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**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH MAST LIGHTS AND OVERHEAD SIGNS
QEW INTERCHANGE AT THIRD LINE
AND THIRD LINE FROM THE QEW NORTHERLY TO
KING'S COLLEGE DRIVE
REGIONAL MUNICIPALITY OF HALTON
GWP: 180-00-00**

Submitted to:

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HML6 and HML9 to HML13)

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PART A

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Drawing 1

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Appendix A

1.0 INTRODUCTION

Golder Associates Ltd. has been retained by Morrison Hershfield Limited (Morrison Hershfield) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation at the site of the proposed Third Line and Queen Elizabeth Way (QEW) Interchange in the Region of Halton, Ontario. The project involves reconstruction of the Third Line and QEW interchange and Third Line from the QEW northerly to King's College Drive. The project includes new underpass structures to carry Third Line over the QEW and Fourteen Mile Creek, a culvert extension, retaining wall, high embankments and high mast lighting (HML). This report addresses the HML and overhead signs for the interchange project.

The purpose of the foundation investigation is to determine the subsurface conditions at the site by drilling boreholes, and carrying out in-situ tests and laboratory tests on selected samples. The terms of reference for the scope of work are outlined in our Total Project Management proposal P01-1321, dated October 2000. The work was carried out in accordance with our Quality Control Plan for Foundation Design Services, Agreement No. 2005-A-000290, dated October 2000.

The following Golder Associates Ltd. report was referenced in the preparation of this report:

- Geotechnical Investigation, Proposed Mid-Halton Water Pollution Control Plant, Oakville, Ontario, Report No. 871-1526 dated April 1988.

2.0 SITE DESCRIPTION

The site is located at the existing QEW and Third Line interchange (see Drawing 1). The site is located in MTO District 4 in the City of Oakville, in the Region of Halton.

The topography of the site area is generally level and gradually slopes downwards towards the south. The existing Third Line has been constructed in cut. Existing culverts carry Fourteen Mile Creek underneath the QEW to the west of Third Line and underneath Third Line south of the QEW. Within the project limits, the vegetation cover generally consists of grass, bushes, and mature trees.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between February 12 and July 16, 2001. At this time 24 boreholes were put down at the site. Boreholes QEW1, QEW2, 1B, 2B, 3B, 4B, 1, 1D and 5 were put down in the location of the proposed QEW / Third Line underpass structure and approaches. Boreholes 201 to 203, 300, 301, 401 and 804 to 806 were put down at the proposed high embankment locations. Boreholes HML6 and HML9 to HML11 were put down in the four quadrants of the interchange and Boreholes HML12 and HML13 were put down along the north side of the QEW east of Third Line, specifically for HML. The boreholes put down for the previous Golder investigation (Golder Report 871-1526) are located north of the QEW west of Third Line.

The current investigation was carried out using a truck-mounted D-90 drill rig (for the boreholes drilled on existing roadways) and bombardier-mounted CME-55 and B-57 drill rigs (for the boreholes drilled elsewhere at the site) supplied and operated by Master Soil Investigation of Toronto. In the boreholes, samples of the overburden were obtained at regular intervals of depth of 0.75 m to 1.5 m using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedures. The boreholes were extended to depths of between 2.1 m and 9.2 m below the existing ground surface. NQ size core samples were obtained in selected boreholes at the retaining wall and bridge sites. Groundwater conditions in the open boreholes were observed throughout the drilling operations. Piezometers were installed in four boreholes to permit monitoring of the groundwater levels at the site. The piezometers consisted of a 200 mm long slotted tip threaded into 12 mm diameter PVC rigid tubing.

The field work was supervised on a full-time basis by a member of our engineering staff who located the boreholes in the field, directed the drilling, sampling and coring operations, and logged the boreholes. The soil samples were identified in the field, placed in labeled containers and transported to our laboratory in Mississauga for further examination. Index and classification tests consisting of grain size analyses, Atterberg Limits tests and water content determinations were carried out on selected samples.

The borehole locations were established in the field relative to the centreline chainages of the proposed Third Line and ramps as staked in the field by Morrison Hershfield. The northing and easting co-ordinates of the borehole locations are given in UTM, and the borehole elevations are referenced to the Geodetic Datum. The co-ordinates of the boreholes are indicated on the Record of Borehole sheets and the locations of the boreholes are shown on Drawing 1.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

The site is located in the physiographic region known as the Iroquois Plain. The subsoils in the Iroquois Plain area between Hamilton and Toronto generally consist of a shallow thickness of sand and till (Chapman and Putnam, "The Physiography of Southern Ontario", 3rd Edition, 1984). The surface topography slopes gradually and fairly uniformly towards Lake Ontario. The overburden at the site consists of a shallow cover of residual soil which is underlain by bedrock comprised of red shale of the Queenston Formation.

4.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets following the text of this report. Boreholes from the previous Golder Report (referenced in Section 1.0) are included in Appendix A. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the subsoils at the site generally consist of 0.2 m to 3.8 m of topsoil and clayey silt to silty clay fill underlain by a 0.3 m to 1.6 m thick deposit of clayey silt residual soil. The fill or residual soil is directly underlain by shale bedrock of the Queenston Formation.

Locations and elevations of all the borings are shown on Drawing 1. A detailed description of the subsurface conditions encountered in the boreholes for this investigation is provided in the following sections.

4.2.1 Topsoil

A surficial layer of topsoil, between 100 mm and 900 mm thick, was encountered in Boreholes 5, 1D, 202, 203, 300, 401, 805, 806, HML6 and HML9 to HML11 and HML13. The topsoil consists of black clayey silt containing some sand, trace gravel and shale fragments, grass and organics. Measured Standard Penetration Test (SPT) 'N' values range between 6 and 17 blows per 0.3 m of penetration indicating a firm to very stiff consistency. Atterberg Limits testing was carried out on

one sample of the topsoil and the liquid limit was 42 percent and the plasticity index was 18 percent indicating that the topsoil is clayey and of intermediate plasticity. The natural water content measured on selected samples of the topsoil range from 22 to 58 percent.

A 150 mm thick layer of topsoil was encountered in all the boreholes in the previous Golder Report.

4.2.2 Road Base Fill

Boreholes QEW1 and QEW2 were drilled through the paved median shoulder of the QEW. The asphalt thickness was 200 mm (Boreholes QEW1 and QEW2) and the crushed limestone (sand and gravel sizes) road base was 400 mm thick. The SPT 'N' values on two samples of the sand and gravel were 15 and 17 blows per 0.3 m of penetration indicating that the material is compact. The natural water content measured on one sample of the sand and gravel was 7 percent.

4.2.3 Clayey Silt to Silty Clay Fill

A 0.6 m to 3.8 m thick deposit of red brown to black brown to grey clayey silt to silty clay fill was encountered below the ground surface, topsoil or road base fill in all boreholes except Boreholes 5 and 806. The fill contains trace to with sand, trace to some gravel, trace organics and trace shale fragments. Measured SPT 'N' values on samples of the fill range between 7 and 79 blows per 0.3 m of penetration indicating a firm to hard consistency. Occasional grinding during augering through the fill was noted. Grain size distribution curves for selected samples of the fill are shown on Figure 1. Atterberg Limits testing was carried out on selected samples of the fill. The liquid limits were between 22 and 29 percent and the plasticity indices were between 6 and 12 percent, indicating that the fill is of low plasticity. The test results are shown on the plasticity chart on Figure 2. The natural water content measured on selected samples of the fill ranged from about 8 to 25 percent.

In Borehole 201, a 0.8 m thick zone with a high concentration of organics was noted within the fill just above the residual soil or bedrock surface about Elevation 103.6 m.

In Boreholes 202, 301, 804, 805, 1D, C1, QEW2 and HML9 to HM11, the fill directly overlies the bedrock surface.

4.2.4 Clayey Silt Residual Soil

A 0.2 m to 1.6 m thick deposit of residual soil containing sand, occasional trace gravel and trace shale fragments was encountered below the fill, topsoil or ground surface in Boreholes 1B, 2B, 3B, 4B, QEW1, 1, 5, 806, 201, 203, 300, 401, HML6 and HML12. The residual soil is derived through weathering of the shale bedrock and is essentially comprised of clayey silt. This deposit generally has a till-like structure but can contain zones of rock-like structure. The deposit was encountered below Elevations 102.8 m to 106.2 m in the borings drilled for the high embankments and HMLs and below Elevations 107.0 m and 107.4 m in the borings drilled for the bridge structure and approaches.

Measured SPT 'N' values on samples of the residual soil were between 50 blows and greater than 100 blows per 0.3 m of penetration, indicating a hard consistency. Occasional grinding during augering through the residual soil was noted. Grain size distribution curves for selected samples of the residual soil are shown on Figure 3. Atterberg Limits testing was carried out on selected samples of the residual soil. The liquid limits were between 26 and 33 percent and the plasticity indices were between 9 and 15 percent indicating that the clayey silt is of low plasticity. The test results are shown on the plasticity chart on Figure 4. The natural water content measured on selected samples of the residual soil ranged from about 8 to 17 percent. Where encountered, the residual soil directly overlies the shale bedrock.

At the borehole locations for the previous Golder report, this deposit is found directly below the topsoil and is described as clayey silt till containing some sand, trace gravel, frequent silt lenses and occasional rootlets and shale fragments. The SPT 'N' values measured in samples of the deposit range from 7 to 59 blows indicating a firm to hard consistency. The natural water content measured on samples of the till ranged from about 11 to 23 percent. The till is considered to be derived from the underlying shale bedrock and is equivalent to the residual soil described above.

