

**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 407/BROCK ROAD INTERCHANGE CONNECTION
DEEP CUTS & HIGH FILLS
Contract No.: E2-2012**

Report to

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Appendix B	South Connection to Brock Road (Boreholes BH-C1 and BH-C2)

Appendices include:

- Record of Borehole Sheets
- Laboratory Test Results
- Site Photographs
- Drawing titled “Borehole Locations and Soil Strata”
- Slope Stability Analysis Output

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the locations of a proposed deep cut and a high fill embankment required for the new Highway 407 / Brock Road Interchange Connection project located in Pickering, Ontario near the community of Brougham.

The purpose of this investigation was to explore the subsurface conditions at the proposed deep cut and high fill embankment locations and, based on the data obtained, to provide borehole location plans, records of boreholes, laboratory test results, stratigraphic profiles and written descriptions of the subsurface conditions. A model of the subsurface conditions was developed using the data obtained during the present investigation as well as previous investigations conducted by Thurber for the Highway 407 /Brock Road Interchange Connection project.

In preparation of this report and in addition to the boreholes drilled under the present investigation, reference has been made to information on subsurface conditions contained in previous foundation investigation reports and previous borehole logs within the investigated sections. The available data from previous investigations are indicated below:

- Foundation Investigation and Design Reports for two new bridge structures for the new Highway 407 / Brock Road Interchange Connection, Pickering Ontario, Contract E2-2012, prepared by Thurber Engineering Ltd. in 2012-2013.
 - Structure M-4 (Site 3A) – Realigned Brock Road over Brougham Creek (Reference 1)
 - Structure M-8 – Realigned Brock Road over Highway 407 (Reference 2)
- Foundation Investigation and Design Reports for one new culvert for the new Highway 407 / Brock Road Interchange Connection, Pickering Ontario, Contract E2-2012, prepared by Thurber Engineering Ltd. in 2012-2013.
 - Structure M-5 (Site 5) – Realigned Brock Road over Brougham Creek Tributary ‘A’ (Reference 3)

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

There is one high fill embankment section for the proposed Realigned Brock Road and one deep cut section for the proposed South Connection to Brock Road. The high fill section is located south of the existing Highway 407 and the deep cut section is located just east of the existing Brock Road north of Whitevale Road. Details of the high fill and deep cut sections are presented in Table 2-1, below.

Table 2-1. Deep Cut and High Fill Sections

Road	Station	Site Description	Maximum Depth of Cut / Height of Fill (m)
Realigned Brock Road	10+000 to 10+400	This high fill section extends from just south of the existing Highway 407 to the Brougham Creek valley and cross over the Brougham Creek Tributary 'A' valley.	20 (fill)
South Connection	9+900 to 10+000	This cut section extends from the existing Brock Road eastward into farmers' fields where the Realigned Brock Road will be.	8.5 (cut)

Lands surrounding the project site consist primarily of agricultural fields and undeveloped grass areas near the existing Highway 407 and existing Brock Road. Photographs included in Appendices A and B show the general nature of the surrounding lands.

The Highway 407 / Brock road Interchange Connection project is located in the physiographic region known as the South Slope, which lies between the Oak Ridges Moraine and the Iroquois Plain, and is typically characterized by overburden deposits consisting of sands and silts overlying glacial till sheets. 'Surficial Geology of Southern Ontario' published by The Ontario Geological Survey shows that the majority of the project site is located in an area underlain by sandy silt to silty sand till.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for the deep cut and high fill sections were carried out from January 7 to 9, 2013 and consisted of drilling and sampling a total of three boreholes (identified as BH-C1 and BH-C2, and BH-F1). These boreholes were located along the centreline of the proposed Realigned Brock Road (BH-F1) and proposed South Connection to Brock Road (BH-C1 and BH-C2) at the deep cut and high fill embankment sections.

In addition to the borehole data obtained during the current investigation, selected boreholes from References 1, 2, and 3 are also included in this report as summarized below.

Table 3-1. Boreholes for Deep Cut and High Fill Sections

Road	Station	Boreholes	Appendix
Realigned Brock Road	10+000 to 10+400	BH-F1, SM4-01, SM4-03, SM5-03, SM8-07, and SM8-08	A
South Connection	9+900 to 10+000	BH-C1 and BH-C2	B

The boreholes referenced in this report (BH-C1, BH-C2, BH-F1, SM4-01, SM4-03, SM5-03, SM8-07, and SM8-08) were advanced to depths of 6.1 to 12.3 m (Elevations 177.1 to 159.8 m). The coordinates and elevations at the borehole locations are given on the Record of Borehole sheets and drawings, included in the appendices.

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

The boreholes were drilled using a track-mounted drill rig using solid stem augers, except Borehole BH-C2 which was advanced with hollow stem augers. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with the Standard Penetration Test (SPT).

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

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. Standpipe piezometers were installed in selected boreholes for subsequent monitoring of groundwater levels. The installation details of the piezometers and completion details for the boreholes included in this report are summarized in Table 3-2.

Table 3-2. Borehole Completion and Piezometer Installation Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Completion/ Installation Details
BH-F1	10.2 / 167.6	Piezometer with 1.5 m slotted screen installed with sand filter to 7.7 m, bentonite to 1.8 m and cuttings to surface.
SM4-01	None installed	Backfilled with bentonite holeplug to 1.4 m, then cuttings to surface.
SM4-03	None installed	Backfilled with bentonite holeplug to 1.5 m, then cuttings to surface.
SM5-03	None installed	Backfilled with bentonite holeplug to 1.9 m, then cuttings to surface.
SM8-07	9.1 / 174.2	Piezometer with 1.5 m slotted screen installed with sand filter to 6.7 m, bentonite to 1.8 m and cuttings to surface.
SM8-08	None installed	Backfilled with bentonite holeplug to 1.8 m, then cuttings to surface.
BH-C1	None installed	Backfilled with bentonite holeplug to 1.1 m, then cuttings to surface.
BH-C2	7.9 / 169.7	Piezometer with 1.5 m slotted screen installed with sand filter to 5.0 m, bentonite to 0.6 m and cuttings to surface.

4 LABORATORY TESTING

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

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets and Borehole Location and Soil Strata drawings included in Appendix A and Appendix B. An overall description of the stratigraphy encountered in the boreholes drilled along the high fill and deep cut sections 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 High Fill – Realigned Brock Road, Station 10+000 to 10+400 (Boreholes SM8-07, SM8-08, BH-F1, SM5-03, SM4-01 and SM4-03)

In general, the soil stratigraphy encountered along this high fill section consists of a thin layer of organics overlying clayey silt fill (near Highway 407 only), underlain by a layer of

either sandy silt or clayey silt overlying silty sand to sandy silt till. Layers of sand and silt were encountered at depth, below the till in some boreholes. More detailed descriptions of the individual strata are presented below.

5.1.1 Organics

A thin layer of organics was encountered surficially in the boreholes drilled along the high fill section. The thickness of the organic layer ranged from 150 to 250 mm. The thickness of the organic layer may vary between and beyond the borehole locations.

5.1.2 Clayey Silt Fill

A layer of clayey silt fill was encountered below the surficial organics layer in Boreholes SM8-07 and SM8-08. The clayey silt fill was brown in colour and contained trace gravel.

The fill was 1.1 m thick in Borehole SM8-07 and 1.3 m thick in Borehole SM8-08, with the lower boundary of the fill encountered at depths of 1.2 and 1.5 m (Elevation 182.1 and 181.7 m).

SPT N-values of 28 and 29 blows for 0.3 m penetration were recorded in the clayey silt fill, indicating a very stiff consistency. Moisture contents of samples of the clayey silt fill ranged from 10 to 16%.

5.1.3 Clayey Silt

A layer of clayey silt was encountered below the surficial organics layer in Boreholes SM4-01 and SM4-03 and below the clayey silt fill in Boreholes SM8-07 and SM8-08. The clayey silt was dark brown to brown, topsoil stained and contained trace to some sand and trace gravel.

The thickness of the clayey silt layer ranged from 0.3 to 1.5 m, with the lower boundary of the clayey silt encountered at depths of 1.4 to 3.0 m (Elevation 181.8 to 170.7 m).

SPT N-values recorded in the clayey silt layer ranged from 21 blows for 0.3 m penetration to 50 blows for 0.15 m penetration, indicating a very stiff to hard relative density. Typically N-values were less than 33. Moisture contents of samples of the clayey silt ranged from 9 to 32%.

5.1.4 Sandy Silt

A layer of sandy silt was encountered locally in Borehole SM5-03, below the surficial organics layer. The sandy silt was brown in colour and contained some clay and trace gravel.

The sandy silt was 1.2 m thick, with the lower boundary of this layer encountered at a depth of 1.4 m (Elevation 172.8 m).

A single SPT N-value of 28 blows for 0.3 m penetration was recorded in the sandy silt, indicating a compact relative density. The moisture content of one sample of the sandy silt was measured to be 12%.

5.1.5 Sandy Silt to Silty Sand Till

A deposit of sandy silt to silty sand till was encountered in all of the boreholes drilled along this high fill section. The till was encountered directly below the surficial organics layer in Borehole BH-F1, below a layer of clayey silt in Boreholes SM4-01, SM4-03, SM8-07, and SM8-08 and below a layer of sandy silt in Borehole SM5-03. The sandy silt to silty sand till contained trace gravel, trace clay to clayey with some clayey zones, occasional cobbles and was brown to grey with increasing depth.

The till was fully penetrated in two boreholes only (BH-F1 and SM4-03). In these two boreholes, the till was 8.4 to 10.2 m thick, with the lower boundary of the till encountered at depths of 8.7 to 11.7 m (Elevation 169.1 to 160.4 m). The other four boreholes were terminated within the till at depths of 6.1 to 9.3 m (Elevation 177.1 to 165.8 m).

