the lower boundary of the fill encountered at depths of 1.4 to 4.3 (Elevations 167.2 to 163.2 m).

SPT N-values recorded in the sand fill ranged from 9 to 42 blows for 0.3 m penetration, indicating a loose to dense relative density. Moisture contents ranged from 4 to 14%.

Four samples of the sand fill 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 B1, Appendix B.

Soil Particles	Gravelly Sand Fill	Sand Fill
Gravel (%)	28	3 to 11
Sand (%)	52	46 to 83
Silt (%)	-	11 to 33
Clay (%)	-	3 to 13
Silt and Clay (%)	20	-

5.4 Clayey Silt / Silty Clay

A layer of clayey silt, 0.5 m thick, was encountered below the surficial organic layer in Borehole SM9-03 and a layer of silty clay was encountered at surface in Borehole SM9-04 and below the sand fill in Borehole SM9-07. The silty clay was dark brown to brown in colour and contained trace sand to sandy, trace gravel (in Borehole SM9-07), and some organics and wood fibres.

In Borehole SM9-04, the silty clay was 1.5 m thick, with the lower boundary encountered at Elevation 167.5 m while in Borehole SM9-07 the silty clay layer was 0.6 m thick with the lower boundary encountered at a depth of 4.9 m (Elevation 162.6).

SPT N-values recorded in the silty clay layer ranged from 4 to 12 blows for 0.3 m penetration, indicating a firm to stiff consistency. A moisture content of 36% was recorded in the silty clay in Borehole SM9-04.

5.5 Sand to Silty Sand

Layers of native brown to grey sand containing trace silt to silty, trace to some gravel, occasional gravelly zones, and trace clay were the predominant foundation soil deposit and these deposits were encountered at the depths and elevations indicated in Table 5.1.

In Boreholes RW-03 and RW-05, the upper 1 to 2 m of the sand was organic, with roots and rootlets, occasional wood fragments and occasional peat pockets.

Table 5.1 – Depths and Elevations of Sand to Silty Sand Layers

Foundation Element	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
West Approach and Abutment	BH-F4	3.4 to 6.7	172.9 to 169.6	3.3
	SM9-01	0.2 to 5.0	172.4 to 167.6	4.8
		6.1 to 9.8 (Borehole termination depth)	166.5 to 162.8	3.7
	SM9-02	1.4 to 4.3	170.7 to 167.8	2.9
		8.7 to 11.9	163.4 to 160.2	3.2
		13.3 to 18.0	158.8 to 154.1	4.7
		20.7 to 22.9 (Borehole termination depth)	151.4 to 149.2	2.2
	SM9-03	0.7 to 4.9	171.1 to 166.9	4.2
		6.1 to 15.6	165.7 to 156.2	9.5
		19.0 to 21.6 (Borehole termination depth)	152.8 to 150.2	2.6
Pier 1	SM9-04	1.5 to 2.2	167.5 to 166.8	0.7
		3.1 to 7.3	165.9 to 161.7	4.2
	SM9-05	2.0 to 2.2	167.1 to 166.9	0.2
		4.1 to 8.8	165.0 to 160.3	4.7
Pier 2	SM9-06	1.2 to 12.3 (Borehole termination depth)	163.4 to 152.3	11.1
	SM9-07	6.1 to 9.1	161.3 to 158.3	3.0
		12.2 to 13.7	155.3 to 153.7	1.5
		16.8 to 18.4 (Borehole termination depth)	150.7 to 149.0	1.6
East Approach and Abutment	SM9-08	7.6 to 10.7	158.6 to 155.5	3.1
	SM9-09	10.6 to 16.6	155.8 to 149.8	6.0
		19.5 to 21.3	146.9 to 145.1	1.8
	SM9-10	3.0 to 4.3	163.3 to 162.1	1.3
		10.2 to 12.8 (Borehole termination depth)	156.1 to 153.5	2.6
Retaining Wall at East Approach	RW-03	2.3 to 11.3 (Borehole termination depth)	164.0 to 155.0	9.0
	RW-04	4.1 to 8.2 (Borehole termination depth)	162.9 to 158.8	4.1
	RW-05	1.6 to 3.2	166.3 to 164.7	1.6
	RW-06	3.0 to 5.2 (Borehole termination depth)	165.6 to 163.4	2.2

SPT N-values recorded in the sand/silty sand layers ranged from 4 blows for 0.3 m penetration to 100 blows for less than 0.3 m penetration, indicating a variable relative density ranging from loose to very dense. Typically, SPT N-values recorded in the sand/silty sand

ranged from 20 to 50 blows for 0.3 m penetration (compact to dense). Higher N-values were typically encountered at greater depth. Moisture contents ranged from 2 to 26%, typically 10 to 20%.

Fifteen samples of the sand/silty sand were selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figures B2, B3, and B4, Appendix B.

Soil Particles	Percentage (%)
Gravel	0 to 29
Sand	60 to 92
Silt	12 to 32
Clay	4 to 5
Silt and Clay	2 to 26

5.6 Gravelly Sand to Sand and Gravel

Localized gravelly sand to sand and gravel deposits were encountered within the sand layers in Boreholes RW-04, RW-05, SM9-02, SM9-08, and SM9-10 at various depths. The gravelly sand to sand and gravel was brown to grey and contained trace to some silt and occasional cobbles. The depths and elevations at which the gravelly sand to sand and gravel deposits were encountered are summarized on Table 5.2.

Table 5.2 – Depths and Elevations of Gravelly Sand and Sand & Gravel Layers

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
RW-04	2.1 to 4.1	164.9 to 162.9	2.0
RW-05	3.2 to 6.7 (Borehole termination depth)	164.7 to 161.2	3.5
SM9-02	4.3 to 8.7	167.8 to 163.4	4.4
SM9-08	10.7 to 17.2 (Borehole termination depth)	155.5 to 149.0	6.5
SM9-10	8.7 to 10.2	157.7 to 156.1	1.5

SPT N-values recorded in the gravelly sand to sand and gravel deposits ranged from 31 blows for 0.3 m penetration to 100 blows for less than 0.3 m penetration, indicating a dense to very dense relative density. Moisture contents ranged from 3 to 16%.

Three samples of the sand and gravel 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	34 to 48
Sand	42 to 52
Silt and Clay	10 to 14

5.7 Sandy Silt to Silty Sand Till

Interlayered within the sands and silts and underlying the sands and silts, layers of sandy silt to silty sand till were encountered at the depths and elevations indicated in Table 5.3. The sandy silt to silty sand till contained trace to some clay, with some clayey zones, and trace to some gravel with occasional gravelly and cobble zones.

Table 5.3 – Depths and Elevations of Sandy Silt to Silty Sand Till

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
BH-F4	0.2 to 3.4	176.1 to 172.9	3.2
RW-06	1.4 to 3.0	167.2 to 165.6	1.6
SM9-02	0.2 to 1.4	171.9 to 170.7	1.2
	18.0 to 20.7	154.1 to 151.4	2.7
SM9-03	4.9 to 6.1	166.9 to 165.7	1.2
	16.6 to 18.3	155.2 to 153.5	1.7
SM9-04	2.2 to 3.1	166.8 to 165.9	0.9
	7.3 to 10.2	161.7 to 158.8	2.9
	13.3 to 13.9 (Borehole termination depth)	155.7 to 155.1	0.6
SM9-05	0.2 to 2.0	168.9 to 167.1	1.8
	2.2 to 4.1	166.9 to 165.0	1.9
	10.4 to 13.9 (Borehole termination depth)	158.7 to 155.2	3.5
SM9-07	4.9 to 6.1	162.6 to 161.3	1.2
	9.1 to 12.2	158.3 to 155.3	3.1
SM9-08	0.0 to 7.6	166.2 to 158.6	7.6
SM9-09	3.0 to 10.6	163.4 to 155.8	7.6
SM9-10	4.3 to 7.2	162.1 to 159.2	2.9

In Borehole RW-06 only, the till consisted of brown, stiff to very stiff clayey silt and sand.

SPT N-values recorded in the sandy silt and silty sand till ranged from 5 blows for 0.3 m penetration to 100 blows for less than 0.3 m penetration, indicating a variable relative density ranging from loose to very dense. Typically, N-values were greater than 30 blows for 0.3 m penetration (dense). Moisture contents ranged from 5 to 16%.

Twelve samples of the sandy silt and silty sand till and one sample of the clayey silt and sand till underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the corresponding Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figures B6 to B8, Appendix B.

Soil Particles	Sandy Silt to Silty Sand Till	Clayey Silt and Sand Till
Gravel (%)	0 to 22	0
Sand (%)	33 to 63	28
Silt (%)	17 to 46	42
Clay (%)	3 to 21	30

One sample of the silty sand till exhibited sufficient plasticity for Atterberg Limits testing, the results of which are summarized below.

Index Property	Percentage (%)
Liquid Limit	22
Plastic Limit	12
Plasticity Index	10

The results of the Atterberg Limits testing indicate that the silty sand till has occasional low plastic zones with a group symbol of CL as plotted of Figure B11, Appendix B.

Glacial tills inherently contain cobbles and boulders.

5.8 Silt to Sandy Silt

Localized layers of silt to sandy silt were encountered within the sand deposit in some boreholes at various depths. The depths and elevations at which the silt to sandy silt layers were encountered are summarized in Table 5.4. The silt to sandy silt was brown to grey and contained trace to some clay, occasional gravel and occasional clay pockets (Borehole SM9-09).

Table 5.4 – Depths and Elevations of Silt to Sandy Silt Layers

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
SM9-01	5.0 to 6.1	167.6 to 166.5	1.1
SM9-02	11.9 to 13.3	160.2 to 158.8	1.4
SM9-03	15.6 to 16.6	156.2 to 155.2	1.0
	18.3 to 19.0	153.5 to 152.8	0.7
SM9-04	10.2 to 13.3	158.8 to 155.7	3.1
SM9-05	8.8 to 10.4	160.3 to 158.7	1.6
SM9-09	28.8 to 32.0 (Borehole termination depth)	137.6 to 134.4	3.2
SM9-10	7.2 to 8.7	159.2 to 157.7	1.5

SPT N-values recorded in the silt to sandy silt layers ranged from 25 blows for 0.3 m penetration to 100 blows for less than 0.3 m penetration, indicating a compact to very dense relative density. Moisture contents ranged from 15 to 30%.

Five samples of the silt to sandy silt underwent 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 plotted on Figure B9, Appendix B.

Soil Particles	Percentage (%)
Gravel	0 to 1
Sand	3 to 54
Silt	21 to 81
Clay	5 to 41

5.9 Silty Clay

A layer of silty clay was encountered at depth in Boreholes SM9-07 and SM9-09. The silty clay was grey and contained trace sand. A single layer of silty clay was encountered in Borehole SM9-07 while two layers of silty clay were encountered in Borehole SM9-09. The depths and elevations at which the silty clay was encountered in these boreholes are summarized below.

Table 5.5 – Depths and Elevations of Silty Clay Layers

Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
SM9-07	13.7 to 16.8	153.7 to 150.7	3.1
SM9-09	16.6 to 19.5	149.8 to 146.9	2.9
	21.3 to 28.8	145.1 to 137.6	7.5

SPT N-values recorded in the silty clay ranged from 28 blows for 0.3 m penetration to greater than 100 blows for 0.15 m penetration, indicating a very stiff to hard consistency. Moisture content ranged from 17 to 28%.

Two samples of the silty clay underwent laboratory grain size analysis testing and one sample underwent Atterberg Limits 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 B10, Appendix B.

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 8
Silt	22 to 32
Clay	60 to 78

Index Property	Percentage (%)
Liquid Limit	53
Plastic Limit	24
Plasticity Index	29

The results of the Atterberg Limits testing indicate that the silty clay is high plastic with a group symbol of CH as plotted of Figure B12, Appendix B.

5.10 Groundwater Levels

Where practical, groundwater levels were observed in the open boreholes upon completion of the drilling. One 25 mm diameter piezometer and three 50 mm diameter monitoring wells were installed at this site to monitor groundwater levels. The measured groundwater levels are summarized in Table 5.1.

Table 5.1. Measured Groundwater Levels

Borehole	Date	Groundwater Level (m)		Comment
		Depth (m)	Elevation (m)	
SM9-02	Oct.16, 2012	2.8	169.3	25 mm piezometer
	Oct.19, 2012	2.8	169.3	
	Oct.22, 2012	2.8	169.3	
	Nov.29, 2012	2.7	169.4	
	Dec. 5, 2012	3.0	168.7	
	Dec.12, 2012	3.2	168.9	
	Jan. 2, 2013	2.7	169.4	
SM9-04 (Deep)	Oct.19, 2012	1.5	167.5	50 mm well
	Oct.26, 2012	1.4	167.6	
	Nov.27, 2012	1.4	167.6	
	Nov.29, 2012	1.4	167.6	
	Dec. 4, 2012	1.4	167.6	
	Dec.12, 2012	1.6	167.4	
	Jan. 2, 2013	1.6	167.4	
SM9-04 (Shallow)	Oct.19, 2012	0.7	168.3	50 mm well
	Oct.26, 2012	0.9	168.1	
	Nov.27, 2012	0.9	168.1	
	Nov.29, 2012	0.9	168.1	
	Dec. 4, 2012	0.8	168.2	
	Dec.12, 2012	1.1	167.9	
	Jan. 2, 2013	0.8	168.2	
SM9-06	Dec.13, 2012	0.6	164.0	Upon completion
	Dec.18, 2012	0.2*	164.8	25 mm piezometer
	Jan.2, 2013	0.4* (frozen)	165.0	25 mm piezometer
SM9-07	Nov. 30, 2012	2.1	165.3	Upon completion
SM9-08	Dec.12, 2012	8.7	157.5	50 mm well
	Dec.19, 2012	8.6	157.6	
	Jan. 2, 2013	8.6	157.6	
SM9-09	Nov.29, 2012	6.1	160.3	Upon completion
SM9-10	Nov.30, 2012	3.4	162.9	Upon completion

* *Water level above ground surface. Artesian condition.*

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 precipitation.

6 MISCELLANEOUS

The borehole locations were selected by Thurber Engineering Ltd. and staked in the field using Trimble Pathfinder ProXRT differential GPS. 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 a track-mounted drill rig (and a truck-mounted rig for Boreholes SM9-09 and RW-03 to RW-06) and conducted the drilling, sampling and in-situ testing operations for Boreholes SM9-01 to SM9-09. Malone's Soil Samples Co. Ltd. of Bolton, Ontario supplied a track-mounted drill rig and conducted the drilling, sampling and in-situ testing operations for Borehole SM9-10. Walker Drilling Ltd of Barrie, Ontario supplied a track-mounted drill rig and conducted the drilling, sampling and in-situ testing operations for Borehole BH-F4.

The drilling and sampling operations in the field were supervised by Mr. Stephane Loranger, Mr. George Azzopardi, Mr. Ryan Kromer, and Mr. Alistair Hall, all 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. Alastair Gorman, P.Eng.

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

Thurber Engineering Ltd.

L. Blaine
Lindsey Blaine, E.I.T.
Project Manager

Jan. 28/13



Alastair Gorman, P.Eng.
Senior Geotechnical Engineer

P. K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact



**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 407/BROCK ROAD INTERCHANGE CONNECTION
STRUCTURE M-9
REALIGNED HWY 7
OVER BROUGHAM CREEK TRIBUTARY 'B' AND HWY 407
Contract No: E2-2012**

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This section of the report provides an interpretation of the factual data presented in the foregoing section, and also presents geotechnical recommendations for design of the Highway 7 underpass based on the factual information as well as our understanding of the project. The plans and profiles and GA drawing used for preparation of this report were provided by MMM Group Limited.