4.2.5 Bedrock

Shale bedrock was encountered in all boreholes. The bedrock was augered for lengths of 0.1 m to 2.8 m in all the boreholes and prior to rock coring at selected borehole locations. Occasional grinding during augering through the bedrock was noted. The bedrock surface was encountered at the depths and elevations as shown in the table below:

<i>Borehole</i>	<i>Location</i>	<i>Ground Surface Elevation (m)</i>	<i>Depth (m)</i>	<i>Bedrock Surface Elevation (m)</i>
1	QEW / Third Line	108.9	3.0	105.9
1D	Underpass	109.1	1.2	107.9
1B		108.9	3.1	105.8
2B		108.7	3.1	105.6
3B		108.0	1.1	106.9
4B		108.1	1.5	106.6
QEW1		108.5	2.4	106.1
QEW2		108.4	1.5	106.9
5		107.9	1.5	106.4
201	High Embankments	105.9	3.8	102.1
202		106.5	3.8	102.7
203		107.2	3.1	104.1
300		107.0	2.3	104.7
301		106.1	2.3	103.8
401		107.3	3.0	104.3
804		109.6	1.2	108.4
805		107.4	1.4	106.0
806		104.4	0.8	103.6
C1	Culvert	103.6	0.6	103.0
HML6	High Mast Lights	107.4	2.3	105.1
HML9		109.0	0.8	108.2
HML10		109.8	0.9	108.9
HML11		108.0	1.5	106.5
HML12		106.4	0.2	106.2
HML13		108.2	0.3	107.9

The shale bedrock was cored in Boreholes 1B, 2B, 3B, 4B, QEW1, HML6 and HML9 to HML11. The bedrock is described as moderately to highly weathered, red brown, thinly laminated, fine-grained, very weak to weak, calcareous shale of the Queenston Formation. Rock Quality Designation (RQD) values were measured between 0 and 82 percent indicating rock of very poor to

fair quality. Seams of slightly less weathered, grey shale was encountered within the core samples. Zones of residual soil between 25 mm and 100 mm thick were encountered within the core samples from Boreholes 3B, 4B, QEW1, HML6, HML9 and HML10.

In terms of the strength classification as noted above, weak rock encompasses rock with unconfined compressive strength between 5 MPa and 25 MPa. Based on the core samples obtained and previous experience, the calcareous shale typically has strength closer to the upper limit of the range. Uniaxial compression strength testing was carried out on two samples obtained from the previous borehole investigation carried out by Golder Associates (Report No. 871-1526) at the site. The tests indicate uniaxial compressive strengths of 27 MPa and 46 MPa. This would classify the rock as having medium strength, where medium strong rock encompasses rock with unconfined compressive strength between 25 MPa and 50 MPa.

A faint hydrocarbon odour was noted at 1.5 m depth in Borehole 4B at the surface of the shale bedrock.

The boreholes put down during the previous investigation encountered the bedrock surface at the depths and the elevations as given in the following table:

<i>Borehole</i>	<i>Approximate QEW Station (m)</i>	<i>Approximate Offset (m)</i>	<i>Ground Surface Elevation (m)</i>	<i>Depth (m)</i>	<i>Bedrock Surface Elevation (m)</i>
A1	13+210	70 m LT	117.7	1.7	116.1
B1	13+260	70 m LT	115.6	1.7	114.0
C1	13+310	70 m LT	118.1	1.4	116.7
D1	13+360	70 m LT	118.7	2.1	116.5
E1	13+410	70 m LT	118.9	1.4	117.5
F1	13+460	70 m LT	118.6	2.3	116.3
G1	13+510	70 m LT	118.2	2.1	116.1
H1	13+560	70 m LT	117.6	2.3	115.3
X1	13+645	50 m LT	114.0	1.2	112.7
X2	13+845	50 m LT	106.9	1.4	105.5
X3	13+830	55 m RT	105.6	2.5	103.1
X4	See Drawing I		105.5	2.9	102.6

described as moderately to slightly weathered, reddish brown, thinly laminated, fine-grained, interbedded with green calcareous siltstone layers and occasional clay seams. Rock Quality Designation (RQD) values were measured between 60 and 80 percent indicating rock of fair to good quality. The siltstone seams were typically between 15 mm and 150 mm thick.

4.3 Groundwater Conditions

Water levels were noted in the open boreholes during and upon completion of the drilling operation; these levels are shown on the attached Record of Borehole sheets. Piezometers were sealed into the bedrock in Boreholes 1B, 3B HML10 to HML12 to permit the monitoring of the groundwater levels across the site. Details of the piezometer installations and water level measurements are shown on the attached Record of Borehole sheets.

All of the open boreholes were dry upon completion of overburden drilling operations. A summary of the water level monitoring results for the piezometer installations are provided in the following table.

Borehole	Bedrock Surface Elevation (m)	Water Level in Piezometer					
		March 26, 2001		April 30, 2001		October 9, 2001	
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
1B	105.8	3.6	105.3	4.0	104.9	---	---
3B	106.9	2.0	106.0	2.5	105.5	---	---
HML10	108.9	3.9	105.9	4.5	105.3	---	---
HML11	106.5	3.5	104.5	3.3	104.7	---	---
HML12	106.2	---	---	---	---	Dry at 2.6	Below 103.8

Piezometers were installed within the cored holes in the previous Golder report. All open holes were dry upon completion of drilling. The water levels measured in the piezometers are provided in the following table.

Previous Golder Borehole	Bedrock Surface Elevation (m)	Water Level in Piezometer	
		January 27, 1988	
		Depth (m)	Elevation (m)
H1	115.3	4.3	113.3
X1	112.7	3.1	110.9
X2	105.5	2.5	104.4
X3	103.1	2.4	103.2
X4	102.6	4.4	101.1

The above water level measurements indicate that the groundwater level is below the surface of the bedrock and generally slopes downward toward the south, following the ground surface topography.

It should be noted that groundwater levels are expected to fluctuate seasonally and are expected to be higher during wet periods of the year.

GOLDER ASSOCIATES LTD.



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PART B

**FOUNDATION DESIGN REPORT
HIGH MAST LIGHTS
QEW INTERCHANGE AT THIRD LINE
AND THIRD LINE FROM THE QEW NORTHERLY TO
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REGIONAL MUNICIPALITY OF HALTON
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5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of design of proposed HML and overhead signs based on our interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

It is understood that the proposed HML locations will be along the median of the QEW at regularly spaced intervals and in the four ramp quadrants of the interchange. It is further understood that three overhead signs will be required along the QEW west of Third Line in both the eastbound and westbound directions.

5.2 High Mast Light / Overhead Sign Foundations

Reference should be made to Special Provision No. 631S01 – Construction Specification for Concrete Footings for HML Poles.

The subsoils encountered in the boreholes put down during the present investigation typically consist of clayey silt to silty clay fill and hard clayey silt residual soil overlying shale bedrock of the Queenston Formation. The groundwater table is generally at depths ranging from 2.5 m to 4 m below ground surface across the site.

The subsurface conditions at specific HML and overhead sign locations can be inferred from the nearest borehole. Simplified soil stratigraphy and design parameters for the soils as encountered in the closest boreholes are given in the table below:

Approximate QEW Station	Relevant Borehole Numbers	Strata	Depth to Bedrock Surface (m)	Depth to Ground Water Level	Design Parameters				
					c_u	c'	ϕ'	γ	K_p
13+100 to 13+300	A1,B1	Residual Soil	1.7	4.0	-	-	32	21	3.2
		Shale Bedrock	Below 1.7		-	10	40	23	4.6
13+300 to 13+450	C1, D1, E1	Residual Soil	2.0	4.0	-	-	32	21	3.2
		Shale Bedrock	Below 2.0		-	10	40	23	4.6
13+450 to 13+600	F1, G1, H1	Residual Soil	2.3	4.0	-	-	32	21	3.2
		Shale Bedrock	Below 2.3		-	10	40	23	4.6
13+600 to 13+900	X1,X2	Residual Soil	1.4	2.5	-	-	32	21	3.2
		Shale Bedrock	Below 1.4		-	10	40	23	4.6
14+000 to 14+200	QEW1, QEW2	Residual Soil	2.4	4.0	-	-	32	21	3.2
		Shale Bedrock	Below 2.4		-	10	40	23	4.6
14+200 to 14+450	HML12	Shale Bedrock	Below 0.2		-	10	40	23	4.6
14+450 to 14+800	HML13	Shale Bedrock	Below 0.3		-	10	40	23	4.6
NW Quadrant	HML9, 1B	Residual Soil	2.0	4.0	-	-	32	21	3.2
		Shale Bedrock	Below 2.0		-	10	40	23	4.6
SW Quadrant	300,301, X4 201,202,203	Residual Soil	2.5	3.0	-	-	32	21	3.2
		Shale Bedrock	Below 2.5		-	10	40	23	4.6
NE Quadrant	HML10	Residual Soil	1.0	4.5	-	-	32	21	3.2
		Shale Bedrock	Below 1.0		-	10	40	23	4.6
SE Quadrant	HML11	Residual Soil	1.5	3.0	-	-	32	21	3.2
		Shale Bedrock	Below 1.5		-	10	40	23	4.6

Where

c_u is the undrained shear strength, in kPa
 c' is the effective cohesion, in kPa
 ϕ' is the effective angle of friction, degrees
 γ is the bulk unit weight, in kN/m³
 K_p is the passive earth pressure coefficient

The unfactored passive lateral earth pressure, P_p , distributed along the caisson acting over depth, d in m, may be calculated using the following expression and the parameters given above:

$$P_p = K_p \gamma d + 2 c' \sqrt{K_p}$$

The groundwater level as encountered in the boreholes is generally within the shale bedrock. As such, the effective unit weight of the shale bedrock should be used below the design groundwater given above and should be taken as 13 kN/m^3 .

