

**FOUNDATION INVESTIGATION AND DESIGN REPORT
CULVERT, SWM POND, UTILITY CROSSINGS
AND WATERMAIN PROTECTION
QEW WIDENING, THIRD LINE TO BURLOAK DRIVE
G.W.P. 169-00-00**

Geocres Number: 30M5-255

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a geotechnical investigation conducted at the location of a proposed culvert, a stormwater management pond (SWM Pond), and utility crossings to be constructed in connection with the widening of the QEW from Third Line to Burloak Drive in Oakville, Ontario. The results of an investigation at the location of an existing watermain under the widening section are also presented.

Specific locations of the various structures are as follows:

Culvert	QEW, Station 11+636, approximately 250 m west of existing Bronte Road
East SWM Pond	Southeast quadrant of realigned QEW-Bronte Road interchange
Utility Crossings	QEW, Stations 9+970, 10+935, 11+533, 12+100, 12+308, 12+930
Existing Watermain	QEW, Station 12+550

The purpose of this investigation was to explore the subsurface conditions at the various sites and, based on the data obtained, to provide borehole location plans, records of boreholes, stratigraphic profiles, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation to describe the geotechnical conditions influencing design and construction of the various facilities.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 2005-A-000566.

2 SITE DESCRIPTION

The project area is located along the shoreline of the glacial Lake Iroquois. From published geological information, this area is situated at the border between a physiographic region known as the Peel Plain to the north and Iroquois Plain to the south. In this area, the relatively thin native soil deposits typically consist of cohesive soils (some tills) overlying shale bedrock of the Queenston Formation. The till is known to contain shale and limestone fragments/slabs. Wave action in the glacial lake modified the original ground moraine and lacustrine deposits in the form of stratified silts and sands are present at locations along the shoreline of the glacial lake.

In general, the terrain in the area is flat to slightly undulating with overall grades trending downwards to the south. Along the QEW, grades typically fall from near Elevation 126 m at Burloak Drive to Elevation 113 m east of Bronte Road. The QEW crosses the Bronte Creek valley immediately to the west of Bronte Road. The creek valley is incised up to approximately 28 m below the surrounding tableland, and the valley slopes are steeply cut into shale bedrock. Drainage generally flows towards Bronte Creek, which flows southward to Lake Ontario.

The lands north of the QEW and west of Bronte Road are occupied by the Bronte Creek Provincial Park while to the north of QEW and east of Bronte Road lies a golf course. The Halton Regional Centre is located on the east side of Bronte Road a short distance north of the QEW E – N/S Ramp terminal. To the southeast and southwest of QEW, the lands have been developed for industrial and commercial uses. Vegetation is moderate consisting mainly of tall grass, shrubs and occasional small trees.

3 SITE INVESTIGATION AND FIELD TESTING

The field investigation for this project was carried between November 13 and December 9, 2006. A total of 16 sampled boreholes were drilled for the proposed culvert, SWM Pond and utility crossings. In addition, information from a borehole completed during a previous study and another borehole completed in connection with the concurrent retaining wall investigation was used in preparation of this report. At the existing watermain location, investigation was carried out using a hydraulic vacuum truck and rock coring equipment.

A summary of the borehole designations employed at each facility, and the respective appendices where the borehole logs, laboratory results, and Borehole Locations and Soil Strata drawings are presented, is provided in Table 3.1.

Table 3.1 – Borehole Designations

Facility	Borehole Numbers	Appendix
Culvert	C1, C2, C3	A
SWM Pond	SWM1, SWM2, SWM3	B
Utility Crossings	UC1, UC2, UC3, UC4, UC5, UC6, UC7, 06-10, UC9, UC10, WBT7, UC12	C
Watermain	FM1, FM2 to FM5 (unsampled holes)	D

The boreholes were terminated at depths of 1.6 to 9.4 m, and included coring of the bedrock at six locations (Boreholes SWM1, UC1, UC4, 06-10, UC12 and FM1).

Prior to the start of drilling, utility clearances were obtained for all borehole locations. Encroachment permits and road occupancy permits were also obtained.

Solid stem augers were used to advance the boreholes in overburden and into shale. Samples were obtained using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). NQ rock coring equipment was used to recover core samples of the underlying bedrock.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The inspector logged the boreholes, visually examined the recovered samples, and transported them to Thurber's laboratory for further examination and testing. All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined. The recovered rock core was packaged in core boxes with moist towels and parafilm wrap, and returned to our laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Coring operations introduced water into Boreholes SWM1, UC1, UC4 and UC12 and therefore observation of the groundwater in the bedrock was not possible at these locations. Standpipe piezometers consisting of 19 mm PVC pipe with slotted screens were installed and enclosed in sand in selected boreholes to monitor groundwater levels. The location and completion details of the piezometers are shown in Table 3.2.

Table 3.2 – Piezometer Installation Details

Location	Borehole	Piezometer Details	
		Tip Depth/ Elevation (m)	Completion Details
SWM Pond	SWM1	6.3/103.4	Piezometer with 1.5 m slotted screen installed with sand filter to 4.8 m, bentonite grout seal from 4.8 m to 0.6 m, sand from 0.6 m to 0.3 m and concrete from 0.3 m to surface.
Station 9+970	UC1	4.6/121.9	Piezometer with 1.5 m slotted screen installed with sand filter to 1.2 m, bentonite grout seal from 1.2 m to 0.6 m, sand from 0.6 m to 0.15 m and concrete from 0.15 m to surface.
Station 10+935	UC4	6.2/112.6	Piezometer with 1.5 m slotted screen installed with sand filter to 4.3 m, bentonite grout seal from 4.3 m to 0.95 m, sand from 0.95 m to 0.15 m and concrete from 0.15 m to surface.
Station 11+533	UC6	9.2/105.6	Piezometer with 1.5 m slotted screen installed with sand filter to 6.7 m, bentonite grout seal from 6.7 m to 1.8 m, sand from 1.8 m to 0.15 m and concrete from 0.15 m to surface.
Station 12+308	UC10	4.8/111.5	Piezometer with 1.5 m slotted screen installed with sand filter to 2.1 m, bentonite grout seal from 2.1 m to 0.3 m, sand from 0.3 m to 0.15 m and concrete from 0.15 m to surface.
Station 12+930	UC12	6.2/106.9	Piezometer with 1.5 m slotted screen installed with sand filter to 3.9 m, bentonite grout seal from 3.9 m to 0.9 m, sand from 0.9 m to 0.3 m and concrete from 0.3 m to surface.

Results of the field drilling, sampling and coring are presented on the Record of Borehole sheets in Appendices A to D.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendices A to D.

Approximately 25% of the recovered samples were subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing. The results of these testing programs are shown on the Record of Borehole sheets and Figures in Appendices A to D.

Point load tests were carried out on selected samples of intact shale upon arrival at the laboratory.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendices A to D for details of the encountered soil and rock stratigraphy. Stratigraphic profiles are presented on the Borehole Locations and Soil Strata Drawing in the appendices, for illustrative purposes. Overall descriptions of the stratigraphy are given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between borehole locations.

The subsurface conditions generally consist of surficial topsoil or pavement structure, overlying native silty clay till, and sand and silt, underlain by shale bedrock of the Queenston formation.

More detailed descriptions of the individual strata at each of the various proposed structures are presented below.

5.1 Culvert

Three boreholes (Boreholes C1 to C3) were drilled at the proposed culvert location. The borehole logs, figures and drawings pertaining to the culvert are presented in Appendix A.

5.1.1 Pavement Structure

A pavement structure consisting of approximately 150 and 200 mm of asphalt overlying 600 to 650 mm of crusher run limestone (road base) was encountered in Boreholes C1 and C2 drilled on the QEW shoulders. SPT 'N' values in the granular material were 19 and 29 blows for 0.3 m penetration indicating a compact relative density. Measured moisture contents of the granular material were approximately 3%.

5.1.2 Fill

Fill was contacted below the pavement structure in Borehole C2. The fill comprised reddish brown silty clay with some sand, trace of gravel and occasional shale fragments. The fill extends to 4.1 m depth (Elevation 110.3 m). SPT N-values measured in the clay

fill ranged from 5 to 19 blows for 0.3 m penetration indicating a firm to very stiff consistency. Moisture contents varied from 12 to 20%.

Borehole C3 was located on a fill stockpile south of the QEW. The stockpile material consisted of very soft to soft silty clay and was penetrated at 1.5 m depth (Elevation 115.5 m). The stockpile is underlain by an 800 mm thick layer of sand fill. An SPT N-value of 22 blows/0.3 m was obtained in the cohesionless sand fill, indicating a compact relative density. The lower boundary of the sand fill was encountered at 2.3 m depth (Elevation 114.7 m). Moisture contents of 15 to 17% and 8 to 10% were obtained in the clay fill and sand fill, respectively.

A sample of the silty clay fill was subjected to grain size distribution analysis and Atterberg Limits testing. The grain size distribution results for the silty clay, presented on the Record of Borehole sheets and Figure A1 of Appendix A, indicate that the percentage of silt and clay size particles was generally 69 and 11%, respectively. Atterberg Limits testing, Figure A3, indicates that the clay is low plastic.

5.1.3 Silty Clay

Native brown silty clay with some sand, trace of gravel and occasional shale fragments was contacted below the pavement structure in Borehole C1. The silty clay layer was 1.0 m thick with a lower boundary at 1.8 m (Elevation 112.0 m).

An SPT N-value measured in the native silty clay was 19 blows for 0.3 m penetration, indicating a very stiff consistency. The moisture content was 9%.

5.1.4 Silty Sand Till

Brown silty sand till with some gravel to gravelly and trace of clay was contacted below the native silty clay in Borehole C1 at 1.8 m depth (elevation 112.0m). The thickness of this layer was 2.2 m.

A sample of this layer was subjected to grain size distribution analysis. The grain size distribution results, presented on the Record of Borehole sheets and Figure A2 of Appendix A, indicated that the percentage of sand and silt were 49 and 21%, respectively. Although not encountered, glacial till may contain cobbles, boulders and rock slabs.

SPT N-values measured in the native silty sand till were 38 for 0.3 m penetration to 50 blows for 0.1 m penetration, indicating a dense to very dense relative density. Moisture contents ranged from 7 to 10%.

5.1.5 Sand to Silty Sand

Brown to reddish brown sand to silty sand with trace to some gravel and occasional shale fragments was contacted below the fill and native silty sand till in the boreholes at depths varying from 2.3 m to 4.1 m (Elevation 109.9 to 114.7 m). Boreholes C1 and C2 were terminated within the sand and silty sand layers at 6.7 m depth (elevations 107.1 m and

107.7 m). The lower boundary of this unit in Borehole C3 was encountered at 3.0 m depth (Elevation 114.0 m).

Three samples from this unit were subjected to grain size distribution analyses. The grain size distribution results, presented on the Record of Borehole sheets and Figure A2 of Appendix A, indicate that the percentage of sand ranged from 43 to 80% and the percentage of silt and clay ranged from 20 to 43%.

SPT N-values measured in the native silty sand in Boreholes C1 and C3 were 46 to 57 blows for 0.3 m penetration, indicating a dense to very dense relative density. Locally in Borehole C2, two SPT N-values of 4 blows for 0.3 m penetration were recorded, indicating a loose relative density. Moisture contents ranged from 5 to 21%.

5.1.6 Shale Bedrock

Reddish brown shale bedrock of the Queenston formation was contacted below the silty sand, at 3.0 m depth (Elevation 114.0 m), in Borehole C3 located at the south end of the culvert. The shale is described as thinly bedded and highly weathered. The bedrock was penetrated by drill augering to 6.7 m depth (Elevation 110.3 m).

SPT 'N' values in the shale ranged from 29 to 64 blows per 0.3 m penetration (increasing with depth). Moisture contents ranged from 4 to 6%. The rock is known to contain hard limestone interbeds and clay seams, and to get less weathered and harder with depth.

5.1.7 Water Levels

Water was not observed in the boreholes during or upon completion of drilling. However, the groundwater level may fluctuate on a seasonal basis or after heavy rainfall events, and may be above the base of the excavation at the time of construction.

5.2 SWM Pond

Three boreholes (Boreholes SWM1 to SWM3) were drilled for the proposed SWM Pond located at the QEW-Bronte Road interchange. The borehole logs, figures and drawings pertaining to the SWM pond are presented in Appendix B.

5.2.1 Pavement Structure

A pavement structure consisting of approximately 40 mm of asphalt over 560 mm of sand and gravel was encountered in Borehole SWM1 drilled within the existing car pool lot. An SPT N-value 19 blows for 0.3 m penetration was obtained in the granular material, indicating a compact relative density. The measured moisture content of the granular material was approximately 7%.

5.2.2 Topsoil

A 75 mm thick layer of dark brown topsoil was encountered surficially in Boreholes SWM2 and SWM3. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.2.3 Silty Clay Till

The topsoil and pavement structure are underlain by native reddish brown silty clay till with trace sand to sandy, and trace gravel. The silty clay till extends to depths ranging from 0.9 to 1.5 m (Elevations 107.8 to 108.8 m).

Two samples of the silty clay till were subjected to grain size distribution analyses and Atterberg Limits tests. The grain size distribution results for the silty clay till, presented on the Record of Borehole sheets and Figure B1 of Appendix B, indicate that the percentages of silt and clay size particles were 42 to 45% and 21 to 45%, respectively. Atterberg Limits testing, Figure B2 of Appendix B, indicates that the clay is low to medium plastic. Although not encountered, glacial till may contain cobbles, boulders and rock slabs.

SPT N-values ranged from 6 to 74 blows for 0.3 m penetration in this cohesive stratum, indicating a firm to hard consistency. The moisture content of samples from this deposit ranged from 15 to 22%.

5.2.4 Shale Bedrock

The overburden soils are underlain by reddish brown Queenston shale bedrock contacted in the boreholes at depths ranging from 0.9 to 1.5 m. The depths and elevations at which shale was contacted are summarized in Table 5.1.

Table 5.1 – Depth to Bedrock

Borehole	Top of Bedrock	
	Depth (m)	Elevation (m)
SWM1	1.5	108.1
SWM 2	0.9	108.8
SWM 3	1.1	107.8

The shale encountered in the boreholes is thinly bedded and contains numerous hard interbedded limestone layers. Boreholes SWM2 and SWM3 were terminated in the shale at 2.3 m depth (Elevation 107.3 and 106.6 m). Within this depth, the shale is described as highly weathered. SPT N-values obtained in the shale bedrock were greater than 50 blows per 0.3 m penetration. Moisture contents ranged from 2 to 12%.

A 4.8 m length of shale core was recovered from Borehole SWM1. In this core, the shale bedrock is described as moderately to highly weathered, becoming moderately to slightly weathered below 4 m depth. The maximum thickness of the hard limestone layers measured in the core was 130 mm.

Total core recovery was 100% in each of the three core runs. The RQD values recorded in the cores increased with depth from 26 to 81%, indicating poor to good rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, generally ranged from 1 to 4.

The results of Point Load tests conducted on rock core samples indicated unconfined compressive strength (UCS) values of 17 and 12 MPa. It must be noted however that point load tests were possible only on less weathered shale or higher strength limestone samples as the more typical weathered shale cores tended to disintegrate or split under point loading.

Queenston Shale typically contains layers of siltstone and limestone that can be significantly harder than the shale itself, with unconfined compressive strengths in excess of 100 MPa being measured at some locations. The distribution, thickness and strength of these layers vary from location to location, and these layers typically exhibit less pronounced weathering than the shale. Sampling and interpretation from small diameter boreholes may underestimate the frequency and strength of the strong layers and therefore geological expertise and past experience must be applied in any decision making process regarding the bedrock.

5.2.5 Water Levels

Water was not observed in the boreholes during or upon completion of drilling. On December 14, 2006, a water level at 4.2 m depth (Elevation 105.5 m) was measured in the standpipe piezometer installed in Borehole SWM1.

The above value is a short-term reading 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.

5.3 Utility Crossings

Ten boreholes (Boreholes UC1 to UC7, UC9, UC10, UC12) were drilled for the proposed utility crossings. Reference was also made to Borehole WBT7 drilled for the concurrent retaining wall investigation and to Borehole 06-10 drilled in June 2006 for the Bronte Road structure. The borehole logs, figures and drawings pertaining to the utility crossings are presented in Appendix C.

5.3.1 Pavement Structure

A flexible pavement structure consisting of approximately 100 to 275 mm of asphalt overlying 325 to 860 mm of crusher run limestone was encountered in eight boreholes drilled through the paved shoulder of the QEW. A rigid pavement consisting of 110 to 375 mm of asphalt overlying 240 to 260 mm of concrete was encountered in three boreholes (Boreholes UC3, UC6 and UC7). The concrete was underlain by 450 mm of crusher run limestone in Borehole UC3 and was underlain directly by silty clay till in Boreholes UC6 and UC7.