The proposed underpass structure, as shown on the General Arrangement (GA) drawing dated October 2012, is a twin, three-span structure with a total length of approximately 197 m, with each deck being approximately 13 m wide. The centreline of the highway will lie approximately at Elevation 180.3 at the west abutment and 177.6 at the east abutment. The resulting approach fill will be approximately 8 m high at the west abutment. At the east abutment, the new approach fill will be up to 12 m above the existing Highway 7 grade which, on the south side of the highway is already on a fill approximately 8 m above the original ground surface in the adjacent creek valley. A retaining wall will be constructed at the south east quadrant of the site to contain the high fill adjacent to the creek valley.

8 STRUCTURE FOUNDATIONS

In general terms, the site was found to be underlain by deposits of gravelly sand, sand with varying proportions of gravel, silt and clay and by silt and sand glacial till. The soils were found to be generally compact to dense near the surface, becoming very dense at depths between 10 and 20 m. In the eastern portion of the site, the native soils are overlain by the fill embankment of existing Highway 7.

The groundwater level measured at the site upon completion of drilling ranged from 0.2 m above ground surface (Elevation 164.8) at Pier 2 to 8.7 m below the ground surface (Elevation 157.5) at the east abutment.

Consideration was given to the following foundation types:

- Spread footings:
 - bearing on native soil
 - bearing on engineered fill

- Driven steel H-piles
- Augered caissons (drilled shafts)

After reviewing the ground conditions, generally non-cohesive soils and a high groundwater level, it was concluded that caissons are not a suitable foundation solution at this site as it would be very difficult to maintain undisturbed founding conditions in the excavated shaft prior to concreting. Accordingly, the caisson option has not been carried forward.

A comparison of the remaining foundation alternatives, with advantages and disadvantages of each, are included in Appendix D.

8.1 Spread Footings Bearing on Native Soil

Spread footings may be founded on undisturbed, dense or very dense native soil. The existing fill encountered on site, in particular the existing highway embankment, is not suitable for founding spread footings.

The design of spread footings must be in accordance with the elevations and factored geotechnical resistance at Ultimate Limit States (ULS) and geotechnical resistance at Serviceability Limit States (SLS) as provided in Table 8-1.

Table 8-1. Founding Elevation and Bearing Resistances for Spread Footings

Locations	Highest Founding Elevation (m)	Factored ULS Resistance (kPa)	SLS Resistance (kPa)	Comments
West Abutment (SM9-02 & 03)	170.5	450	300	Groundwater at El 168.9, no dewatering anticipated.
West Pier (SM9-04 & 05)	166.0	450	300	Groundwater at El 167.9. Dewatering required.
East Pier WBL (SM9-06)	158.0	750	500	Very deep excavation and will require dewatering. Not recommended
East Pier EBL (SM9-07)	161.0	450	300	Very deep excavation and will require dewatering. Not recommended
East Abutment WBL (SM9-08)	164.0	450	300	Very deep excavation, not recommended.
East Abutment EBL (SM9-09)	157.0	450	300	Very deep excavation, not recommended.

The bearing resistances in Table 8-1 are for vertical, concentric loading. In the case of eccentric or inclined loading, the bearing resistance must be adjusted as shown in the CHBDC (2006) Clause 6.7.3 and Clause 6.7.4.

The geotechnical SLS resistance values given above are based on an estimated total settlement not exceeding 25 mm. This settlement is expected to be substantially complete by the end of construction. Differential settlement is not expected to exceed 20 mm across the width of the structure.

Founding elevations presented in Table 8-1 are near or below the groundwater level observed during the investigation. If temporary excavations required to construct these footings extend below the water table, local groundwater control will be required to construct the footing in the dry and to prevent disturbance of the footing base.

8.2 Spread Footings Bearing on Engineered Fill

Founding spread footings on a Granular A engineered fill pad can be considered at this site, particularly at the west abutment. Spread footings on engineered fill are not recommended at the piers or east abutment.

If an engineered fill pad is used, all organics or other deleterious materials must be stripped from the footprint of the foundation to expose competent native subgrade material. At this site, it is recommended that the engineered fill pad be at least 2.0 m thick and conform to the geometry illustrated in Figure 1 at the end of the text. The footings may then be designed on the basis of the following bearing resistances:

$$ULS_f = 750 \text{ kPa}$$

$$SLS = 350 \text{ kPa}$$

The engineered fill must bear on native compact to very dense sand and silt till and the highest permitted base elevations, at which engineered fill pads may be founded, are giving in Table 8-2.

Table 8-2. Founding Elevation and Bearing Resistances of Engineered Fill Pads

Locations	Base Elevation for Engineered Fill (m)	Comments
West Abutment (SM9-02 & 03)	171.0	Groundwater at El 168.9, no dewatering anticipated.
West Pier (SM9-04 & 05)	166.5	Groundwater at El 167.9. Dewatering will be required, not recommended.
East Pier WBL (SM9-06)	158.0	Very deep excavation and dewatering required. Not recommended.
East Pier EBL (SM9-07)	161.5	Not recommended
East Abutment (SM9-08 & 09)	164.0	Not recommended

The geotechnical resistances shown in Table 8-2 are based on a minimum 2.0 m thick layer of engineered granular fill. Additionally, the resistance values shown are for concentric, vertical loads only. In the case of eccentric or inclined loading, the bearing resistance must be adjusted as shown in the CHBDC (2006) Clause 6.7.3 and Clause 6.7.4.

The geotechnical SLS resistance values given above are based on an estimated total settlement not exceeding 25 mm. This settlement is expected to be substantially complete by the end of construction. Differential settlement is not expected to exceed 20 mm across the width of the structure.

The Granular A fill must be placed in 150 mm lifts and compacted to 100% of Standard Proctor Maximum Dry Density (SPMDD) at optimum moisture content of +/- 2%.

8.3 Steel H-Pile Foundations

The soil stratigraphy encountered at this site is also considered to be suitable for the support of foundations on driven steel piles. Steel H-piles (HP 310x110) driven to refusal within the sand and silt till, may be designed for the geotechnical resistances presented in Table 8-3 based on the tip elevations shown.

Table 8-3. Recommended Axial Resistance for Steel H-Piles

Locations	Approximate Pile Tip Elevation (m)	Factored ULS Resistance (kN)	SLS Resistance (kN)
West Abutment (SM9-02 & 03)	150.0	1600	1400
West Pier (SM9-04 & 05)	156.0		
East Pier (SM9-06 & 07)	154.5		
East Abutment WBL (SM9-08)	150.0		
East Abutment EBL (SM9-09)	146.0		

The structural resistance of the pile must be checked by the structural designer and pile installation must be in accordance with OPSS 903.

8.3.1 Pile Tips

All piles must be fit with driving shoes in accordance with OPSD 3000.100.

8.3.2 Pile Driving

Pile driving must be controlled by the Hiley Formula and an ultimate pile resistance should be specified by the designer in accordance with Clause 3.3.2 (b) Construction Stage of the

Structural Manual. The Hiley formula need not be used until the piles are within 2.0 m of the bearing stratum. The appropriate pile driving note is "Piles to be driven in accordance with Standard SS 103-11 using an ultimate resistance of "R" kN per pile. "R" must have a minimum value of twice the factored design load at ULS but must not exceed 3,200 kN.

8.3.3 Downdrag

Downdrag on the piles is not considered to be an issue at this site, since the soils are generally non-plastic.

8.3.4 Pile Lateral Resistance

The geotechnical lateral resistance of an H-pile embedded in till may be calculated using a value for the coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$$\begin{aligned}k_s &= n_h z / D \quad (\text{kN/m}^3) \\p_{ult} &= 3 \gamma z K_p \quad (\text{kPa})\end{aligned}$$

where

z	=	depth of embedment of pile in metres
D	=	pile width in metres
n_h	=	coefficient of horizontal subgrade reaction
	=	10,000 kN/m ³ (in dense to very dense till)
γ	=	21 kN/m ³ (unit weight)
γ_w	=	11 kN/m ³ (submerged unit weight below water table)
K_p	=	passive earth pressure coefficient
	=	4.2 (for dense to very dense till)

The above equations and recommended parameters may be used to analyze the interaction between a pile and the surrounding soil. The lateral pressures obtained from the analysis must not exceed the ultimate lateral resistance.

The spring constant, K_s , for analysis may be obtained by the expression, $K_s = k_s \times L \times D$ (kN/m), where L is the length (m) of the pile segment or element used in the analysis and remaining variables are as defined earlier. The ultimate lateral resistance, P_{ult} , may be obtained from the expression, $P_{ult} = p_{ult} \times L \times D$. This represents the ultimate load at which the pile fails and will not support any additional load at greater displacements. It is recommended, however, that the total lateral resistance assumed in one pile be limited to no more than 120 kN at ULS and 50 kN at SLS.

The modulus of subgrade reaction may have to be reduced due to pile interaction, based on the center-to-center pile spacing. The reduction factors to be used for a pile group oriented perpendicular and/or parallel to the direction of loading are provided in Table 8-4 with

intermediate values obtained by linear interpolation. Alternatively, horizontal loads may be resisted by means of battered piles

Table 8-4. Reduction of Subgrade Reaction Factors based on Pile Spacing

Condition	Pile Spacing, Centre to Centre*	Reduction Factor
Pile group oriented perpendicular to direction of loading	4D	1.0
	1D	0.5
Pile group oriented parallel to direction of loading	8D	1.0
	6D	0.7
	4D	0.4
	3D	0.25

Note: D is the width of pile

8.4 Frost Cover

The depth of frost penetration at this site is 1.2 m. The base of all pile caps or spread footings must be provided with a minimum of 1.2 m of earth cover as protection against frost action.

8.5 Recommended Foundation

From geotechnical perspective and considering the soil stratigraphy, groundwater conditions, load demands and the fact that construction may be staged, the recommended foundation for the abutments and piers consists of steel H-piles driven into the dense to very dense sand and silt soils at the elevations described above.

9 BRIDGE APPROACHES AND EMBANKMENTS

The west approach fill, which will be up to 8 m high, will be constructed across the relatively flat land in the former Dutchmaster property. Based on the findings in Boreholes SM9-01 to SM9-03, the soil underlying the approach fill is predominantly a compact to dense sand. Embankments constructed using Granular or SSM fill with side slopes no steeper than 2H:1V will be stable on the base.

At the east approach, the fill will be up to 12 m high and the south side will be retained by a RSS wall for some distance back from the abutment. Where the wall is not present, the embankment will be stable if constructed using Granular or SSM fill with side slopes that do not exceed 2H:1V. The RSS wall must be designed by the suppliers, who are responsible for the performance and internal stability of the reinforced soil mass. The global stability of the RSS has been checked and the analysis yielded a factor of safety of greater than 1.3. Typical output from the analysis is included in Appendix E.

The staging drawings show that Stage 4 includes partial construction of the east approach to carry 2 lanes of traffic. The permanent north side slope will be constructed but the south side

will be supported by a temporary RSS wall to permit a 2-lane detour on the south side of the embankment. As with the permanent RSS wall, the internal design must be completed by the supplier. At Borehole SM9-10, a buried layer of organic soil was encountered below the existing highway embankment fill, at a depth of 2.1 to 3.0 m, with loose organic contaminated sand below that. The presence of this soil will lead to settlements, possibly up to 200 mm under the increased embankment loading and must be taken into account.

The permanent RSS wall must be specified as High Performance and High Appearance. The temporary RSS wall may be specified as Low Performance and Low Appearance. In both cases, the contract drawings must show:

- The horizontal extent of the wall
- Elevation of top of the wall
- Elevation of the base of the wall

Allowance should be made for self-consolidation within the embankment equal to approximately 1% of the embankment height, which may take a few months to complete. Accordingly, paving should be delayed for as long as possible after construction of the embankment.

10 EXCAVATION AND GROUNDWATER CONTROL

All excavation must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the sand fill forming the existing Highway 7 embankment is classified as Type 3 soil. The native soils are also classed as Type 3 soils.

Based on the available information, excavation below the natural groundwater level may be required in order to construct footings at the piers. Inflow of groundwater into an excavation at this site will cause boiling and sloughing of the soil below the water table, which will compromise the bearing resistance of the soil and the stability of the excavation. Accordingly, the groundwater must be depressed to sufficient depth below the base of the excavation to prevent inflow of water and to provide a dry, stable working surface. It is recommended that all footing bases that require dewatering be protected by a mud slab as soon after excavation as is practical.

The design of the dewatering system, that may be required, is the responsibility of the Contractor and the Contract Documents must alert him to this responsibility and the need to engage a dewatering specialist. The Contractor must also be prepared to pump from sumps to remove any remaining seepage water or surface water collecting in an excavation. Placement of concrete must be done in the dry. Dewatering must remain operational and effective until the foundation is installed and backfilled.

Furthermore, the excavation and backfilling for foundations must be carried out in accordance with OPSS 902.

11 BACKFILL AND LATERAL EARTH PRESSURES

The backfill to the abutment walls must be Granular B Type II material meeting the requirements of Special Provisions 110S13 "Amendment to OPSS 1010, April 2004". The backfill must be in accordance with OPSS 902 and placed to the extent shown in OPSD 3101.150.

Heavy compaction equipment should not be used adjacent to the abutment walls and wing walls. Compaction should be carried out in accordance with OPSS 501.

Earth pressures acting on the abutment walls may be assumed to impose a triangular distribution governed by the characteristics of the backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC but generally are given by the expression:

$$p = K (\gamma h + q)$$

Where: p = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see table below)

γ = unit weight of retained soil (see table below)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Earth pressure coefficients for backfill behind abutments are dependent on the material used as backfill. Recommended unfactored values are shown in Table 11.1. The at-rest coefficients should be employed for conventional abutment walls. Active pressures may be used for walls when a degree of movement is permissible.

The parameters presented in the table correspond to full mobilization of active and passive earth pressures, and require certain relative movements between the wall and adjacent soil to produce these conditions. The values to be used in design should be assessed from Figure C6.16 of the Commentary to the CHBDC.

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or 1.7 m for Granular A or Granular B Type II.

Table 11.1 – Earth Pressure Coefficients (K)

Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active K_a (Unrestrained Wall)	0.27	0.40	0.31	0.48
At rest K_0 (Restrained Wall)	0.43	-	0.47	-
Passive K_p (Movement Towards Soil Mass)	3.7	-	3.3	-

The design of the abutments must incorporate measures such as subdrains to permit drainage of the backfill and avoid the potential build-up of hydrostatic pressures behind the walls. Alternatively, the abutment walls must be designed to withstand the potential build-up of hydrostatic pressures behind the walls.

12 SEISMIC CONSIDERATIONS

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 1
- Zonal Acceleration Ratio 0.05
- Peak Horizontal Acceleration 0.06

The soil profile type at this site has been classified as Type II. Therefore, according to Table 4.4 of the CHBDC, a Site Coefficient “S” (ground motion amplification factor) of 1.2 should be used in seismic design.

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. The coefficients of horizontal earth pressure for seismic loading presented in Table 12-1 may be used:

Table 12-1. Earth Pressure Coefficients for Earthquake Loading

Condition	Earth Pressure Coefficient (K)		
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$	Existing Sand Fill or OPSS Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	Native Silt or sand $\phi = 30^\circ$ $\gamma = 21.2 \text{ kN/m}^3$
Active (K_{AE})*	0.30	0.34	0.36
Passive (K_{PE})	3.6	3.2	0.54
At Rest (K_{OE})**	0.53	0.58	2.9

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.

** After Woods

The potential for liquefaction of the foundations soils was assessed using the Seed and Idriss (1971) method¹. Using this method, it is estimated that under the existing conditions the foundation soils are not prone to liquefaction.