SPT N-values recorded in the till ranged from 34 blows for 0.3 m penetration to 100 blows for 0.1 m penetration, indicating a dense to very dense relative density. In general, blow counts were greater than 50 within the till (very dense). Moisture contents measured in samples of the till ranged from 4 to 21%.

Nine samples of the till underwent laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure A1 and A2, included in Appendix A.

Soil Particles	(%)
Gravel	2 to 7
Sand	33 to 54
Silt	31 to 45
Clay	8 to 21

Three samples of the till exhibited sufficient plasticity for Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets and Figure A4, Appendix A.

Index Property	Percentage (%)
Liquid Limit	20 to 23
Plastic Limit	12 to 13

The results of the Atterberg Limits tests indicate that the sandy silt to silty sand till has zones of low plasticity.

Glacial tills inherently contain cobbles and boulders.

5.1.6 Sand

A layer of grey sand containing some silt to becoming silty and trace clay was encountered below the till in Boreholes BH-F1 and SM4-03.

In Borehole BH-F1, the sand layer was 1.5 m thick, with the lower boundary encountered at a depth of 10.2 m (Elevation 167.6 m). The sand layer encountered in Borehole SM4-03 was not fully penetrated and the borehole was terminated at a depth of 12.3 m (Elevation 159.8 m), within the silty sand.

SPT N-values of 50 to 100 blows for less than 0.3 m penetration were recorded in the sand, indicating a very dense relative density. Moisture contents of samples of the sand ranged from 13 to 17%.

5.1.7 Silt

A layer of silt was encountered locally in Borehole BH-F1, below the sand layer. The silt was grey in colour and contained some clay and trace sand.

The silt layer was not fully penetrated in this borehole, which was terminated at a depth of 10.8 m (Elevation 167.0 m) within the silt.

An SPT N-value of 50 blows for 0.1 m penetration was recorded in the silt, indicating a very dense relative density. A moisture content of 18% was measured in one sample of the silt.

One sample of the silt was selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also summarized on the corresponding Record of Borehole sheet included in Appendix A and the grain size distribution curve for this sample is plotted on Figure A3, Appendix A.

Soil Particles	(%)
Gravel	0
Sand	9
Silt	71
Clay	20

5.1.8 Groundwater

Groundwater was observed in the boreholes upon completion of drilling.

Standpipe piezometers were installed in selected boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers, along with the water levels measured in the open boreholes upon completion of drilling are listed in Table 5-1.

Table 5-1. Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
BH-F1	Jan. 14, 2013	0.9	176.9	Piezometer
SM4-01	Sept. 11, 2012	4.6	167.8	Open borehole
SM4-03	Sept. 12, 2012	3.8	168.3	Open borehole
SM5-03	Aug. 16, 2012	Dry		Open borehole
SM8-07	Oct. 16, 2012	3.4	179.9	Piezometer
	Oct. 26, 2012	2.8	180.5	
	Nov. 26, 2012	2.7	180.6	
	Dec. 19, 2012	2.5	180.8	
	Jan. 3, 2012	2.7	180.6	
SM8-08	Sept. 9, 2012	Dry		Open borehole

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

5.2 Deep Cut – South Connection to Brock Road, Sta. 9+900 to 10+000 (Boreholes, BH-C1 and BH-C2)

In general, the soil stratigraphy encountered in the two boreholes drilled along the deep cut section consists of a thin surficial organics layer overlying silty sand till. In Borehole BH-C1, a layer of sand was encountered at depth below the till. More detailed descriptions of the individual strata are presented below.

5.2.1 Organics

A thin layer of organics was encountered surficially in both boreholes drilled along this deep cut section. The thickness of the organic layer ranged from 200 to 250 mm. The thickness of the organic layer may vary between and beyond the borehole locations.

5.2.2 Silty Sand Till

A deposit of silty sand till was encountered below the surficial organics layer in both boreholes drilled along this deep cut section. The silty sand till contained trace gravel, some clay to clayey with some clayey zones, occasional cobbles and was brown to grey in colour with increasing depth.

The till was fully penetrated in Borehole BH-C1 only. The till was 7.2 m thick in this borehole, with the lower boundary encountered at a depth of 7.5 m (Elevation 164.1 m). Borehole BH-C2 did not fully penetrate the till and was terminated at a depth of 7.9 m (Elevation 169.7 m).

SPT N-values recorded in the silty sand till ranged from 15 blows for 0.3 m penetration to 100 blows for less than 0.3 m penetration, indicating a compact to very dense relative density. In general, the relative density of the silty sand till increased with increasing depth. Moisture contents measured in samples of the silty sand till ranged from 4 to 9%.

Three samples of the till underwent laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the Record of Borehole sheets included in Appendix B. The grain size distribution curves for these samples are plotted on Figure B1, included in Appendix B.

Soil Particles	(%)
Gravel	3 to 6
Sand	39 to 46
Silt	32 to 34
Clay	19 to 21

Glacial tills inherently contain cobbles and boulders.

5.2.3 Sand

A layer of grey silty sand containing trace gravel and trace to some clay was encountered below the till in Borehole BH-C1.

The sand layer was not fully penetrated in this borehole, which was terminated at a depth of 9.4 m (Elevation 162.2 m) within the sand layer.

SPT N-values of 50 blows for 0.075 and 0.15 m penetration were recorded in the sand, indicating a very dense relative density. The moisture content of two samples of the sand was measured to be 12%.

One sample of the sand was selected for laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the corresponding Record of Borehole sheet included in Appendix B. The grain size distribution curve for this sand sample is plotted on Figure B2, Appendix B.

Soil Particles	(%)
Gravel	6
Sand	51
Silt	29
Clay	14

5.2.4 Groundwater

Groundwater was observed in the open boreholes upon completion of drilling.

A standpipe piezometer was installed in Borehole BH-C2 to monitor water levels after completion of drilling. The water levels measured in the piezometer are presented in Table 5-2 along with the water levels measure upon completion of drilling.

Table 5-2. Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
BH-C1	Jan. 8, 2013	Dry		Open borehole
BH-C2	Jan. 9, 2013	4.3	173.3	Piezometer
	Jan. 14, 2012	2.5	175.1	

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

6 MISCELLANEOUS

The borehole locations were selected by Thurber based on profiles provided by MMM Group dated November 28, 2012. The borehole locations were staked in the field by Thurber using a Trimble Pathfinder ProXRT differential GPS unit prior to drilling. The co-ordinates and ground surface elevations at the borehole locations were surveyed by MMM upon completion of drilling.

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

Walker Drilling Ltd. of Barrie, Ontario supplied a track-mounted drill rig and conducted the drilling, sampling and in-situ testing operations for the boreholes.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Stephane Loranger, C.E.T. 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.

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**FOUNDATION INVESTIGATION AND DESIGN REPORT
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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This section of the report presents interpretation of the geotechnical data in the factual report and presents geotechnical recommendations for the design of high fill embankments and deep cuts identified along sections of the Highway 407 / Brock Road Interchange Connection project in Pickering, Ontario. The information and profiles used for the preparation of this report were provided by MMM Group Limited.

A summary of the cut and fill sections, including approximate locations, lengths, maximum fill height and cut depth and relevant boreholes are presented below. The factual data for each section has been assigned to separate appendices, and the respective appendix designation is also included below.

Table 7-1. High Fill and Deep Cut Sections

Location		Approx. Length (m)	Type	Maximum Fill Height or Cut Depth(m)	Relevant Boreholes	Appendix
Road Section	Station					
Realigned Brock Road	10+000 to 10+400	400	High Fill	20.5	SM8-07 and 08, BH-F1, SM5-03, SM4-01 and 03	A
South Connection	9+900 to 10+000	100	Deep Cut	8.5	BH-C1 and C2	B

The discussion and recommendations presented in this report are based on our understanding of the project and the information provided by MMM and the factual data obtained during the course of the investigation. In addition, factual data obtained during previous investigations is also referenced where appropriate.

8 ENGINEERING ANALYSIS METHODOLOGY

The geotechnical analyses summarized in this report includes assessment of the global stability of the embankment and cut slope geometries for both short and long term conditions. Assessment of immediate and long-term settlements, including magnitude and time rate, was also carried out for

the embankments. The analyses were based on the soil profiles and properties encountered at various locations.

For the purpose of preparing geotechnical design recommendations, a number of assumptions have been made that are consistent with MTO's standard highway design practices:

- High fills will be constructed using Select Subgrade Material (SSM) or granular fill.
- High fills will be constructed with side slopes not steeper than 2H:1V for SSM and granular fill.
- Embankment slopes greater than 8 m high in SSM or granular fill will be provided with a 2 m wide mid-height berm.
- Cut slopes exceeding 6 m in depth will be provided with a 2 m wide mid-height bench.
- Organic deposits, peat, soft and deleterious material will be removed prior to constructing fill embankments.
- Drainage will be provided along the highway.

9 HIGH FILL

9.1 Stability Analyses

The proposed fill heights of the investigated section ranges from 8.0 to 20.5 m, when measured at the embankment centreline. Analyses were carried out for SSM and granular fill embankments, under static and seismic loading conditions. The foundation soils on this project are essentially cohesionless, and therefore short-term (undrained) and long-term (effective stress) conditions will be similar.

A factor of safety (FS) of 1.3 is considered appropriate to achieve both short and long-term global stability for embankments founded on cohesionless soils. For seismic analysis, a FS greater than 1.0 is considered acceptable. Limit equilibrium slope stability analysis was completed with Slope/W developed by Geo-Slope International Limited.

Results of the stability analyses carried out at selected locations are summarized in Table 9-1. The input parameters and soil model used in the stability analyses, including soil stratigraphy, soil properties, groundwater conditions, and embankment geometry, are shown on figures included in each Appendix A.