One sample from the granular layer was subjected to grain size distribution analysis. The grain size distribution results, presented on the Record of Borehole sheet and Figure C1 of Appendix C, indicate that the percentage of gravel and sand size particles was 30 and 52%, respectively.

SPT N-values obtained in the granular material were 17 to 47 blows for 0.3 m penetration, indicating a compact to dense relative density. Measured moisture contents of the granular material ranged from approximately 2 to 6%.

5.3.2 Topsoil

A 100 mm thick layer of topsoil was encountered surficially in Borehole 06-10 located south of the QEW.

5.3.3 Silty Clay Till

Native brown to reddish brown silty clay till with trace sand and occasional shale fragments was contacted below the pavement structure in all boreholes except for Borehole UC9. This deposit was classified as clayey silt till in previous borehole 06-10. The thickness of the cohesive till layer ranged from 0.3 m to 1.9 m and locally 3.4 m in Borehole UC10. The upper and lower boundaries of the till were encountered at levels ranging from Elevation 112.3 to 125.5 m and Elevation 110.4 to 125.1 m, respectively. A second layer of silty clay till was also contacted below sandy silt and silt deposits in Borehole UC6 at 7.5 m (Elevation 107.3).

Six samples from the silty clay till layer were subjected to grain size distribution analyses and four samples to Atterberg Limits tests. The grain size distribution results, presented on the Record of Borehole sheets and Figure C2 of Appendix C, indicate that the percentage of silt generally ranged from 49 to 79% and the percentage of clay size particles ranged from 18 to 42%. Atterberg Limits results, Figure C5 of Appendix C, indicate that the till is low to medium plastic. Although not encountered, glacial till may contain cobbles, boulders and rock slabs.

SPT N-values in the silty clay till typically ranged from 18 to greater than 50 blows for 0.3 m penetration, indicating a very stiff to hard consistency. Locally in Boreholes 06-10 and UC10, N-values of 8 to 14 (stiff consistency) were obtained. Measured moisture contents ranged from approximately 8 to 20%.

5.3.4 Sand, Sandy Silt and Silt

Layers of brown sand, sandy silt and silt were encountered below the silty clay till in Boreholes UC5 and UC6 at 1.8 and 2.1 m depth (elevations 113.1 and 112.7 m), respectively. Borehole UC5 was terminated in the sandy silt at 5.2 m depth (Elevation 109.7 m), and the silt was underlain by hard silty clay till at 7.5 m depth (Elevation 107.3 m) in Borehole UC6.

Three samples of the sandy silt and one of silt were subjected to grain size distribution analyses. The grain size distribution results, presented on the Record of Borehole sheets and Figure C3 of Appendix C, indicate that the percentage of sand ranges from 9 to 33% and the percentage of silt size particles ranged from 48 to 82%.

SPT N-values in the silt/sand ranged from 58 blows for 0.3 m penetration to greater than 50 blows for 0.15 m, indicating a very dense relative density. The upper 0.4 m of this unit in Borehole UC5 was compact (N=17). Measured moisture contents ranged from approximately 8 to 22%. This unit may contain cobbles and boulders.

5.3.5 Shale Bedrock

Reddish brown Queenston shale bedrock was contacted below the overburden soils in nine boreholes at depths ranging from 0.7 to 2.7 m, and at 4.1 m in Borehole UC10. Shale was not encountered in Boreholes UC5 and UC6. The depths and elevations at which shale was contacted are summarized in Table 5.2.

Table 5.2 – Depth to Bedrock

Station	Borehole	Depth to Bedrock (m)	Top of Bedrock Elevation
9+970	UC1	1.4	125.1
	UC2	1.1	124.7
10+935	UC3	1.1	117.4
	UC4	1.4	117.4
11+533	UC5	*	*
	UC6	*	*
12+100	UC7	0.9	116.1
	06-10	1.8	114.3
12+308	UC9	0.7	115.3
	UC10	4.1	112.2
12+930	WBT7	1.2	112.5
	UC12	2.7	110.4

* Bedrock was not encountered within the depth of exploration.

The shale is thinly bedded and contains hard interbedded limestone layers. Boreholes UC2, UC3, UC7, UC9, UC10 and WBT7 were terminated 0.5 to 1.0 m into the shale at depths of 1.6 to 4.8 m (Elevation 111.5 to 124.2 m). Within this depth, the shale is described as highly weathered. SPT N-values in the shale ranged from 65 blows per 0.3 m penetration to 50 blows per 0.05 m penetration. Moisture contents ranged from 3 to 13%.

Core samples of the shale, 3.0 to 4.8 m long, were recovered from Boreholes UC1, UC4, UC12 and 06-10 using NQ sized coring equipment. The shale in the core from Borehole UC1 and the upper 2.9 m in Borehole UC4 is described as moderately to highly weathered. It is described as moderately to slightly weathered in the cores from boreholes 06-10 and UC12, and slightly weathered to fresh in the lower part of Borehole UC4, indicating that the bedrock becomes harder with depth. The maximum thickness of hard limestone layers recorded in the cores was 150 mm.

Total core recovery varied from 90 to 100%, locally 50% in Run 2 of Borehole UC4. Measured RQD values ranged from 12 to 95%, indicating a wide range in the rock quality, from very poor to excellent. Locally an RQD value of 0% was recorded in the initial run in Borehole 06-10. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, generally ranged from 1 to 8, and locally greater than 10.

The results of Point Load tests conducted on rock cores indicate unconfined compressive strength (UCS) values of 13 and 30 MPa in two core runs. It must be noted however that point load tests were possible only on less weathered shale or higher strength limestone samples as the more typical weathered shale cores tended to disintegrate or split under point loading.

Queenston Shale typically contains layers of siltstone and limestone that can be significantly harder than the shale itself, with unconfined compressive strengths in excess of 100 MPa being measured at some locations. The distribution, thickness and strength of these layers vary from location to location, and these layers typically exhibit less pronounced weathering than the shale. Sampling and interpretation from small diameter boreholes may underestimate the frequency and strength of the strong layers and therefore geological expertise and past experience must be applied in any decision making process regarding the bedrock.

5.3.6 Water Levels

Water was not observed in the boreholes during or upon completion of drilling. The water level readings obtained from the standpipe piezometers installed in selected boreholes are presented in Table 5.3.

Table 5.3 – Water Level Measurements

Borehole	Station	Date	Water Level	
			Depth (m)	Elev. (m)
UC1	Station 9+970	14-Dec-2006	2.1	124.4
UC4	Station 10+935	14-Dec-2006	3.3	115.5
UC6	Station 11+533	14-Dec-2006	6.1	108.7
UC10	Station 12+308	14-Dec-2006	2.3	114.0
UC12	Station 12+930	14-Dec-2006	4.5	108.6

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.

5.4 Watermain Protection

At the existing watermain location, five unsampled explorations were extended to shale bedrock or concrete using a vacuum truck and drillrig augers. At one location (Borehole FM1), the bedrock was cored. The conditions encountered at the cored location (Borehole FM1) and excavations (designated FM2 to FM5) are presented on the Record of Borehole sheet and Table D1, respectively, in Appendix D. The locations are shown on the drawing in Appendix D.

Shale bedrock was encountered at depths of 3.0 to 3.7 m (elevations 112.1 to 112.8 m) at locations FM1, FM2 and FM5. Shale was not encountered within the exploration depth of 4.6 m (elevation 111.3 m) at location FM3.

At location FM4 on the west side of the watermain alignment, a concrete structure at least 1.6 m wide was encountered at 1.5 m depth (elevation 114.4 m). Shale was not encountered within the exploration depth of 3.7 m (elevation 112.2 m) adjacent to the east side of this structure. The west limit of the structure was not encountered.

A 5.7 m length of rock core was recovered from Borehole FM1. The bedrock consists of thinly bedded, reddish brown shale of the Queenston Formation. The shale contains clay seams, rubble zones and interbedded layers of hard greenish-grey limestone. The maximum thickness of hard limestone layers recorded in the cores was 200 mm.

Total core recovery was 100%. Measured RQD values ranged from 50 to 100%, indicating a fair to excellent rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 4, and locally greater than 10 in the upper 1.2 m.

The results of Point Load tests conducted on rock cores indicated an unconfined compressive strength (UCS) value of 8 MPa in one core run. It must be noted however that point load tests were possible only on the less weathered shale at depth as the more typical weathered shale cores tended to disintegrate or split under point loading. Queenston Shale typically contains layers of siltstone and limestone that can be significantly harder than the shale itself, with unconfined compressive strengths in excess of 100 MPa being measured at some locations.

Water was not observed in the auger holes during drilling.

6 MISCELLANEOUS

Borehole locations and ground surface elevations were supplied to Thurber by McCormick Rankin Corporation.

DBW Drilling Limited of Ajax, Ontario supplied truck-mounted CME 75 and track-mounted CME 55 drill rigs to carry out the field investigation and testing.

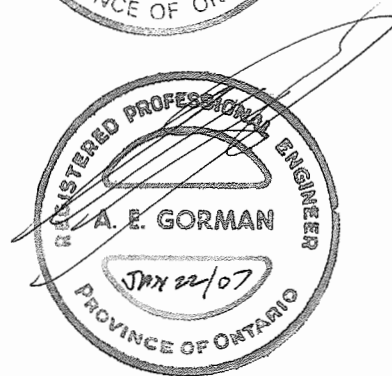
The drilling and sampling operations were supervised in the field on a full time basis by Mr. Stephane Loranger and Mr. George Azzopardi of Thurber. Mr. Murray Anderson, P.Eng. and Mr. Mark E. Farrant, P.Eng. directed the field operations.

Interpretation of the data and preparation of the report were carried out by Ms. Rocío Palomeque Reyna, P.Eng and Mr. Murray Anderson, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng., and by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects.

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FOUNDATION INVESTIGATION AND DESIGN REPORT
CULVERT, SWM POND, UTILITY CROSSINGS
AND WATERMAIN PROTECTION
QEW WIDENING, THIRD LINE TO BURLOAK DRIVE
G.W.P. 169-00-00

Geocres Number: 30M5-255

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical recommendations for design of the proposed culvert, stormwater management pond (SWM Pond), utility crossings and watermain protection. The proposed structures will be located along the QEW as follows:

Culvert	QEW, Station 11+636, approximately 250 m west of existing Bronte Road
East SWM Pond	Southeast quadrant of realigned QEW-Bronte Road interchange
Utility Crossings	QEW, Stations 9+970, 10+935, 11+533, 12+100, 12+308, 12+930
Existing Watermain	QEW, Station 12+060

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of the investigation.

8 CULVERT

8.1 Culvert Bedding and Backfill

Current plans call for installation of a 74 m long, 1200 mm diameter rigid pipe culvert. The proposed invert levels for the culvert are Elevation 112.5 and 111.8 m at the upstream (north) and downstream (south) ends, respectively. The borehole data indicates that the following conditions will be encountered at the invert level of the culvert:

Table 8.1 – Anticipated Culvert Subgrade Conditions

Location	Borehole	Invert El. (m)	Founding Stratum
North End	C1	112.5	Very stiff silty clay over dense to very dense silty sand till
Centre	C2	112.1	Stiff clay fill over loose silty sand
South End	C3	111.8	Shale bedrock

The culvert will be used to transfer storm water from the north to south side of the QEW. No culvert or stream channel presently exists at this location and no stream diversion will be required.

As shown in the table, the pipe subgrade will vary from relatively incompressible clay, till and shale at the inlet and outlet, to potentially more compressible clay fill material in the centre (Borehole C2). To reduce the potential impacts of the material variation along the culvert length, it is recommended that the support conditions in the central part of the culvert be improved by subexcavation of the clay fill to a depth of 1.0 m below the pipe invert and replacement with well compacted granular material. In addition, a camber should be applied along the box culvert to accommodate a potential differential settlement of 25 mm between the centre and ends of the culvert.

Rigid pipe bedding, cover and backfill should conform to OPSD 802.031 (Type 3 soil, earth excavation) and 802.033 (rock excavation), with frost treatment as per 803.030 and 803.031 where applicable, and construction as per OPSS 514. Prior to placement of the bedding, the base of the culvert trench should be maintained in a dry condition, free of loose, soft or undisturbed material as per SP 902S01. Any excessively soft, loose or compressible materials at the pipe subgrade should be subexcavated and replaced with additional lifts of compacted bedding material. The pipe subgrade should be uniformly competent.

Erosion protection should be provided at the culvert inlet and outlet areas as applicable. Typically, rip-rap should be provided over all surfaces with which flowing water is likely to be in contact. Treatment at the outlet should be in accordance with OPSD 810.010. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion, in accordance with OPSS 572.

A clay seal or concrete cut-off wall should be used to minimize the potential for erosion near the inlet. The clay should extend above the high water level, have a minimum thickness of 0.5 m, and extend laterally the width of the granular backfill material. The material requirements should be in accordance with OPSS 1205.

Design of the erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in this field.

8.2 Excavation

Excavation for culvert installation is expected to extend approximately 1.5 to over 2.0 m below existing grades on the QEW, based on the ground elevations determined at Boreholes C1 and C2. In this area, the excavation will extend through the existing pavement structure and into very stiff silty clay and very stiff to firm silty clay fill. The depth of excavation at the south end (Borehole C3) will depend upon finished grades when the existing fill stockpile is removed. The excavation at this end is expected to extend through fill, dense silty sand and approximately 2.2 m into shale. No culvert or stream channel presently exists at this location and no stream diversion will be required.

Temporary excavations must be carried out in accordance with the current Occupational Health and Safety Act (OHSA) of Ontario. For the purposes of assessing excavation slope requirements in compliance with the OHSA, the existing fill and silty clay is classified as Type 3 soil. Where space restrictions preclude excavation of trench sidewalls using inclined slopes, installation may be carried out using a trench box or temporary shoring.

Where excavation for culvert installation is located in close proximity to live traffic lanes, an item titled "Roadway Protection" as per SP539SO1 should be included in the contract documents. Performance Level 2 is recommended as per Clause 539.04.02.01.

Use of a hydraulic excavator should be suitable for culvert excavation in the fill and silty clay. Provision should be made for handling of asphalt and concrete pavement structures, possible obstructions in the fill, and fragments/slabs of shale and limestone.

The upper 1.0 to 2.0 m of the shale is typically highly weathered and excavation should be possible using heavy excavation equipment and rippers, supplemented by pneumatic rock breakers where thick layers of hard material are encountered. The shale becomes less weathered and harder with depth, and intensive use of pneumatic/hydraulic breakers or other methods of loosening the bedrock may be required. The contract documents should contain an NSSP alerting the contract bidders that rock excavation may require the use of such equipment. Suggested wording for this NSSP is provided in Appendix E.

Water was not measured in the boreholes and is not expected to impact culvert installation. If seepage into the excavation is experienced, dewatering using sumps and pumps is considered feasible. The possibility exists that additional pumps may be required if localized zones of perched water are encountered in the fill, or if concentrated seepage is experienced from seams or fractures in the shale bedrock.

9 SWM POND

The proposed SWM pond will be located within the realigned W-N/S Ramp at the southeast quadrant of the Bronte Road interchange. Current plans call for the following design parameters:

Maximum Water Level	105.2 m
Permanent Pool Elevation	104.0 m
Pond Base Elevation	103.0 m
Side Slope Inclination	5H:1V from El. 103.0 to 105.6 m 3H:1V above El. 105.6 m

The subsurface stratigraphy revealed in the boreholes drilled in the SWM Pond area consists of topsoil or a pavement structure overlying silty clay till underlain by shale bedrock encountered at 0.9 to 1.5 m depth (Elevations 107.8 to 108.8). The depth of earth excavation will therefore be relatively shallow at this site. Excavation to the pond base will extend 4.8 to 5.8 m below the shale surface encountered at the borehole locations.

Permanent pond slopes cut into the native silty clay till and shale bedrock are expected to be stable at the proposed slope inclinations noted above. However, exposed shale above the permanent pool level will be subject to weathering and slope protection will be required, as discussed below.

Erosion protection such as hydroseeding and vegetation, and rip-rap in areas of high flow velocities subject to erosion (such as at the pond inlet and outlet), should be established on all exposed soil and shale bedrock slopes. General reference may be made to OPSS 511, OPSS 572 and related special provision(s) for more detailed requirements, where applicable.

Granular sheeting or other measures may also be required along the sides and base of the pond where persistent ongoing seepage may result in surficial instability. These areas are best identified by examination after pond excavation. The need for and design of supplementary slope treatment procedures should be as directed by the Contract Administrator in consultation with the design engineer during construction. Suggested wording for an NSSP to advise the contractor of this requirement is provided in Appendix E. A contingency item per square metre of granular sheeting should be included in the tender documents, based on an estimated area of 5% of the pond slope face between elevation 106.0 m and the permanent pool level (elevation 104.0 m) requiring granular sheeting.