The unfactored lateral resistance should be calculated assuming an equivalent pile width equal to 3 times the caisson diameter. A resistance factor of 0.5 should be applied to the lateral resistance as calculated to obtain the factored lateral geotechnical resistance.

The design frost protection depth for this site should be 1.2 m.

5.3 Construction Considerations

Sockets for the HML and overhead sign foundations will primarily be formed in the residual soil deposits and the shale bedrock. Heavy grinding was noted at some locations during augering through the bedrock which was carried out in all boreholes to up to 2.8 m below the bedrock surface. Although significant resistance and / or auger refusal was not met, there was grinding of augers noted in almost every borehole. Based on our experience with the shale in this area, there is potential for encountering calcareous zones with strength classification of medium strong.

All of the boreholes were dry upon completion of drilling; however, the groundwater level is within the bedrock and some water seepage into caisson excavations below the groundwater table should be expected.

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SEMP/LCC/ASP/FJH/clg

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LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

(b) Cohesive Soils

Consistency	c_u, s_u	psf
	kPa	
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

LIST OF SYMBOLS

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

I GENERAL

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

II STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stresses (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (con't.)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity Index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(c) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(d) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_α	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	Overconsolidation ratio = σ'_p / σ'_{vo}

(e) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1. $\tau = c' + \sigma' \tan \phi'$

2. Shear strength = (Compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	> 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	1 - 3 m
Moderately close	0.3 - 1 m
Close	50 - 300 mm
Very close	< 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 - 60 mm
Medium Grained	60 microns - 2 mm
Fine Grained	2 - 60 microns
Very Fine Grained	< 2 microns

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

CORE CONDITION

Total Core Recovery

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B - Bedding	P - Polished
FO - Foliation/Schistosity	S - Slickensided
CL - Cleavage	SM - Smooth
SH - Shear Plane/Zone	R - Ridged/Rough
VN - Vein	ST - Stepped
F - Fault	PL - Planar
CO - Contact	FL - Flexured
J - Joint	UE - Uneven
FR - Fracture	W - Wavy
MF - Mechanical Fracture	C - Curved
- Parallel To	
⊥ - Perpendicular To	

PROJECT 001-1158		RECORD OF BOREHOLE No QEW1		1 OF 1	METRIC
W.P. 180-00-00		LOCATION N 4809362; E 286557		ORIGINATED BY GM	
DIST 4 HWY QEW		BOREHOLE TYPE 114mm Solid Stem Augers		COMPILED BY SEP	
DATUM Geodetic		DATE Mar.19/01		CHECKED BY ASP	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED							
108.5	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	20 40 60					GR SA SI CL		
0.0	Asphalt															
107.9	Crushed limestone sand and gravel (Fill)		1	SS	15											
0.6	Compact															
107.0	Clayey Silt to Silty Clay, trace to some sand, trace gravel and shale fragments (Fill)		2	SS	12											
1.5	Stiff															
107.0	Grey brown															
1.5	Moist		3	SS	65											
106.1	Clayey Silt, trace sand, trace shale fragments (Residual Soil)															
2.4	Hard															
106.1	Red brown		4	SS	119											
2.4	Moist															
	Moderately to highly weathered, red brown with occasional grey seams, calcareous SHALE BEDROCK (Queenston Formation).															
	Bedrock cored from 3.0m to 6.8m.															
	For bedrock coring details see Record or Drillhole QEW1.															
101.7																
6.8	END OF BOREHOLE															
	Note: 1. Open borehole dry upon completion of overburden drilling.															

ON_MOT 001-1158.GPJ ON_MOT.GDT 26/9/01

PROJECT: 001-1158

RECORD OF DRILLHOLE: QEW1

SHEET 2 OF 2

LOCATION: N 4809362; E 286557

DRILLING DATE: Feb.19/01

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D-90

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	COLLOID % RETURN FLUSH	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		Refer to Previous page		105.50										
3		Moderately to highly weathered, red brown with occasional grey seams, thinly laminated, fine-grained, very weak to weak, calcareous SHALE (Queenston Formation).		3.00										
		Residual soil zones from 3.6m to 3.7m, 4.4m to 4.5m and 6.6m to 6.7m depth.												
4														
5														
6														
7		END OF BOREHOLE		101.70 6.80										
8														
9														
10														
11														
12														
13														

DRILLHOLE 1158ROCK GPJ GLDR CAN.GDT 26/9/01 PS

DEPTH SCALE

1 : 50



LOGGED: GM

CHECKED: ASP

<div style="display: flex; justify-content: space-between;"> PROJECT <u>001-1158</u> RECORD OF BOREHOLE No QEW2 1 OF 1 METRIC </div>															
W.P. <u>180-00-00</u>		LOCATION <u>N 4809347; E 286544</u>				ORIGINATED BY <u>GM</u>									
DIST <u>4</u> HWY <u>QEW</u>		BOREHOLE TYPE <u>114mm Solid Stem Augers</u>				COMPILED BY <u>SEP</u>									
DATUM <u>Geodetic</u>		DATE <u>Mar.19/01</u>				CHECKED BY <u>ASP</u>									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							
108.4	GROUND SURFACE														
0.0	Asphalt														
107.8	Crushed limestone sand and gravel road base (Fill)		1	SS	17										
0.6	Compact Clayey Silt to Silty Clay, trace sand and gravel (Fill)		2	SS	16										
106.9	Firm to stiff Black brown to red brown Moist														
1.5	Red-brown SHALE bedrock. (Queenston Formation)		3	SS	102										
			4	SS	70/15										
105.3			5	SS	90/08										
3.1	END OF BOREHOLE														
Note: Open borehole dry upon completion of drilling.															

ON MOT 001-1158.GPJ ON MOT.GDT 26/9/01

PROJECT 001-1158				RECORD OF BOREHOLE No 1B				1 OF 1		METRIC									
W.P. 180-00-00		LOCATION N 4809382; E 286521		ORIGINATED BY GM															
DIST 4 HWY QEW		BOREHOLE TYPE 114mm Solid Stem Augers		COMPILED BY SEP															
DATUM Geodetic		DATE Feb.12/01		CHECKED BY ASP															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80	100	20	40
108.9	GROUND SURFACE																		
0.0	Clayey Silt to Silty Clay, trace sand (Fill) Hard Red brown		1	SS	30														
107.4	Clayey Silt, trace sand and gravel (Residual Soil) Hard Red brown		2	SS	68														
1.5			3	SS	75														
105.8	Grinding at 2.7m depth		4	AG															
3.1	Moderately to highly weathered, red brown with occasional grey seams, calcareous SHALE BEDROCK (Queenston Formation). Bedrock cored from 3.1m to 7.7m. For bedrock coring details see Record or Drillhole 1B.																		
101.2	END OF BOREHOLE																		
7.7	Note: 1. Open borehole dry upon completion of overburden drilling. 2. Water level in piezometer at 3.6m depth (Elev. 105.3m) on March 26, 2001 and at 4.0m depth (Elev. 104.9m) on April 30, 2001.																		

ON MOT 001-1158.GPJ ON MOT.GDT 26/9/01

PROJECT: 001-1158

RECORD OF DRILLHOLE: 1B

SHEET 2 OF 2

LOCATION: N 4809382; E 286521

DRILLING DATE: Feb.13/01

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR % RETURN	FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED										DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
				DEPTH (m)					RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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DEPTH SCALE

1 : 50



LOGGED: GM

CHECKED: ASP

DRILLHOLE 1158ROCK.GPJ GLDR_CAN.GDT 26/9/01 PS

PROJECT 001-1158				RECORD OF BOREHOLE No 2B				1 OF 1		METRIC				
W.P. 180-00-00		LOCATION N 4809401; E 286536				ORIGINATED BY GM								
DIST 4 HWY QEW		BOREHOLE TYPE 114mm Solid Stem Augers				COMPILED BY SEP								
DATUM Geodetic		DATE Feb. 12/01				CHECKED BY ASP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED						
108.7 0.0	GROUND SURFACE Clayey Silt to Silty Clay, trace sand and fine gravel (Fill) Very stiff Red brown		1	SS	24		108							0 3 70 27
107.2 1.5	Clayey Silt, trace sand and fine gravel, trace shale fragments (Residual Soil) Hard Red brown Grinding from 2.4m to 3.0m depth		2	SS	100/25		107							
105.6 3.1	Highly to moderately weathered, red brown with occasional grey seams, calcareous SHALE BEDROCK (Queenston Formation). Bedrock cored from 3.3m to 6.2m. For bedrock coring details see Record or Drillhole 2B.		3	SS	100/15		106							
102.5 6.2	END OF BOREHOLE Note: 1. Open borehole dry upon completion of overburden drilling.						105							
							104							
							103							