The existing embankments are above the groundwater level and are not considered to be in danger of undergoing liquefaction. Some toe failure may occur but it is expected to be of limited nature and readily repairable.

13 ROADWAY PROTECTION

During the construction, temporary excavation adjacent to existing Highway 7 may be required and roadway protection may be required to facilitate staging and to support existing Highway 7 adjacent to the excavation. The roadway protection must be supplied in accordance with OPSS 539 and designed for Performance Level 2.

Conventional steel soldier piles and timber lagging walls is one option to provide temporary support to the soils during excavation. Timber lagging boards should be installed as soon as the soil face is exposed and properly prepared.

The following parameters apply for design of the temporary shoring system.

γ	=	20 kN/m ³	(bulk unit weight)
γ_w	=	10 kN/m ³	(submerged unit weight under groundwater table)
K_a	=	0.33	(Active pressure coefficient for road embankment fill)
	=	0.27	(Active pressure coefficient for till)
K_p	=	3.0	(Passive pressure coefficient for road embankment fill)
	=	3.7	(Passive pressure coefficient for till)

¹ Seed, H.B. and Idriss, I.M. 1971, "Simplified Procedure for Evaluating Soil Liquefaction Potential" *Journal of Soil Mechanics and Foundations Division*, ASCE, Vol. 101, No. SM9, September, pp. 1249-1273.

The design of roadway protection must remain the responsibility of the Contractor. The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system. All shoring systems must be designed by a Professional Engineer experienced in such designs, who must determine an appropriate support system.

Temporary groundwater and surface water control measures will be required during construction.

14 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- **Variable Pile Lengths.** The lengths of the driven piles may vary from the predicted values due to the inherent variable composition of the glacial and post-glacial soils at this site. If the pile tip elevations vary by more than 3 m from the predicted values, the design team should be notified and permitted to review the possible implications.
- **Excavation Below the Groundwater Level.** For any excavation below the natural groundwater level, the groundwater level must be depressed to maintain a stable base and sides in the excavation.

The successful performance of the structure will depend largely upon good workmanship and quality control during construction. Pile driving supervision, subgrade examination and field density testing should be carried out by qualified geotechnical personnel during construction to confirm that foundation recommendations are correctly implemented and material specifications are met.

15 CLOSURE

Engineering analysis and preparation of the report was carried out by Mr Alastair Gorman, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng. who is a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Alastair Gorman, P.Eng.
Senior Geotechnical Engineer



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

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

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


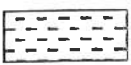



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	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	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	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	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	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 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					
							168					
167.6			5	SS	46		167					
5.0	Sandy SILT Dense Brown Wet											
166.5												
6.1	SAND, some gravel, some silt											
166.2	Dense		6	SS	66		166					
6.4	Brown Wet											
	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
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(%) 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 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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _P	W	W _L		
	Continued From Previous Page BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, THEN CUTTINGS TO SURFACE.																

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 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									WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE								
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>		1	SS	28														
170.7																			
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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								○ UNCONFINED	+ FIELD VANE			
								● QUICK TRIAXIAL	× LAB VANE			
	Continued From Previous Page											
160.2	SAND , some silt to silty Dense to Very Dense Grey Wet		9	SS	58							
11.9	SILT and SAND , trace clay Very Dense Grey Wet		10	SS	63							0 54 41 5
158.8	SAND , trace to some gravel, some silt Dense to Very Dense Grey Wet		11	SS	46							
13.3												
	Silty		13	SS	78							
154.1												
18.0	SILT and SAND , some clay, trace gravel Very Dense Grey Moist (TILL)		14	SS	73							7 44 38 11

Continued Next Page

+ 3, × 3: Numbers refer to
Sensitivity

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15 5
10 (%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV. DEPTH	DESCRIPTION	STRAT. PLT.	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)			
								○ UNCONFINED				+ FIELD VANE		● QUICK TRIAXIAL	× LAB VANE	
	Continued From Previous Page															
151.4 20.7	SAND and SILT, some clay, trace gravel Very Dense Grey Moist (TILL) Cobbles grinding at 20.5m Silty SAND Very Dense Grey Moist to Wet		15	SS	100/ 0.175											
			16	SS	100/ 0.175											
149.2 22.9	END OF BOREHOLE AT 22.9m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. 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. 05/12 3.0 168.7 Dec. 12/12 3.2 168.9 Jan. 02/13 2.7 169.4		17	SS	100/ 0.075											

RECORD OF BOREHOLE No SM9-03

1 OF 3

METRIC

WP# E2-2012 LOCATION N 4 864 763.5 E 337 345.4 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.10.16 - 2012.10.17 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	
171.8 0.0	ORGANICS, with roots and rootlets: (150mm)											
171.1 0.2	Clayey SILT, some sand to sandy Dark Brown Moist to Wet											
171.1 0.7	SAND, trace to some gravel, trace silt Compact to Very Dense Brown Moist		1	SS	21		171					
			2	SS	37		170					
	Wet Gravelly		3	SS	33		169					29 61 10 (SI+CL)
			4	SS	38		168					
166.9 4.9	Silty SAND, trace gravel and clay Very Dense Brown Moist (TILL)		5	SS	78		167					
165.7 6.1	SAND, trace to some gravel, trace to some silt Compact to Dense Brown Wet		6	SS	27		166					
			7	SS	34		165					
			8	SS	29		164					
							163					
							162					5 79 16 (SI+CL)

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

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15
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(%) STRAIN AT FAILURE

METRIC

[illegible]

(%) STRAIN AT FAILURE


ONTMT4S 1130A.GPJ 1/28/13

RECORD OF BOREHOLE No SM9-03

3 OF 3

METRIC

WP# E2-2012 LOCATION N 4 864 763.5 E 337 345.4 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.10.16 - 2012.10.17 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 (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								20 40 60 80 100									W P W W L		
Continued From Previous Page																			
	SAND, some silt, trace gravel Very Dense Grey Moist to Wet				0.175		151												
150.2			16	SS	100/														
21.6	END OF BOREHOLE AT 21.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.125														

RECORD OF BOREHOLE No SM9-04

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 788.7 E 337 422.0 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2012.10.18 - 2012.10.18 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	
169.0							169					
0.0	Silty CLAY , trace sand, with organic matter, with roots and rootlets Firm Dark Brown Moist		1	SS	4		168					
167.5							167					
1.5	Silty SAND , trace clay Loose Dark Brown Wet		2	SS	9		166					
166.8							165					
2.2	Clayey SILT and SAND , trace gravel Very Stiff Brown Moist (TILL)		3	SS	25		164					
165.9							163					
3.1	SAND , some gravel to gravelly, trace silt Dense Brown Wet		4	SS	47		162					
							161					
	Trace gravel, fine grained		5	SS	36		160					
												0 86 14 (SI+CL)
			6	SS	40							
161.7												
7.3	Silty SAND , trace gravel to gravelly, trace clay Dense Grey Moist to Wet (TILL)		7	SS	40							
												22 51 24 3
			8	SS	45							

Continued Next Page

+ 3 , x 3 : Numbers refer to
Sensitivity

20
15
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(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-04

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 788.7 E 337 422.0 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.10.18 - 2012.10.18 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	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	w _p	w	w _L	
158.8							159	20 40 60 80 100				GR SA SI CL
10.2	Sandy SILT, trace clay, trace gravel Very Dense Grey Wet		9	SS	100		158					1 23 69 7
							157					
			10	SS	100/ 0.100		156					
155.7												
13.3	Clayey SILT and SAND, trace gravel Hard Grey											
155.1	Moist		11	SS	100/							
13.9	(TILL)				0.175							
<p>END OF BOREHOLE AT 13.9m. Monitoring well installation consists of two 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.</p> <p>DEEP WELL WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 19/12 1.5 167.5 Oct. 26/12 1.4 167.6 Nov. 27/12 1.4 167.6 Nov. 29/12 1.4 167.6 Dec. 04/12 1.4 167.6 Dec. 12/12 1.6 167.4 Jan. 02/13 1.6 167.4</p> <p>SHALLOW WELL WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 19/12 0.7 168.3 Oct. 26/12 0.9 168.1 Nov. 27/12 0.9 168.1 Nov. 29/12 0.9 168.1 Dec. 04/12 0.8 168.2 Dec. 12/12 1.1 167.9 Jan. 02/13 0.8 168.2</p>												

RECORD OF BOREHOLE No SM9-05

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 765.7 E 337 404.1 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.10.17 - 2012.10.18 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			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
					20	40	60	80	100	20	40	60	GR	SA	SI	CL	
169.1							169										
0.0	ORGANICS, with roots and rootlets: (225mm)																
0.2	SILT and SAND, some clay to clayey, trace gravel Loose to Compact Brown Moist to Wet (TILL)		1	SS	5												
			2	SS	14												
167.1																	
2.0	Silty SAND, trace clay						167										
166.9	Brown																
2.2	Moist to Wet		3	SS	100/ 0.275												
	Sandy SILT, trace gravel Very Dense Brown Moist (TILL)		4	SS	70												
165.0																	
4.1	SAND, some gravel, trace silt Dense Brown Wet		5	SS	44												
			6	SS	41												
			7	SS	40												
160.3																	
8.8	Sandy SILT, trace clay Very Dense Grey Moist to Wet		8	SS	79												

Continued Next Page

+ 3 x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-05

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 765.7 E 337 404.1 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.10.17 - 2012.10.18 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											
158.7							159					
10.4	SILT and SAND, trace gravel, trace to some clay Very Dense Grey Moist (TILL)		9	SS	100/ 0.150		158					
							157					
			10	SS	100/ 0.200		156					
155.2												
13.9	END OF BOREHOLE AT 13.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.		11	SS	100/ 0.150							

METRIC

+ 3, × 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SM9-06

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 788.3 E 337 467.2 ORIGINATED BY GA
 HWY 407 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2012.12.13 - 2012.12.13 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								WATER CONTENT (%)		
								20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																	
	SAND, trace to some gravel, trace silt Very Dense Grey Wet		10	SS	102/ 0.150		154								11 87 2 (SI+CL)			
							153											
152.3 12.3	END OF BOREHOLE AT 12.3m. WATER LEVEL AT 0.6m 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. 19/12 0.2* 164.8 Jan. 02/13 0.4* (Frozen) 165.0 * Above ground surface (Artesian Condition) NOTE: Piezometer broken at 2.3m below ground surface.		11	SS	121/ 0.150													

RECORD OF BOREHOLE No SM9-07

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 768.6 E 337 479.7 ORIGINATED BY GA
 HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.11.30 - 2012.11.30 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	
167.4 0.0	SAND, some gravel, trace to some silt Compact to Loose Brown Damp (FILL)		1	SS	20		167					
			2	SS	15		166					
	Occasional asphalt fragments		3	SS	21		165					28 52 20 (SH+CL)
			4	SS	9		164					
	Occasional clay pockets		5	SS	10		163					
163.2 4.3	Silty CLAY, sandy, trace gravel, occasional sand seams, occasional wood fibres		6	SS	12		162					
162.6 4.9	Stiff Brown						161					
	Silty SAND, some gravel, some clay Compact Brown Damp (TILL)		7	SS	38		160					
161.3 6.1	SAND, some gravel, trace silt Dense Brown Damp		8	SS	44		159					
	Wet						158					5 53 34 8
158.3 9.1	Silty SAND, trace gravel, trace clay Dense to Very Dense Grey Wet (TILL)		9	SS	52							

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+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-07

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 768.6 E 337 479.7 ORIGINATED BY GA
 HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.11.30 - 2012.11.30 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											
155.3	Silty SAND , trace gravel, trace clay Dense to Very Dense Grey Wet (TILL)		10	SS	112		157					
							156					
12.2	SAND , trace gravel Very Dense Grey Wet		11	SS	106/ 0.150		155					
153.7							154					
13.7	Silty CLAY , trace sand Hard Grey		12	SS	109/ 0.150		153					0 8 32 60
							152					
			13	SS	100/ 0.150		151					
150.7							150					
16.8	SAND , trace silt Very Dense Grey Wet		14	SS	132							0 92 8 (SI+CL)
149.0												
18.4	END OF BOREHOLE AT 18.4m. WATER LEVEL AT 2.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.3m THEN SAND AND GRAVEL TO SURFACE.		15	SS	109/ 0.150							

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RECORD OF BOREHOLE No SM9-08

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 810.1 E 337 545.0 ORIGINATED BY GA
HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.12.04 - 2012.12.04 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	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
166.2								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	W _P	W	W _L	
0.0	Clayey SILT , some sand, trace gravel Firm to Stiff Brown Damp (TILL)		1	SS	9		166	20 40 60 80 100				7 42 32 19
			2	SS	8		165					
164.8												
1.4	Silty SAND , trace to some clay, trace gravel Compact to Very Dense Brown Damp (TILL)		3	SS	17		164					
			4	SS	71		163					
			5	SS	44		162					
			6	SS	57		161					5 49 31 15
							160					
	Grey		7	SS	44		159					
							158					
158.6												0 67 29 4
7.6	Silty SAND , trace clay Dense to Very Dense Brown Wet		8	SS	88		157					
			9	SS	48							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-08

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 810.1 E 337 545.0 ORIGINATED BY GA
 HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.12.04 - 2012.12.04 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	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 20 40 60			
155.5	SAND, trace silt Very Dense Brown Wet						156					
10.7	SAND and GRAVEL, trace silt Dense to Very Dense Grey Wet		10	SS	45		155					
							154					
			11	SS	74		153					
							152					
			12	SS	106/ 0.150		151					
	Silty		13	SS	109		150					
149.0			14	SS	102							
17.2	END OF BOREHOLE AT 17.2m. WATER LEVEL AT 2.4m UPON COMPLETION. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec. 12/12 8.7 157.5 Dec. 19/12 8.6 157.6 Jan. 02/13 8.6 157.6											


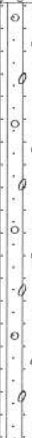

ONTMT4S 1130A.GPJ 1/28/13

RECORD OF BOREHOLE No SM9-09

1 OF 4

METRIC

WP# E2-2012 LOCATION N 4 864 788.0 E 337 536.4 ORIGINATED BY GA/AH
HWY 407 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.11.29 - 2012.11.30 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 (%)				GR	SA	SI	CL		
								20	40	60	80	100	w _p	w		w _L					
166.4	0.0	SAND , trace to some silt, trace to some gravel Compact Brown Damp (FILL)		1	SS	17															
				2	SS	15															
				3	SS	15															
				4	SS	15															
163.4	3.0			Silty SAND , trace gravel, occasional clay till pockets Compact to Loose Damp (TILL)		5	SS	23													
		6	SS			8															
160.5	5.9	Silty SAND , some clay, trace gravel Loose to Very Dense Brown to Grey Damp (TILL) Wet				7	SS	9													
				8	SS	9															
				9	SS	57															

Continued Next Page

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

RECORD OF BOREHOLE No SM9-09

2 OF 4

METRIC

WP# E2-2012 LOCATION N 4 864 788.0 E 337 536.4 ORIGINATED BY GA/AH
 HWY 407 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2012.11.29 - 2012.11.30 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								WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
Continued From Previous Page								20 40 60 80 100										
155.8	SAND, some silt, some gravel, occasional clayey till pockets Compact Grey Wet						156											
10.6			10	SS	25													
			11	SS	103													
			12	SS	75													
			13	SS	83		151											
149.8	Silty CLAY, trace sand Hard Grey						150											
16.6			14	SS	46													
			15	SS	106/ 0.150		148											
146.9	Silty SAND, some silt, trace clay, trace gravel Very Dense						147											
19.5			16	SS	130/													

ONTMT4S 1130A.GPJ 1/28/13

Continued Next Page

+ 3, x 3 :
Sensitivity

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-09

3 OF 4

METRIC

WP# E2-2012 LOCATION N 4 864 788.0 E 337 536.4 ORIGINATED BY GA/AH
 HWY 407 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
 DATUM Geodetic DATE 2012.11.29 - 2012.11.30 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				0.150			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%) 20 40 60			GR SA SI CL
145.1	Silty SAND , some silt, trace clay, trace gravel Very Dense Grey Wet						146					
21.3	Silty CLAY Hard Grey/Brown		17	SS	34		145					
							144					
			18	SS	36		143					0 0 22 78
							142					
			19	SS	28		141					
							140					
			20	SS	28		139					
							138					
137.6	SAND and SILT , with clay pockets Very Dense Grey Wet		21	SS	105		137					
28.8												

Continued Next Page

+ ³, x ³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-09

4 OF 4

METRIC

WP# E2-2012 LOCATION N 4 864 788 0 E 337 536 4 ORIGINATED BY GAAH
HWY 407 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN
DATUM Geodetic DATE 2012.11.29 - 2012.11.30 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	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	W _P	W	W _L		
			22	SS	123		136						0 38 21 41
			23	SS	104		135						
134.4 32.0	END OF BOREHOLE AT 32.0m. WATER LEVEL AT 6.1m UPON COMPLETION. BOREHOLE GROUTED.												