Use of a hydraulic excavator should be suitable for excavation in the clay till. Provision should be made for handling of pavement materials as well as possible cobbles, boulders and fragments/slabs of shale and limestone in the till.

The bulk of the excavation will extend into relatively sound shale with hard limestone and siltstone interbeds. Heavy excavating equipment, ripping machinery and rock breakers/splitters may be required to break up hard limestone and other intact rock slabs. The contract documents should contain an NSSP alerting the contract bidders that rock excavation may require the use of such equipment. Suggested wording for this NSSP is provided in Appendix E.

Water was measured in the piezometer installed in Borehole SWM1 at 4.2 m depth, elevation 105.5 m. The measured groundwater level is approximately 2.5 m above the proposed pond bottom level, 1.5 m above the permanent pool level, and 2.6 m below the bedrock surface. In general, the shale is expected to have a relatively low permeability and therefore groundwater control using sumps and pumps is considered feasible during construction.

The possibility exists that concentrated seepage may be experienced from localized seams or fractures in the shale bedrock. The NSSP for shale excavation provided in Appendix E includes a comment in this regard. The design of any dewatering system that may be required is the responsibility of the Contractor.

10 UTILITY CROSSINGS

Details regarding the depth and size of the utility crossings under the QEW were not established at the time of report preparation. However, the crossings are expected to require bore/drill hole diameters of no more than 200 mm. To provide guidance on the type and boundaries of material anticipated at the utility crossings, a summary of the subsurface stratigraphy is presented in Table 10.1.

Table 10.1 – Summary of Subsurface Stratigraphy at Utility Crossings

Location along QEW		Borehole	Bottom of Pavement Structure		Silty Clay Till		Sand to Silt		Top of Shale Bedrock	
Station	Offset		Depth (m)	El. (m)	Depth (m)	El. (m)	Depth (m)	El. (m)	Depth (m)	El. (m)
9+970	WBL	UC1	1.0	125.5	1.0 – 1.4	125.5–125.1	-	-	1.4	125.1
	EBL	UC2	0.7	125.1	0.7-1.1	125.1-124.7	-	-	1.1	124.7
10+935	WBL	UC3	0.8	117.7	0.8-1.1	117.7-117.4	-	-	1.1	117.4
	EBL	UC4	0.6	118.2	0.6-1.4	118.2-117.4	-	-	1.4	117.4
11+533	WBL	UC5	0.8	114.1	0.8-1.8	114.1-113.1	1.8-5.2	113.1-109.7	-	-
	EBL	UC6	0.6	114.2	0.6-2.1 7.5-9.2	114.2-112.7 107.3-105.6	2.1-7.5	112.7-107.3	-	-
12+100	WBL	UC7	0.5	116.5	0.5-0.9	116.5-116.1	-	-	0.9	116.1
	EBL	06-10	0.1	116.0	0.1-1.8	116.0-114.3	-	-	1.8	114.3
12+308	WBL	UC9	0.7	115.3	-	-	-	-	0.7	115.3
	EBL	UC10	0.7	115.6	0.7-4.1	115.6-112.2	-	-	4.1	112.2
12+930	WBL	WBT7	0.8	112.9	0.8-1.2	112.9-112.5	-	-	1.2	112.5
	EBL	UC12	0.8	112.3	0.8-2.7	112.3-110.4	-	-	2.7	110.4

Note: dash (-) indicates stratum was not encountered.

Utility installation under the existing lanes of the QEW will be carried out using trenchless technology. Assuming the utility crossings will be installed at a typical depth of 1.5 to 2.5 m, the crossings at Stations 9+970, 10+935 and 12+100 will be carried out within shale bedrock. At Stations 12+308 and 12+930, the crossings may be installed partially in silty clay till and partially in shale. At Station 11+533, the crossing is expected to encounter silty clay till as well as non-cohesive, sandy silt and sand.

Utility installation through the clay till and shale bedrock is considered technically feasible using directional drilling, jack and bore, pipe jacking or micro-tunnelling methods. Considering the relatively small diameter of the installations, directional drilling is expected to be the most practical

method. Jack and bore methods are likely to be problematic due to the hard layers in the rock. Selection of an appropriate method should be the responsibility of the Contractor and will depend upon the relative costs and risks associated with each method. The equipment selected must be capable of excavating and advancing through the shale bedrock with hard interbeds.

At Station 11+533, a layer of cohesive, very stiff to hard silty clay till was encountered below the QEW pavement between depths of 0.8 to 1.8 m in borehole UC5 and 0.6 to 2.1 m in Borehole UC6. Below this layer, sand and sandy silt with clay contents of 9 to 13% were encountered. If a larger diameter hole (greater than 150 mm) is extended through the sand/silt, loss of ground (sloughing or cave) may occur in the boring. For this reason, it is recommended that methods which preclude caving and loss of ground, such as jack and bore with the pipe advancing closely behind the boring face, be employed at this location for any hole diameter exceeding 150 mm.

A Non-Standard Special Provision (NSSP) for trenchless installation should be included in the contract documents to alert the Contractor to the subsurface conditions outlined below. Suggested wording for the NSSP is presented in Appendix E.

- The shale bedrock contains strong to very strong limestone or siltstone layers. Trenchless technology that can penetrate both hard rock and highly weathered shale must be supplied.
- The shale bedrock is bedded horizontally and contains hard limestone and siltstone layers that may tend to deflect boring equipment when contacted. The Contractor must be prepared to maintain the alignment in these conditions.
- Mixed face conditions may be encountered if the utility crossing is carried out at a level near the boundary between the clay till and shale. Mixed face conditions are typically problematic during trenchless installation, and selection of equipment that is capable of excavating the different material types with minimum loss of ground is critical for successful construction.

The experience of the Contractor is of primary importance for trenchless installation. The Contractor must submit a detailed work plan, including the proposed methodology for boring, maintenance of alignment, and disposal of cuttings.

A preconstruction survey of utilities should be carried out, and monitoring of the roadway surface, underground utilities, and any nearby structures should be carried out during construction to minimize the impacts of any settlement caused by the underground operations. The Contractor's work plan must include details of the proposed instrumentation and monitoring program.

A minimum vertical distance of 900 mm or two times the drill/bore diameter, whichever is greater, is recommended between the bottom of the roadway granular material and the top of the installation to reduce the potential for disturbance of the roadway pavement. Clearance requirements from existing utilities should be obtained from the applicable utility authority.

Based on groundwater observations during drilling and the piezometer measurements, groundwater seepage is expected to be minimal. Sumps and pumps should be adequate to handle groundwater entering the excavation and launching shaft. The shale is fractured however and water-bearing fissures producing relatively higher inflow of groundwater may be encountered locally.

11 WATERMAIN PROTECTION

Drawings provided by the Region of Halton indicate that a feedermain was previously installed by tunnelling under the QEW near Station 12+060. The feedermain has a diameter of 1050 mm and is installed in an 1800 mm diameter tunnel. The tunnel ends approximately 20 m south of the existing QEW pavement edge. An access shaft was constructed at the south end of the tunnel, and the watermain to the south of the shaft was installed by open-cut trenching.

The new eastbound lanes of the QEW will extend over the backfilled shaft and trench areas. Prior to construction of the new lanes, construction of a reinforced concrete slab is proposed to span over the disturbed material in the shaft and trench excavation. Preliminary drawings of the proposed watermain protection slab, provided by the Prime Consultant, indicate that the slab perimeter will be placed on shale bedrock and extend at least 1.5 m beyond the edge of the previous excavation.

The results of the subsurface investigation conducted at the feedermain location are presented in Appendix D. Three exploratory holes augered/excavated adjacent to the shaft area encountered the shale bedrock surface at depths of 3.0 to 3.7 m (elevations 112.1 to 112.8 m). Two other excavations, presumably located within the shaft backfill, did not encounter bedrock within depths of 3.7 and 4.6 m (elevation 112.2 and 111.3 m). An unidentified concrete structure at least 1.6 m wide was encountered at 1.5 m depth (elevation 114.4 m) on the west side of the shaft location.

The investigation conducted at the feedermain location provides a limited assessment of the subsurface conditions to be anticipated. However, it will be necessary to excavate down to the bedrock surface and expose a larger open area to provide a complete assessment of the limits and geometry of the previous excavation, and to determine the function/origin/impact of the existing buried concrete structure. The structural design and areal limits of the slab may require adjustment, as directed by the Contract Administrator in consultation with the design engineer at the time of construction. The contract documents must identify this requirement for the contractor.

A geotechnical resistance of 250 kPa at factored ULS is recommended for design of the slab founded on shale bedrock, assuming the slab extends a minimum 1.5 m beyond the edge of the shaft/trench excavation. The bearing resistance at SLS (25 mm of settlement) will not govern design of the slab on shale bedrock.

For structural design of the slab, a modulus of subgrade reaction value of 75 MN/m³ is recommended for weathered shale bedrock, and 10 MN/m³ for indigenous silty clay backfill.

All foundation excavation should be carried out in accordance with SP 902S01. Shale is prone to rapid deterioration upon exposure to water and air, and therefore a 100 mm thick mat of concrete should be placed over the founding surfaces within 24 hours of excavation, inspection and approval. The mat concrete should be of the same class as the slab concrete.

12 ROADWAY PROTECTION

Where excavation for culvert or utility installation is located in close proximity to live traffic lanes or existing buried utilities, shoring in the form of trench boxes, continuous timber sheathings and bracing, or other temporary systems should be provided. Temporary shoring should be designed by a licensed Professional Engineer experienced in design of shoring, with consideration of adjacent traffic loads and any sloping retained surfaces.

If shoring is required during construction to retain excavations adjacent to the QEW or other roadways, an item titled "Roadway Protection" as per SP539SO1 should be included in the contract documents. Performance Level 2 is recommended as per Clause 539.04.02.01.

13 CONSTRUCTION CONCERNS

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

- The till soils may contain shale and limestone slabs/fragments, and possibly cobbles and boulders, that must be penetrated or removed during excavation or utility installation.
- The upper part of the shale bedrock is highly weathered and often resembles a till soil. Therefore precise definition of the shale surface in the boreholes is difficult. The bedrock surface elevation determined in a large open excavation may vary from that defined in the boreholes. Further, undulations in the shale surface may be encountered, requiring additional rock excavation or excavation of additional fill/soil.
- The shale contains hard interbeds of limestone, siltstone or calcareous shale that may slow production and/or require the use of breaking equipment to penetrate. Excavation of the shale bedrock may require the use of rock excavation methods such as pneumatic rock breakers to penetrate hard limestone interbeds.
- Care must be exercised during excavation to avoid disturbing the culvert subgrade. The exposed subgrade should be protected from physical disturbance and the granular bedding placed on the approved subgrade expeditiously following excavation.
- Procedures selected for trenchless utility installation must consider the potential for mixed face conditions (till/shale), fragment/slabs of shale and limestone in the till, and hard interbeds of limestone in the shale bedrock. The Contractor must be prepared to deal with these conditions to maintain the alignment.

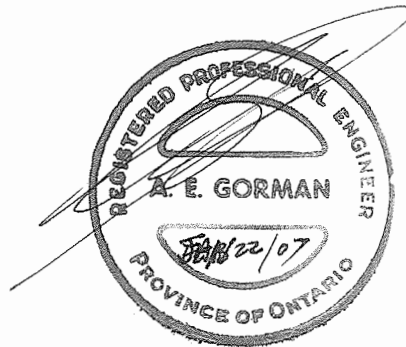
14 CLOSURE

Engineering analysis and preparation of the report were carried out by Ms. Rocío Palomeque Reyna, P.Eng. and Mr. Murray Anderson, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contract for MTO Foundations Projects.

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Appendix A

Culvert

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level

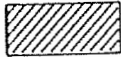

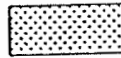


C_{pen} Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

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

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>		
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa) (psi)	Field Estimation of Hardness*
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250 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.
<u>TERMS</u>		Weak	5.0 to 25.0 750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0 150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0 35 to 150	Indented by thumbnail
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.			



METRIC

[illegible]

RECORD OF BOREHOLE No C2

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 457.70 E 285 052.30 ORIGINATED BY SLI
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 15.11.06 - 15.11.06 CHECKED BY MEF

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		
114.4 0.0	ASPHALT: (200 mm)											
0.2 113.6	CRUSHER RUN LIMESTONE Compact Brown Moist (FILL)		1	SS	29		114					
0.8	Silty CLAY, some sand, trace gravel, occasional shale fragments Very Stiff to Firm Brown (FILL)(CL)		2	SS	19		113					
			3	SS	5		112					
			4	SS	10		111					
			5	SS	12		110					
110.3 4.1	Silty SAND, trace gravel Loose Brown Wet		6	SS	4		109					
108.3 6.1	Silty SAND, some gravel, occasional shale fragments Loose Reddish Brown Wet		7	SS	4		108					
107.7 6.7	END OF BOREHOLE AT 6.71 m. BOREHOLE OPEN TO 6.71 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND PATCHED WITH ASPHALT AT SURFACE.											

ONTMT4S 5127A.GPJ 21/12/06

RECORD OF BOREHOLE No C3

1 OF 1

METRIC

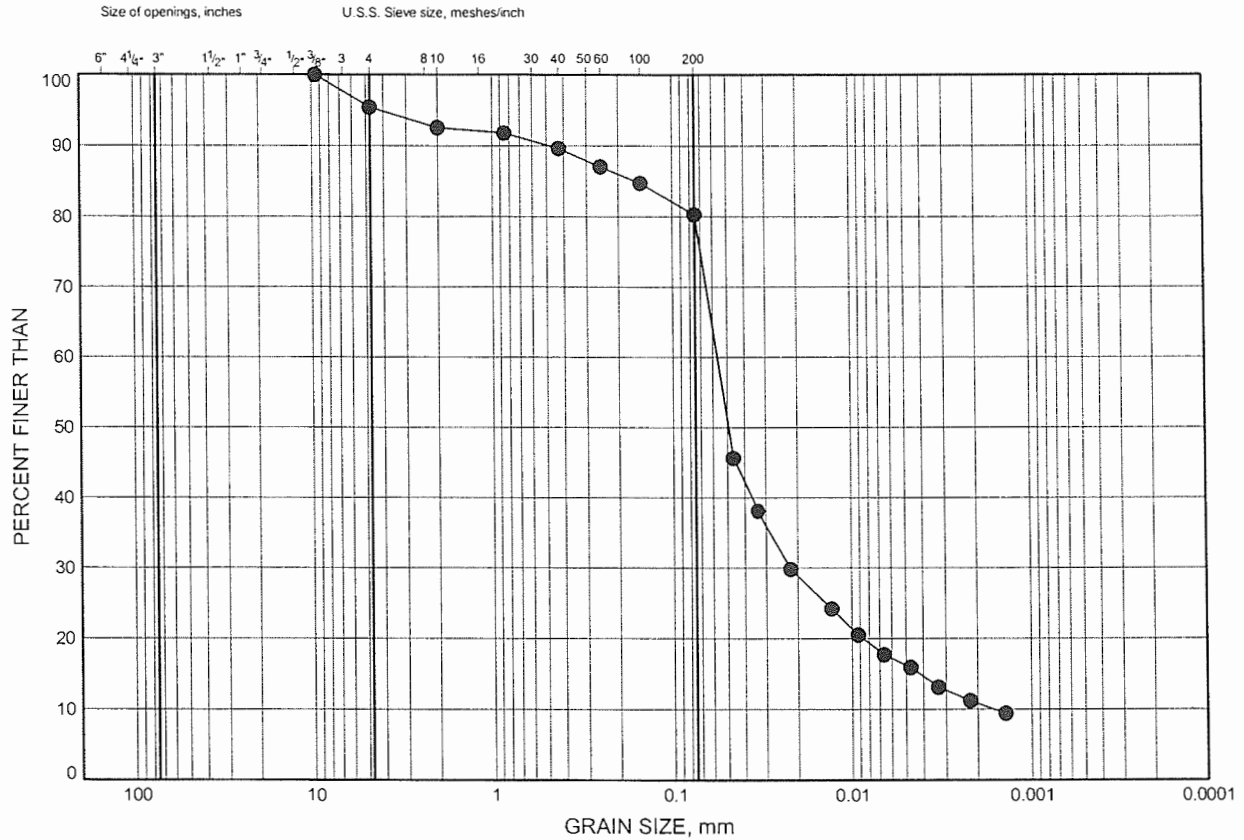
G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 443.00 E 285 089.13 ORIGINATED BY GA
 HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 28.11.06 - 28.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	w _p	w		
117.0							20	40	60	80	100	20	40	60	GR SA SI CL
0.0	Silty CLAY, trace to some sand, trace gravel Very Soft to Soft Mottled Reddish Brown Damp to Moist (FILL)		1	SS	2										
			2	SS	3										
115.5															
1.5	SAND, medium grained, trace to some silt, trace gravel, occasional rootlets Compact Brown		3	SS	22										
114.7	Dry (FILL)														
2.3	Silty SAND, some gravel, trace clay, occasional shale fragments Dense Brown to Reddish Brown		4	SS	50										13 43 33 10
114.0	Dry Highly weathered, thinly bedded, very stiff to hard, reddish brown SHALE		5	SS	29										
3.0															
			6	SS	44										
			7	SS	64										
110.3															
6.7	END OF BOREHOLE AT 6.71 m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.														