Table 9-1. Summary of Slope Stability Analysis Factors of Safety

Appendix	Road Section	Stations	Maximum Elevation Change (m)	Factor of Safety Short and Long-Term Conditions (2H:1V slopes)	
				Static	Seismic
A	Realigned Brock Road	10+000 to 10+400	+ 20.5	1.37	1.14
B	South Connection	9+900 to 10+000	- 8.5	1.36	1.15

In all of the above cases, the analysis indicate that standard embankment side slopes of 2H:1V in SSM or granular fill in conjunction with mid-height berms, where applicable, will be greater than 1.3 for static conditions and greater than 1.0 for seismic conditions. Hence, provided topsoil, organics, soft and deleterious soils are removed from the footprint of the high fill embankments, a side slope of 2H:1V with mid-height berms (where required) is recommended for the high fill embankments built with SSM or granular fill.

9.2 Settlement Analysis

9.2.1 Foundation Settlement

A settlement analysis was completed to predict the immediate settlement of the foundation soils under the imposed embankment loading using elastic theory. The elastic settlement at various embankment heights ranges from 40 to 80 mm. Elastic settlement of the foundation soils will occur as the new fill is placed and should be essentially completed during construction.

The foundation soils at the site, following stripping of the peat/organics, are considered cohesionless and therefore long-term consolidation of the foundation soils should not be an issue.

A thin layer of organics (100 mm to 250 mm thick) was encountered in the boreholes. It is recommended that the topsoil/organics be subexcavated within the embankment footprint prior to embankment construction. Particular attention must be paid in low creek valley areas where thicker layers of organics soils may be present. After removal of organics, the exposed subgrade should be proofrolled to identify any loose/softened areas requiring sub-excavation or additional compaction prior to fill placement.

9.2.2 Embankment Compression

The estimated settlement of SSM or granular fill embankments, due to compression of the compacted fill, is 0.5% of the embankment height and is expected to be completed within

one to two years after construction. The embankment compression is anticipated to range from 40 to 105 mm depending on the height of the embankment.

To mitigate the effects of the settlement, it is recommended that the embankments be constructed at least six months in advance of pavement construction. Embankment and platform width design should allow for the anticipated foundation and embankment compression settlements.

9.3 Embankment Construction

Embankment construction should be carried out in accordance with SP 206S03. Embankment fill may consist of granular materials and SSM in compliance with Special Provision 110F13.

The SSM and granular fill should be placed in thin lifts and compacted in accordance with OPSS 501. Mid-height berms comprising 2 m wide benches must be incorporated along the length of SSM or granular fill embankments with heights exceeding 8 m. The bench should maintain a 2% slope to shed surface run-off.

Where new embankment fill is placed against existing embankment slopes or in a sloping ground surface, the existing earth or fill slope must be benched in accordance with OPSD 208.01, after stripping of vegetation, topsoil, organics, soft soils or otherwise unsuitable materials.

SSM or granular fill embankment slopes must be provided with erosion protection in accordance with OPSS 804.

10 DEEP CUTS

10.1 Stability Analysis

The design pavement elevation within the cut section is proposed at a maximum of 8.5 m below the existing ground surface. An assessment of the global stability of the cut slopes has indicated that the proposed cuts, if constructed with side slopes not steeper than 2H:1V with a mid-height bench, will have a FS greater than 1.3 for static conditions based on the soils encountered within the boreholes. Results of the stability analysis carried out are summarized earlier in Table 9-1. Slope stability outputs are included in Appendix B.

Earth cut slopes must be provided with erosion protection in accordance with OPSS 804.

10.2 Cut Drainage

10.2.1 Construction Drainage

The groundwater level in BH-C2 was measured above the proposed pavement level at an elevation of 175.1 m. Prior dewatering of the site is not considered necessary but groundwater seepage is expected to enter the cut as excavation proceeds. It is expected that seepage will be gradual and will not impede excavation, but the water will accumulate in the low points in the excavation. Accordingly, temporary drainage of the cuts must be provided to maintain a relatively dry, stable excavation and to allow work to continue in the dry and should be implemented in accordance with OPSS 577.

It is the responsibility of the Contractor to maintain a stable excavation and to provide adequate drainage of groundwater seepage and surface runoff during construction. The design of any dewatering measures is the responsibility of the contractor. However, suitable systems that might be considered include:

- Starting the cut from the lowest point and excavating the remainder of the cuts from that point and utilizing gravity drainage
- Temporary drainage ditches
- Pumping from sumps excavated at intervals at the base of the cut

The rate of seepage is expected to decrease over time as the local groundwater table is drawn down. However, some continuing seepage is expected in the long term and permanent drainage must be provided.

10.2.2 Permanent Drainage

Permanent drainage will be required to remove groundwater seepage from the cut slope and from above the subgrade. Roadside ditches are expected to provide an adequate level of permanent drainage. An interceptor ditch should be provided at the top of the cut as per OPSD 200.020. General site drainage should be by gravity towards an outlet at a lower elevation.

Where cut excavation extends below the measured groundwater levels in cohesionless soils, more positive measures to provided permanent slope drainage and mitigate surficial instability may be required. Measures may include provisions for subdrains positioned along the toe of the slope and/or along the rear of the mid-slope bench, as well as gravel sheeting or rip-rap lined channels down the slope. All subdrains must be sloped on a positive grade to an outlet or pumping chamber.

Seepage and surficial instability may also occur from localised permeable zones. Prediction of the extent and location of the seepage zones from the limited borehole data is not possible. Therefore, an observational approach is recommended involving inspection

of the cut slopes during and following construction to identify any areas of surficial instability and provide mitigation measures such as gravel sheeting.

10.3 Construction Considerations

Excavation of cut slopes should be carried out in accordance with OPSS 206 as amended by Special Provision 206S02.

The soil deposits in many of the cut sections will typically be very dense/hard and often contain cobbles and boulders. Excavation in these deposits is likely to be arduous and will require use of heavy duty excavators. However, selection of the method of excavation must remain the responsibility of the contractor based on their equipment, experience and interpretation of the site conditions.

The drainage/unwatering system design must take account of all MOE/MNR requirements regarding, among other things, taking water, discharge water and the turbidity of the discharge.

11 SEISMIC CONSIDERATIONS

11.1 Seismic Design parameters

The following seismic parameters should be used for design

Velocity Related Seismic Zone	1
Zonal Velocity Ratio	0.05
Acceleration Related Seismic Zone	1
Zonal Acceleration Ratio	0.05
Peak Horizontal Acceleration	0.08

The soil profile type at this location 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.

11.2 Liquefaction Potential

Based on the observed stratigraphy and groundwater conditions, the potential for liquefaction of the high fills and deep cut slopes at this site under a seismic event is low. Some toe failure may occur but it is expected to be of limited nature and readily repairable.

12 CONSTRUCTION CONCERNS

During construction, qualified geotechnical staff must be retained to observe activities related to embankment construction and roadway cuts and advise the Contract Administrator on construction concerns or issues.

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

- The thickness and presence of organic deposits were investigated at the borehole locations only. Organic deposits may extend to greater depths particularly in the creek valleys
- Movement of construction equipment may be difficult in areas of organic or excessively soft, loose and/or saturated subgrade. Disturbance of the subgrade by construction traffic must be minimized.
- Excavation difficulties in dense/hard soil layers. Cobbles and boulders should be expected within the till layers during excavation. Provision must be made for the removal of cobbles and boulders
- Control of groundwater seepage during excavation and permanent drainage in cut sections

13 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Stephen. Peters P.Eng(MB) and Mr. Alastair Gorman, P.Eng.

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

Thurber Engineering Ltd.


Jan 28/13

Stephen Peters, P.Eng(MB)
Geotechnical Engineer



Alastair Gorman, P.Eng.
Senior Foundation Engineer



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

Appendix A

**Realigned Brock Road
(Boreholes BH-F1, SM4-01, SM4-03, SM5-03, SM8-07, and SM8-08)**

RECORD OF BOREHOLE No BH-F1

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 236.0 E 337 187.6, Sta. 10+141 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			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	
177.8												
0.0												
177.5	ORGANICS: (250mm)											
0.3	Sandy SILT, some clay to clayey, trace gravel, occasional cobbles Dense to Very Dense Brown Moist (TILL)		1	SS	35		177					4 33 45 19
			2	SS	81		176					
			3	SS	86		175					
			4	SS	50/ .075		174					
			5	SS	50/ .075		173					
	Grey		6	SS	50/ .100		172					
			7	SS	50/ .150		171					
							170					
169.1							169					
8.7	SAND, some silt Very Dense Grey Wet		8	SS	50/ .150		168					

Continued Next Page

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

RECORD OF BOREHOLE No BH-F1

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 236.0 E 337 187.6, Sta. 10+141 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									
	Continued From Previous Page																
167.6																	
10.2	SILT, some clay, trace sand Very Dense Grey																
167.0	Moist		9	SS	50/											0 9 72 20	
10.8	END OF BOREHOLE AT 10.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jan. 14/13 0.9 176.9				100												

+ 3 . X 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM4-01

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 864 027.7 E 337 305.0 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.09.11 - 2012.09.11 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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
172.4														
0.0	ORGANICS, with roots and rootlets: (200mm)													
0.2	Clayey SILT, trace to some sand, trace gravel Hard Brown Moist		1	SS	50/ 0.150									
171.0														
1.4	Silty SAND, trace gravel, trace clay, occasional cobbles Dense to Very Dense Brown Moist (TILL)		2	SS	100/ 0.275									
			3	SS	100/ 0.275									
			4	SS	100/ 0.275									
			5	SS	34									
			6	SS	100									
165.8														
6.6	END OF BOREHOLE AT 6.6m. BOREHOLE OPEN AND WATER LEVEL AT 4.6m ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.4m, THEN CUTTINGS TO SURFACE.													