RECORD OF BOREHOLE No SM9-10

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 794.8 E 337 552.6 ORIGINATED BY RK
HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.11.30 - 2012.11.30 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	
166.3 0.0	SAND, some gravel to gravelly, trace silt Compact Brown Moist (FILL)		1	SS	11		166					
164.2 2.1	ORGANICS, sandy, silty Very Loose Black Moist		2	SS	13		165					
163.3 3.0	SAND, some silt, some gravel, trace organics Loose Brown Wet		3	SS	3		164					
162.1 4.3	SANDY SILT, some clay to clayey, trace gravel Dense to Compact Brown Wet (TILL)		4	SS	5		163					
159.2 7.2	SANDY SILT, some clay Compact Grey Wet		5	SS	31		162					
157.7 8.7	Gravelly SAND, some silt Very Dense Brown Wet		6	SS	27		161					
			7	SS	25		160					
			8	SS	98		159					
							158					
							157					

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM9-10

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 794.8 E 337 552.6 ORIGINATED BY RK
HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.11.30 - 2012.11.30 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 (%)								
								20 40 60 80 100	w _P w w _L									
Continued From Previous Page								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
156.1																		
10.2	SAND, trace silt, trace gravel Compact Brown Wet						156											
		9	SS	23		155								0 84 12 4				
		10	SS	22		154												
153.5																		
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 4.3m AND WATER LEVEL AT 3.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPUG TO 2.7m, CUTTINGS TO 0.6m THEN SAND AND GRAVEL TO SURFACE.																	

+ 3, × 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-03

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 786.1 E 337 594.4 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012 12 13 - 2012 12 13 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	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
166.3													
0.0	ASPHALT: (300 mm)												
166.0													
0.3	SAND, trace to some silt, trace to some gravel, occasional cobbles Compact Brown Moist (FILL)		1	GS			166						
			2	SS	24								
	With wood fragments		3	SS	17		165						11 65 19 5
164.0													
2.3	SAND, with organics, some silt, some clay, trace rootlets and wood fragments Loose to Very Loose Brown Moist Occasional peat pockets		4	SS	8		164						
			5	SS	4		163						
162.1													
4.2	SAND, trace to some silt, trace gravel Compact to Dense Brown/Grey Moist		6	SS	23		162						
							161						
			7	SS	43		160						
							159						
			8	SS	40								2 82 16 (SI+CL)
							158						
			9	SS	54		157						
	Wet Dense												

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-03

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 786.1 E 337 594.4 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.12.13 - 2012.12.13 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 (%)			
								20 40 60 80 100							w _p w w _L			
	Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
155.0	SAND, trace to some silt, trace gravel Dense Grey Moist		10	SS	47		156											
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.3m, CUTTINGS TO 0.2m THEN ASPHALT TO SURFACE.																	

RECORD OF BOREHOLE No RW-04

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 864 806.3 E 337 648.6 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	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
167.0												
0.0	ASPHALT: (260mm)						167					
166.7												
0.3	SAND, some gravel, trace silt Dense Brown Moist (FILL)		1	GS								
			2	SS	42		166					
			3	SS	27		165					
164.9												
2.1	SAND and GRAVEL, some silt, occasional cobbles Very Dense Brown Moist		4	SS	53		164					48 42 10 (SI+CL)
			5	SS	53		163					
162.9												
4.1	SAND, trace to some silt, trace to some gravel, occasional cobbles Dense Brown Moist		6	SS	37		162					
							161					
			7	SS	31		160					0 74 26 (SI+CL)
			8	SS	33		159					
158.8												
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN AND DRY 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 Dry Jan. 2/13 Dry											

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

RECORD OF BOREHOLE No RW-05

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 864 821.6 E 337 692.2 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.12.13 - 2012.12.13 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
167.9 0.0 167.6	ASPHALT: (280 mm)							20 40 60 80 100		w _p w w _L				
0.3	SAND, some gravel, trace silt Brown Moist (FILL)		1	GS			167							
167.0 0.9	Silty SAND, trace gravel Compact Brown Moist (FILL)		2	SS	21		167							9 45 33 13
166.3 1.6	SAND, with organics, some silt, trace rootlets and wood fragments Compact Dark Brown Moist		3	SS	10		166							
165.2 2.7	SAND, some silt, trace gravel Compact Brown Moist		4	SS	10		165							
164.7 3.2	SAND and GRAVEL, some silt, occasional cobbles Dense to Very Dense Brown Moist		5	SS	48		164							
			6	SS	39		163							38 49 13 (SI+CL)
			7	SS	56		162							
161.2 6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.4m, CUTTINGS TO 0.15m THEN ASPHALT TO SURFACE.													

RECORD OF BOREHOLE No RW-06

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 864 848.6 E 337 776.1 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.12.13 - 2012.12.13 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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) w _p w w _L
168.6 0.0 168.3	ASPHALT: (290 mm)												
0.3	SAND, trace to some gravel, trace silt Compact Brown Moist (FILL)		1	GS									
			2	SS	30								
167.2													
1.4	Clayey SILT and SAND Stiff to Very Stiff Brown Moist (TILL-like)		3	SS	10								0 28 42 30
			4	SS	22								
165.6													
3.0	SAND, trace gravel, trace to some silt Compact to Dense Brown Moist		5	SS	34								7 74 19 (SI+CL)
			6	SS	29								
163.4													
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN AND DRY 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 Dry Jan. 2/13 Dry												

RECORD OF BOREHOLE No BH-F4

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 864 773.2 E 337 258.7 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY MA
DATUM Geodetic DATE 2013.01.09 - 2013.01.09 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 (%)							
								20 40 60 80 100	20 40 60	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
176.3																		
0.0	ORGANICS: (175mm)																	
0.2	Silty SAND, trace clay, trace gravel Dense to Very Dense Brown Moist (TILL)		1	SS	38		176											
	Occasional cobbles		2	SS	81		175								10 49 28 13			
			3	SS	69		174								9 55 24 12			
			4	SS	64		173											
172.9																		
3.4	SAND, some silt Very Dense Brown Moist		5	SS	89		172											
							171											
	Some gravel Grey Wet		6	SS	61		170											
169.6																		
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.6m, THEN CUTTINGS TO SURFACE.																	

ONTMT4S 1130A GPJ 1/28/13

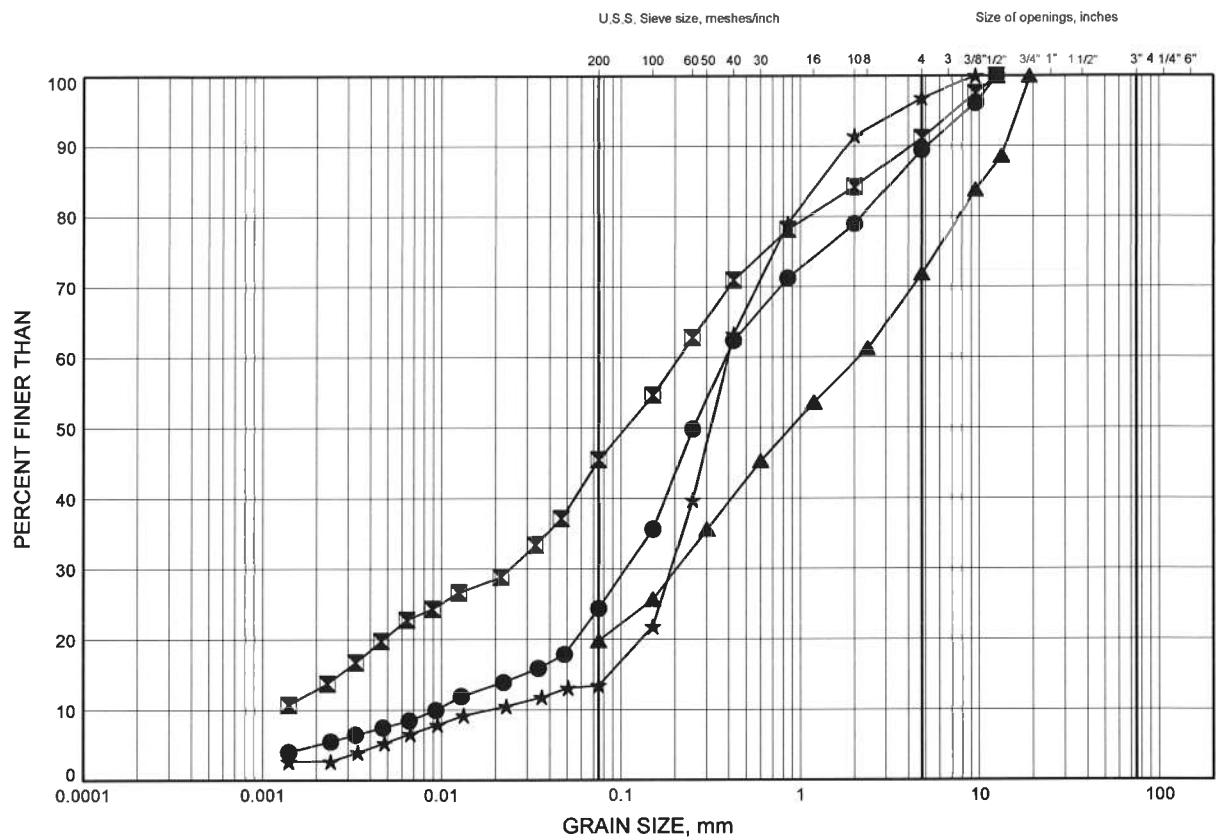
Appendix B
Geotechnical Laboratory Test Results
And
AGAT Certificate of Analysis

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY SAND to GRAVELLY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RW-03	1.83	164.47
■	RW-05	1.07	166.83
▲	SM9-07	1.83	165.61
★	SM9-09	1.83	164.61

Date January 2013
 WP# E2-2012



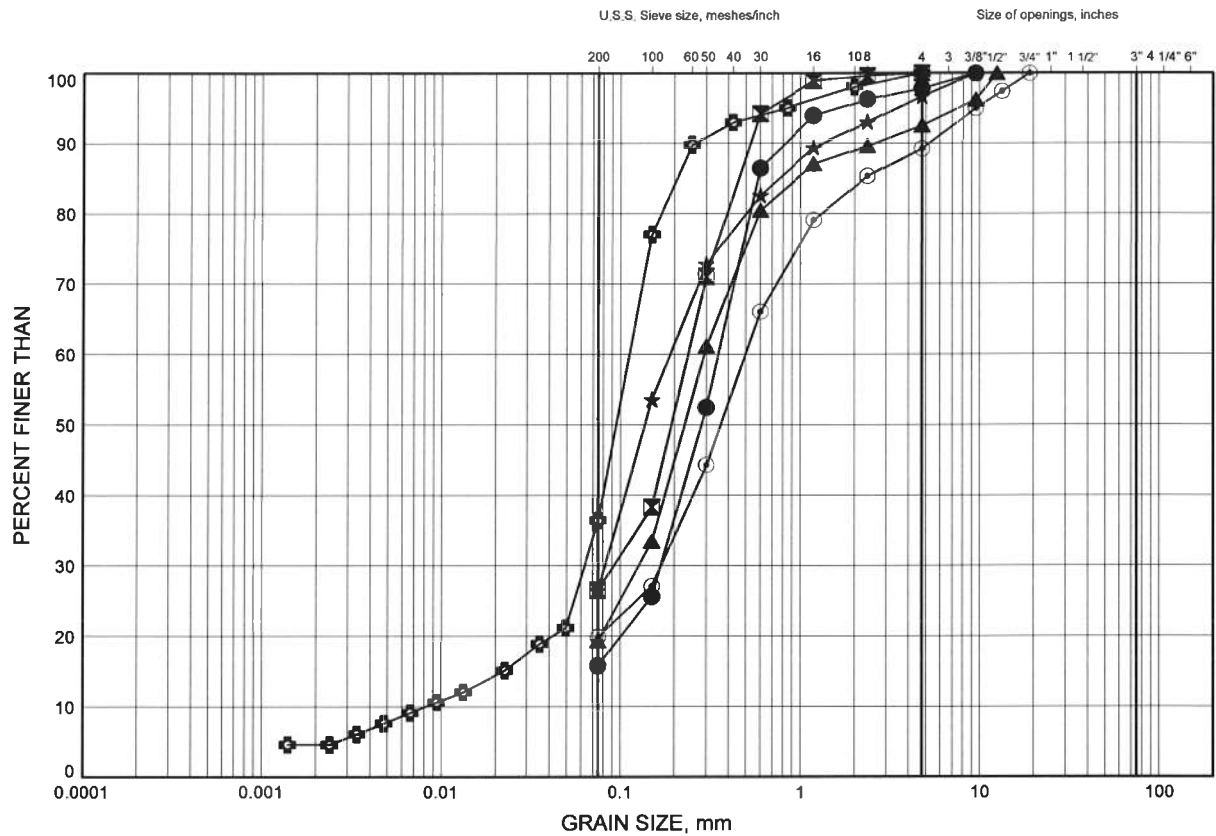
Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY SAND to SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RW-03	7.92	158.38
⊠	RW-04	6.40	160.60
▲	RW-06	3.35	165.25
★	SM9-01	1.83	170.77
⊙	SM9-01	7.92	164.68
⊕	SM9-02	21.50	150.60