GRAIN SIZE DISTRIBUTION

FIGURE A1

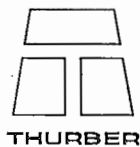
SILTY CLAY FILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C2	2.59	111.80

Date December 2006
Project 169-00-00

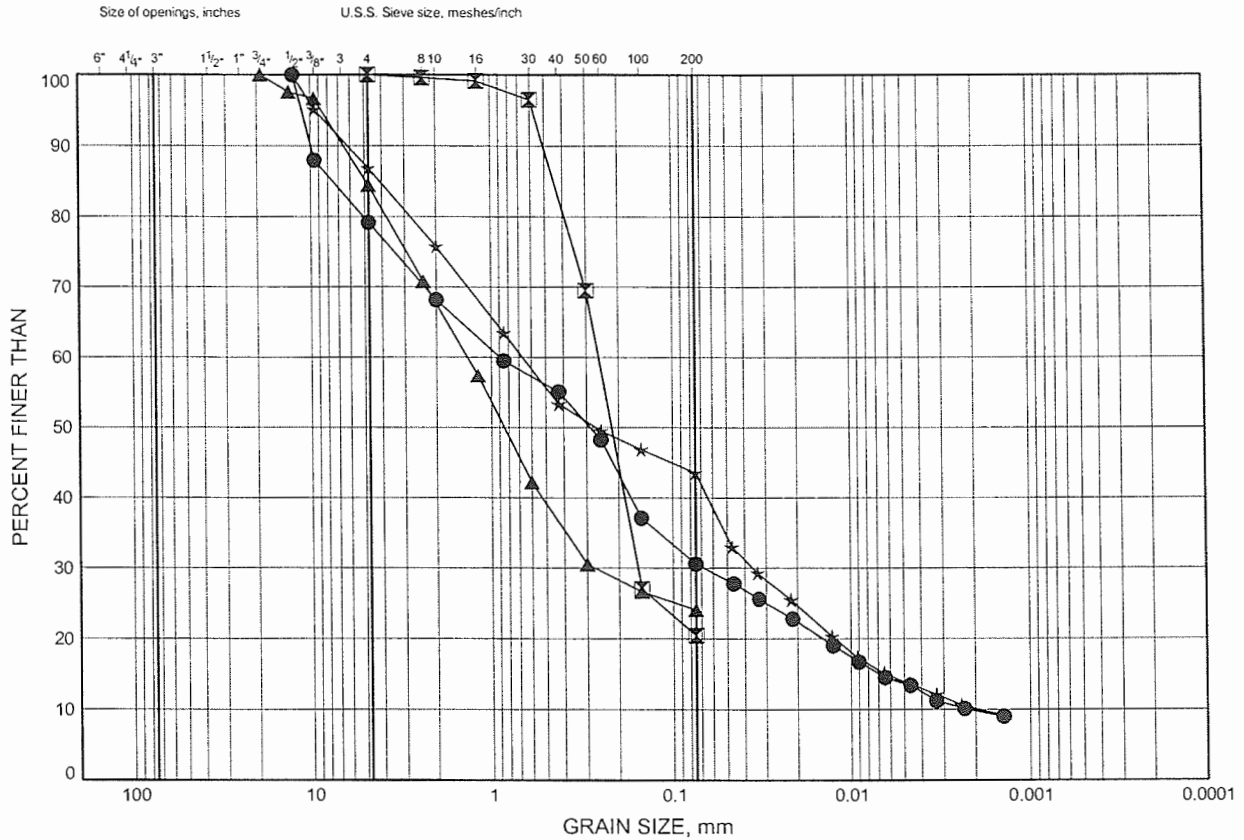


Prep'd JHL
Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE A2

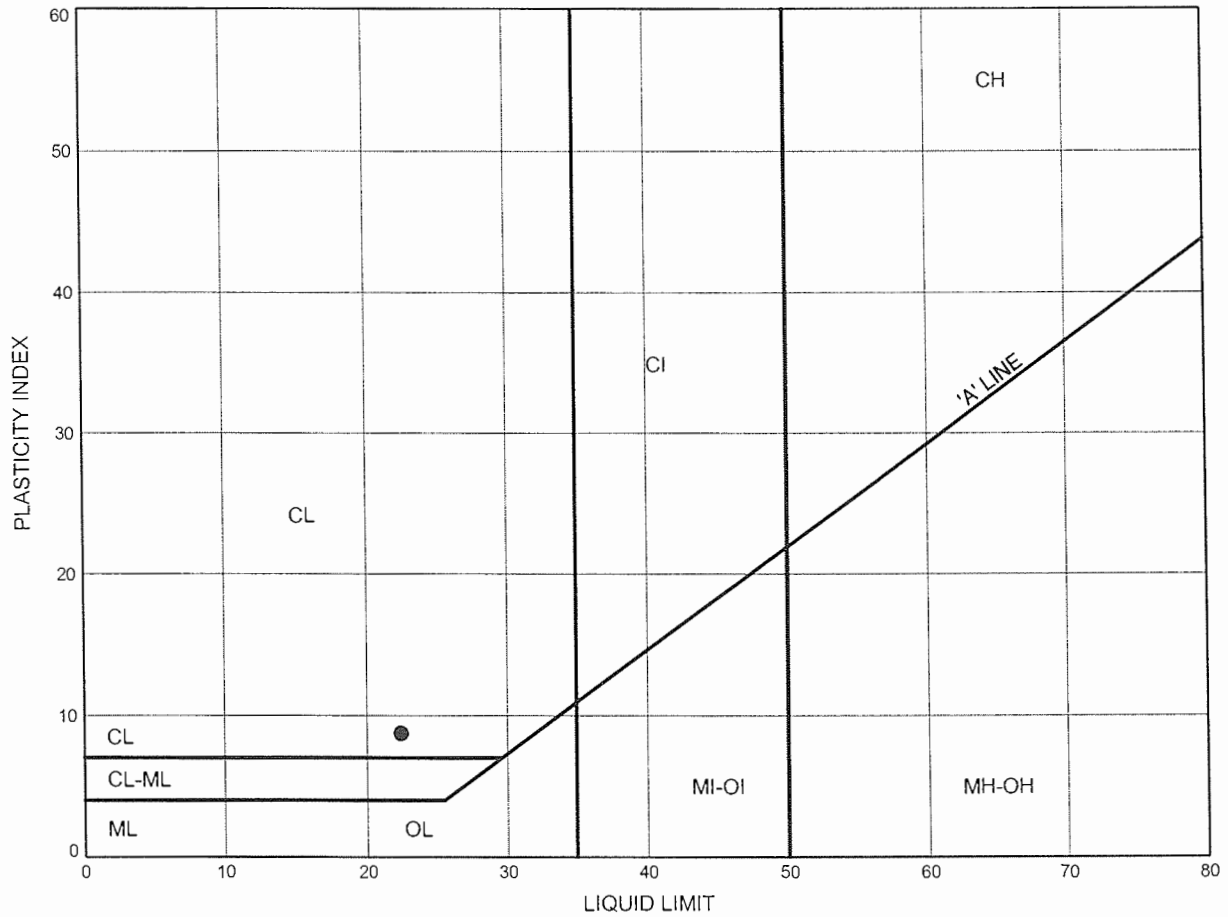
SAND, SILTY SAND AND SILTY SAND TILL



ATTERBERG LIMITS TEST RESULTS

FIGURE A3

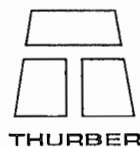
SILTY CLAY FILL



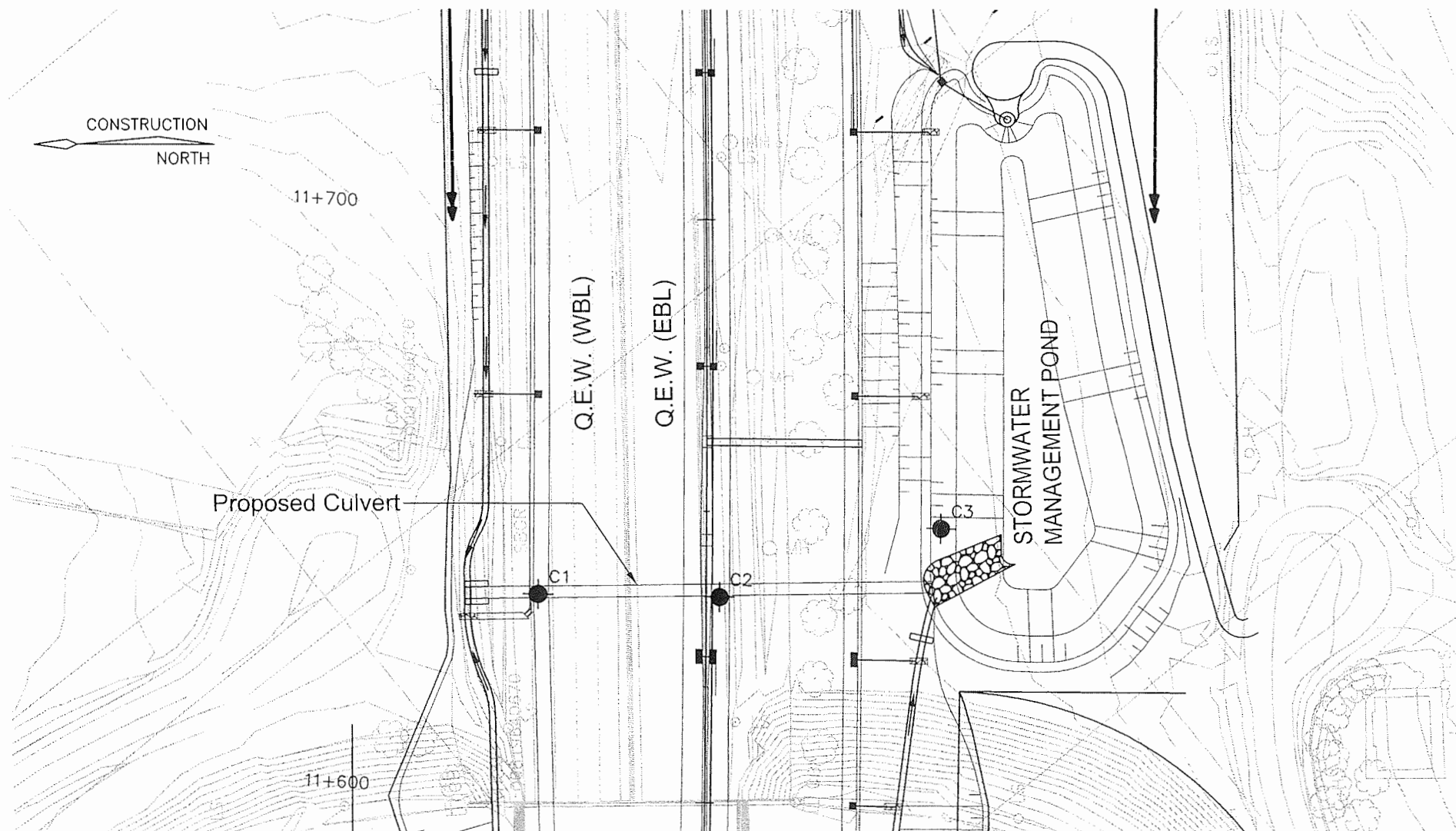
SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	C2	2.59	111.80

THURBALT 5127A.GPJ 21/12/06

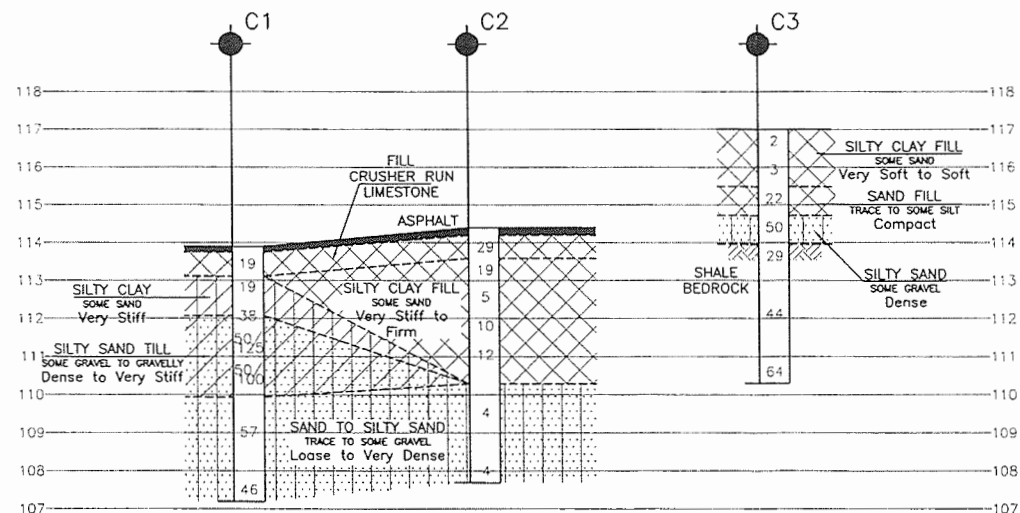
Date December 2006
Project 169-00-00



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PLAN
5 0 10 20m



PROFILE OF PROPOSED CULVERT

1 0 2 4m
5 0 10 20m
VERT 1:200
HORI 1:1000

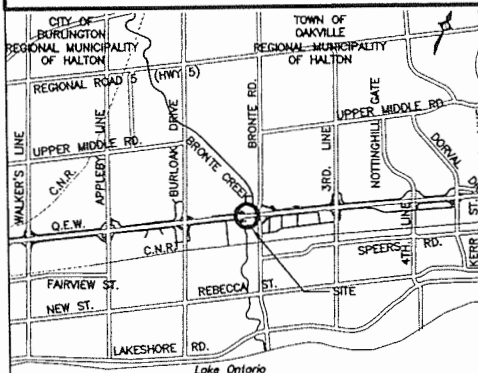
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No 2007-2026
GWP No.169-00-00

QEW-BRONTÉ ROAD
CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

MRC McCORMICK RANKIN
CORPORATION

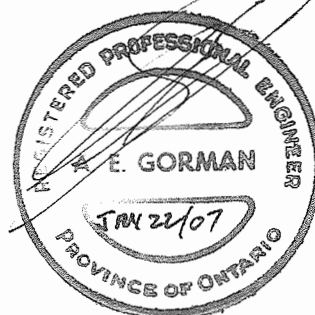
THURBER ENGINEERING LTD.
GEO-TECHNICAL • ENVIRONMENTAL • MATERIALS



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
C1	113.9	4 807 477.5	285 028.6
C2	114.4	4 807 457.7	285 052.3
C3	117.0	4 807 443.0	285 089.1



-NOTE-

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			</
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Appendix B

SWM Pond

RECORD OF BOREHOLE No SWM1

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 766.37 E 285 464.27 ORIGINATED BY GA
 HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY WM
 DATUM Geodetic DATE 23.11.06 - 23.11.06 CHECKED BY MEF

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		
109.7	ASPHALT: (40 mm)													
0.0	SAND and GRAVEL													
109.1	Compact		1	SS	19									
0.6	Brown													
	Dry to Damp													
	(FILL)													
	Silty CLAY, trace to some sand		2	SS	15									0 13 42 45
	Very Stiff													
	Reddish Brown													
108.1	Dry													
1.5	(TILL)(CL-CI)													
	Highly to moderately weathered, thinly bedded, very weak to weak, reddish brown, SHALE with greenish grey limestone interbeds		3	SS	89/ 200									
			4	SS	50/ .075									
	Rubble zone from 3.18 to 3.25 m													
	Limestone interbeds at 3.61 to 3.66, and 4.09 to 4.11 m		1	RUN										RUN 1# TCR=100%, SCR=93%, RQD=26%
	Limestone interbeds at 4.32 to 4.35, 5.11 to 5.13, and 5.41 to 5.54 m													
			2	RUN										RUN 2# TCR=100%, SCR=96%, RQD=63%, UCS=17MPa
104.1	Becoming moderately to slightly weathered													
5.5	Limestone interbeds at 5.77 to 5.81, and 6.01 to 6.06 m		3	RUN										RUN 3# TCR=100%, SCR=100%, RQD=81%, UCS=12MPa
103.3	END OF BOREHOLE AT 6.32 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.													
6.3	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 14.12.06 4.16 105.54													