+ 3 × 3. Numbers refer to 20
Sensitivity 15 5 6
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM4-03

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 017.1 E 337 323.1 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.09.12 - 2012.09.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
172.1													
0.0	ORGANICS, with roots and rootlets: (175mm)						172						
0.2	Clayey SILT, some sand, trace gravel Hard Brown Moist		1	SS	33		171						
170.7													
1.4	Silty SAND, trace to some clay, trace gravel Compact to Very Dense Brown Moist (TILL)		2	SS	40		170						
			3	SS	100/ 0.275								6 53 32 9
	Occasional cobbles		4	SS	100/ 0.175		169						
							168						
	Moist becoming wet		5	SS	71		167						
							166						6 48 33 14
	Grey		6	SS	100		165						
			7	SS	100/ 0.150		164						
							163						
			8	SS	100/ 0.125								

Continued Next Page

+ 3, X 3, Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM4-03

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 017.1 E 337 323.1 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.09.12 - 2012.09.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
	Continued From Previous Page													
160.4			9	SS	100/ 0.150		162							
11.7	Silty SAND, trace clay Very Dense Grey Wet						161							
159.8			10	SS	100/ 0.150		160							
12.3	END OF BOREHOLE AT 12.3m. BOREHOLE OPEN TO 5.4m AND WATER LEVEL AT 3.8m ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, THEN CUTTINGS TO SURFACE.													

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15
10
5
0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM5-03

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 864 135.0 E 337 276.3 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.08.16 - 2012.08.16 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
174.2														
0.0	ORGANICS, with roots and rootlets: (200mm)													
0.2	Sandy SILT, some clay, trace gravel Compact Brown Moist		1	SS	28									
172.8														
1.4	Silty SAND, trace clay, trace gravel, occasional cobbles Very Dense Brown Moist (TILL)		2	SS	100/ 0.150									
			3	SS	90									
			4	SS	100/ 0.125									
	Grey		5	SS	100/ 0.200									
168.1														
6.1	Clayey SAND and SILT, trace gravel, occasional cobbles Hard Grey Moist (TILL)		6	SS	100/ 0.125									
166.1			7	SS	100/ 0.275									
8.1	END OF BOREHOLE AT 8.1m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.9m, THEN CUTTINGS TO SURFACE.													

ONTMT4S 1130A.GPJ 29/1/13

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

RECORD OF BOREHOLE No SM8-07

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 298.0 E 337 111.7 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.09.05 - 2012.09.05 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			
								20 40 60 80 100	20 40 60		
183.3											
0.0	ORGANICS, with roots and rootlets										
0.2	Clayey SILT , trace gravel Very Stiff Brown Moist (FILL)		1	SS	29		183				
182.1											
1.2	Clayey SILT , topsoil stained, trace rootlets						182				
181.8	Dark Brown Moist		2	SS	43						
1.5	Silty SAND , some clay, trace gravel, occasional rootlets Very Dense Brown Moist (TILL)		3	SS	72		181				
			4	SS	63		180				
	Grey										
			5	SS	100/ 0.275		179				
							178				
			6	SS	100/ 0.025		177				
							176				
			7	SS	100/ 0.150		175				
174.0			8	SS	100/ 0.150						
9.3	END OF BOREHOLE AT 9.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

Continued Next Page

+ ³ . X ³ : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM8-07

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 864 298.0 E 337 111.7 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.09.05 - 2012.09.05 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						
	Continued From Previous Page													
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 16/12 3.4 179.9 Oct. 26/12 2.8 180.5 Nov. 26/12 2.7 180.6 Dec. 19/12 2.5 180.8 Jan. 03/13 2.7 180.6													

+³ . X³ : Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SM8-08

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 864 301.0 E 337 130.4 ORIGINATED BY SLL
HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.09.06 - 2012.09.06 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		
183.2														
0.0	ORGANICS, with roots and rootlets: (150mm)													
0.2	Clayey SILT, trace gravel, topsoil stained Very Stiff Brown Moist (FILL)		1	SS	28									
181.7														
1.5	Clayey SILT, trace gravel, with rootlets, topsoil stained Very Stiff Dark Brown Moist		2	SS	21									
			3	SS	25									
180.2														
3.0	SAND and SILT, some clay, trace gravel Very Dense Brown Moist (TILL)		4	SS	100/ 0.250									
			5	SS	100/ 0.200									
177.1			6	SS	100/ 0.050									
6.1	END OF BOREHOLE AT 6.1m. BOREHOLE OPEN AND DRY ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.8m, THEN CUTTINGS TO SURFACE.													

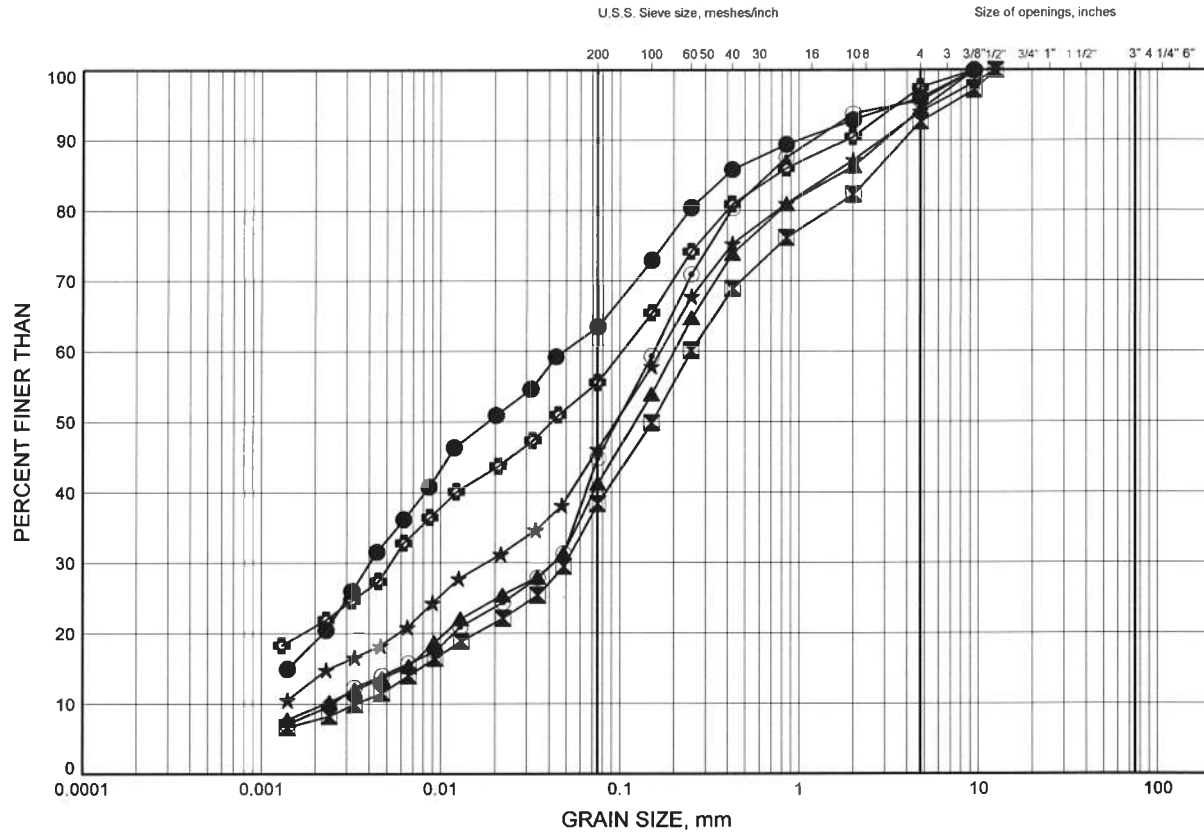
+ 3. x 3. Numbers refer to
Sensitivity

20
15 5 10 (%) STRAIN AT FAILURE

HWY 407 Brock Road Connection - Foundations
GRAIN SIZE DISTRIBUTION

FIGURE A1

SANDY SILT to SILTY SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-F1	1.07	176.73
⊠	SM4-01	2.50	169.90
▲	SM4-03	2.50	169.60
★	SM4-03	6.32	165.78
⊙	SM5-03	2.59	171.61
⊕	SM5-03	6.31	167.89