Date January 2013
WP# E2-2012



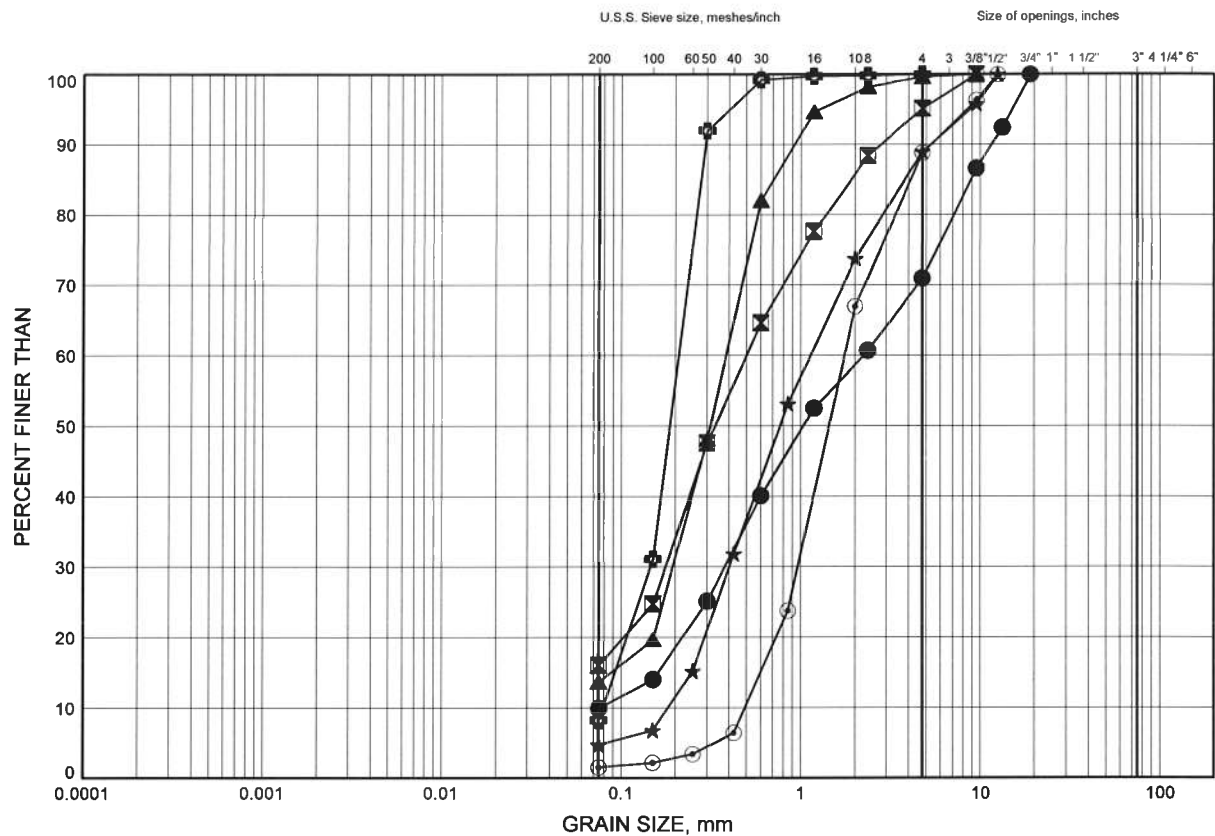
Prep'd AN
Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND to SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SM9-03	2.59	169.21
⊠	SM9-03	9.45	162.35
▲	SM9-04	4.88	164.12
★	SM9-06	2.59	162.01
⊙	SM9-06	10.74	153.86
⊕	SM9-07	17.07	150.37

Date January 2013
WP# E2-2012



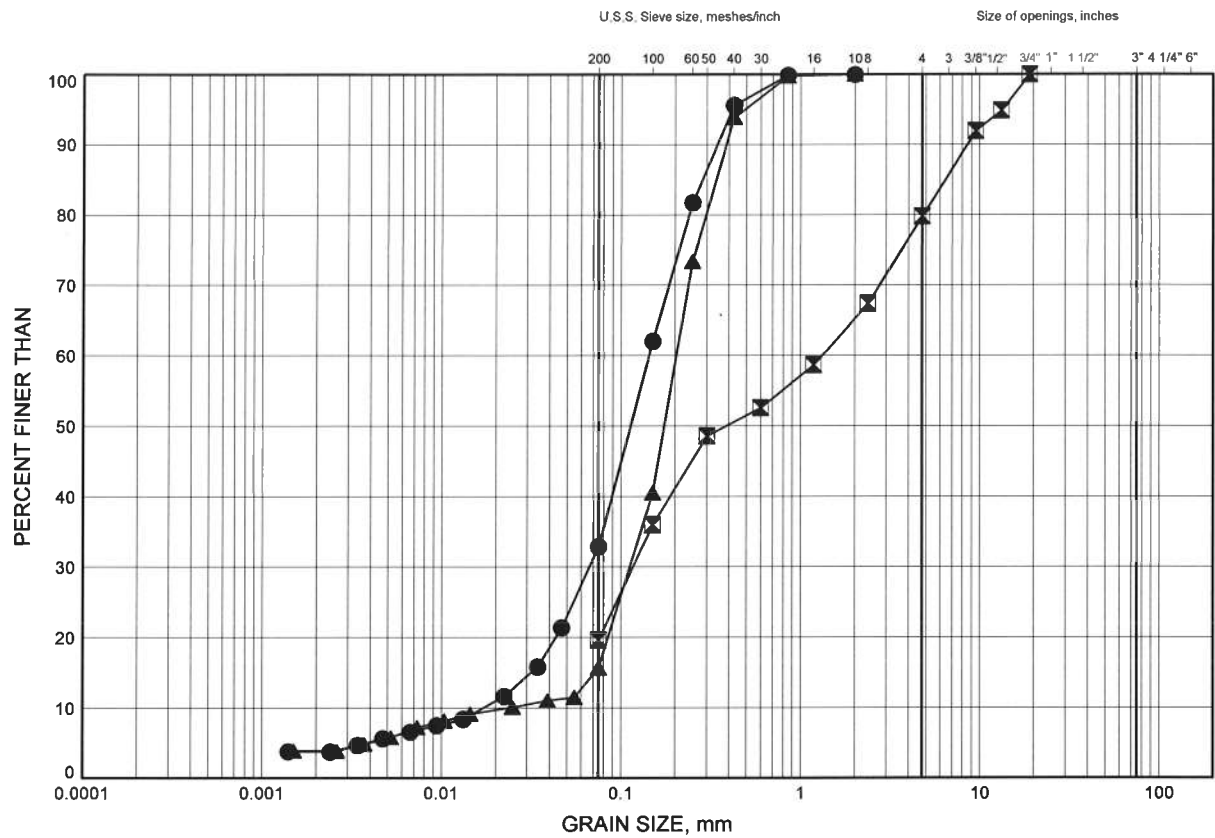
Prep'd AN
Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY SAND to SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SM9-08	9.45	156.74
⊠	SM9-09	14.02	152.41
▲	SM9-10	10.97	155.37

Date January 2013
WP# E2-2012



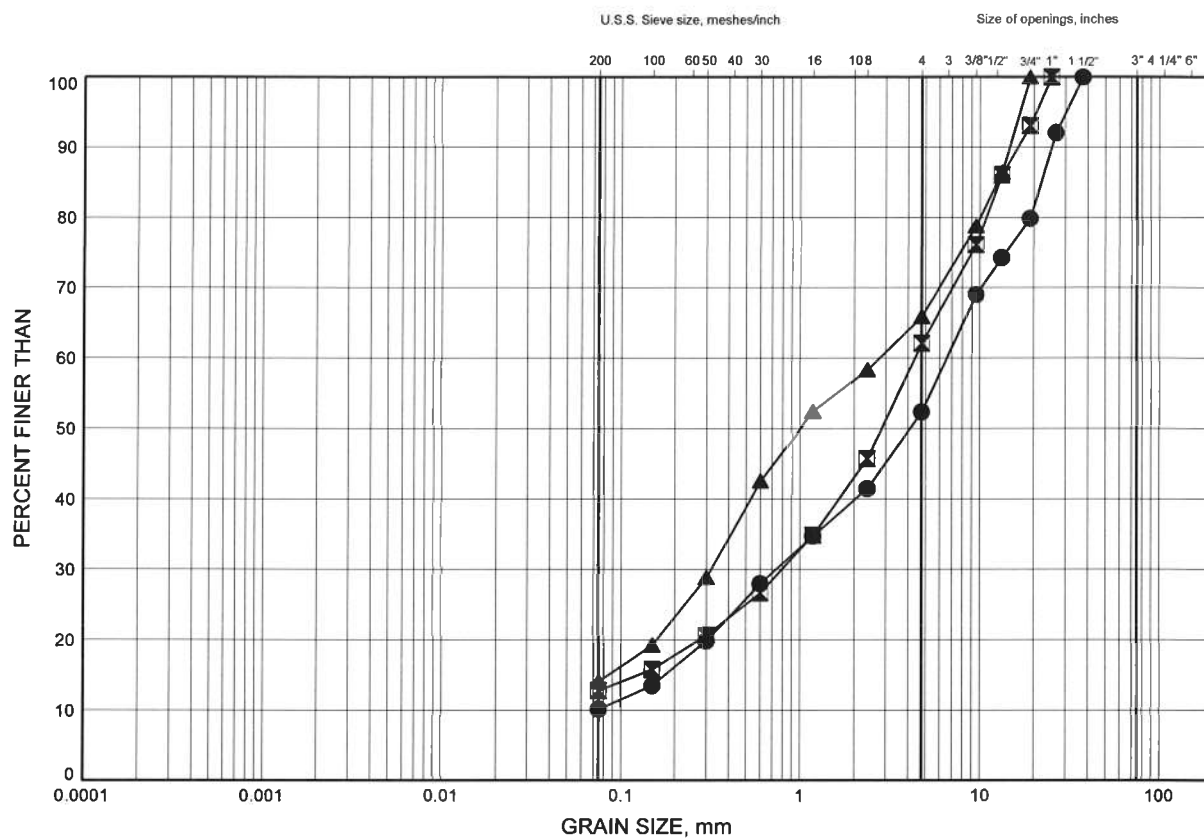
Prep'd AN
Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	RW-04	2.59	164.41
■	RW-05	4.88	163.02
▲	SM9-02	4.71	167.39

Date January 2013
 WP# E2-2012



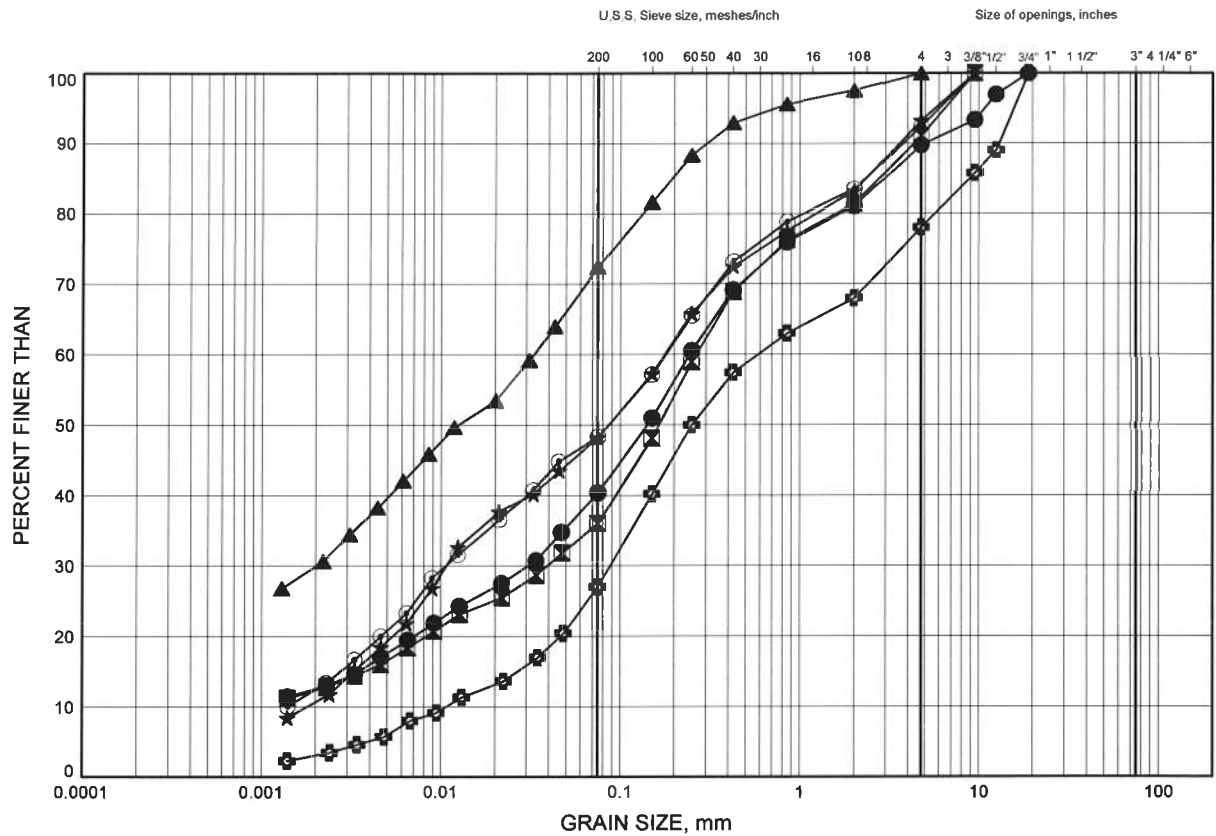
Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B6

CLAYEY SILT & SAND 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)
●	BH-F4	1.83	174.47
⊠	BH-F4	2.59	173.71
▲	RW-06	1.83	166.77
★	SM9-02	18.59	153.51
⊙	SM9-03	17.03	154.77
⊕	SM9-04	7.92	161.08

Date January 2013
WP# E2-2012



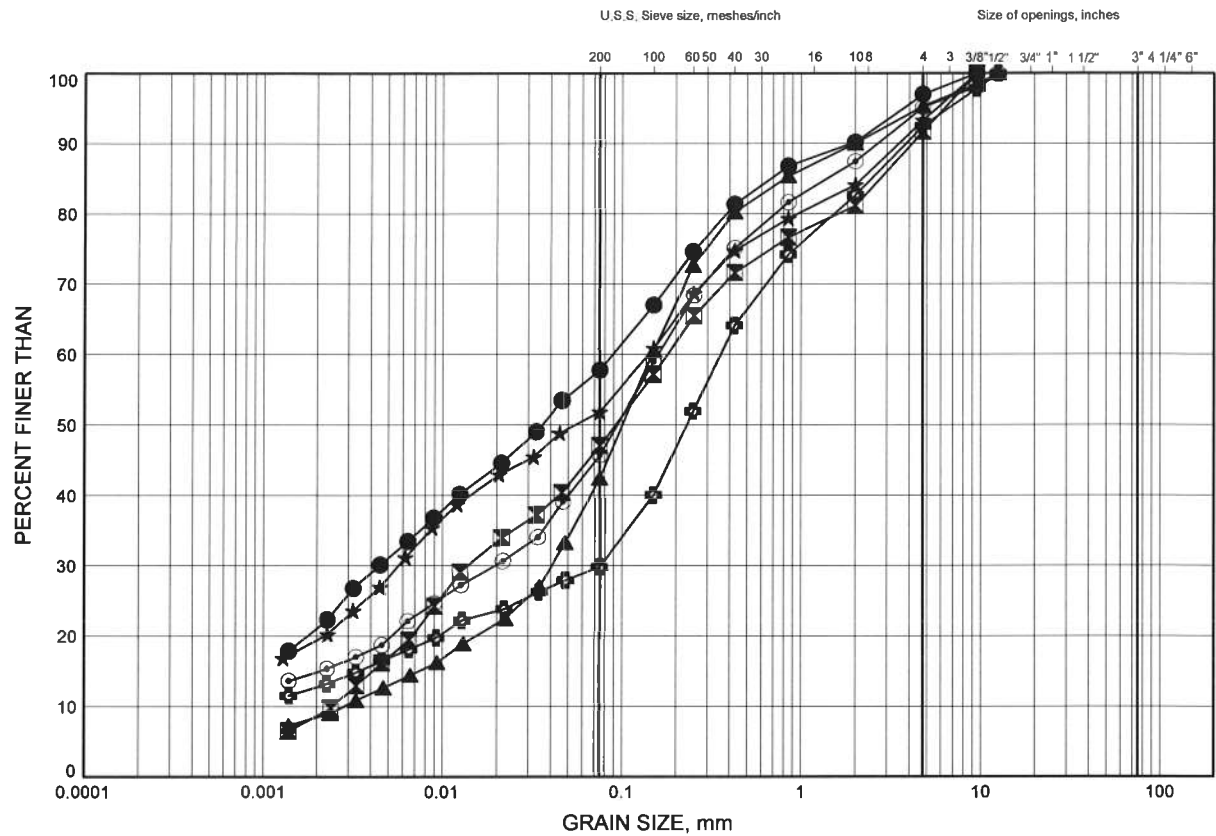
Prep'd AN
Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B7