RECORD OF BOREHOLE No SWM2

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Bur Oak Drive N 4 807 835.08 E 285 489.21 ORIGINATED BY GA
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 28.11.06 - 28.11.06 CHECKED BY MEF

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							WATER CONTENT (%) w p w w L
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
109.7							20	40	60	80	100				
0.0 0.1	TOPSOIL: (75 mm) Silty CLAY, some sand, trace gravel, occasional rootlets Firm Reddish Brown (TILL)		1	SS	6										
108.8															
0.9	Highly weathered, thinly bedded, reddish brown, hard SHALE		2	SS	50										
			3	SS	50/ .125										
107.3															
2.3	END OF BOREHOLE AT 2.33 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.		4	SS	50/ .050										

ONTMT4S 5127A.GPJ 21/12/06

RECORD OF BOREHOLE No SWM3

1 OF 1

METRIC

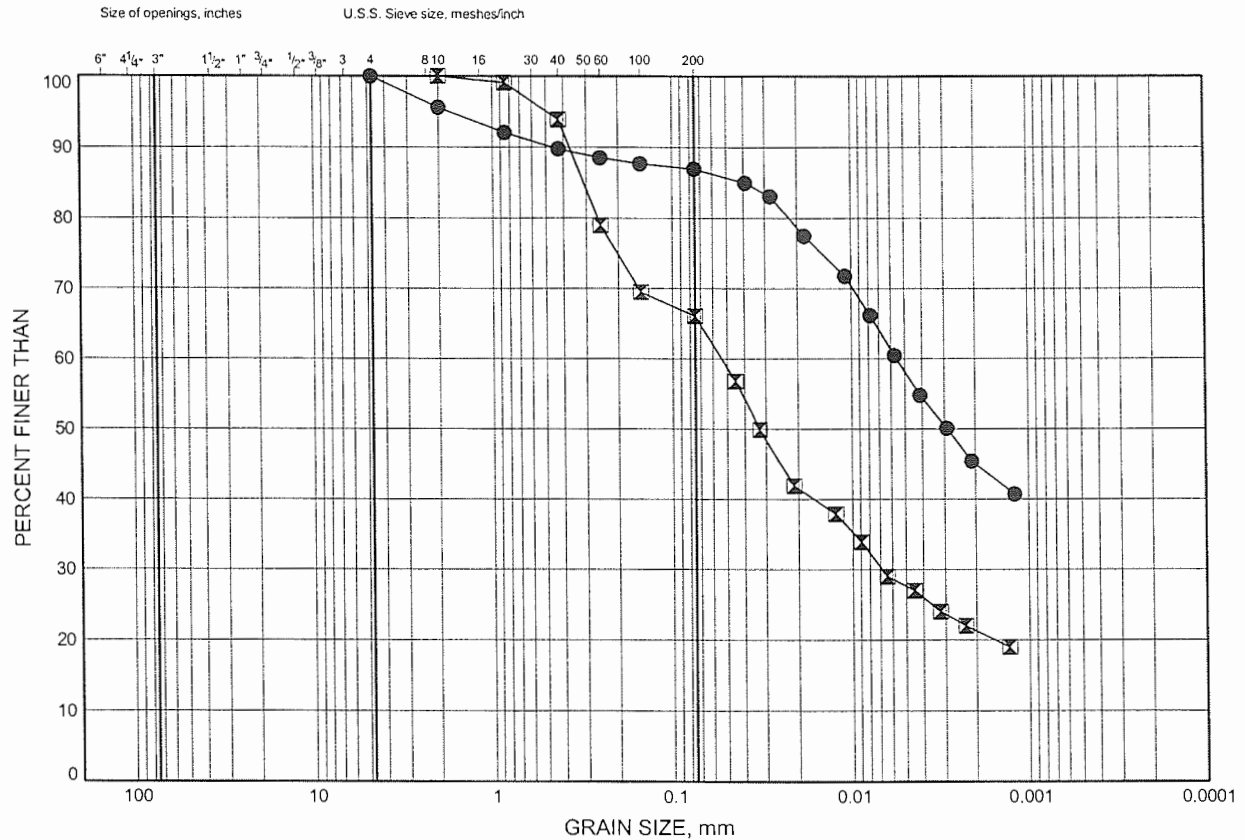
G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 780.51 E 285 544.08 ORIGINATED BY GA
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 27.11.06 - 27.11.06 CHECKED BY MEF

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				WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE			
108.9							20 40 60 80 100	PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L				
0.0 0.1	TOPSOIL: (75 mm) Silty CLAY, some sand to sandy, trace gravel, occasional rootlets Firm to Hard Mottled Brown/Reddish Brown (TILL)		1	SS	6							
107.8			2	SS	74		108					
1.1	Highly weathered, thinly bedded, reddish brown, hard SHALE		3	SS	50/ .100		107					
106.6			4	SS	50/ .075							
2.3	END OF BOREHOLE AT 2.33 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.											

GRAIN SIZE DISTRIBUTION

FIGURE B1

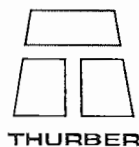
SILTY CLAY TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SWM1	1.07	108.60
⊠	SWM3	1.07	107.83

Date December 2006
Project 169-00-00

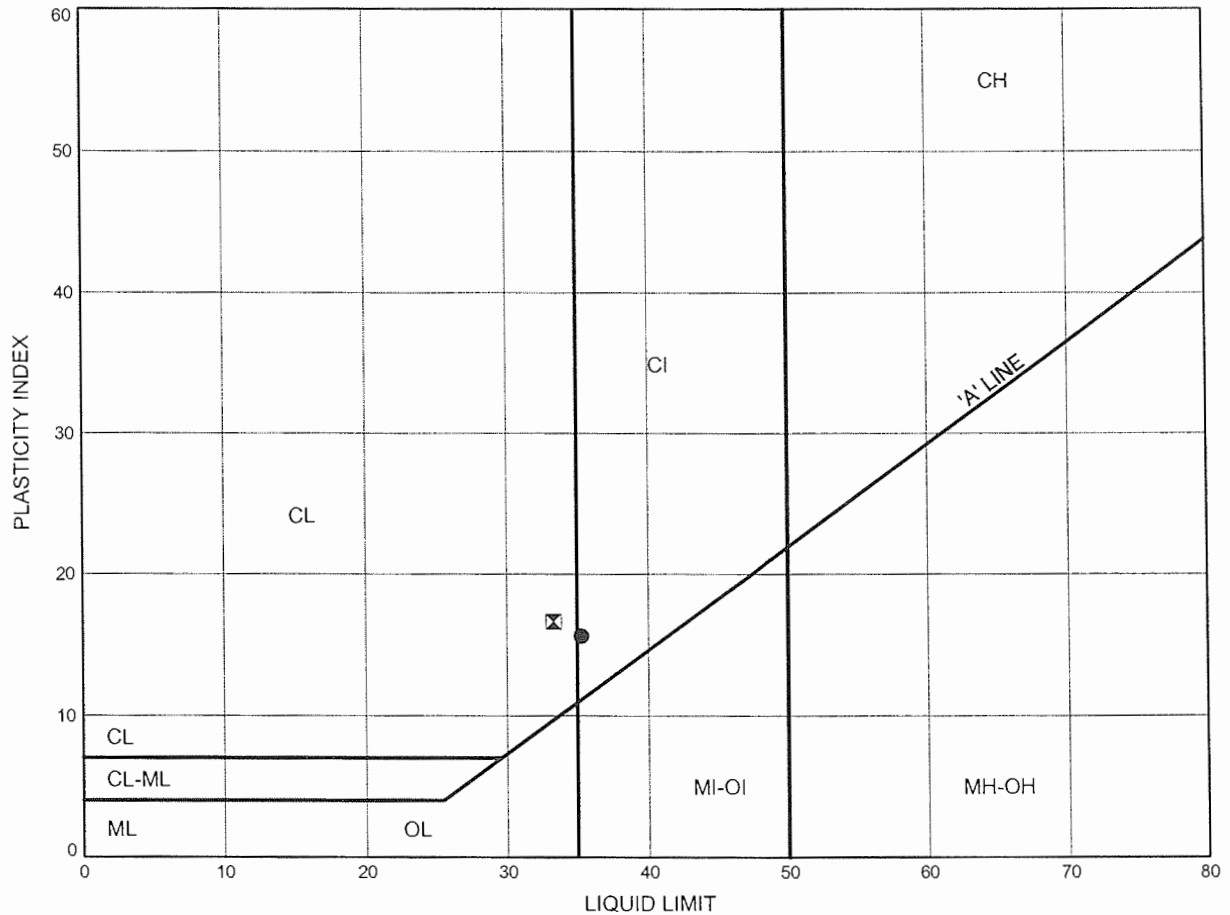


Prep'd JHL
Chkd. MRA

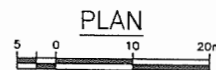
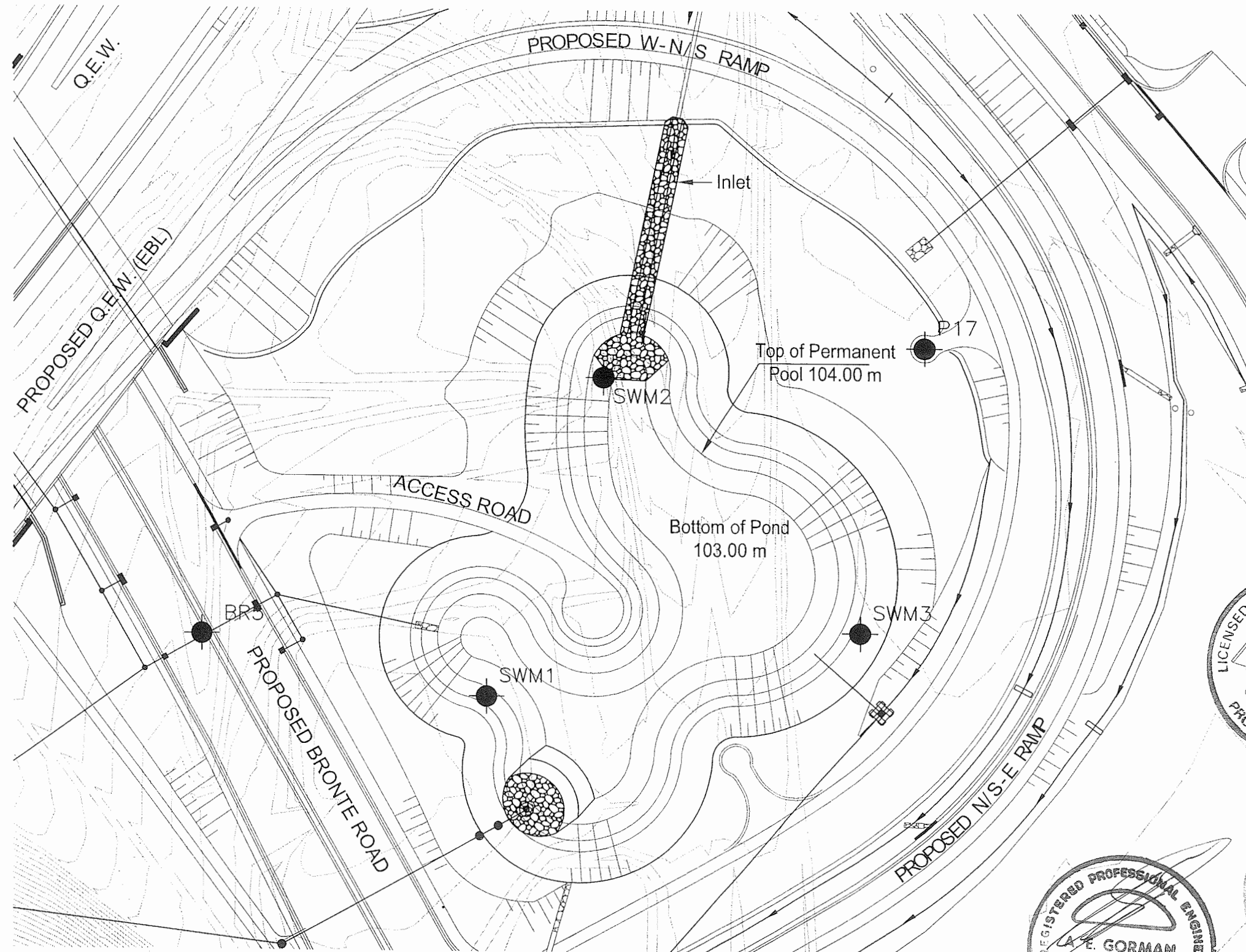
ATTERBERG LIMITS TEST RESULTS

FIGURE B2

SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	SWM1	1.07	108.60
⊠	SWM3	1.07	107.83



PLAN

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

CONT No 2007-2026
GWP No.169-00-00

QEW-BRONTE ROAD
SWM POND
BOREHOLE LOCATIONS AND SOIL STRATA

MRC McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

City of Burlington Regional Municipality of Halton
Town of Oakville Regional Municipality of Halton
Regional Road 5 (Hwy 5)
Upper Middle Rd.
Walker's Line
C.N.R.
Fairview St.
New St.
Lakeshore Rd.
Bronte Rd.
Bronte Creek
Upper Middle Rd.
Gate
Dorval
Kerri St.
8th Line
Speers Rd.
Rebecca St.
Site
Lake Ontario

KEYPLAN

LEGEND

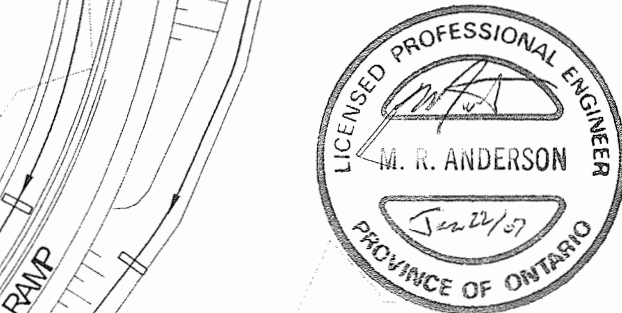
- BoreHole
- BoreHole and Cone
- N
- CONE
- PH
- Water Level
- Head Artesian Water
- Piezometer
- 90%
- A/R

- Blows /0.3m (Std Pen Test, 475J/blow)
- Blows /0.3m (60' Cone, 475J/blow)
- Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- Rock Quality Designation (RQD)
- Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SWM1	109.7	4 807 766.37	285 464.27
SWM2	109.7	4 807 835.08	285 489.21
SWM3	108.9	4 807 780.51	285 544.08

-NOTE-

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	RPR	CHK	PKC	CODE
DRAWN	JHL	CHK	MEF	SITE
LOAD				
STRUCT				
DWG	B1			

Appendix C

Utility Crossings

RECORD OF BOREHOLE No UC1

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 806 176.21 E 263 988.78 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY WM
 DATUM Geodetic DATE 29.11.06 - 30.11.06 CHECKED BY MEF

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 (%)		
								20 40 60 80 100							
								20 40 60 80 100							
126.5															
0.0	ASPHALT: (140 mm)														
0.2	CRUSHER RUN LIMESTONE Compact Brown Moist (FILL)		1	SS	31		126					30 52 18 (SI+CL)			
125.5			2	SS	65							0 10 70 20			
1.0	Silty CLAY, trace sand, occasional shale fragments														
125.1	Hard														
1.4	Brown (TILL)		3	SS	50/ .125		125								
	Highly to moderately weathered, thinly bedded, reddish brown, very weak to medium strong SHALE with greenish grey limestone interbeds		4	SS	50/ .125		124								
	Limestone interbeds at 3.0 to 3.07 m, 3.12 to 3.20 m		1	RUN											
	Rubble zones at 3.58 to 3.66 and 4.22 to 4.32 m		2	RUN			123								
121.9															
4.6	END OF BOREHOLE AT 4.60 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.						122								
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 14.12.06 2.10 124.40														

RECORD OF BOREHOLE No UC2

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 806 150.19 E 284 021.49 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 23.11.06 - 23.11.06 CHECKED BY MEF

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		
125.8	ASPHALT: (110 mm)													
0.0	CRUSHER RUN LIMESTONE													
0.1	Dense													
125.1	Brown		1	SS	35									
0.7	Moist													
124.7	(FILL)													
1.1	Silty CLAY, trace sand, occasional grey silt lenses, occasional shale fragments		2	SS	56									0 6 69 26
124.2	Hard													
1.6	Brown		3	SS	50/									
	(TILL)(CL)				.075									
	Highly weathered, thinly bedded, reddish brown, SHALE													
	Hard													
	END OF BOREHOLE AT 1.60 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND PATCHED WITH ASPHALT AT SURFACE.													