ON_MOT 001-1158.GPJ ON_MOT.GDT 26/9/01

PROJECT: 001-1158

RECORD OF DRILLHOLE: 2B

SHEET 2 OF 2

LOCATION: N 4809401; E 286536

DRILLING DATE: Feb.14/01

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY 10 ⁻⁸ K cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
				DEPTH (m)					TOTAL CORE %	SOLID CORE %			DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION			
		Refer to Previous page		105.40													
		Highly to moderately weathered, red brown with occasional grey seams, thinly laminated, fine-grained, weak, calcareous SHALE (Queenston Formation).		3.30													
4		Extremely weak from 3.3m to 3.4m.			1		90										
	NQ																
5					2		90										
6				102.50													
		END OF BOREHOLE		6.20													
7																	
8																	
9																	
10																	
11																	
12																	
13																	

DEPTH SCALE

1 : 50



LOGGED: GM

CHECKED: ASP

DRILLHOLE 1158ROCK.GPJ GLDR_CAN.GDT 26/9/01 PS

RECORD OF BOREHOLE No 3B										1 OF 1		METRIC		
PROJECT 001-1158			LOCATION N 4809319; E 286576			ORIGINATED BY GM								
W.P. 180-00-00			BOREHOLE TYPE 114mm Solid Stem Augers			COMPILED BY SEP								
DIST 4 HWY QEW			DATE Feb. 14/01			CHECKED BY ASP								
DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div>			<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div>			<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div>			<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div>			<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div>		
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES									
108.0	GROUND SURFACE													
0.0	Clayey Silt to Silty Clay (Fill)													
107.2														
106.9	Clayey Silt, trace sand and gravel (Residual Soil)		1	SS	100									
1.1	Hard Red brown Highly to moderately weathered, red brown with occasional grey seams, calcareous SHALE BEDROCK (Queenston Formation).		2	SS	100/13									
	Smooth grinding at 2.7m depth		3	SS	90/15									
	Bedrock cored from 3.3m to 6.3m.													
	For bedrock coring details see Record or Drillhole 3B.													
101.7	END OF BOREHOLE													
6.3	Note: 1. Open borehole dry upon completion of overburden drilling. 2. Water level in piezometer at 2.0m depth (Elev. 106.0m) on March 26, 2001 and at 2.5m depth (Elev. 105.5m) on April 30, 2001.													

ON_MOT_001-1158.GPJ ON_MOT.GDT 26/9/01

PROJECT: 001-1158

RECORD OF DRILLHOLE: 3B

SHEET 2 OF 2

LOCATION: N 4809319; E 286576

DRILLING DATE: Feb.15/01

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: B-57

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL CORE LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION										
				DEPTH											RECOVERY	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K, cm/sec					
				(m)																TOTAL CORE %	SOLID CORE %	DIP W.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³
		Refer to Previous page		104.70																				
		Highly to moderately weathered, red brown with occasional grey seams, thinly laminated, fine-grained, weak, calcareous SHALE (Queenston Formation).		3.30																				
4					1		80																	
5		Residual soil zones, 50mm to 75mm thick at 4.9m and 6.2m depth.																						
					2		90																	
6																								
		END OF BOREHOLE		101.70																				
				6.30																				
7																								
8																								
9																								
10																								
11																								
12																								
13																								

DEPTH SCALE

1 : 50



LOGGED: GM

CHECKED: ASP

DRILLHOLE 1158ROCK GPJ GLDR CAN.GDT 26/9/01 PS

PROJECT 001-1158				RECORD OF BOREHOLE No 4B				1 OF 1		METRIC					
W.P. 180-00-00				LOCATION N 4809334; E 286588				ORIGINATED BY GM							
DIST 4 HWY QEW				BOREHOLE TYPE 114mm Solid Stem Augers				COMPILED BY SEP							
DATUM Geodetic				DATE Feb.14/01				CHECKED BY ASP							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
108.1	GROUND SURFACE														
0.0	Clayey Silt to Silty Clay (Fill)														
107.3															
0.8	Clayey Silt, trace sand and gravel (Residual Soil) Hard Red brown		1	SS	50										
106.6															
1.5	Highly to moderately weathered, red brown with occasional grey seams, calcareous SHALE BEDROCK (Queenston Formation). Faint hydrocarbon odour at 1.5m depth. Grinding at 2.7m depth. Bedrock cored from 3.0m to 6.0m. For bedrock coring details see Record or Drillhole 4B.		2	SS	100/10										
			3	SS	99/10										
102.1															
6.0	END OF BOREHOLE Note: 1. Open borehole dry upon completion of overburden drilling.														

ON MOT 001-1158.GPJ ON MOT GDT 26/9/01

PROJECT: 001-1158

RECORD OF DRILLHOLE: 4B

SHEET 2 OF 2

LOCATION: N 4809334; E 286588

DRILLING DATE: Feb.15/01

DATUM: Geodetic

INCLINATION: -90°

AZIMUTH: --

DRILL RIG: B-57

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	RECOVERY	R.O.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K _f cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
3		Refer to Previous page		105.10										
4		Highly to moderately weathered, red brown with occasional grey seams, thinly laminated, fine-grained, weak to very weak, calcareous SHALE (Queenston Formation).		3.00	1	90								
5		Residual soil zones from 3.2m to 3.4m and 4.6m to 4.8m.			2	90								
6		END OF BOREHOLE		102.10										
7				6.00										
8														
9														
10														
11														
12														
13														

DRILLHOLE 1158ROCK GPJ GLDR CAN.GDT 26/9/01 PS

DEPTH SCALE

1 : 50



LOGGED: GM

CHECKED: ASP

PROJECT <u>001-1158</u>		RECORD OF BOREHOLE No 1		1 OF 1	METRIC
W.P. <u>180-00-00</u>	LOCATION <u>N 4809395; E 286523</u>	ORIGINATED BY <u>GM</u>			
DIST <u>4</u> HWY <u>QEW</u>	BOREHOLE TYPE <u>114mm Solid Stem Augers</u>	COMPILED BY <u>SEP</u>			
DATUM <u>Geodetic</u>	DATE <u>Feb.12/01</u>	CHECKED BY <u>ASP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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 (%)				
								\circ UNCONFINED	$+$ FIELD VANE	\bullet QUICK TRIAXIAL	\times REMOULDED		w_p	w	w_L		
108.9	GROUND SURFACE																
0.0	Clayey Silt to Silty Clay, trace sand and gravel and rootlets (Fill) Very stiff Red brown		1	SS	22												
107.4																	
1.5	Clayey Silt, trace sand (Residual Soil) Hard Red brown		2	SS	102/25												
	Grinding at 2.6m depth		3	SS	100/23												
105.9																	
3.1	Red-brown SHALE bedrock. (Queenston Formation) END OF BOREHOLE		4	SS	78/00												
	Note: 1. Open borehole dry upon completion of drilling.																

ON_MOT_001-1158.GPJ ON_MOT.GDT 26/9/01

PROJECT 001-1158		RECORD OF BOREHOLE No 1D		1 OF 1	METRIC
W.P. 180-00-00		LOCATION N 4809409; E 286512		ORIGINATED BY GM	
DIST 4 HWY QEW		BOREHOLE TYPE 114mm Solid Stem Augers		COMPILED BY SEP	
DATUM Geodetic		DATE Feb.27/01		CHECKED BY ASP	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100		w _p w w _L				
								SHEAR STRENGTH kPa		WATER CONTENT (%)				
109.1	GROUND SURFACE													
0.0	Clayey Silt, trace sand, some grass (Topsoil)		1	SS	7		109							
108.6	Firm Black													
0.5	Clayey Silt to Silty Clay, trace sand and gravel (Fill)													
107.9	Very stiff Red brown		2	SS	42		108							
1.2	Moist Red-brown SHALE bedrock. (Queenston Formation)													
			3	SS	100									
							107							
			4	SS	100/23									
106.2														
2.9	END OF BOREHOLE													
	Note: 1. Open borehole dry upon completion of drilling.													

ON_MOT 001-1158.GPJ ON MOT.GDT 26/9/01

PROJECT 001-1158			RECORD OF BOREHOLE No 5			1 OF 1		METRIC	
W.P. 180-00-00			LOCATION N 4809316; E 286600			ORIGINATED BY GM			
DIST 4 HWY QEW			BOREHOLE TYPE 114mm Solid Stem Augers			COMPILED BY SEP			
DATUM Geodetic			DATE Feb.23/01			CHECKED BY ASP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)					
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x REMOULDED	w _p			w
107.9	GROUND SURFACE					20	40	60	80	100	20	40	60		
0.0	Clayey Silt, some sand, trace gravel, rootlets, trace shale fragments (Topsoil)		1	SS	10										
107.4	Stiff Black Clayey Silt, trace sand and gravel (Residual Soil)		2	SS	100/25										
0.5	Hard Red brown Moist Red-brown SHALE bedrock. (Queenston Formation)		3	SS	100/15										
106.4															
1.5															
104.8	Smooth grinding from 2.4m to 3.0m depth.														
3.1	END OF BOREHOLE														
Note: 1. Open borehole dry upon completion of drilling.															