CLAYEY SILT & SAND 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)
●	SM9-05	1.75	167.35
⊠	SM9-05	12.37	156.73
▲	SM9-07	9.45	157.99
★	SM9-08	1.83	164.36
⊙	SM9-08	6.40	159.79
⊕	SM9-09	7.92	158.51

Date January 2013

WP# E2-2012



Prep'd AN

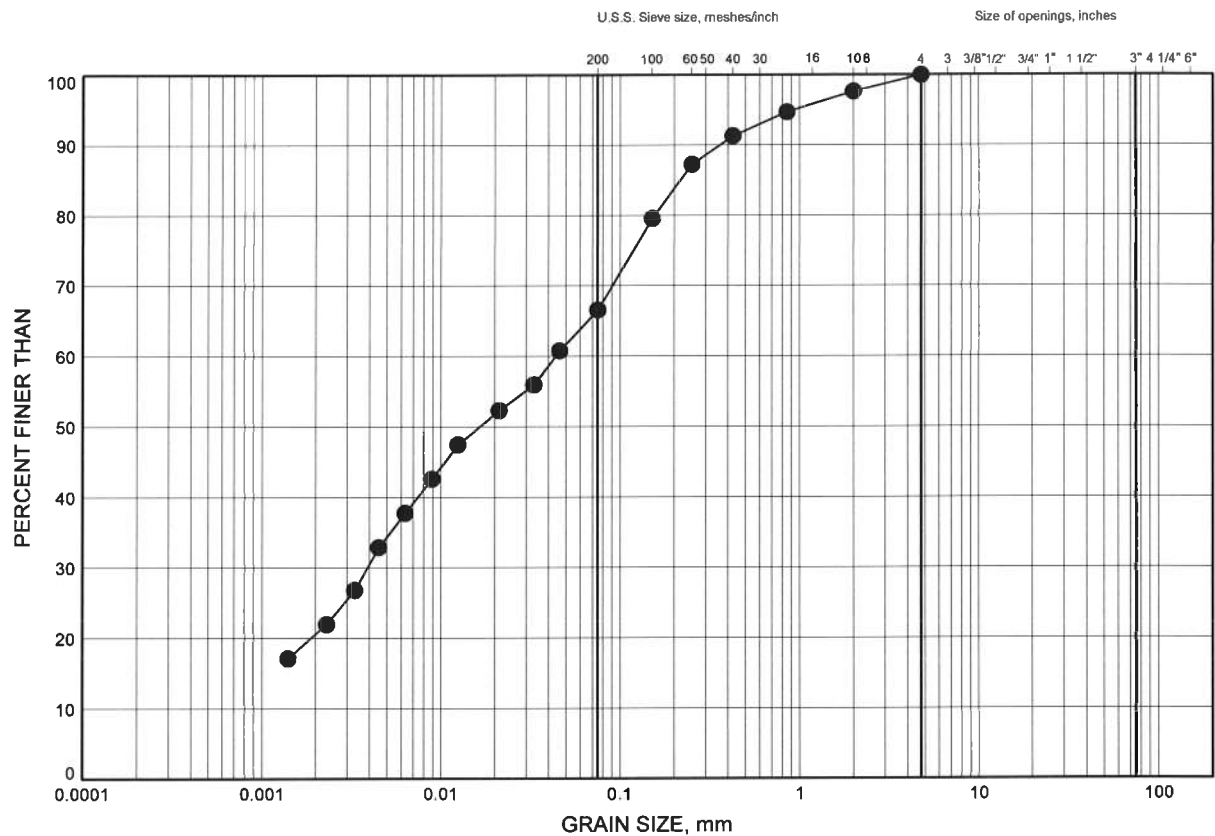
Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B8

CLAYEY SILT & SAND 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)
●	SM9-10	6.40	159.94

Date January 2013
 WP# E2-2012

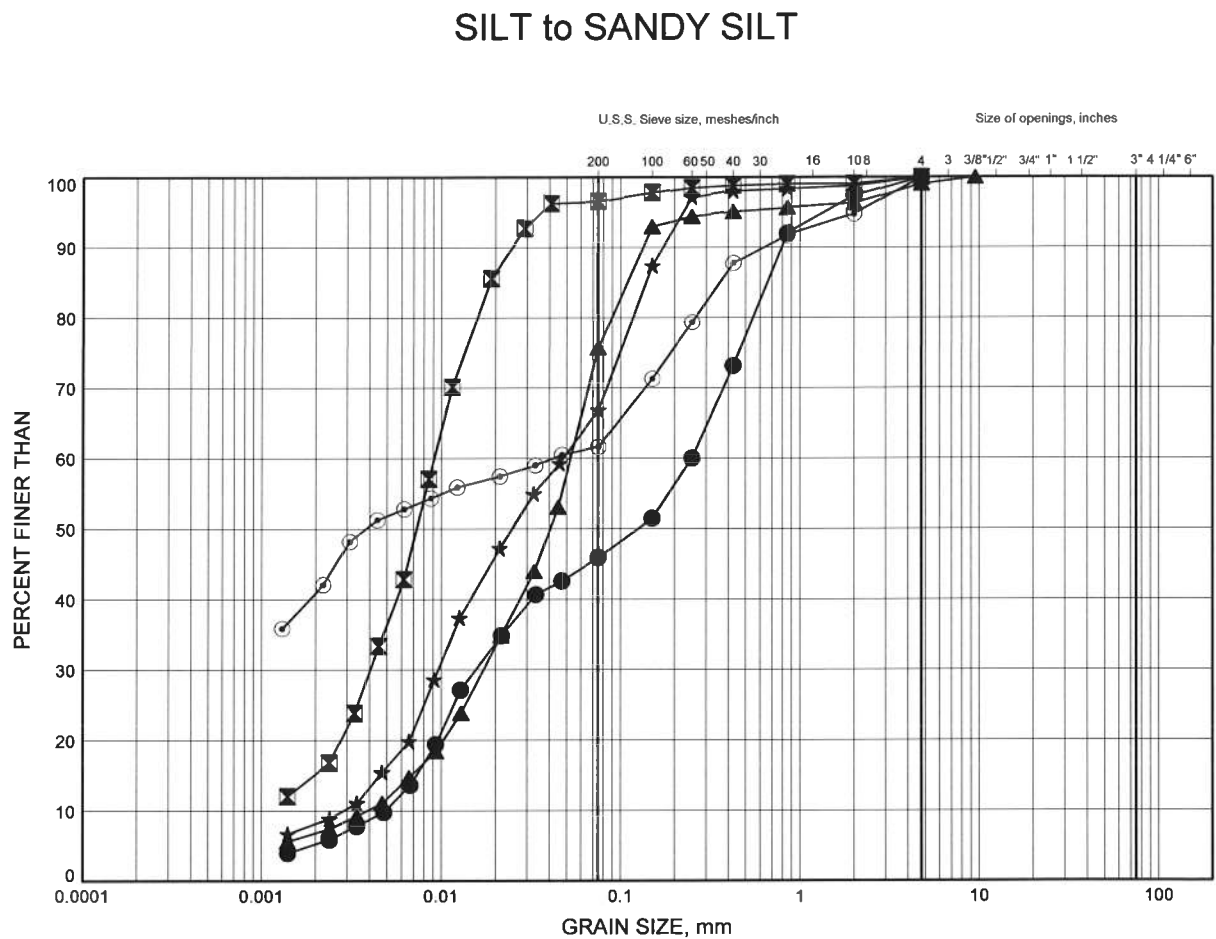


Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B9



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SM9-02	12.50	159.60
⊠	SM9-03	18.35	153.45
▲	SM9-04	10.90	158.10
★	SM9-05	9.45	159.65
⊙	SM9-09	30.78	135.65

Date January 2013
 WP# E2-2012

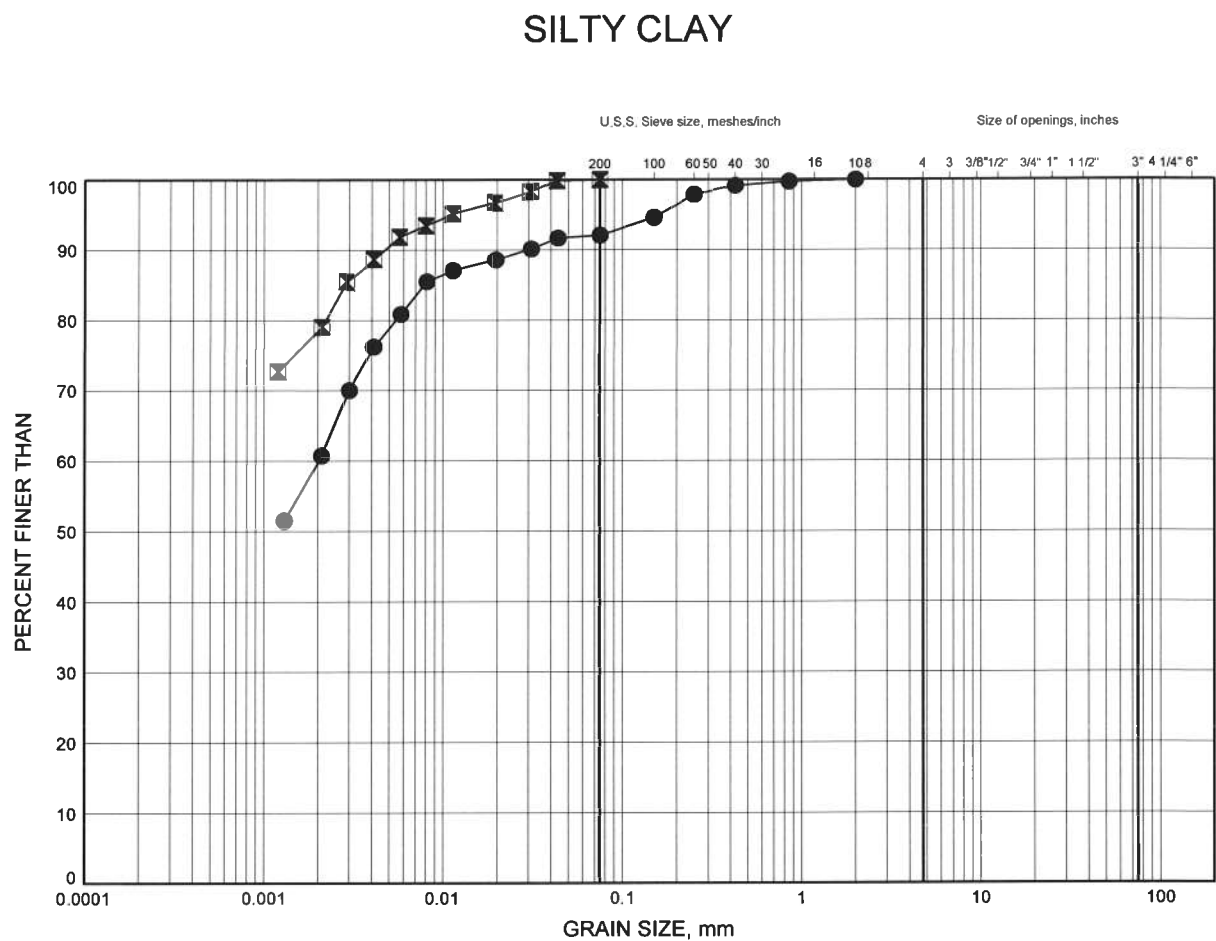


Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B10



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SM9-07	14.02	153.42
⊠	SM9-09	23.16	143.27

Date January 2013
 WP# E2-2012



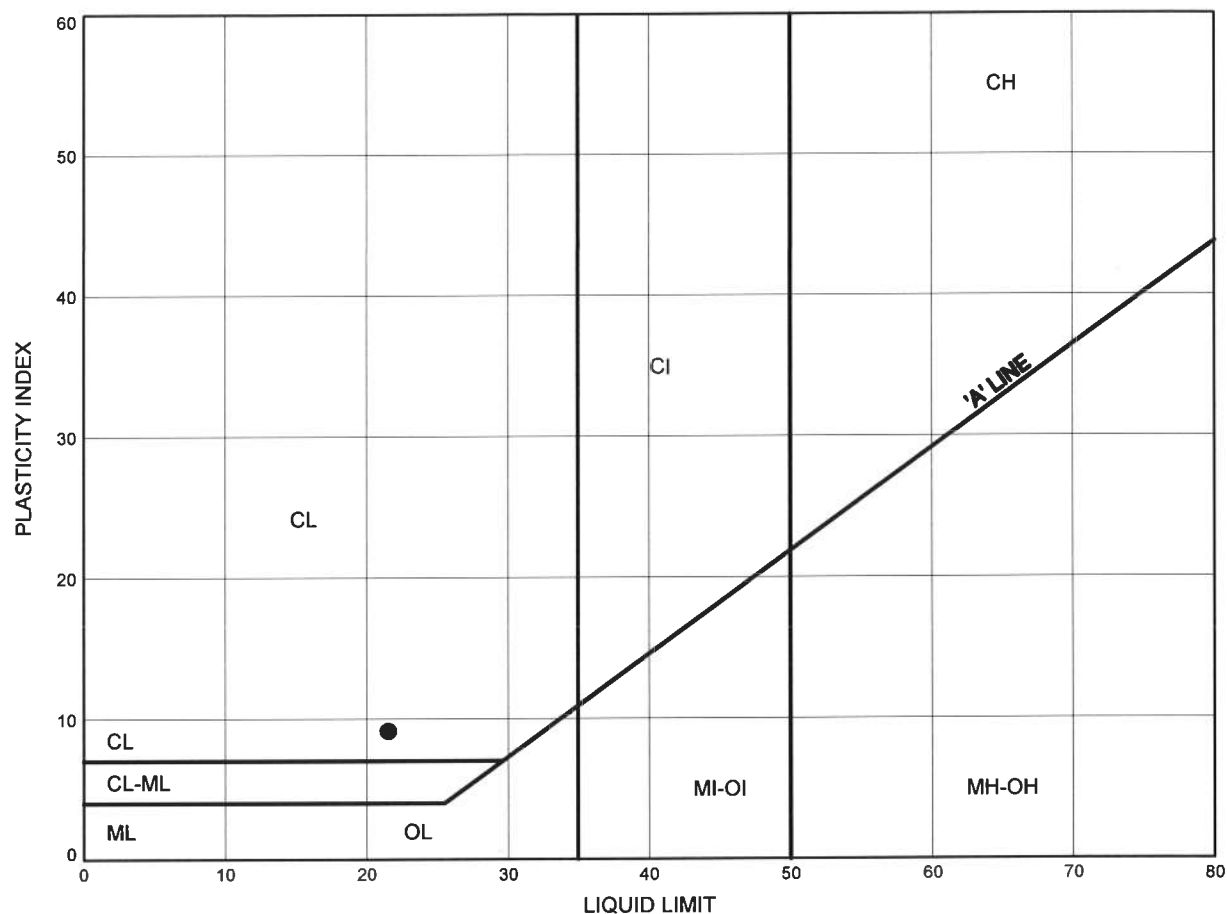
Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations

ATTERBERG LIMITS TEST RESULTS

FIGURE B11

SILTY SAND TILL (Some Clay)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SM9-08	1.83	164.36