RECORD OF BOREHOLE No UC3

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 806 933.25 E 284 587.22 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Agers COMPILED BY WM
 DATUM Geodetic DATE 29.11.06 - 29.11.06 CHECKED BY MEF

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		
118.5														
0.0	ASPHALT: (110 mm)													
0.1	CONCRETE: (240 mm)													
118.1														
0.4	CRUSHER RUN LIMESTONE													
117.7	Brown													
117.4	Dry													
0.8	(FILL)													
117.4	Silty CLAY, trace sand, occasional		1	SS	91									0 9 74 18
1.1	shale fragments													
	Hard													
	Reddish Brown													
116.8	(TILL)		2	SS	50/									
1.7	Highly weathered, thinly bedded,				.050									
	reddish brown SHALE													
	Hard													
	END OF BOREHOLE AT 1.72 m.													
	BOREHOLE OPEN AND DRY TO													
	BOTTOM ON COMPLETION.													
	BOREHOLE BACKFILLED WITH													
	DRILL CUTTINGS AND PATCHED													
	WITH ASPHALT AT SURFACE.													

RECORD OF BOREHOLE No UC4

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 806 908.43 E 284 618.42 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA
 DATUM Geodetic DATE 23.11.06 - 24.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT Y 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 80 100							
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT								
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+ 3 . x 3 : Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No UC5

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 398.59 E 284 964 40 ORIGINATED BY SLI
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 14.11.06 - 14.11.06 CHECKED BY MEF

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		
114.9	ASPHALT: (140 mm)													
0.0	CRUSHER RUN LIMESTONE													
	Dense		1	SS	30									
	Brown													
	Moist													
114.1	(FILL)													
0.8	Silty CLAY, some sand, some shale		2	SS	20		114							
	fragments													
	Very Stiff													
	Brown													
113.1														
1.8	Sandy SILT, some clay, trace gravel		3	SS	17		113							6 33 48 13
	Compact													
	Brown													
112.7	Moist to Wet													
2.2	SAND, some gravel, trace silt		4	SS	50/ .150									
	Very Dense													
	Brown													
112.1	Moist													
2.8	Sandy SILT, trace clay, trace gravel		5	SS	58		112							2 22 67 9
	Very Dense													
	Brown													
	Wet													
							111							
			6	SS	61		110							
109.7														
5.2	END OF BOREHOLE AT 5.18 m. BOREHOLE OPEN TO 4.42 m AND DRY ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, DRILL CUTTINGS TO 0.1m AND PATCHED WITH ASPHALT AT SURFACE.													

RECORD OF BOREHOLE No UC6

1 OF 2

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 376.00 E 284 990.35 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Auger COMPILED BY MFA
 DATUM Geodetic DATE 23.11.06 - 23.11.06 CHECKED BY MEF

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	
114.8	ASPHALT: (375 mm)											
114.4												
114.2	CONCRETE: (250 mm)											
0.6	Silty CLAY, some sand, trace gravel Very Stiff to Hard Brown (TILL)		1	SS	23		114					
			2	SS	50/ .125		113					
112.7	Sandy SILT, some clay, trace gravel Very Dense Brown Moist		3	SS	84/ .275		112					2 28 61 9
			4	SS	59		111					
110.7	SILT, trace sand, trace clay, trace gravel Very Dense Brown Moist (TILL)		5	SS	82		110					1 9 82 8
4.1			6	SS	58		109					
							108					
107.3	Silty CLAY, trace shale fragments Hard Reddish Brown (TILL)		7	SS	50/ .150		107					
							106					
105.6	END OF BOREHOLE AT 9.22 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.		8	SS	50/ .075							
9.2												

Continued Next Page

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

ONTMTJ45 5127A.GPJ 21/12/06

RECORD OF BOREHOLE No UC7

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 841.45 E 285 315.39 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 28.11.06 - 28.11.06 CHECKED BY MEF

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		
117.0	ASPHALT: (240 mm)						117							
0.0	CONCRETE: (260 mm)													
0.2														
116.5														
0.5	Silty CLAY, some shale fragments													
116.1	Hard													
0.9	Brown (TILL)		1	SS	50/		116							
	Highly weathered, thinly bedded, reddish brown, SHALE				.125									
115.3	Hard		2	SS	50/									
					.050									
1.7	END OF BOREHOLE AT 1.68 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND PATCHED WITH ASPHALT AT SURFACE.													

RECORD OF BOREHOLE No 06-10

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION N 4 807 820.4 E 285 351.1 (Bronte) ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Augers / NQ Rock Coring COMPILED BY JHL
 DATUM Geodetic DATE 12.06.06 - 12.06.06 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT Y 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	
116.1 0.0 0.1	TOPSOIL: (100 mm) Stiff Clayey SILT, trace to some gravel Stiff Reddish Brown Moist (TILL) sand seam (50 mm)		1	SS	10		116					10 53 29 8
			2	SS	8		115					
114.3			3	SS	65		114					
113.5			4	SS	50/ 125		113					
2.6	SHALE, weathered, with grey limestone layer Reddish Brown		1	RUN			112					RUN 1# TCR=100%, SCR=81%, ROD=0% RUN 2# TCR=95%, SCR=85%, ROD=85% RUN 3# TCR=100%, SCR=100%, ROD=85%
	Limestone layers from 2.64 to 2.92 m Limestone layer (50 mm) at 3.25 m Clay seam (50 mm) at 3.49 m		2	RUN			111					
	Limestone layer (50 mm) at 4.65, 4.77 m		3	RUN								
110.5	Limestone layer (50 mm) at 5.31, 5.47 m											
5.6	END OF BOREHOLE AT 5.61 m. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.											

RECORD OF BOREHOLE No UC9

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 006.01 E 285 441.39 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 28.11.06 - 28.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
116.0	ASPHALT: (175 mm)						116							
0.0														
0.2	CRUSHER RUN LIMESTONE													
115.3	Compact		1	SS	28									
0.7	Brown													
	Moist													
	(FILL)													
	Highly weathered, thinly bedded,		2	SS	50/		115							
	reddish brown, SHALE				.150									
	Hard													
114.3			3	SS	50/									
1.7	END OF BOREHOLE AT 1.68 m.				.150									
	BOREHOLE OPEN AND DRY TO													
	BOTTOM ON COMPLETION.													
	BOREHOLE BACKFILLED WITH													
	DRILL CUTTINGS AND PATCHED													
	WITH ASPHALT AT SURFACE.													

RECORD OF BOREHOLE No UC10

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Bur Oak Drive N 4 807 986.16 E 285 468.85 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 25.11.06 - 25.11.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT Y 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	
116.3												
0.0	ASPHALT: (100 mm)											
0.1	CRUSHER RUN LIMESTONE											
115.6	Compact		1	SS	21		116					
0.7	Brown											
	Moist											
	(FILL)											
	Silty CLAY, some sand, trace gravel		2	SS	22		115					
	Very Stiff to Stiff											
	Brown											
	(CL)		3	SS	14							
			4	SS	10		114					
	becoming hard: (TILL)		5	SS	82/ 250		113					
112.2												
4.1	Highly weathered, thinly bedded, reddish brown, SHALE						112					
	Hard											
111.5			6	SS	50/ 100							
4.8	END OF BOREHOLE AT 4.82 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.											
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 14.12.06 2.31 113.99											

RECORD OF BOREHOLE No WBT7

1 OF 1

METRIC

G.W.P.: 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 489.44 E 285 825 22 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 14.11.06 - 14.11.06 CHECKED BY MEF

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	20 40 60 80 100		
113.7														
0.0	ASPHALT: (150 mm)													
0.2	CRUSHER RUN LIMESTONE													
112.9	Dense Brown Moist (FILL)		1	SS	32		113							
0.8	Silty CLAY, trace to some sand, trace gravel													
112.5	Hard Reddish Brown (TILL)		2	SS	31									0 0 79 21
1.2	Highly weathered, thinly bedded, reddish brown, SHALE													
112.0	Hard		3	SS	50/									
1.8	END OF BOREHOLE AT 1.75 m. BOREHOLE OPEN AND DRY TO BOTTOM ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO 0.2m THEN ASPHALT TO SURFACE.				.075									

RECORD OF BOREHOLE No UC12

1 OF 1

METRIC

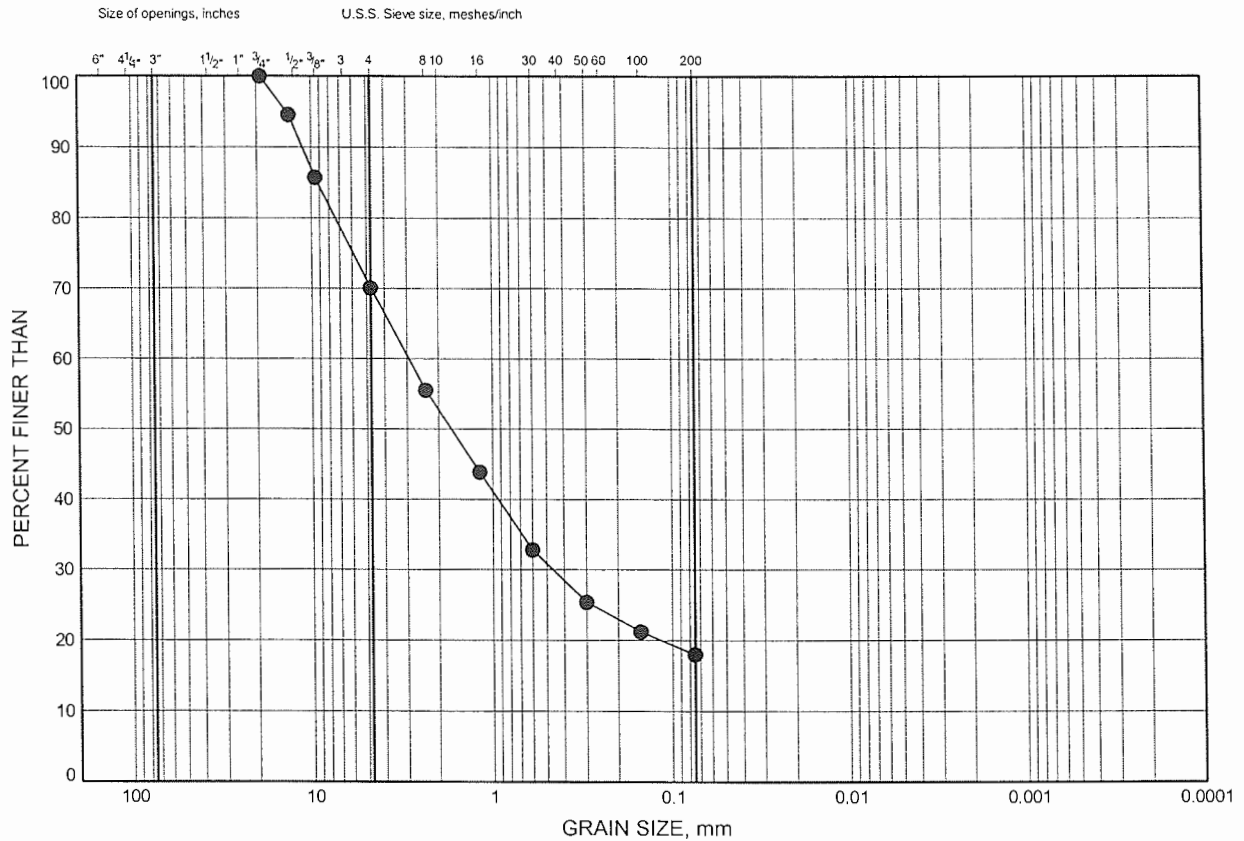
G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 808 467.2 E 285 862.6 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA
 DATUM Geodetic DATE 27.11.06 - 28.11.06 CHECKED BY MEF

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		
113.1												
0.0	ASPHALT: (225 mm)						113					
0.2	CRUSHER RUN LIMESTONE		1	SS	47							
112.3	Dense Brown Moist (FILL)											
0.8	Silty CLAY, trace sand, trace roots Very Stiff to Hard Brown to Reddish Brown (TILL)(CL)		2	SS	31		112					
			3	SS	18							
			4	SS	74/ 275		111					
110.4												
2.7	Moderately to slightly weathered, thinly bedded, reddish brown, very weak SHALE with greenish grey limestone interbeds		5	SS	50/ .075		110					
	Vertical joint at 3.45 to 3.55 m											
	Limestone interbeds at 3.66 to 3.81, 4.21 to 4.27, and 4.42 to 4.45 m		1	RUN								
							109					
	Limestone interbeds at 4.74 to 4.82, and 5.26 to 5.41 m		2	RUN			108					
106.9												
6.2	END OF BOREHOLE AT 6.18 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.						107					
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 14.12.06 4.51 108.59											

GRAIN SIZE DISTRIBUTION

FIGURE C1

CRUSHER RUN LIMESTONE

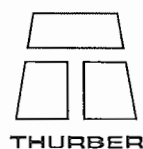


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	UC1	0.46	126.04

Date December 2006

Project 169-00-00



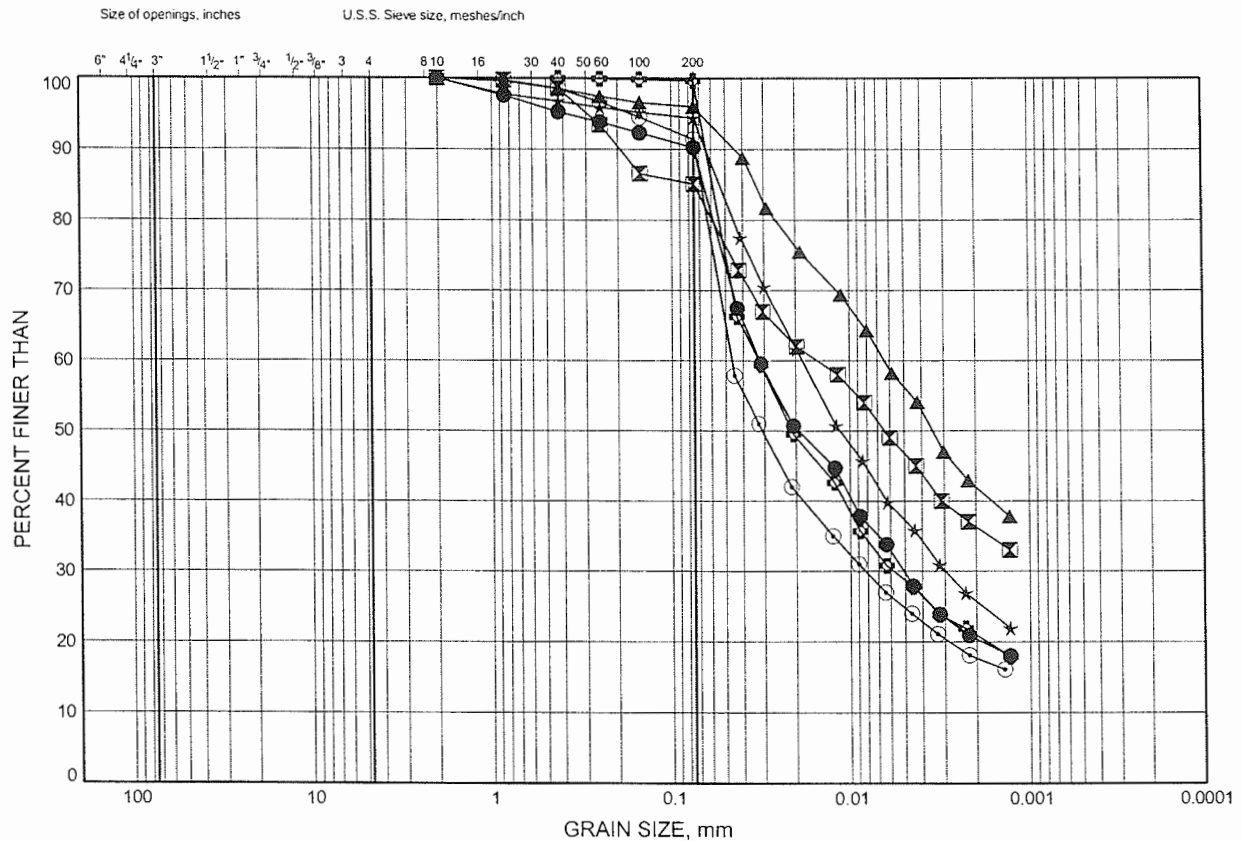
Prep'd JHL

Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE C2

SILTY CLAY TILL

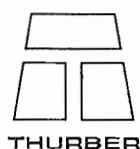


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	UC1	0.99	125.51
⊠	UC10	2.59	113.71
▲	UC12	1.83	111.27
★	UC2	1.07	124.73
⊙	UC3	0.99	117.51
⊛	UC4	1.07	117.73