Date January 2013
 WP# E2-2012

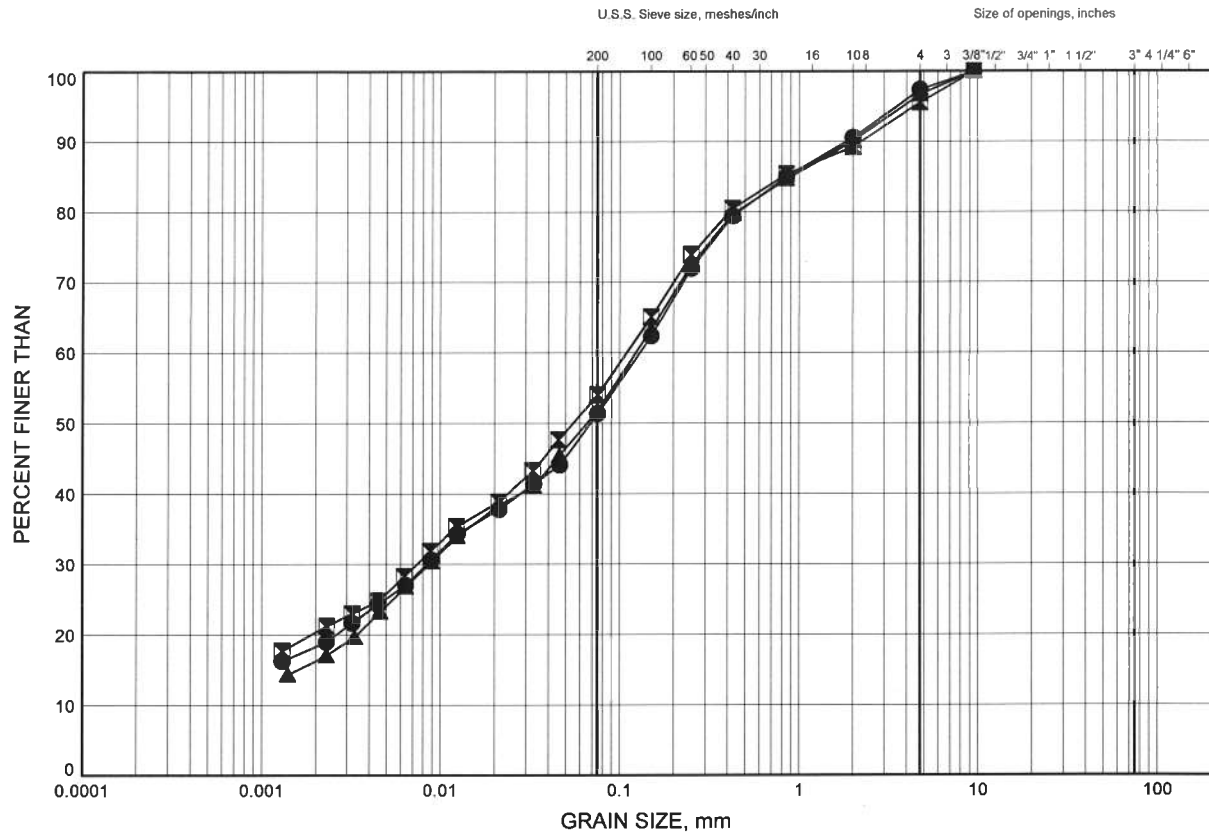


Prep'd AN
 Chkd. LRB

HWY 407 Brock Road Connection - Foundations
GRAIN SIZE DISTRIBUTION

FIGURE A2

SANDY SILT to SILTY SAND TILL



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

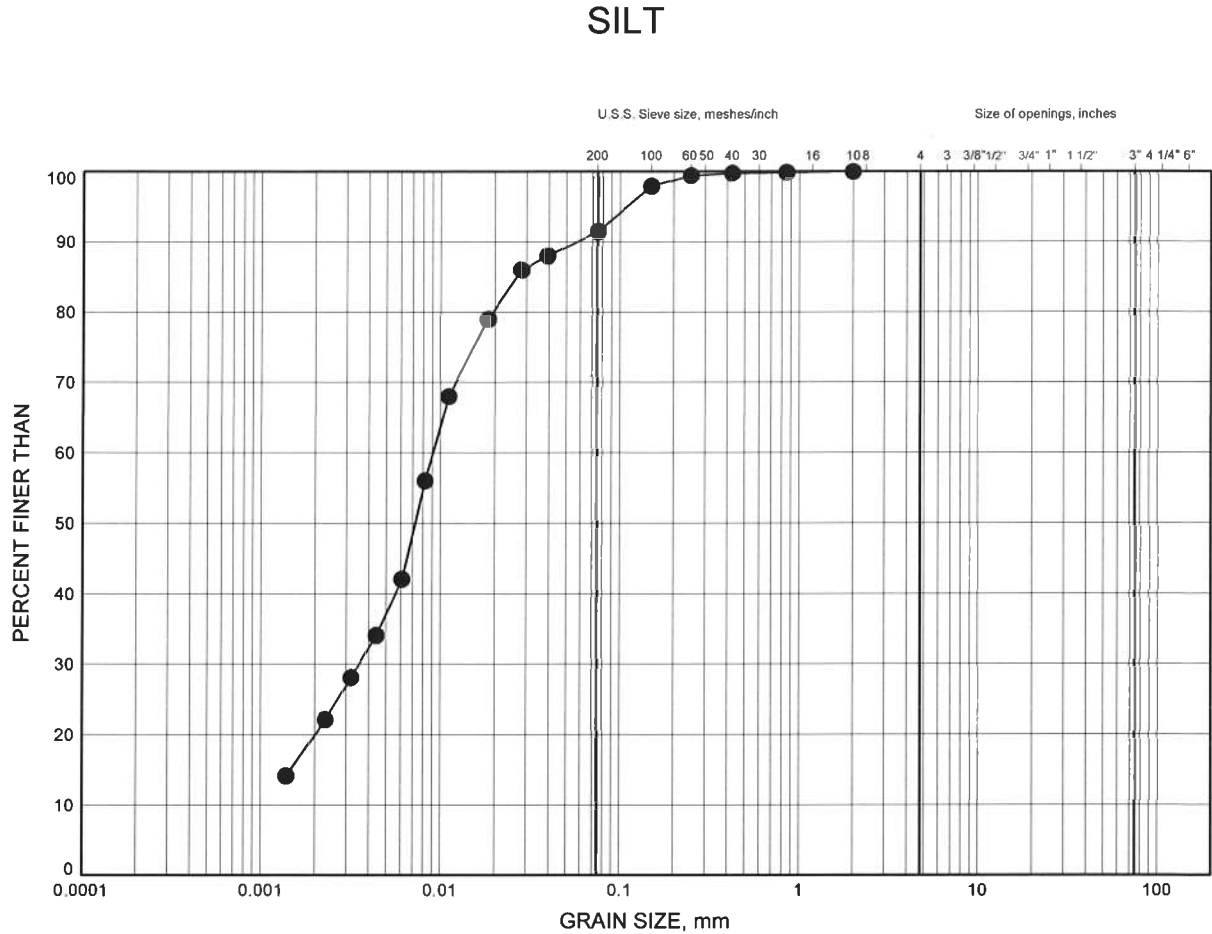
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SM8-07	2.59	180.71
⊠	SM8-07	7.77	175.53
▲	SM8-08	3.25	179.95

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE A3



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-F1	10.72	167.08

Date January 2013
 WP# E2-2012

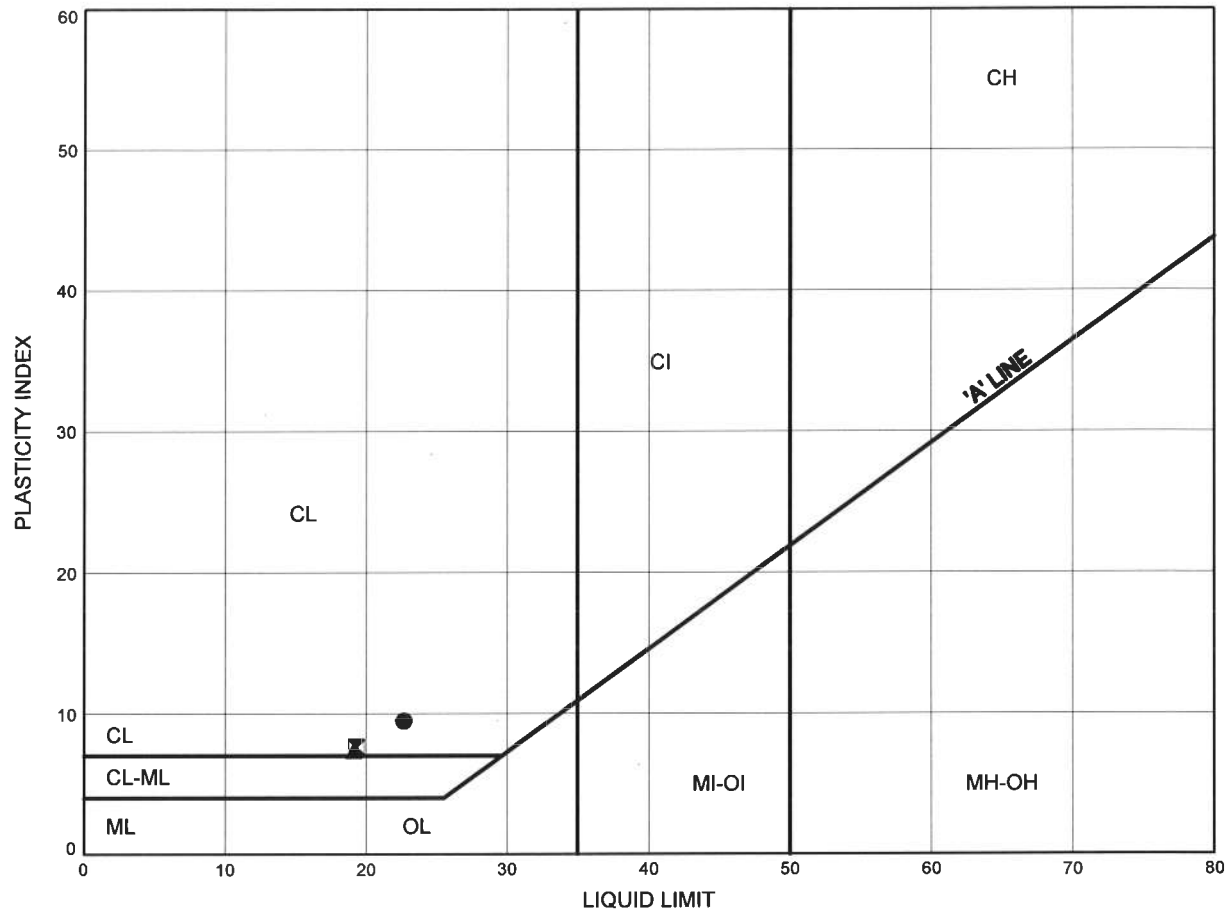


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 Chkd. LRB

HWY 407 Brock Road Connection - Foundations
ATTERBERG LIMITS TEST RESULTS

FIGURE A4

SANDY SILT to SILTY SAND TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-F1	1.07	176.73
⊠	SM8-07	2.59	180.71
▲	SM8-08	3.25	179.95

Date January 2013
 WP# E2-2012



Prep'd AN
 Chkd. LRB

Highway 407/Brock Road Interchange Connection
Deep Cuts and Fills



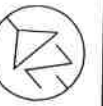
Photo 1: Looking north from BH-F1 along proposed Realigned Brock Road.



Photo 2: Looking southeast from BH-F1.

NO.	DATE	REVISIONS	BY	CHK	LEAD	PROJ.