ON_MOT_001-1158.GPJ ON_MOT.GDT 26/9/01

PROJECT <u>001-1158</u>		RECORD OF BOREHOLE No C1		1 OF 1	METRIC
W.P. <u>180-00-00</u>		LOCATION <u>N 4809125; E 286434</u>		ORIGINATED BY <u>GM</u>	
DIST <u>4</u> HWY <u>QEW</u>		BOREHOLE TYPE <u>114mm Solid Stem Augers</u>		COMPILED BY <u>SEP</u>	
DATUM <u>Geodetic</u>		DATE <u>Feb.14/01</u>		CHECKED BY <u>ASP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100					W _p W W _L				
103.6	GROUND SURFACE																
0.0	Clayey Silt with sand and gravel, trace rock fragments and rootlets (Fill)		1	SS	21												
103.0	Very stiff						103										
0.6	Red-brown SHALE bedrock. (Queenston Formation)		2	SS	100/18												
102.4			3	AS													
1.2	END OF BOREHOLE																
	Note: 1. Open borehole dry upon completion of drilling.																

ON_MOT_001-1158.GPJ ON_MOT.GDT 26/9/01

PROJECT 001-1158			RECORD OF BOREHOLE No 201			1 OF 1			METRIC								
W.P. 180-00-00			LOCATION N 4809210; E 286636			ORIGINATED BY PKS											
DIST 4 HWY QEW			BOREHOLE TYPE 114mm Solid Stem Augers			COMPILED BY SEP											
DATUM Geodetic			DATE Feb.21/01			CHECKED BY ASP											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED			WATER CONTENT (%) w _p — w — w _L			γ	GR SA SI CL		
105.9	GROUND SURFACE							20 40 60 80 100									
0.0	Clayey Silt to Silty Clay, some organics, trace shale fragments (Fill) Stiff to very stiff Red brown		1	SS	11												
	Rootlets from ground surface to 0.6m depth and at 2.3m depth.		2	SS	22		105										
			3	SS	16		104										
			4	SS	12		103										
102.8			5	SS	100/13		102										
3.1	Clayey Silt, some sand, trace gravel and shale fragments (Residual Soil) Hard Red brown																
102.1	Moist		6	SS	100/10												
3.8	Red-brown SHALE bedrock. (Queenston Formation)																
101.2			7	SS	100/13												
4.7	END OF BOREHOLE Note: 1. Open borehole dry upon completion of drilling.																

PROJECT <u>001-1158</u>		RECORD OF BOREHOLE No 202		1 OF 1	METRIC
W.P. <u>180-00-00</u>	LOCATION <u>N 4809180; E 286596</u>	ORIGINATED BY <u>PKS</u>			
DIST <u>4</u> HWY <u>QEW</u>	BOREHOLE TYPE <u>114mm Solid Stem Augers</u>	COMPILED BY <u>SEP</u>			
DATUM <u>Geodetic</u>	DATE <u>Feb.21-22/01</u>	CHECKED BY <u>ASP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20 40 60 80 100										
106.5	GROUND SURFACE																	
0.0	Topsoil																	
0.2	Clayey Silt to Silty clay, some sand, trace gravel, trace topsoil, shale fragments (Fill) Firm to stiff Red brown Moist		1	SS	6								o					
			2	SS	15									o				
			3	SS	9									o				
104.2																		
2.3	Clayey Silt to Silty Clay, some sand, trace gravel (Fill) Firm to very stiff Red brown Moist		4	SS	7								o					
			5	SS	17									o				
			6	SS	100/08													
102.7																		
3.8	Red-brown SHALE bedrock. (Queenston Formation)		7	SS	100													
101.5																		
5.0	END OF BOREHOLE																	
	Note: 1. Open borehole dry upon completion of drilling.																	

ON MOT 001-1158.GPJ ON MOT.GDT 26/9/01

PROJECT 001-1158				RECORD OF BOREHOLE No 203				1 OF 1		METRIC						
W.P. 180-00-00		LOCATION N 4809168; E 286548				ORIGINATED BY PKS										
DIST 4 HWY QEW		BOREHOLE TYPE 114mm Solid Stem Augers				COMPILED BY SEP										
DATUM Geodetic		DATE Feb.22/01				CHECKED BY ASP										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED								
107.2	GROUND SURFACE															
0.0	Topsoil															
0.2	Clayey Silt to Silty Clay, some sand, trace gravel and shale fragments (Fill) Stiff to hard Red brown Moist to dry		1	SS	50											
			2	SS	38											
			3	SS	12											
104.6			4	SS	92											
2.6	Clayey Silt with shale fragments (Residual Soil) Hard															
104.1	Red brown and grey Dry															
3.1	Red-brown SHALE bedrock. (Queenston Formation)															
102.6																
4.6	END OF BOREHOLE															
	Note: 1. Open borehole dry upon completion of drilling.															

ON MOT 001-1158.GPJ ON MOT.GDT 26/9/01

PROJECT <u>001-1158</u>		RECORD OF BOREHOLE No 300		1 OF 1		METRIC	
W.P. <u>180-00-00</u>		LOCATION <u>N 4809275; E 286609</u>		ORIGINATED BY <u>PKS</u>			
DIST <u>4</u> HWY <u>QEW</u>		BOREHOLE TYPE <u>114mm Solid Stem Augers</u>		COMPILED BY <u>SEP</u>			
DATUM <u>Geodetic</u>		DATE <u>Feb.22/01</u>		CHECKED BY <u>ASP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
107.0	GROUND SURFACE							20 40 60 80 100	20 40 60					GR SA SI CL	
0.0	Clayey Silt, with rootlets (Topsoil) Stiff Moist Black to brown		1	SS	10										
106.1															
0.9	Clayey Silt to Silty Clay, some sand, trace gravel and shale fragments, trace organics (Fill) Very stiff to hard		2	SS	29		106								
105.5	Red brown Moist														
1.5	Clayey Silt with shale fragments (Residual Soil) Hard		3	SS	101		105							1 4 67 28	
104.7	Red brown Red-brown SHALE bedrock. (Queenston Formation)														
2.3			4	SS	100/10										
			5	SS	100/08		104								
							103								
102.4															
4.6	END OF BOREHOLE		6	SS	100/05										
	Note: 1. Open borehole dry upon completion of drilling.														

PROJECT 001-1158				RECORD OF BOREHOLE No 301				1 OF 1		METRIC							
W.P. 180-00-00		LOCATION N 4809228; E 286617		ORIGINATED BY GM													
DIST 4 HWY QEW		BOREHOLE TYPE 114mm Solid Stem Augers		COMPILED BY SEP													
DATUM Geodetic		DATE Mar. 1/01		CHECKED BY ASP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
106.1 0.0	GROUND SURFACE						20	40	60	80	100						
	Clayey Silt to Silty Clay, trace sand and gravel (Fill) Very stiff Red brown Moist		1	SS	28												
			2	SS	28												
103.8 2.3	Red-brown SHALE bedrock. (Queenston Formation)		3	SS	100/15												
			4	SS	135/23												
102.4 3.7	END OF BOREHOLE																
	Note: 1. Open borehole dry upon completion of drilling.																

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PROJECT 001-1158			RECORD OF BOREHOLE No 401			1 OF 1			METRIC		
W.P. 180-00-00			LOCATION N 4809297; E 286653			ORIGINATED BY PKS					
DIST 4 HWY QEW			BOREHOLE TYPE 114mm Solid Stem Augers			COMPILED BY SEP					
DATUM Geodetic			DATE Feb.22/01			CHECKED BY ASP					

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× REMOULDED						
107.3	GROUND SURFACE														
0.9	Clayey Topsoil		1	SS	10		107								
	Clayey Silt to Silty Clay, some sand, trace gravel and fragments, trace organics (Fill) Stiff to hard Red brown to grey Moist		2	SS	37		106								
			3	SS	50										
105.0							105								
2.3	Clayey Silt, some to trace sand, trace gravel (Residual Soil) Hard Red Dry		4	SS	100/15										
104.3							104								
3.1	Red-brown SHALE bedrock. (Queenston Formation) Grinding at 3.1m depth.		5	SS	100/15										
102.7							103								
4.6	END OF BOREHOLE Note: 1. Open borehole dry upon completion of drilling.														

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PROJECT <u>001-1158</u>		RECORD OF BOREHOLE No 804		1 OF 1	METRIC
W.P. <u>180-00-00</u>		LOCATION <u>N 4809436; E 286493</u>		ORIGINATED BY <u>GM</u>	
DIST <u>4</u> HWY <u>QEW</u>		BOREHOLE TYPE <u>114mm Solid Stem Augers</u>		COMPILED BY <u>SEP</u>	
DATUM <u>Geodetic</u>		DATE <u>Feb.28/01</u>		CHECKED BY <u>ASP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED												
109.6	GROUND SURFACE																			
0.0	Clayey Silt to Silty Clay with to some sand and gravel (Fill) Very stiff to hard Red to brown to black		1	SS	25															
	Trace rootlets above 0.8m depth.		2	SS	36															
108.4																				
1.2	Red-brown SHALE bedrock. (Queenston Formation)		3	SS	100/23															
			4	SS	103/23															
			5	SS	100/13															
105.6			6	SS	100/15															
4.0	END OF BOREHOLE Note: 1. Open borehole dry upon completion of drilling.																			