Date December 2006

Project 169-00-00



THURBER

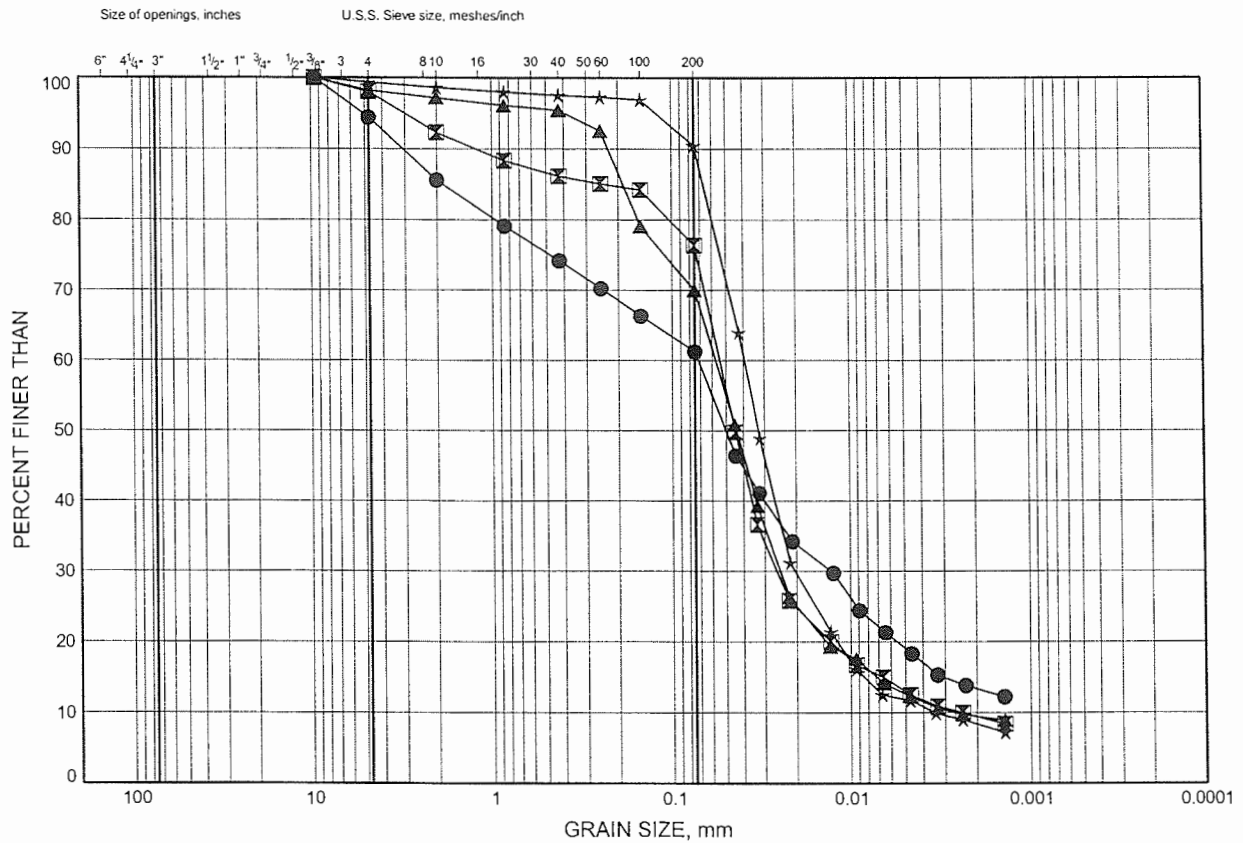
Prep'd JHL

Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE C3

SANDY SILT TO SILT

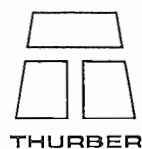


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	UC5	1.83	113.07
⊠	UC5	3.35	111.55
▲	UC6	2.50	112.30
★	UC6	4.86	109.94

Date December 2006

Project 169-00-00



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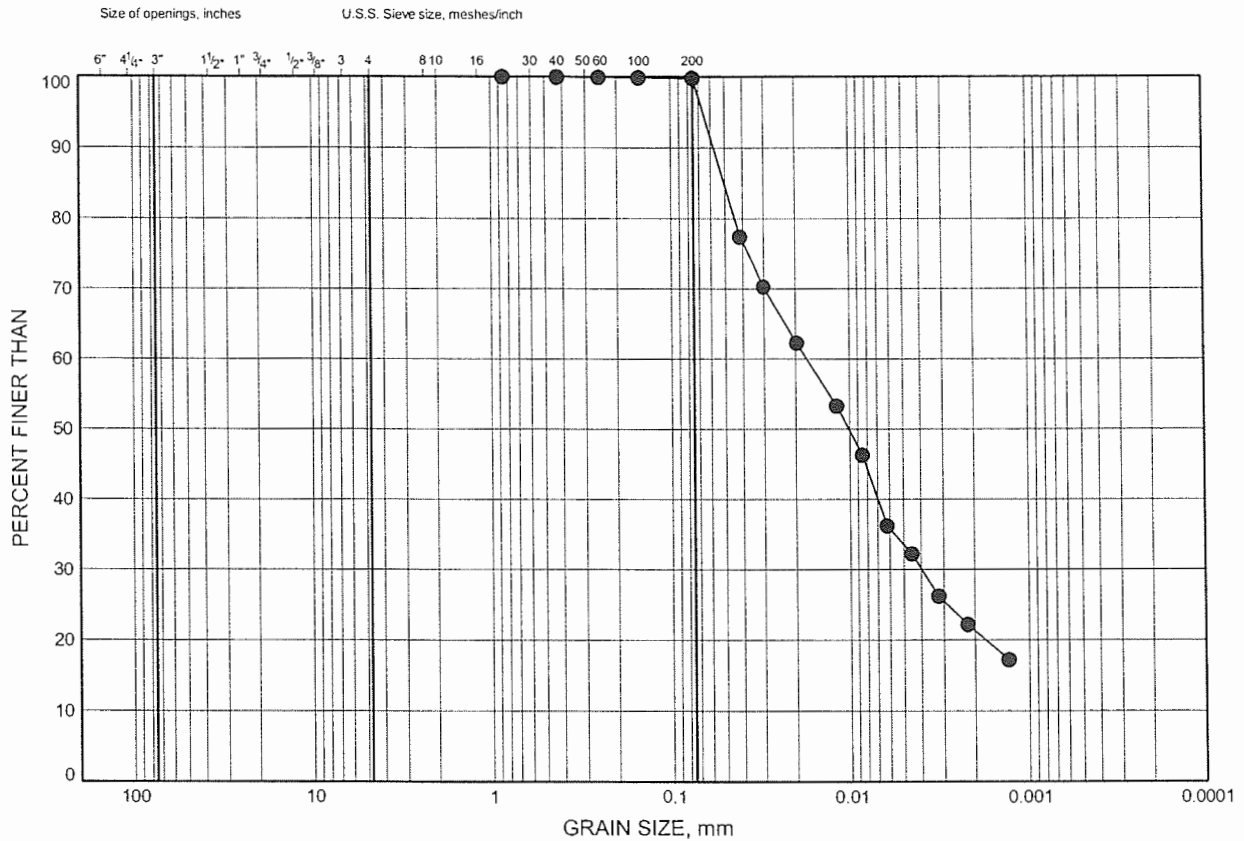
Prep'd JHL

Chkd. MRA

GRAIN SIZE DISTRIBUTION

FIGURE C4

SHALE

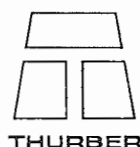


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	WBT7	1.07	112.67

Date December 2006

Project 169-00-00

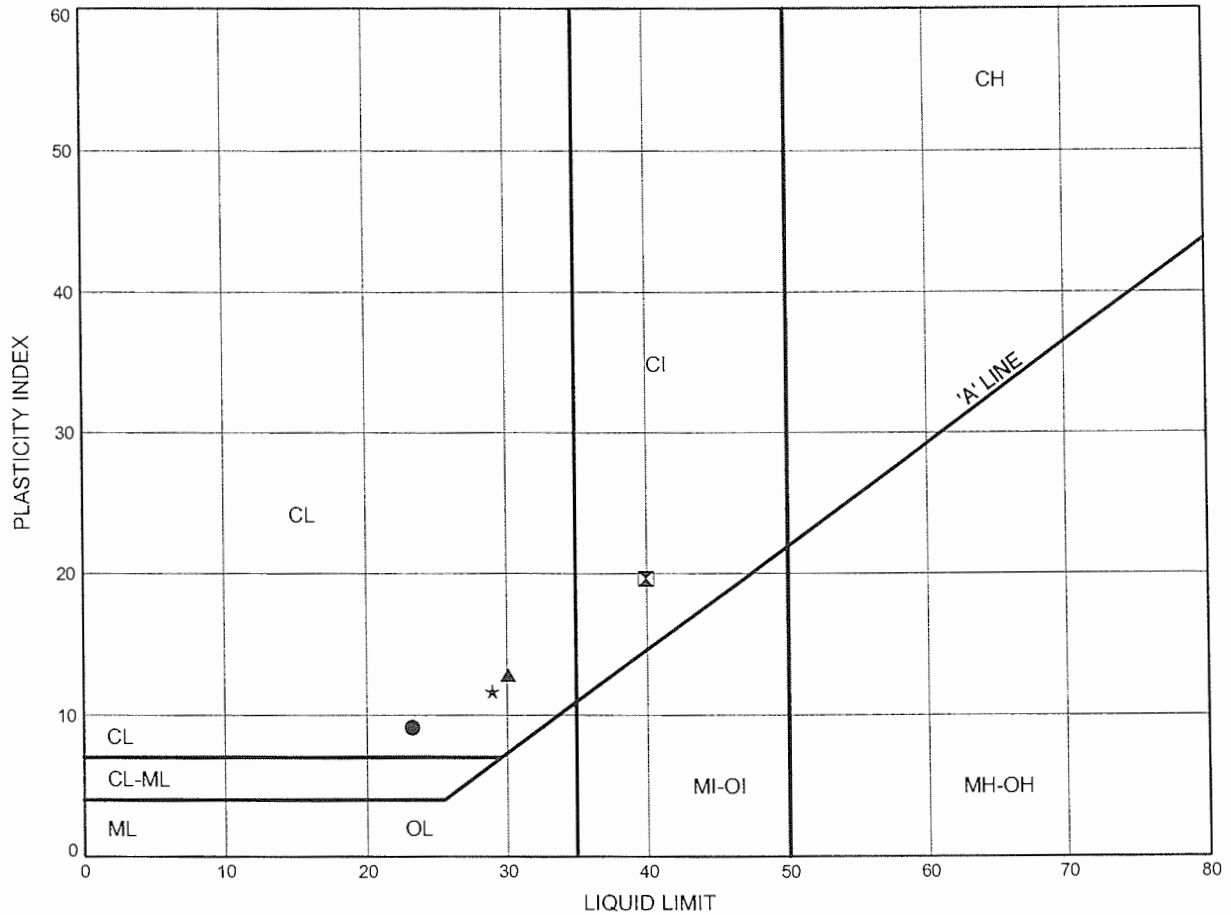


THURBER

Prep'd JHL

Chkd. MRA

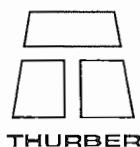
FIGURE C5



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	UC10	2.59	113.71
⊠	UC12	1.83	111.27
▲	UC2	1.07	124.73
*	UC4	1.07	117.73

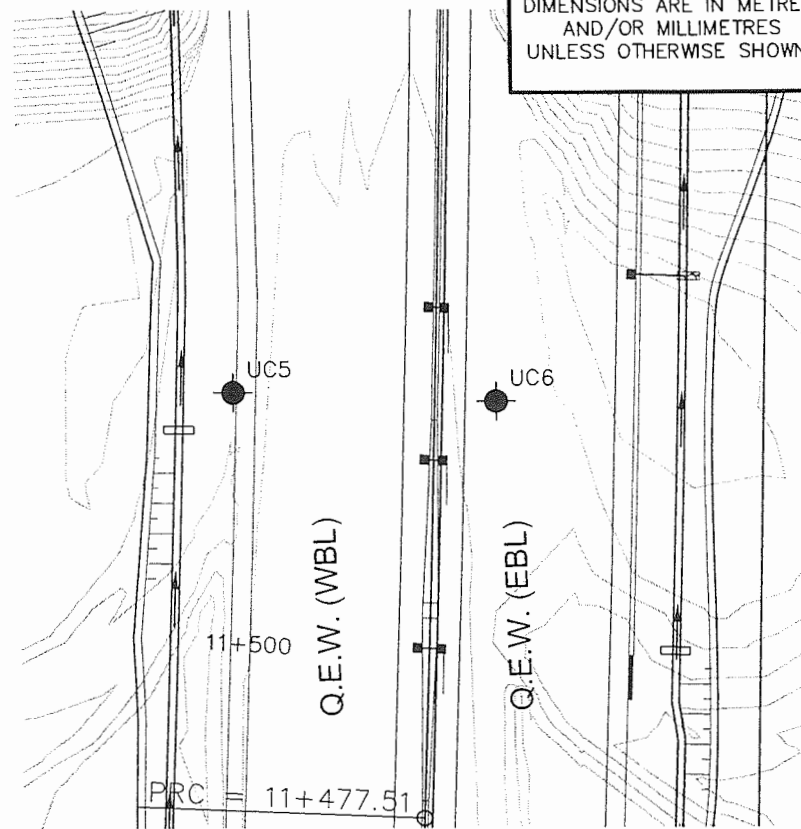
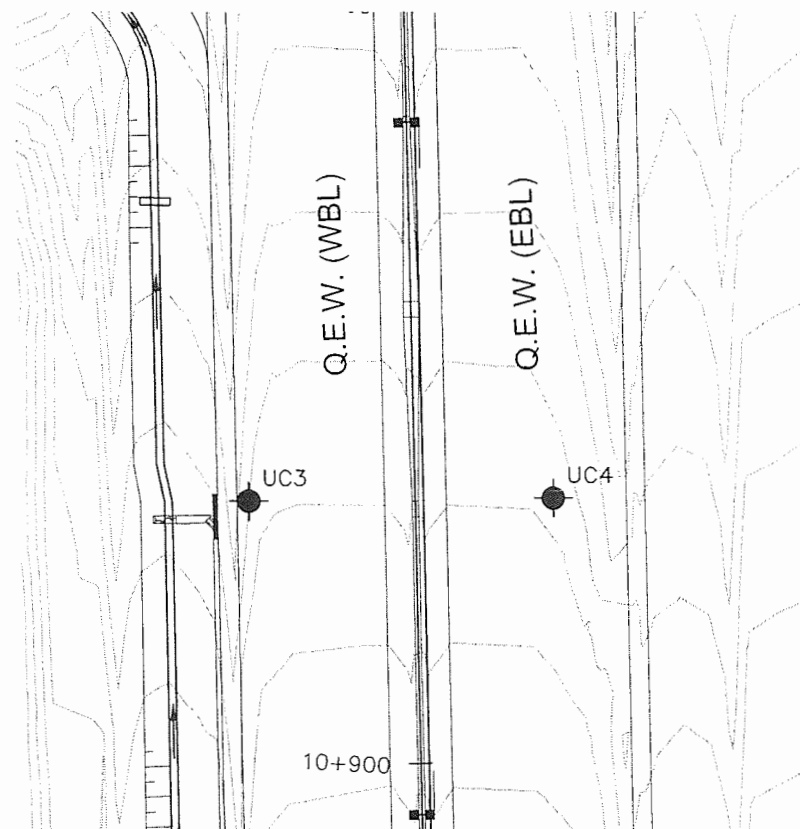
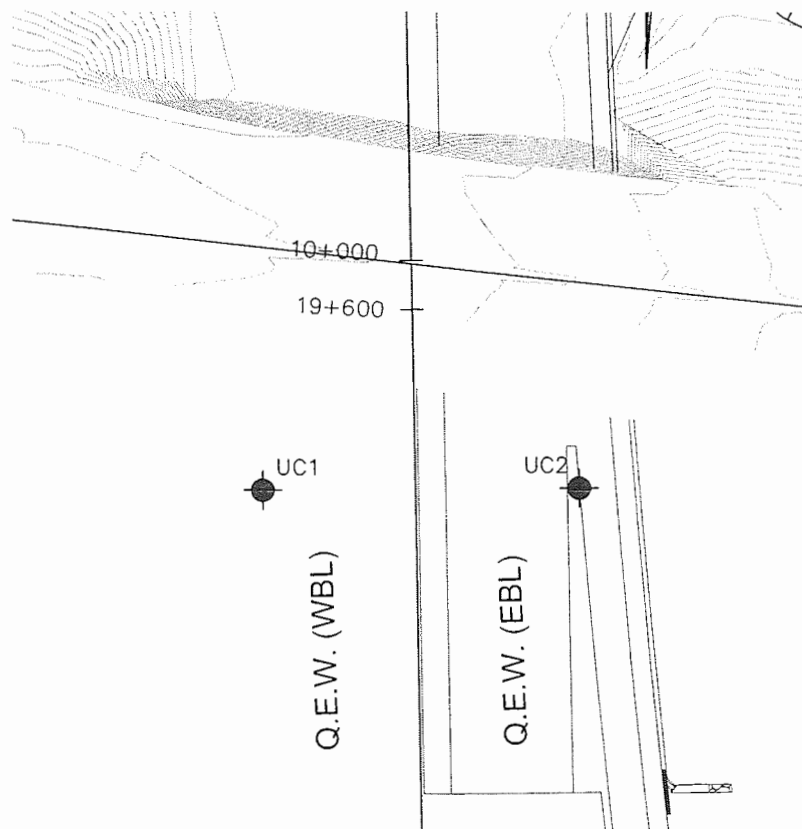
Date December 2006