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



HIGH FILL EMBANKMENT
REALIGNED BROCK ROAD
STA. 10+000 TO 10+400
BOREHOLE LOCATIONS AND SOIL STRATA

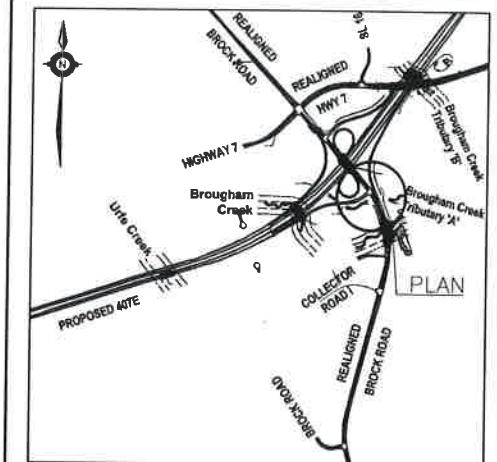
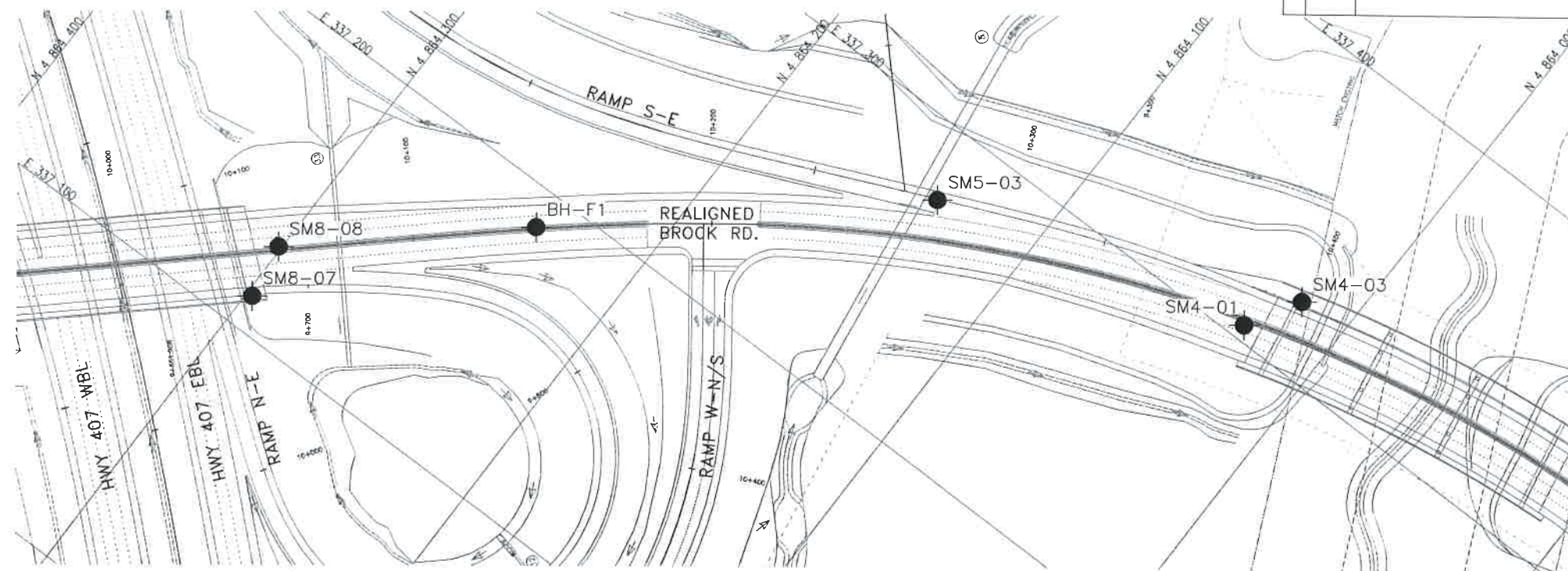
SHEET

407 ETR
Express Toll Route

MMM GROUP

THURBER ENGINEERING LTD.

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



KEYPLAN

LEGEND

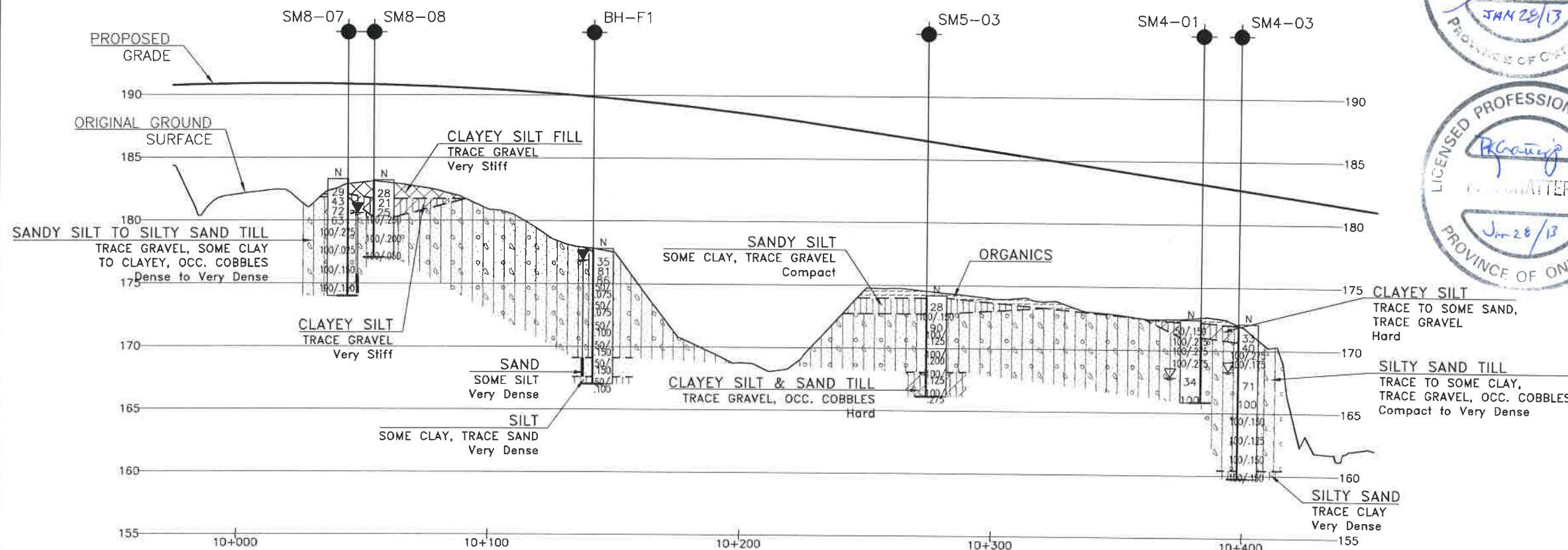
- Borehole
- ◆ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH-F1	177.8	4 864 236.0	337 187.6
SM4-01	172.4	4 864 027.7	337 305.0
SM4-03	172.1	4 864 017.1	337 323.1
SM5-03	174.2	4 864 135.0	337 276.3
SM8-07	183.3	4 864 298.0	337 111.7
SM8-08	183.2	4 864 301.0	337 130.4

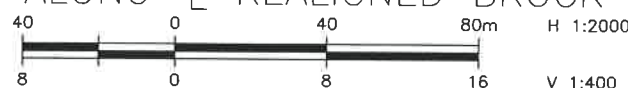
-NOTES-

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

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



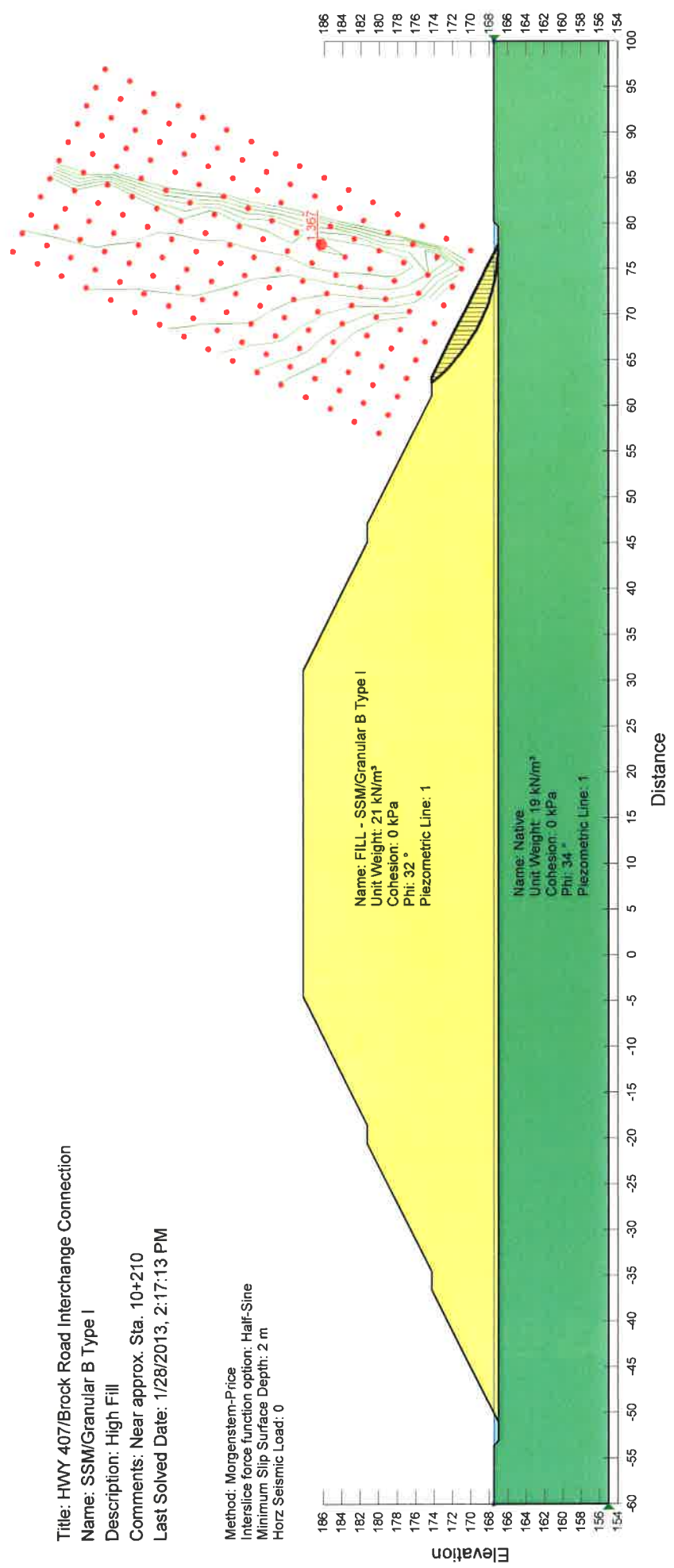
PROFILE ALONG ϕ REALIGNED BROCK RD.