Date January 2013
 WP# E2-2012

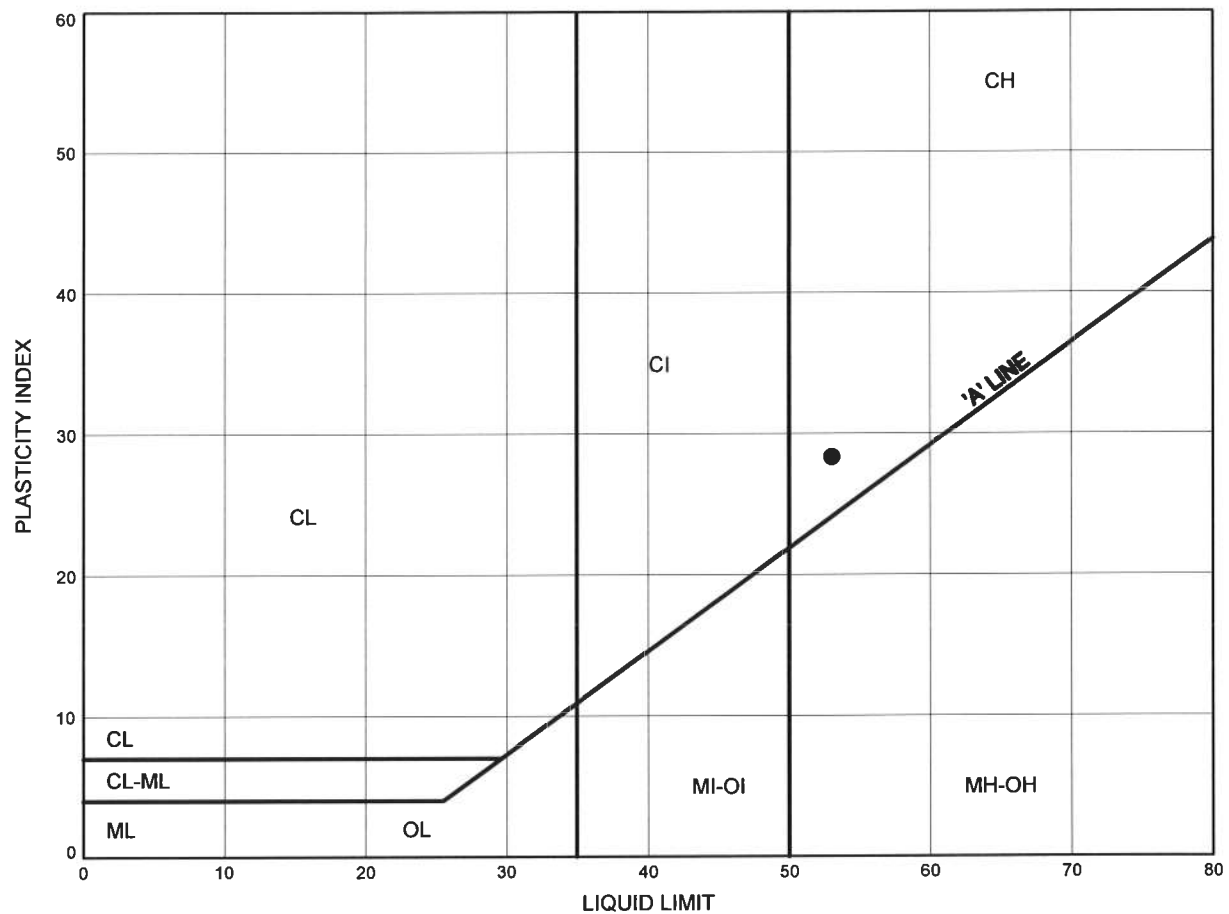


Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations ATTERBERG LIMITS TEST RESULTS

FIGURE B12

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SM9-09	23.16	143.27

Date January 2013
 WP# E2-2012



Prep'd AN
 Chkd. LRB



AGAT

Laboratories

Certificate of Analysis

AGAT WORK ORDER: 13T677837

PROJECT NO: 19-5161-130A

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Lindsey Blaine

O. Reg. 153(511) - ORPs (Soil) pH											
DATE RECEIVED: 2013-01-08			DATE REPORTED: 2013-01-11								
SAMPLE DESCRIPTION:			SM1-02 SS#4	SM1-04 SS#6	SM2-02 SS#4	SM2-08 SS#3	SM2-11 SS#2	SM2-17 SS#4	SM4-02 SS#1	SM4-04 SS#2	
SAMPLE TYPE:			Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	
DATE SAMPLED:			1/7/2013	1/7/2013	1/7/2013	1/7/2013	1/7/2013	1/7/2013	1/7/2013	1/7/2013	
G / S			4058631	4058632	4058634	4058636	4058638	4058640	4058642	4058644	
Parameter	Unit										
pH, 2:1 CaCl2 Extraction	pH Units		7.90	7.91	7.98	7.92	7.44	7.89	7.83	7.90	
SAMPLE DESCRIPTION:			SM4-07 SS#4	SM8-03 SS#5	SM8-04 SS#6	SM9-02 SS#2	SM9-06A SS#3	SM9-08 SS#4	SM10-09 SS#2		
SAMPLE TYPE:			Soil	Soil	Soil	Soil	Soil	Soil	Soil		
DATE SAMPLED:			1/7/2013	1/7/2013	1/7/2013	1/7/2013	1/7/2013	1/7/2013	1/7/2013		
G / S			4058646	4058648	4058650	4058652	4058654	4058656	4058658		
Parameter	Unit										
pH, 2:1 CaCl2 Extraction	pH Units		8.02	8.06	7.94	7.92	7.91	7.86	7.39		

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
4058631-4058658 pH was determined on the 0.01M CaCl₂ extract obtained from 2:1 leaching procedure (2 parts extraction fluid : 1 part wet soil).

Certified By:

Elizabeth Polakowska



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 13T677837

PROJECT NO: 19-5161-130A

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Lindsey Blaine

Sulphate (Soil)													
DATE RECEIVED: 2013-01-08				DATE REPORTED: 2013-01-11									
SAMPLE DESCRIPTION:				SM1-02 SS#4	SM1-04 SS#6	SM2-02 SS#4	SM2-08 SS#3	SM2-11 SS#2	SM2-17 SS#4	SM4-02 SS#1	SM4-04 SS#2		
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil		
DATE SAMPLED:				17/2013	17/2013	17/2013	17/2013	17/2013	17/2013	17/2013	17/2013		
G / S				4058631	4058632	4058634	4058636	4058638	4058640	4058642	4058644		
Parameter	Unit												
Sulphate (2:1)	µg/g	2.0	3.0	9.7	157	3.9	181	35.8	11.6	6.0			
SAMPLE DESCRIPTION:				SM4-07 SS#4	SM8-03 SS#5	SM8-04 SS#6	SM9-02 SS#2	SM9-06A SS#3	SM9-08 SS#4	SM10-09 SS#2			
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil	Soil			
DATE SAMPLED:				17/2013	17/2013	17/2013	17/2013	17/2013	17/2013	17/2013			
G / S				4058646	4058648	4058650	4058652	4058654	4058656	4058658			
Parameter	Unit												
Sulphate (2:1)	µg/g	2.0	8.9	9.4	23.3	5.8	15.3	10.3	544				

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
4058631-4058658 The soluble Sulphate was determined on the DI water extract obtained from the 2:1 leaching procedure (2 part DI water: 1 part dry soil).

Certified By:

Elizabeth Polonsky



Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 13T677837

PROJECT NO: 19-5161-130A

ATTENTION TO: Lindsey Blaine

Soil Analysis

RPT Date: Jan 11, 2013

DUPLICATE

REFERENCE MATERIAL

METHOD BLANK SPIKE

MATRIX SPIKE

PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits		
							Measured Value			Lower	Upper		Lower	Upper	Lower
Sulphate (Soil)															
Sulphate (2:1)	1	4058631	3.0	2.7	10.5%	< 2.0	95%	70%	130%	97%	70%	130%	96%	70%	130%
Sulphate (Soil)															
Sulphate (2:1)	1	4058650	23.3	24.0	3.0%	< 2.0		70%	130%		70%	130%		70%	130%
O. Reg. 153(511) - ORPs (Soil) pH															
pH, 2:1 CaCl2 Extraction	1	4058631	7.90	7.93	0.4%	NA	100%	90%	110%	NA			NA		

Certified By:

Elizabeth Potakowska

Appendix C
Foundation Comparison

COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Footings on Native Soil	Spread Footings on Engineered Fill	Caissons	Driven H-Piles
<p>Advantages:</p> <ul style="list-style-type: none"> i. Generally less costly construction than deep foundation elements. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Typically lower load bearing capacity than deep foundations. ii. Excavation to base of foundation may require shoring. iii. Dewatering will be required. <p>FEASIBLE FOR WEST ABUTMENT AND PIERS</p> <p>NOT FEASIBLE FOR EAST ABUTMENT</p>	<p>Advantages:</p> <ul style="list-style-type: none"> i. Generally less costly construction than deep foundation elements. ii. Lesser depth of excavation is required compared to footings on native fill iii. Possibly higher load bearing resistance than spread footings on native soil. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Typically lower load bearing capacity than deep foundations. ii. Excavation to base of foundation may require shoring. iii. Dewatering may be required. <p>FEASIBLE AT WEST ABUTMENT AND WEST PIER</p> <p>NOT RECOMMENDED AT OTHER FOUNDATION ELEMENTS</p>	<p>NOT RECOMMENDED</p>	<p>Advantages:</p> <ul style="list-style-type: none"> i. Higher geotechnical resistances than shallow foundations. ii. Installation of piles could continue in freezing weather iii. Foundation construction may require less volume of excavation than footings. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher unit costs than footings. ii. Less certainty on quantities as pile lengths may vary. <p>RECOMMENDED AT ALL FOUNDATION ELEMENTS</p>

Appendix D
Site Photographs

Structure M-9: Realigned Hwy 7 over Brougham Creek Trib. 'B' and Hwy 407
Highway 407/Brock Road Interchange Connection

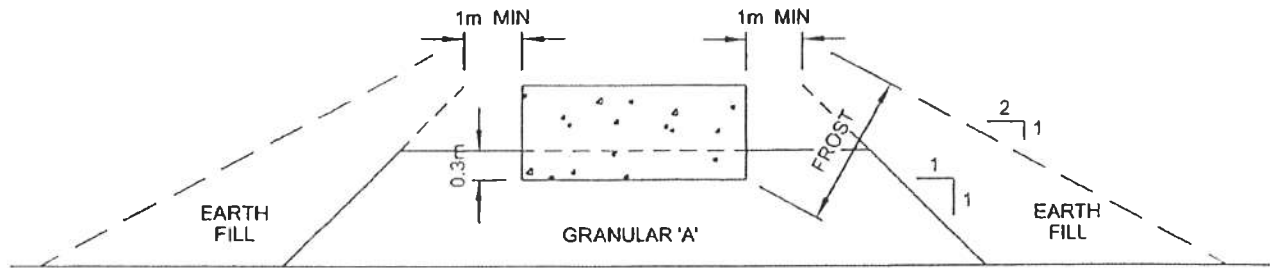


Photo 1: Looking west along the proposed alignment, from the east approach.

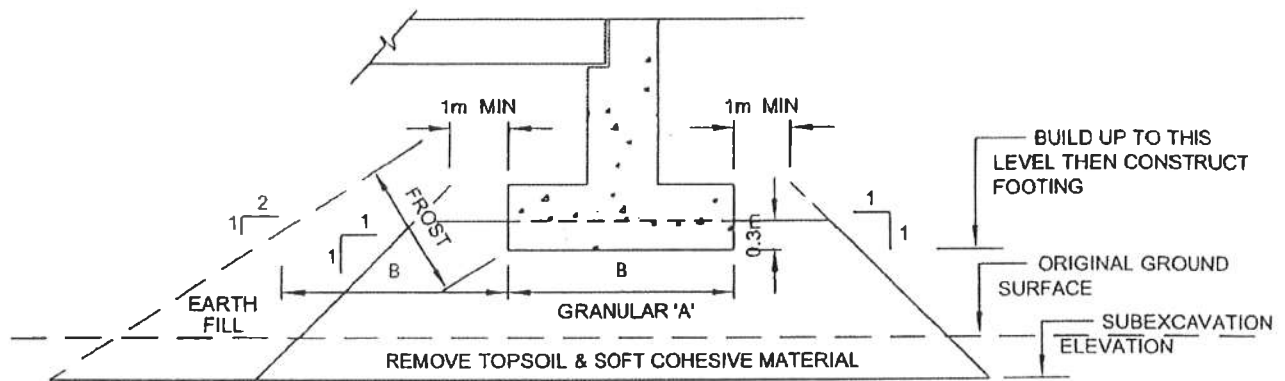


Photo 2: Brougham Creek Tributary 'B' north of Structure M-9

Appendix E
Miscellaneous Figures



CROSS-SECTION




LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. REMOVE TOPSOIL AND SOFT SILTY CLAY SUBSOIL UNDER FOOTPRINT OF COMPACTED GRANULAR 'A'.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
3. CONSTRUCT CONCRETE FOOTING.
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
5. SOURCE M.T.C. 1982.

ENGINEER	AEG	<div style="text-align: center;">  THURSDAY </div>
DRAWN	SS	
DATE	April , 2004	
APPROVED	PKC	
SCALE	NTS	
<div style="text-align: center;"> <h2>ABUTMENT ON COMPACTED FILL SHOWING GRANULAR A CORE</h2> </div>		DWG. NO. FIGURE 1

Title: HWY 407 - Brock Road Connection
Name: Analysis 2
Description: Seismic Analysis
Comments: Structure M-9, MSE Wall
Last Solved Date: 12/6/2012, 4:40:24 PM