ON MOT 001-1158.GPJ ON MOT.GDT 26/9/01

PROJECT <u>001-1158</u>		RECORD OF BOREHOLE No 805		1 OF 1	METRIC
W.P. <u>180-00-00</u>		LOCATION <u>N 4809291; E 286632</u>		ORIGINATED BY <u>GM</u>	
DIST <u>4</u> HWY <u>QEW</u>		BOREHOLE TYPE <u>114mm Solid Stem Augers</u>		COMPILED BY <u>SEP</u>	
DATUM <u>Geodetic</u>		DATE <u>Feb.15/01</u>		CHECKED BY <u>ASP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
107.4	GROUND SURFACE																
0.0	Clayey Silt to Silty Clay, some sand and gravel, some rootlets (Topsoil)		1	SS	8												
106.8	Firm to stiff Black																
0.6	Clayey Silt, some sand and gravel, trace rootlets (Fill)		2	SS	7												
106.0	Firm Red brown																
1.4	Red-brown SHALE bedrock. (Queenston Formation)		3	SS	110												
	Grinding at 2.4m depth.																
105.0			4	SS	60/10												
2.4	END OF BOREHOLE																
	Note: 1. Open borehole dry upon completion of drilling.																

PROJECT 001-1158			RECORD OF BOREHOLE No 806			1 OF 1			METRIC			
W.P. 180-00-00			LOCATION N 4809260; E 286671			ORIGINATED BY GM						
DIST 4 HWY QEW			BOREHOLE TYPE 114mm Solid Stem Augers			COMPILED BY SEP						
DATUM Geodetic			DATE Feb.15/01			CHECKED BY ASP						
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60	W _p W W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
104.4	GROUND SURFACE											
104.1	Clayey Silt to Silty Clay, some sand, trace gravel and rootlets (Topsoil)		1	SS	17		104					
0.3	Very stiff Brown											
103.6	Clayey Silt, trace sand and gravel (Residual Soil)		2	SS	100							
0.8	Hard Red brown											
	Red-brown SHALE bedrock. (Queenston Formation)						103					
102.3	Grinding at 2.1m depth.											
2.1	END OF BOREHOLE											
Note: 1. Open borehole dry upon completion of drilling.												

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PROJECT 001-1158			RECORD OF BOREHOLE No HML 6			1 OF 1			METRIC									
W.P. 180-00-00			LOCATION N 4809291; E 286566			ORIGINATED BY GM												
DIST 4 HWY QEW			BOREHOLE TYPE 114mm Solid Stem Augers			COMPILED BY SEP												
DATUM Geodetic			DATE Feb. 16/01			CHECKED BY ASP												
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N VALUES			20	40						60	80	100	20
107.4	GROUND SURFACE																	
107.1	Clayey Silt, some organics, rootlets and grass (Topsoil)		1	SS	11													
106.2	Stiff Black Clayey silt to Silty Clay, trace sand and gravel (Fill)		2	SS	79													
105.1	Hard Red brown Clayey Silt, trace sand and fine gravel (Residual Soil)		3	SS	100/15													
105.1	Hard Red brown																	
105.1	Highly to moderately weathered, red brown with occasional grey seams, calcareous SHALE BEDROCK (Queenston Formation).		4	SS	100/08													
105.1	Grinding at 2.4m depth.																	
105.1	Bedrock cored from 3.2m to 8.1m.																	
105.1	For bedrock coring details see Record or Drillhole HML6.																	
99.3	END OF BOREHOLE																	
8.1	Note: 1. Open borehole dry upon completion of overburden drilling.																	

PROJECT: 001-1158

LOCATION: N 4809291; E 286566

INCLINATION: -90° AZIMUTH: ---

RECORD OF DRILLHOLE: HML 6

SHEET 1 OF 1

DRILLING DATE: Feb.16/01

DRILL RIG: B-57

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		Refer to Previous page		104.20										
		Highly to moderately weathered, red brown with occasional grey seams, thinly laminated, fine-grained, weak, calcareous SHALE (Queenston Formation).		3.20										
4		Residual soil zones from 3.9m to 4.0m depth and from 4.1m to 4.2m depth.			1		80							
5														
6					2		85							
7														
8					3		90							
9														
10														
11														
12														
13														
		END OF BOREHOLE		99.30 8.10										

DEPTH SCALE

1 : 50



LOGGED: GM

CHECKED: ASP

DRILLHOLE 1158ROCK.GPJ GLDR_CAN.GDT 26/9/01 PS

+³, ×³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

PROJECT: 001-1158

RECORD OF DRILLHOLE: HML 9

SHEET 1 OF 1

LOCATION: N 4809357; E 286472

DRILLING DATE: Feb.23/01

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: B-57

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	COLOUR % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL PISTON LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		Refer to Previous page		104.40										
5		Highly to moderately weathered, red brown with occasional grey seams, thinly laminated, fine-grained, weak, calcareous SHALE (Queenston Formation). Residual soil zones, 25mm to 50mm in thickness at 4.8m, 6.9m, 7.9m, 8.2m and 8.9m depth.		4.80										
6					1		85							
7					2		85							
8					3		90							
9				99.80										
10		END OF BOREHOLE		9.20										
11														
12														
13														
14														

DRILLHOLE 1158ROCK.GPJ GLDR CAN.GDT 26/9/01 PS

DEPTH SCALE

1:50


 LOGGED: GM
 CHECKED: ASP

RECORD OF BOREHOLE No HML 10										1 OF 1		METRIC				
PROJECT 001-1158			LOCATION N 4809483; E 286565			ORIGINATED BY GM										
W.P. 180-00-00			BOREHOLE TYPE 114mm Solid Stem Augers			COMPILED BY SEP										
DIST 4 HWY QEW			DATE Mar. 1/01			CHECKED BY ASP										
DATUM Geodetic																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
109.8	GROUND SURFACE															
0.0	Topsoil		1	SS	12											
0.3	Clayey Silt to Silty Clay, trace sand, gravel, shale fragments and rootlets (Fill)															
108.9	Firm Red brown		2	SS	100/23											
0.9	Highly to moderately weathered, red brown with occasional grey seams, friable, calcareous SHALE BEDROCK (Queenston Formation). Bedrock cored from 3.2m to 7.1m. For bedrock coring details see Record or Drillhole HML10.		3	SS	100/18											
			4	SS	137/23											
102.7	END OF BOREHOLE															
7.1	Note: 1. Open borehole dry upon completion of overburden drilling. 2. Water level in piezometer at 3.9m depth (Elev. 105.9m) on March 26, 2001.															

ON_MOT 001-1158.GPJ ON_MOT.GDT 26/9/01

LOCATION: N 4809483; E 286565

DRILLING DATE: Mar.1/01

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: --

DRILL RIG: B-57

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

[illegible]

DEPTH SCALE

1 : 50

LOGGED: GM

CHECKED: ASP

PROJECT 001-1158		RECORD OF BOREHOLE No HML 11				1 OF 1		METRIC						
W.P. 180-00-00		LOCATION N 4809376; E 286647				ORIGINATED BY GM								
DIST 4 HWY QEW		BOREHOLE TYPE 114mm Solid Stem Augers				COMPILED BY SEP								
DATUM Geodetic		DATE Feb.28/01				CHECKED BY ASP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED						
108.0	GROUND SURFACE													
0.0	Clayey Silt, trace sand and gravel (Topsoil) Black		1	AS										
107.4														
0.6	Fine Sand, some clay, trace gravel with pockets of silty clay (Fill) Compact Gray to brown Moist		2	SS	19									
106.5														
1.5	Highly to moderately weathered, red brown with occasional grey seams, calcareous SHALE BEDROCK (Queenston Formation). Heavy grinding at 2.4m. Bedrock cored from 3.1m to 7.6m. For bedrock coring details see Record or Drillhole HML11.		3	SS	100									
			4	SS	100									
100.4														
7.6	END OF BOREHOLE Note: 1. Open borehole dry upon completion of overburden drilling. 2. Water level in piezometer at 3.5m depth (Elev. 104.5m) on March 26, 2001.													

ON_MOT 001-1158.GPJ ON_MOT.GDT 26/9/01

PROJECT: 001-1158

RECORD OF DRILLHOLE: HML 11

SHEET 1 OF 1

LOCATION: N 4809376; E 286647


DRILLING DATE: Feb.28/01

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: --

DRILL RIG: B-57

DRILLING CONTRACTOR: Master Soil Investigation Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY			DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
				DEPTH (m)	FLUSH					TOTAL CORE %	SOLID CORE %			DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴		
		Refer to Previous page		104.90																
4	NQ	Highly to moderately weathered, red brown with occasional grey seams, thinly laminated, fine-grained, weak, calcareous SHALE (Queenston Formation).		3.10	1	75									BC					
5				2	80									B,R,C B,SM,ST B,SM,PL (x3) B,R,PL (x2) B,R,PL B,SM,C B,R,PL (x8)						
7				3	85										B,SM,C-PL B,SM,PL (x2) B,SM,C-FL B,SM,PL (x2)					
8		END OF BOREHOLE		100.40 7.60																
9																				
10																				
11																				
12																				
13																				

DEPTH SCALE

1 : 50



LOGGED: GM

CHECKED: ASP

DRILLHOLE 1158 ROCK GPJ GLDR CAN GDT 26/9/01 PS

RECORD OF BOREHOLE No HML 12

1 OF 1

METRIC

PROJECT 001-1158

W.P. 180-00-00

LOCATION N 4809548; E 286745

ORIGINATED BY GM

DIST 4 HWY QEW

BOREHOLE TYPE 114mm Solid Stem Augers

COMPILED BY SEP

DATUM Geodetic

DATE July 16, 2001

CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
106.4	GROUND SURFACE					20	40	60	80	100	20	40	60		
0.0	Clayey Silt with sand and gravel, trace rootlets and wood fragments (Residual Soil) Very Stiff Red-brown Red-brown SHALE bedrock (Queenston Formation) Grinding for 50mm at 2.4m and 3.0m depth.		1	SS	60										
0.2			2	SS	60.02										
			3	SS	60.02										
103.3			4	SS	60.06										
3.1	END OF BOREHOLE														
	Note: Piezometer was dry on October 9, 2001.														