Project 169-00-00



Prep'd JHL

Chkd. MRA



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

CONT No 2007-2026
GWP No.169-00-00

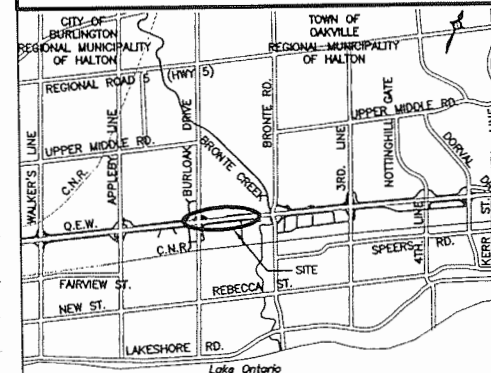


SHEET

QEW-BRONTÉ ROAD
UTILITY CROSSINGS
BOREHOLE LOCATIONS AND SOIL STRATA

MCCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

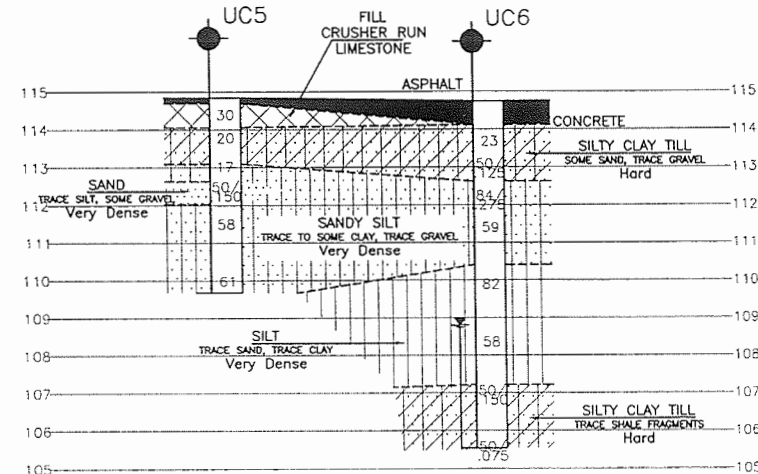
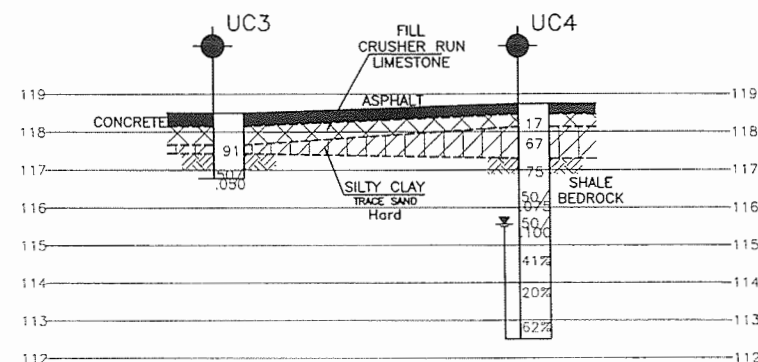
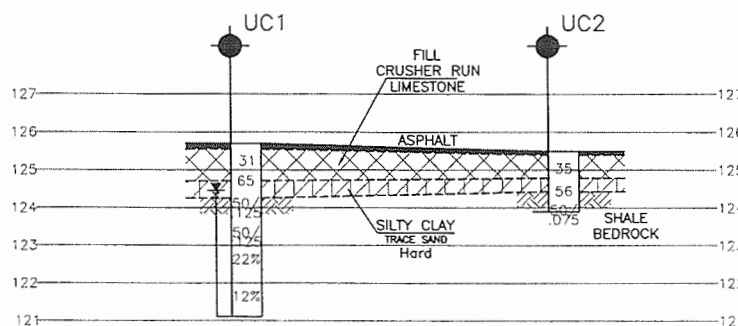
LEGEND

- 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

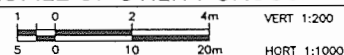
NO	ELEVATION	NORTHING	EASTING
UC1	126.5	4 806 176.21	283 988.78
UC2	125.8	4 806 150.19	284 021.49
UC3	118.5	4 806 933.25	284 587.22
UC4	118.8	4 806 908.43	284 618.42
UC5	114.9	4 807 398.59	284 964.40
UC6	114.8	4 807 376.00	284 990.35

-NOTE-

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

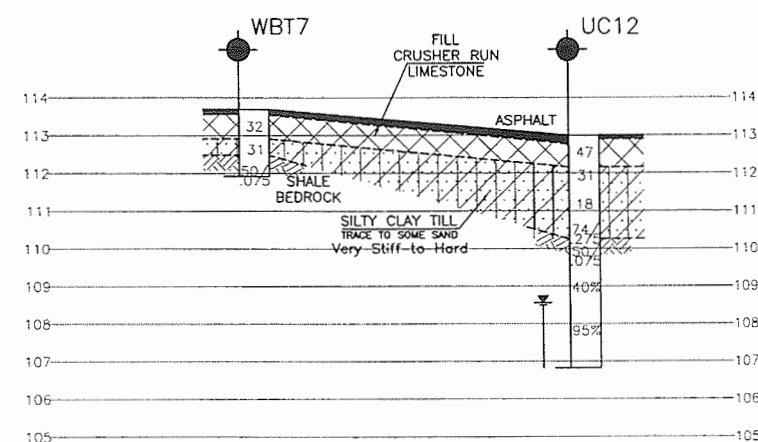
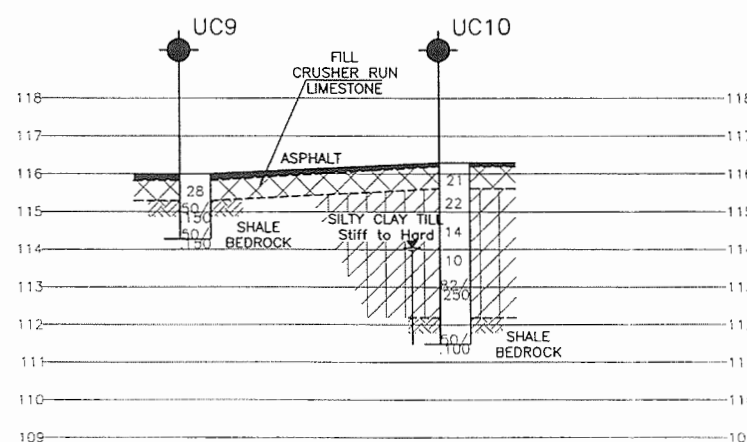
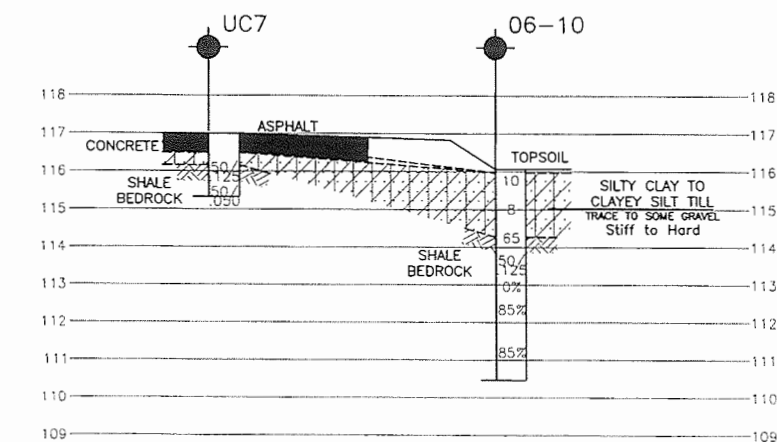


PROFILE OF UTILITY CROSSINGS



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION	DATE
DESIGN	RPR	CHK	PKC	CODE
DRAWN	JHL	CHK	MEF	SITE
STRUCT				DWG
C1				



SHEET



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- [illegible]

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

[illegible]

Appendix D

Watermain Protection

TABLE D1
SUMMARY OF SUBSURFACE FINDINGS AT WATERMAIN LOCATION

Borehole or Excavation Designation	Excavation Equipment	Subsurface Findings
FM1	Drill rig with solid stem augers	Shale bedrock at 3.7 m depth (elevation 112.4 m). Refer to Log of Borehole sheet for rock core results.
FM2	Vacuum truck	Shale bedrock at 3.7 m depth (elevation 112.1 m) on east side of excavation, and 3.0 m depth (elevation 112.8 m) on west side.
FM3	Vacuum truck	Shale was not encountered within the exploration depth of 4.6 m (elevation 111.3 m).
FM4	Vacuum truck	A concrete structure was encountered at 1.5 m depth (elevation 114.4 m) on the west side of excavation, continuing from 3.7 to 5.3 m west of the watermain centreline. Shale was not encountered within the exploration depth of 3.7 m (elevation 112.2 m) adjacent to the east side of the structure.
FM5	Drill rig with solid stem augers	Shale bedrock at 3.4 m depth (elevation 112.3 m).

RECORD OF BOREHOLE No FM1

1 OF 1

METRIC

G.W.P. 169-00-00 LOCATION QEW, Third Line to Burloak Drive N 4 807 771.57 E 285 330.91 ORIGINATED BY GA
 HWY QEW BOREHOLE TYPE Solid Stem Auger/NQ Core Barrel COMPILED BY MFA
 DATUM Geodetic DATE 09.12.06 - 09.12.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
116.1													
0.0	ASPHALT: (50 mm)												
0.1	SAND AND GRAVEL												
115.8													
0.3	Silty CLAY, some sand Brown												
114.6													
1.5	Silty CLAY, some sand Brown (TILL)												
112.4													
3.7	Highly to moderately weathered, thinly bedded, reddish brown, very weak SHAILE with greenish grey limestone interbeds Clay seam at 3.71 and 3.83 m Rubble zones at 3.83 to 3.89, and 4.78 to 4.88 m Sand seam at 4.22 m Limestone interbeds at 4.44 to 4.47, and 4.57 m Clay seams at 4.88 to 4.90, 5.05, and 5.13 m Limestone interbeds at 5.23 to 5.43, and 5.72 to 5.82 m		1	RUN								FI >10 4 4	RUN 1# TCR=100%, SCR=25%, RQD=50%, UCS=MPa
												>10	
			2	RUN								2 2 1	RUN 2# TCR=100%, SCR=95%, RQD=98%, UCS=MPa
												2	
												4	
	Limestone interbeds at 6.40 to 6.58, 6.65, and 6.86 to 6.88 m Rubble zone at 6.40 to 6.48 m Clay seam at 6.86 m		3	RUN								2 2 0	RUN 3# TCR=100%, SCR=84%, RQD=91%, UCS=MPa
												0	
	becoming slightly weathered, weak											0	
	Limestone interbeds at 8.08 to 8.15, 8.48 to 8.56, 8.61 to 8.71, and 8.92 to 9.12 m		4	RUN								0 0 0	RUN 4# TCR=100%, SCR=100%, RQD=100%, UCS=8MPa
106.7												0	
9.4	END OF BOREHOLE AT 9.4 m. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.											1	

Q.E.W.

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No 2007-2026
GWP No.169-00-00

QUEEN ELIZABETH WAY
WATERMAIN PROTECTION SLAB
BOREHOLE LOCATION PLAN



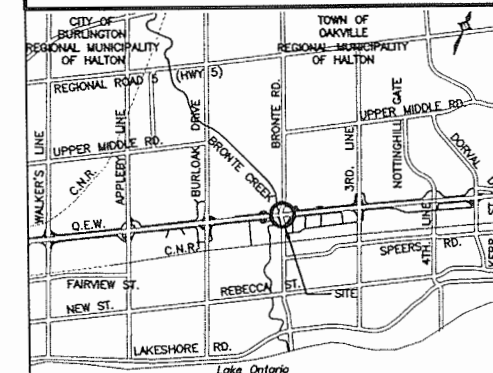
SHEET



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CORPORATION



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KEYPLAN

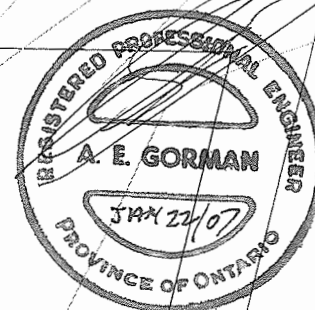
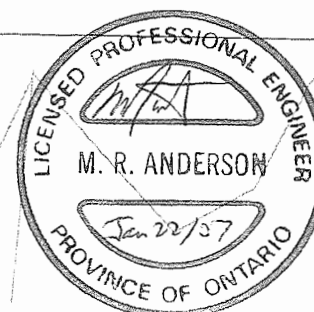
LEGEND

- BoreHole
- BoreHole and Cone
- Test Pit (Vacuum Truck)
- 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
FM1	116.1	4 807 771.6	285 330.9
FM2	115.8	4 807 772.0	285 338.8
FM3	115.9	4 807 767.6	285 335.9
FM4	115.9	4 807 765.3	285 334.4
FM5	115.7	4 807 764.6	285 340.1

-NOTE-

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.



SCALE 1:200

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MRA	CHK	PKC
DRAWN	JHL	CHK	PKC
LOAD			
STRUCT			
DATE	JAN 2007		

Appendix E

Suggested Text for NSSPs

Suggested Text for NSSP on "Rock Excavation and Dewatering"

The upper 1.0 to 2.0 m of the shale bedrock is typically highly weathered and excavation should generally be possible using heavy excavation equipment and rippers, supplemented by pneumatic rock breakers where thick layers of hard material are encountered. The strength and quality of the shale bedrock increases with depth and very hard limestone and/or siltstone interbeds are present. As such, intensive use of pneumatic/hydraulic breakers or other methods of loosening the bedrock may be required and should be available on site to assist in excavation.

Although shale bedrock is intrinsically of low permeability, the possibility exists that concentrated seepage may be experienced from localized seams or fractures in the rock. Means to handle this seepage, such as additional pumps, should be made available.

Suggested Text for NSSP on “Contingency for SWM Pond Slope Treatment”

Although shale bedrock is intrinsically of low permeability, the possibility exists that concentrated seepage may be experienced from localized seams or fractures in the rock. Granular sheeting or other measures may be required in areas of persistent ongoing seepage exhibiting surficial instability.

Areas requiring supplementary slope treatment and the design of such treatments will be determined by the Contract Administrator in consultation with the design engineer following pond excavation.

Suggested Text for NSSP on “Trenchless Utility Installation”

The shale bedrock is horizontally bedded and contains interbeds of strong to very strong limestone or siltstone, which may vary from thin stringers to thick layers greater than 300 mm in thickness. Advancing bores, drills or tunnels through the rock may be difficult. Trenchless technology that can penetrate layers of hard rock as well as highly weathered shale must be supplied.

The horizontal bedding and hard layers in the shale bedrock may tend to deflect boring equipment when contacted. The Contractor must be prepared to maintain the alignment in these conditions.

Mixed face conditions may be encountered if the utility crossing is carried out at a level near the boundary between the clay till and shale. Mixed face conditions are typically problematic during trenchless installation, and selection of equipment that is capable of excavating the different material types with minimal loss of ground is critical for successful construction. In addition, the Contractor must be prepared to maintain the alignment in these conditions.