DRAWING NAME: H:\Drafting\19\3\61\100\ed1130A-BrockRoadHighfillSection-Plan&Profile.dwg
CREATED: January 15, 2013
MODIFIED: January 28, 2013

Title: HWY 407/Brock Road Interchange Connection
Name: SSM/Granular B Type I
Description: High Fill
Comments: Near approx. Sta. 10+210
Last Solved Date: 1/28/2013, 2:17:13 PM

Method: Morgenstern-Price
Interslice force function option: Half-Sine
Minimum Slip Surface Depth: 2 m
Horz Seismic Load: 0



Title: HWY 407/Brock Road Interchange Connection

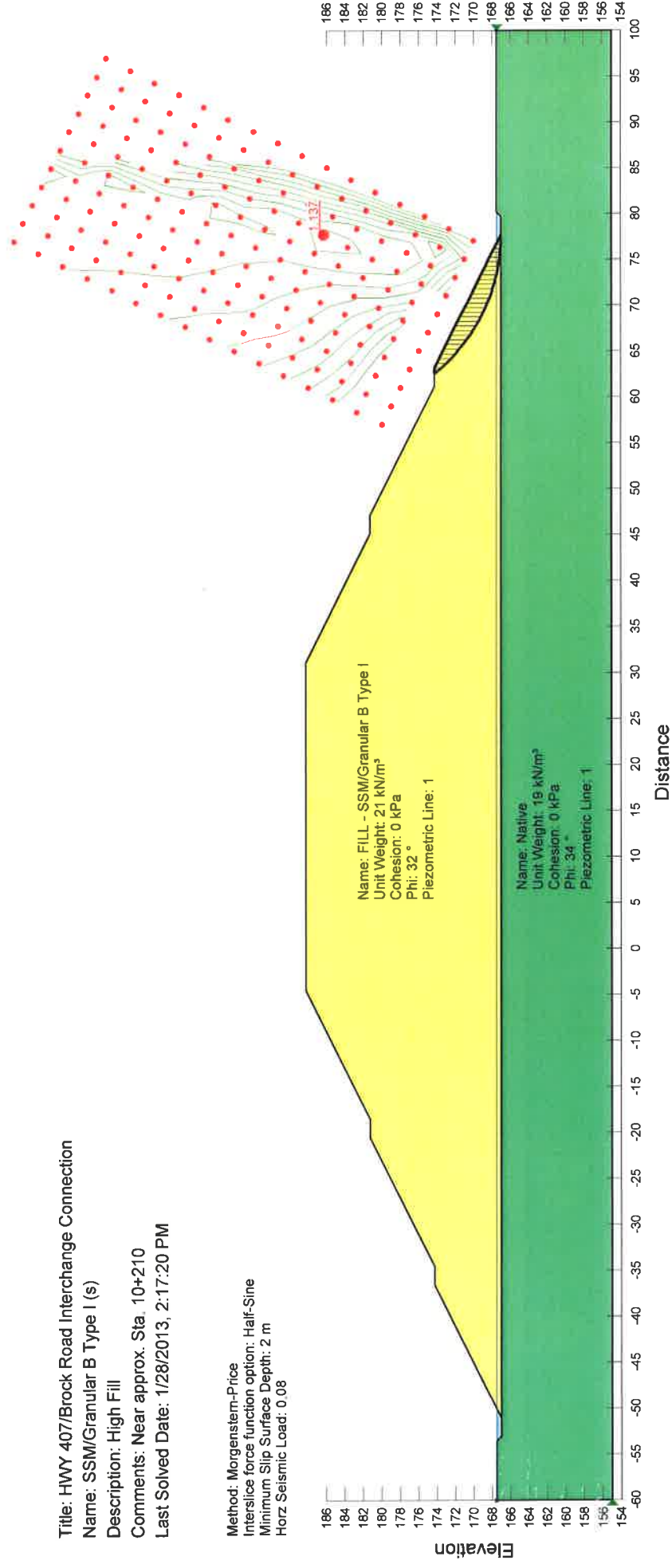
Name: SSM/Granular B Type I (s)

Description: High Fill

Comments: Near approx. Sta. 10+210

Last Solved Date: 1/28/2013, 2:17:20 PM

Method: Morgenstern-Price
Interface force function option: Half-Sine
Minimum Slip Surface Depth: 2 m
Horz Seismic Load: 0.08



Appendix B

South Connection to Brock Road (Boreholes BH-C1 and BH-C2)

RECORD OF BOREHOLE No BH-C1

1 OF 2

METRIC

WP# E2-2012 LOCATION N 4 862 784.2 E 337 085.9, Sta. 9+980 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY MA
 DATUM Geodetic DATE 2013.01.08 - 2013.01.08 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		
171.6														
0.0														
171.3	ORGANICS: (250mm)													
0.3	Silty SAND, some clay, trace gravel Compact to Very Dense Brown Moist (TILL)		1	SS	15		171							
			2	SS	40		170							3 46 32 19
	Occasional cobbles		3	SS	51		169							
			4	SS	85/ .275		168							
	Grey		5	SS	50/ .100		167							
							166							
			6	SS	100/ .225		165							
164.1							164							6 51 29 14
7.5	Silty SAND, trace gravel, trace to some clay Very Dense Grey Moist		7	SS	50/ .150		163							
	Wet		8	SS	50/ .075									
162.2														
9.4	END OF BOREHOLE AT 9.4m. BOREHOLE OPEN TO 8.0m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH													

Continued Next Page

+ 3. X 3. Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

ONTMT4S 1130A.GPJ 29/1/13

RECORD OF BOREHOLE No BH-C1

2 OF 2

METRIC

WP# E2-2012 LOCATION N 4 862 784.2 E 337 085.9, Sta. 9+980 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Solid Stem Augers COMPILED BY MA
 DATUM Geodetic DATE 2013.01.08 - 2013.01.08 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					
	Continued From Previous Page												
	BENTONITE TO 1.1m, THEN CUTTINGS TO SURFACE.												

ONTMT4S 1130A.GPJ 29/1/13

RECORD OF BOREHOLE No BH-C2

1 OF 1

METRIC

WP# E2-2012 LOCATION N 4 862 784.8 E 337 011.7, Sta. 9+904 ORIGINATED BY SLL
 HWY 407 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MA
 DATUM Geodetic DATE 2013.01.07 - 2013.01.07 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		
177.6														
0.0	ORGANICS: (200mm)													
0.2	Silty SAND, some clay to clayey, trace gravel Dense to Very Dense Brown Moist (TILL)		1	SS	40		177							
			2	SS	52		176							
			3	SS	76		175							
			4	SS	71		174							3 45 33 19
			5	SS	69		173							
	Grey		6	SS	60/ .125		172							
							171							
			7	SS	50/ .125		170							6 39 34 21
169.7	Occasional cobbles													
7.9	END OF BOREHOLE AT 7.9m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.													
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jan. 09/13 4.3 173.3 Jan. 14/13 2.5 175.1													

ONTMT4S 1130A.GPJ 29/1/13

+ ³ × ³ : Numbers refer to
Sensitivity

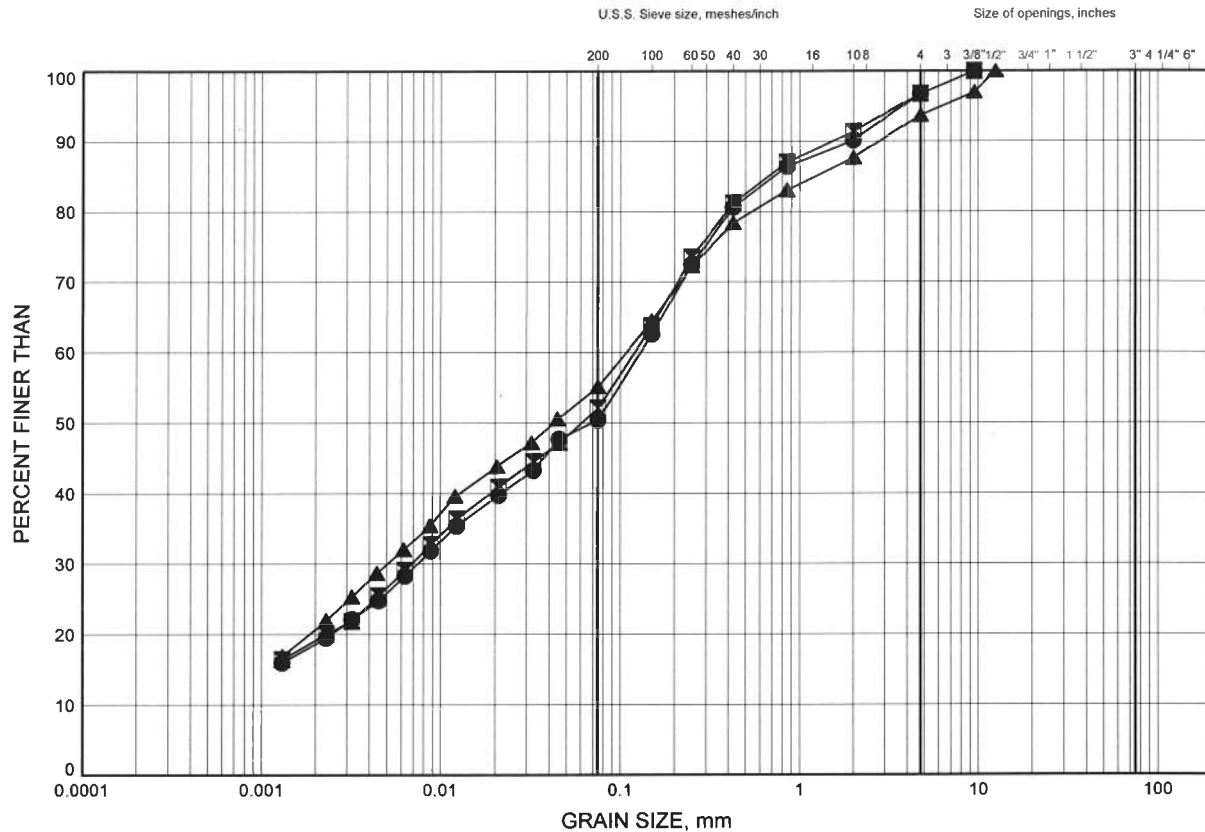
20
15 5
10 (%) STRAIN AT FAILURE

HWY 407 Brock Road Connection - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B1