N. MOT 001-1158.GPJ ON. MOT.GDT 9/10/01

+ 3 . X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ON_MOT 001-1158.GPJ ON_MOT.GDT 9/10/01

RECORD OF BOREHOLE No HML 13

1 OF 1

METRIC

PROJECT 001-1158

W.P. 180-00-00

LOCATION N 4809770; E 286909

ORIGINATED BY

DIST 4 HWY QEW

BOREHOLE TYPE 114mm Solid Stem Augers

COMPILED BY SEP

DATUM Geodetic

DATE July 16, 2001

CHECKED BY ASP

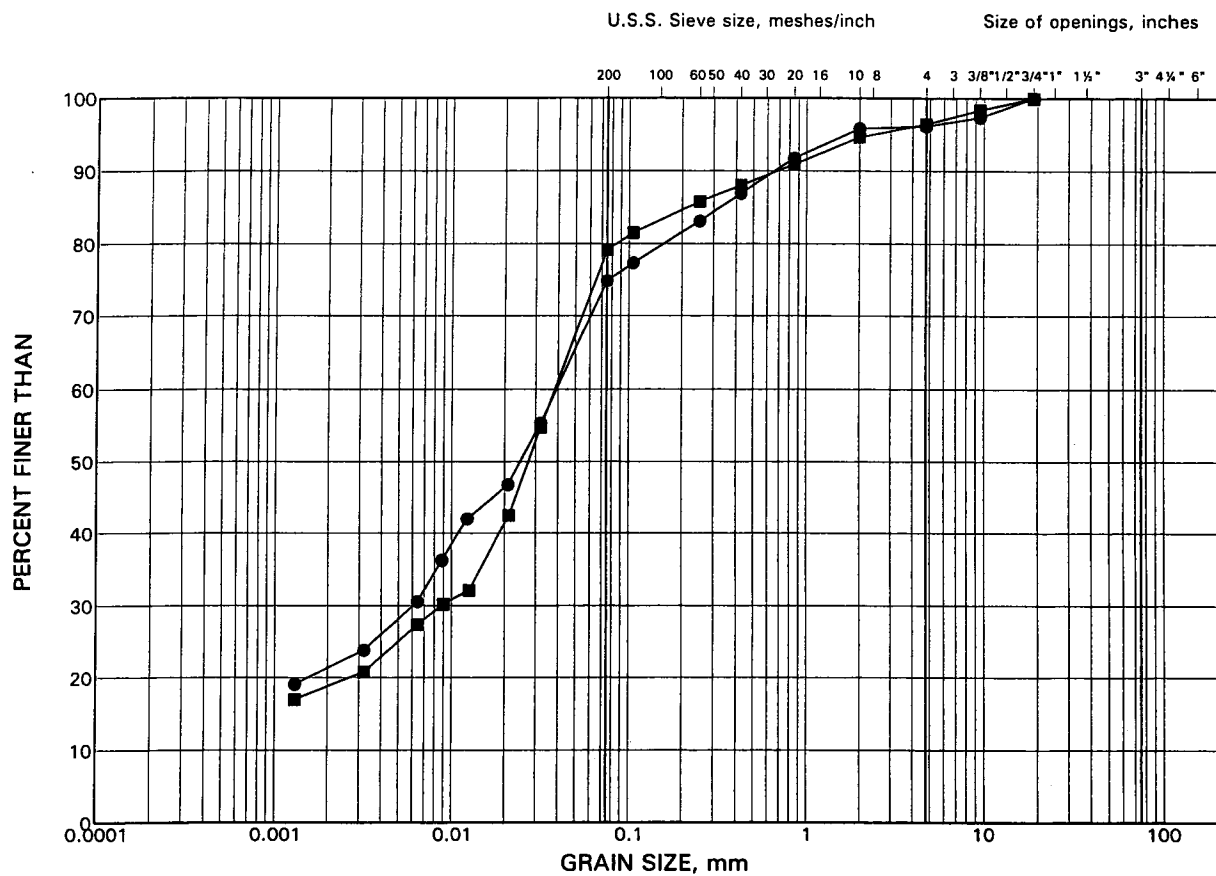
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L				
108.2	GROUND SURFACE													
0.0	Clayey Silt, trace rootlets and grass (Topsoil)		1	SS	6		108							
107.9	Stiff Brown													
0.3	Red-brown SHALE bedrock (Queenston Formation)		2	SS	1007.15		107							
	Grinding from 3.0m to 3.4m depth.		3	SS	301.03		106							
							105							
104.8	END OF BOREHOLE		4	SS	581.89									
3.4														

ON_MOT_001-1158.GPJ ON_MOT.GDT 27/9/01

GRAIN SIZE DISTRIBUTION

Clayey Silt (Fill)

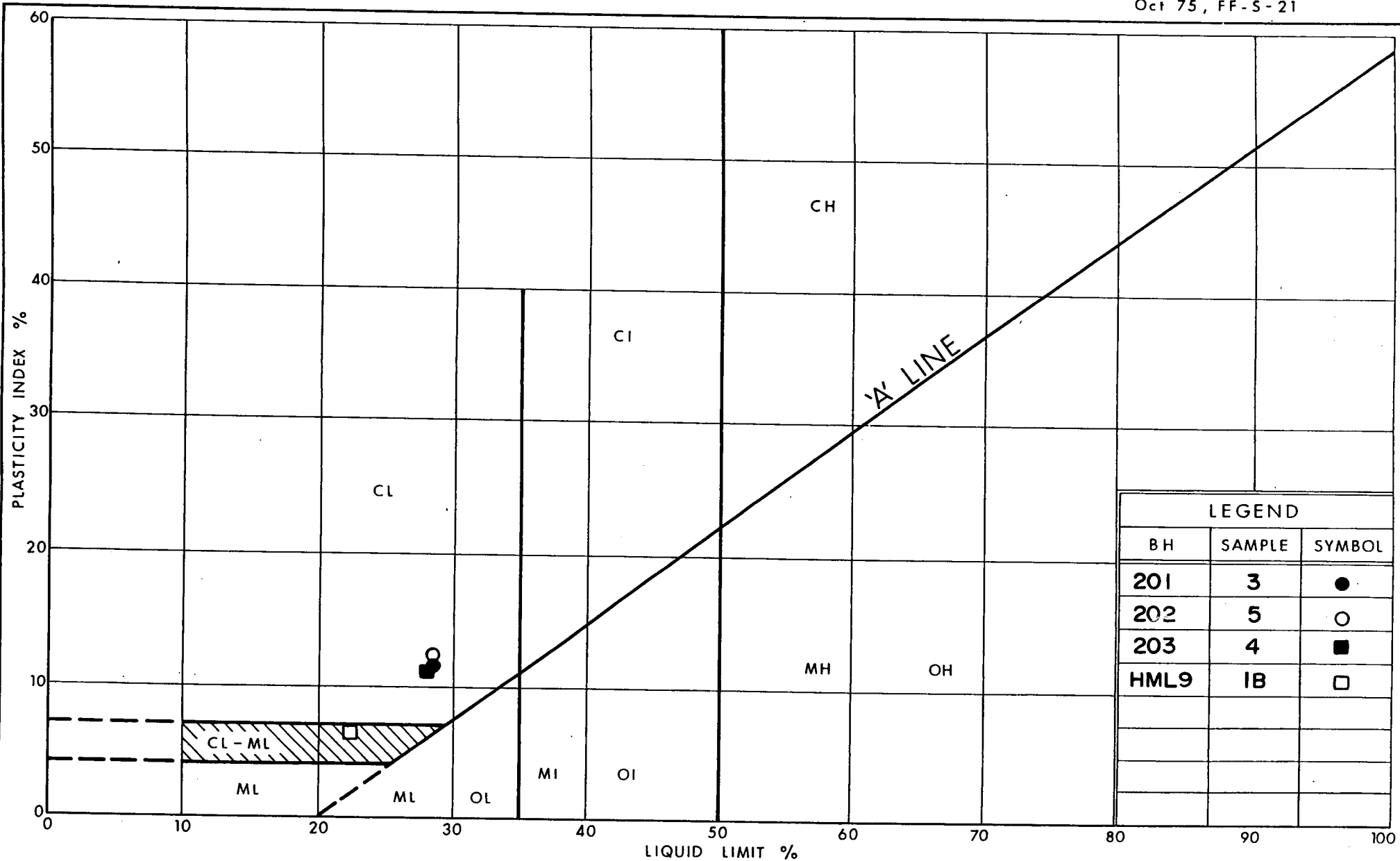
FIGURE 1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	202	5	102.8
■	203	4	104.9