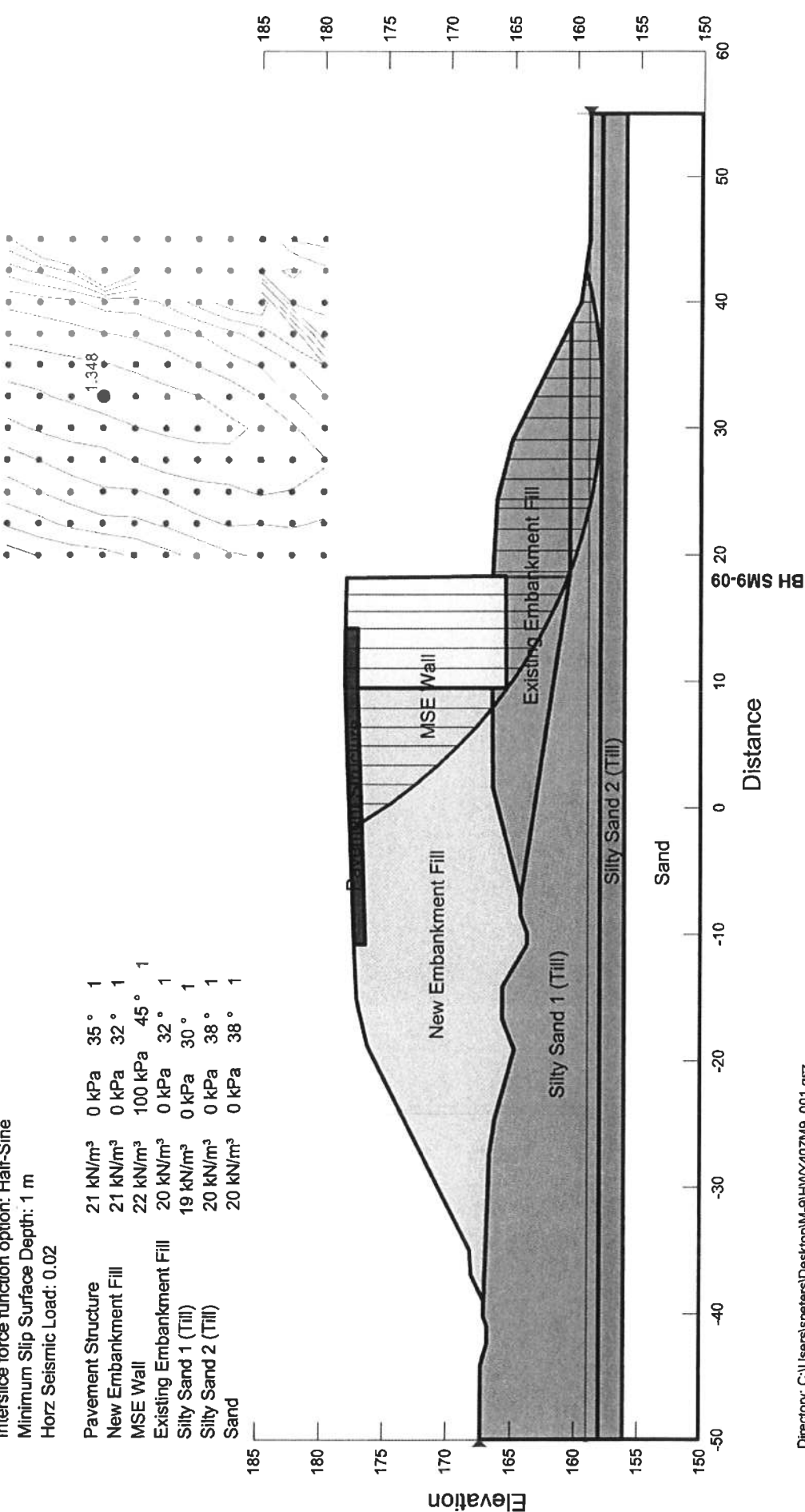
Method: Morgenstern-Price

Interslice force function option: Half-Sine

Minimum Slip Surface Depth: 1 m

Horz Seismic Load: 0.02

Pavement Structure	21 kN/m³	0 kPa	35 °	1
New Embankment Fill	21 kN/m³	0 kPa	32 °	1
MSE Wall	22 kN/m³	100 kPa	45 °	1
Existing Embankment Fill	20 kN/m³	0 kPa	32 °	1
Silty Sand 1 (Till)	19 kN/m³	0 kPa	30 °	1
Silty Sand 2 (Till)	20 kN/m³	0 kPa	38 °	1
Sand	20 kN/m³	0 kPa	38 °	1



Appendix F
Borehole Locations and Soil Strata Drawings

NO.	DATE	REVISIONS	BY	CHK	LEAD	PROJ. MAN.

CONTRACT No. E2-2012
HWY 407/BROCK ROAD INTERCHANGE

STRUCTURE M-9
REALIGNED HWY 7 OVER
BROUGHAM CREEK TRIB. 'B' & HWY 407
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

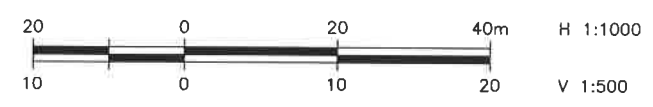
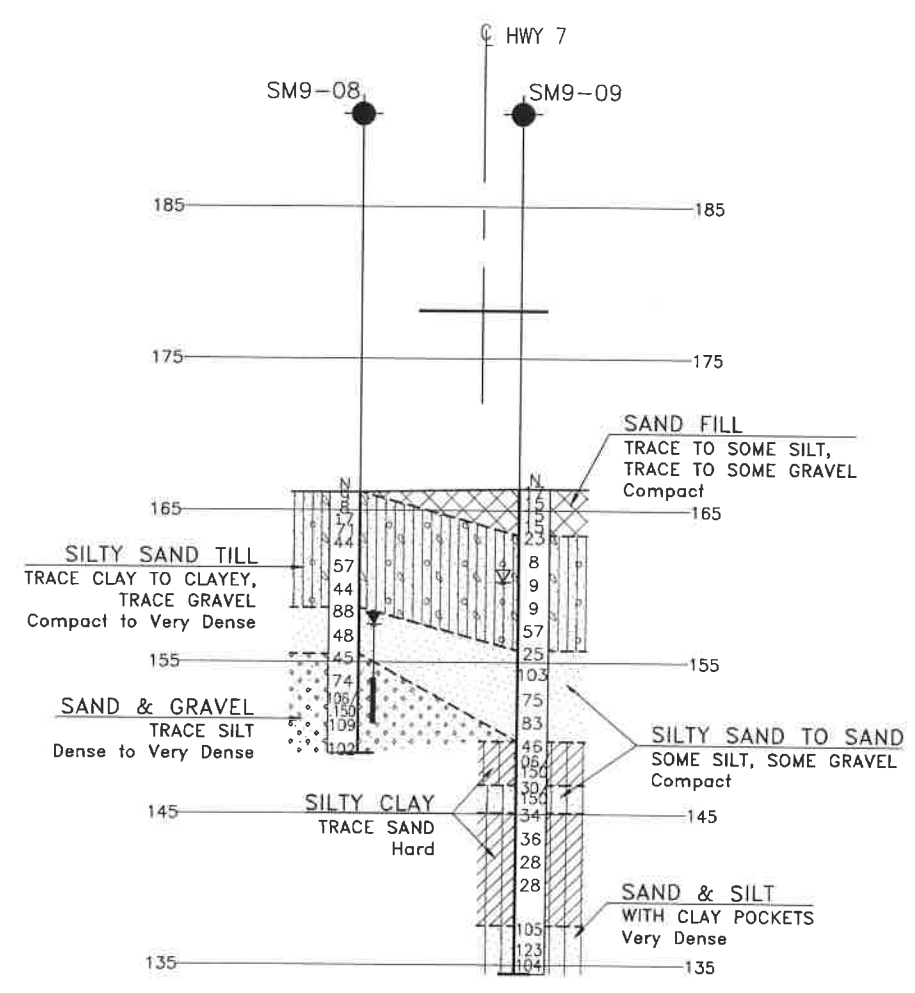
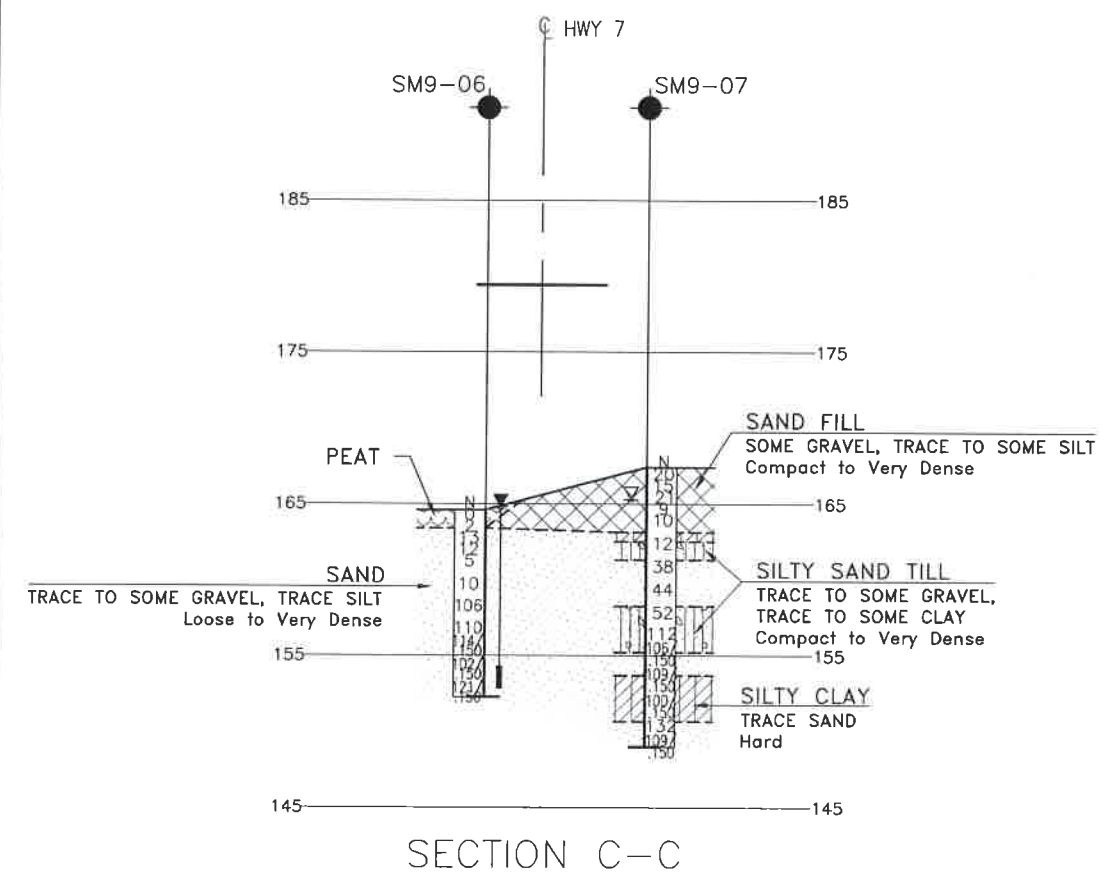
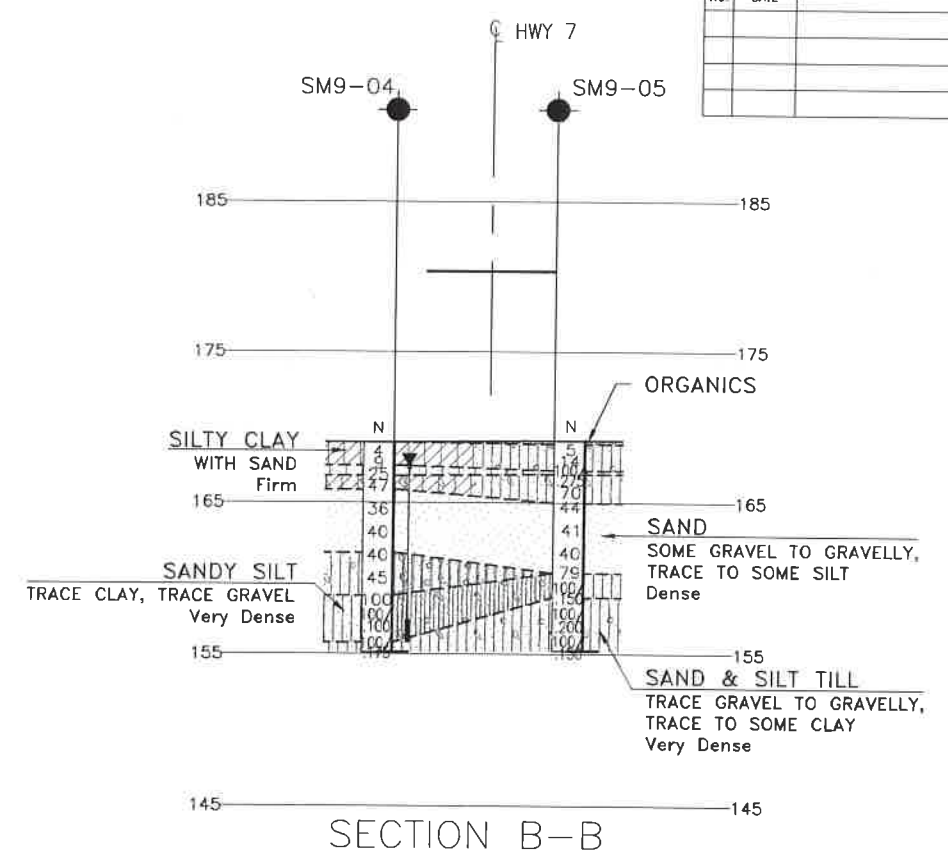
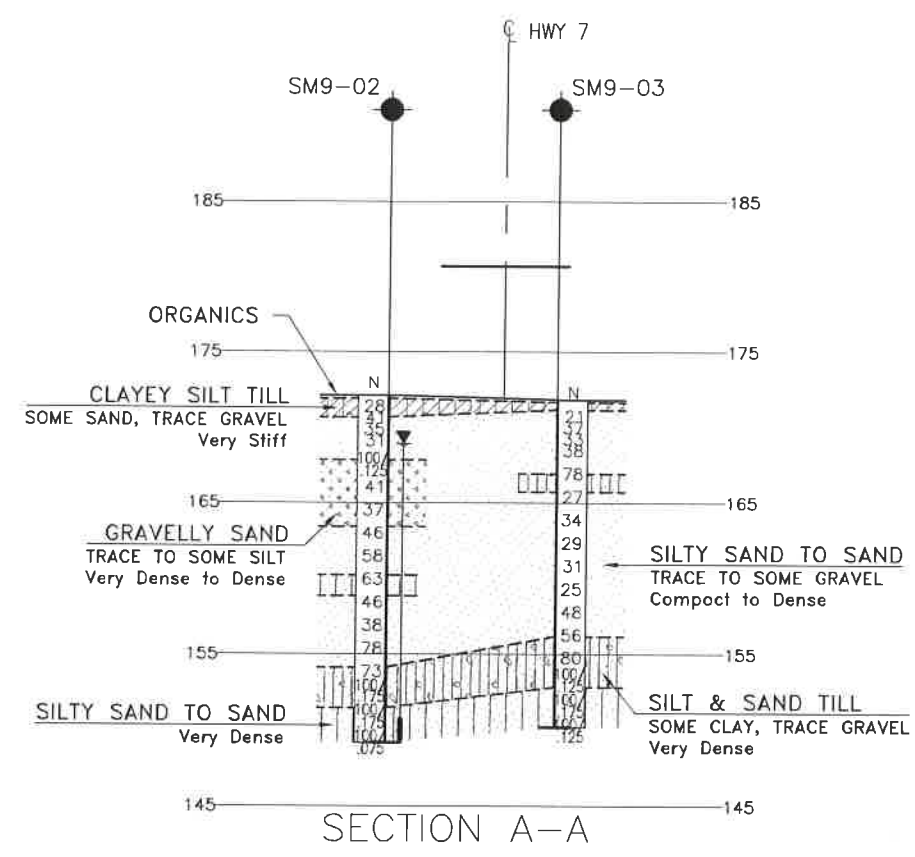
407 ETR
Express Toll Route

MMM GROUP

THURBER ENGINEERING LTD.

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
SM9-01	172.6	4 864 773.4	337 332.2
SM9-02	172.1	4 864 785.9	337 346.3
SM9-03	171.8	4 864 763.5	337 345.4
SM9-04	169.0	4 864 788.7	337 422.0
SM9-05	169.1	4 864 765.7	337 404.1
SM9-06	164.6	4 864 788.3	337 467.2
SM9-07	167.4	4 864 768.6	337 479.7
SM9-08	166.2	4 864 810.0	337 545.0
SM9-09	166.4	4 864 788.0	337 536.4
SM9-10	166.3	4 864 794.8	337 552.6
SM10-05	163.6	4 864 822.9	337 431.3
SM10-06	169.6	4 864 803.7	337 401.3
SM10-10	168.1	4 864 797.8	337 431.9
SM10-12	167.9	4 864 783.7	337 442.2
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
DRAWN AN	CHK AEG	SITE	STRUCT M-9
			DATE JAN. 2013
			DWG 2

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



DRAWING NAME: H:\Draftering\19\5161\1301\Geo1130A-M9-BoreholePlan&Profile.dwg
CREATED: December 18, 2012
MODIFIED: January 28, 2013