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-C1	1.83	169.77
⊠	BH-C2	3.35	174.25
▲	BH-C2	7.74	169.86

Date January 2013

WP# E2-2012

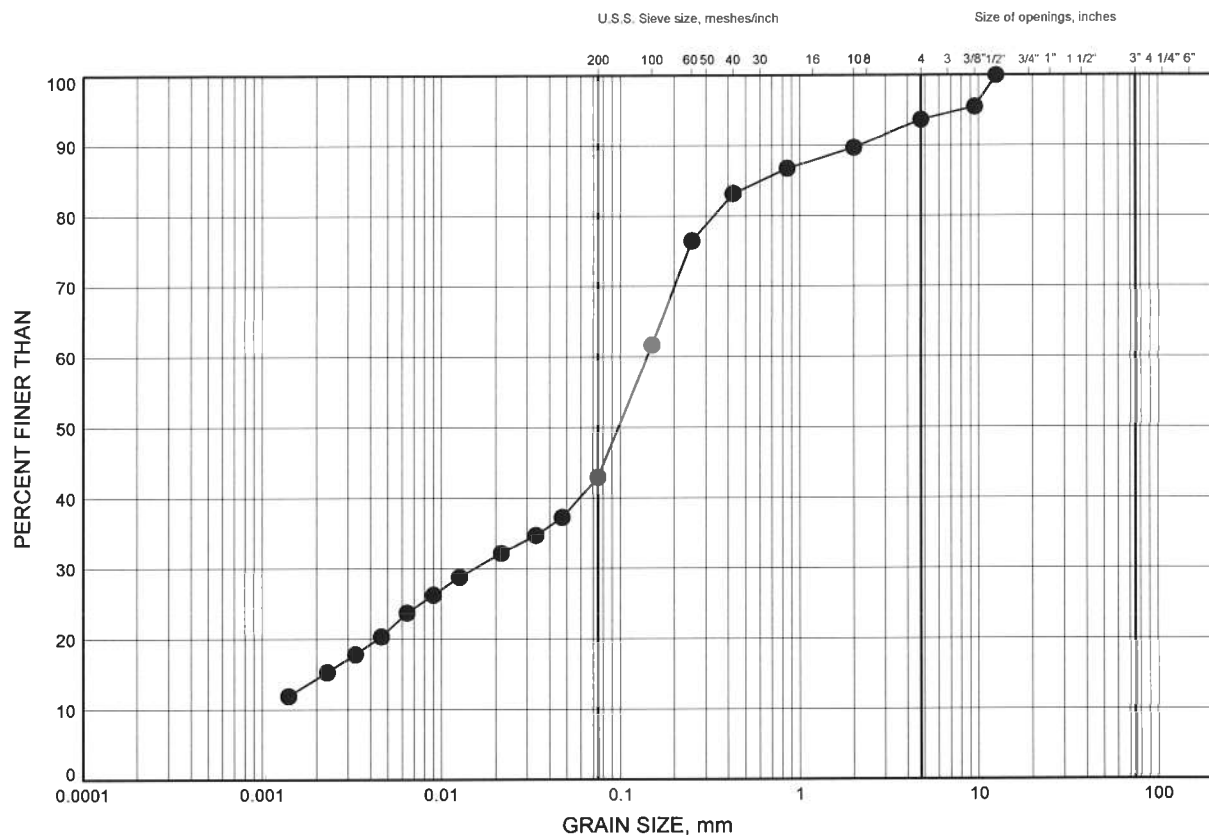


Prep'd AN

Chkd. LRB

GRAIN SIZE DISTRIBUTION

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH-C1	7.77	163.83

Highway 407/Brock Road Interchange Connection
Deep Cuts and Fills



Photo 1: Looking east from BH-C1.



Photo 2: Looking south from BH-C1, towards existing Brock Road.



Photo 3: Looking south from BH-C2, along existing Brock Road.

Title: HWY 407/Brock Road Interchange Connection

Name: Cut, 2H:1V

Description: Deep Cut

Comments: Near approx. Sta. 9+980

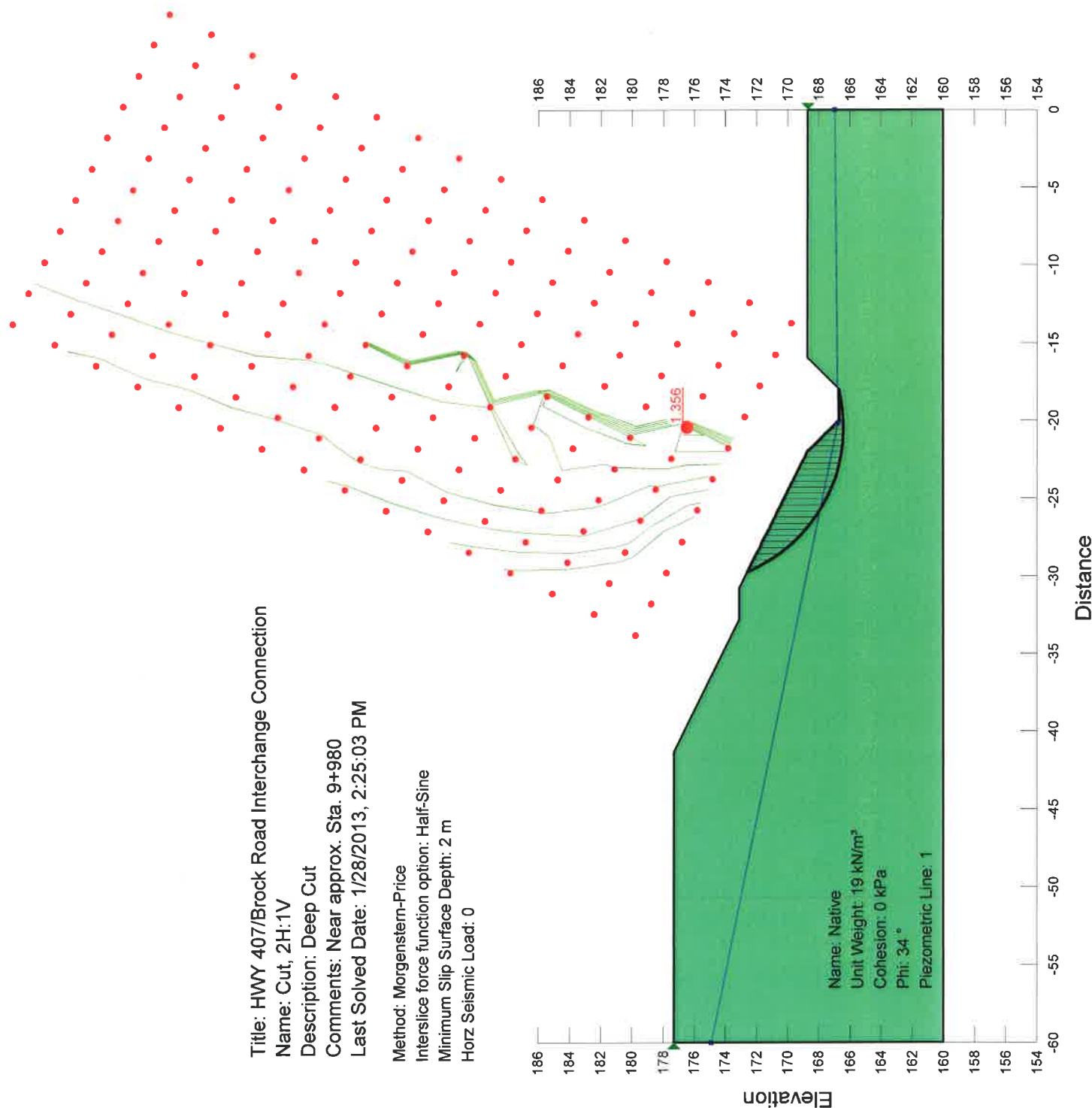
Last Solved Date: 1/28/2013, 2:25:03 PM

Method: Morgenstern-Price

Interslice force function option: Half-Sine

Minimum Slip Surface Depth: 2 m

Horz Seismic Load: 0



Title: HWY 407/Brock Road Interchange Connection

Name: Cut, 2H:1V (s)

Description: Deep Cut

Comments: Near approx. Sta. 9+980

Last Solved Date: 1/28/2013, 2:25:11 PM

Method: Morgenstern-Price

Interslice force function option: Half-Sine

Minimum Slip Surface Depth: 2 m

Horz Seismic Load: 0.08