Ministry of
Transportation

PLASTICITY CHART **CLAYEY SILT TO SILTY CLAY (FILL)**

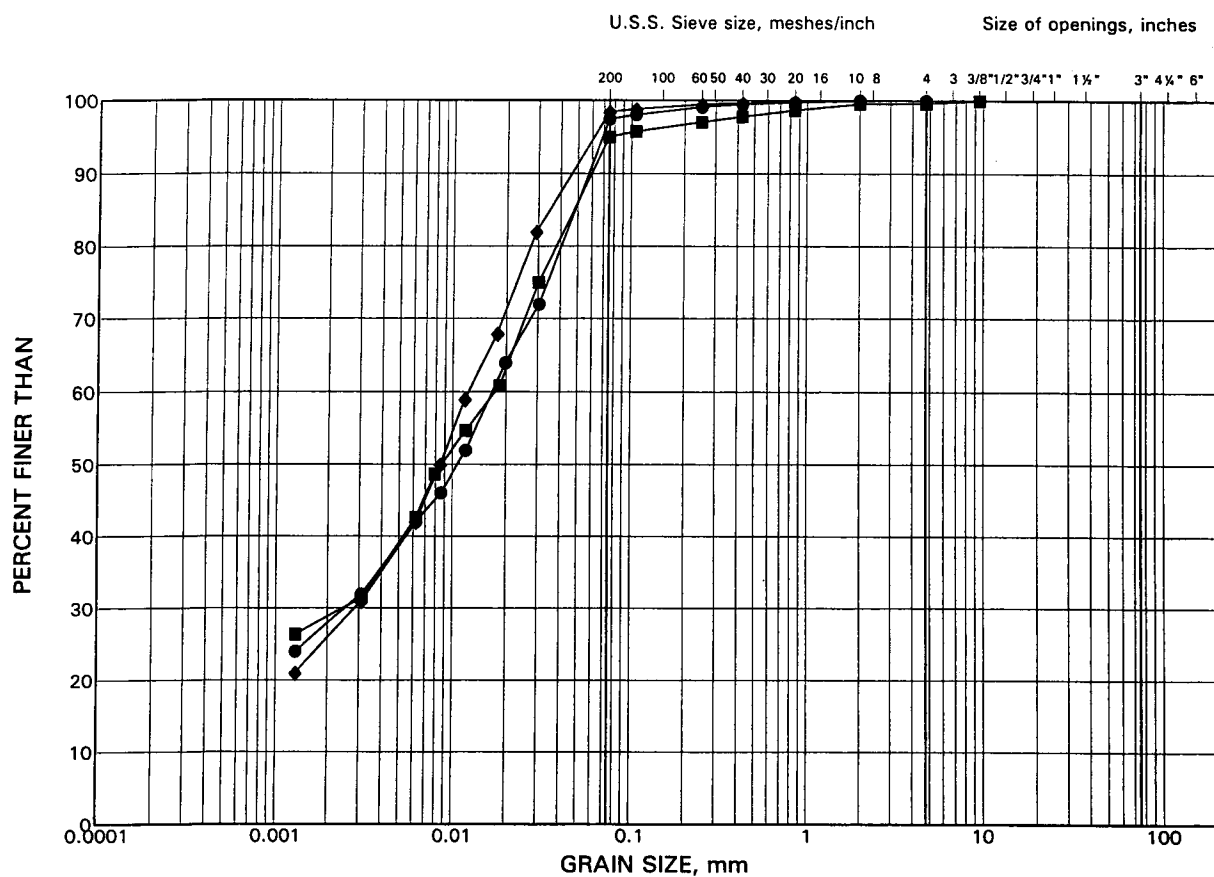
FIG No **2**

W P **180-00-00**

GRAIN SIZE DISTRIBUTION

Clayey Silt (Residual Soil)

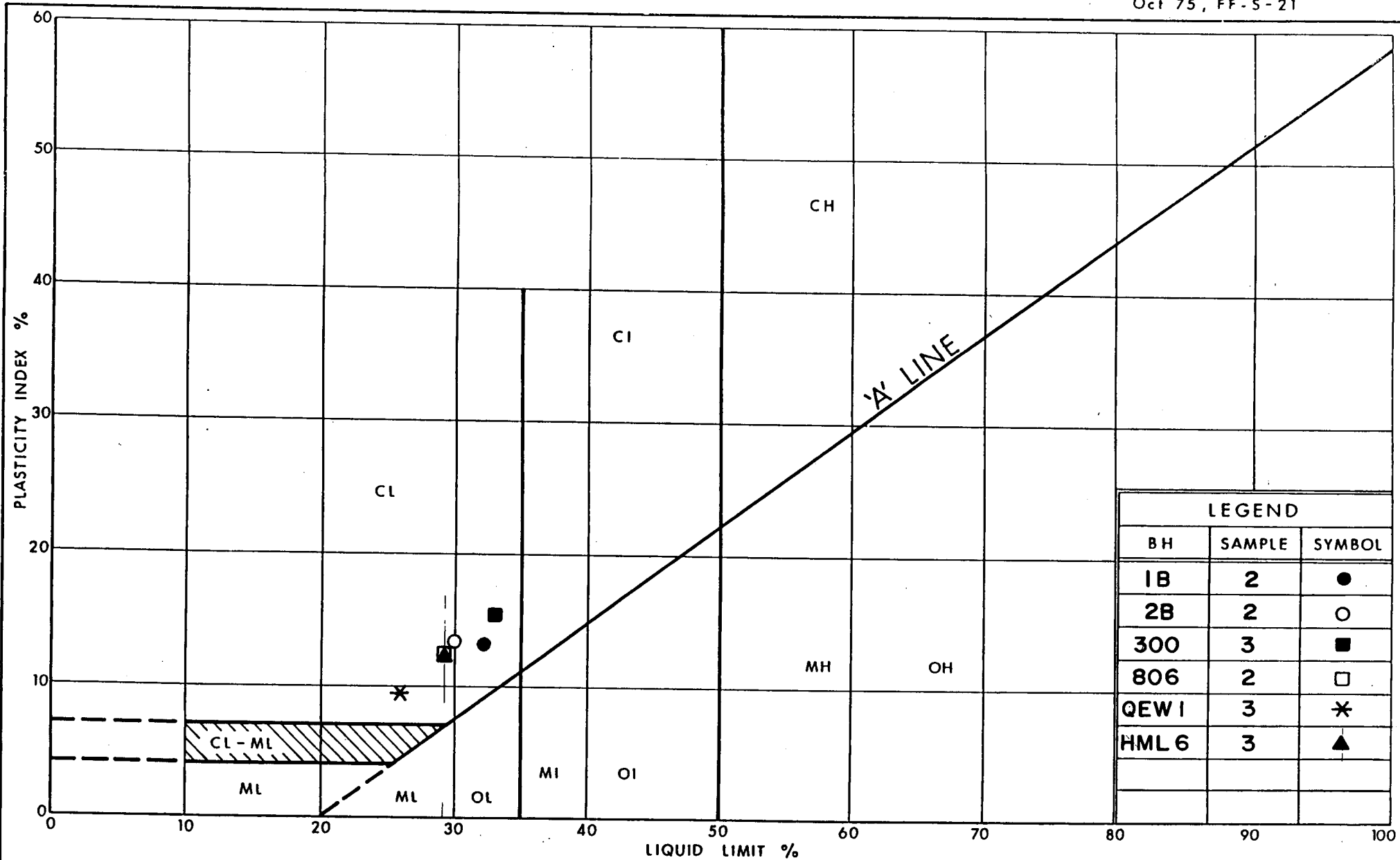
FIGURE 3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	2B	2	106.7
■	300	3	105.2
♦	HML6	3	105.7



Ministry of
Transportation

PLASTICITY CHART CLAYEY SILT (RESIDUAL SOIL)

FIG No 4

W P 180-00-00

APPENDIX A

**RECORD OF BOREHOLE SHEETS FROM
GOLDER ASSOCIATES REPORT
"GEOTECHNICAL INVESTIGATION
PROPOSED MID-HALTON WATER POLLUTION CONTROL PLANT,
OAKVILLE, ONTARIO,"
REPORT NO. 871-1526
DATED APRIL 1988**

RECORD OF BOREHOLE A1

SHEET 1 OF 1



LOCATION: SEE FIGURE 2

BORING DATE: JAN 8, 1988

DATUM: GEODETIC

SAMPLER: HAMMER, 63.5kg, DROP: 760mm

PENETRATION TEST: HAMMER, 63.5kg, DROP: 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (M)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH Cu, kPa nat.V. - + O - ● rem.V. - ● U - ○	WATER CONTENT, PERCENT			
0	POWER AUGER BORING 110 mm DIAMETER STEM AUGERS	GROUND SURFACE	117.74								
		TOPSOIL	0.15								
1		Hard reddish brown CLAYEY SILT, trace sand and gravel, some grey silt lenses. (TILL)		1	50 DO	37		0			
2		Reddish brown completely to highly weathered SHALE, thinly bedded, fine grained (QUEENSTON SHALE)	118.08 1.68	2	50 DO	100 / .1					
3				3	50 DO	100 / .2					
4				4	50 DO	100 / .1					
5		END OF HOLE	114.61 3.13								
6											
7											
8											
9											
10											

0
16 → 6 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1: 50

Golder Associates

LOGGED RF

CHECKED PC

OPEN HOLE DRY
ON COMPLETION
OF DRILLING.

RECORD OF BOREHOLE B1

SHEET 1 OF 1

LOCATION SEE FIGURE 2

BORING DATE JAN. 8, 1988

DATUM GEODETIK

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (M)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH Cu, kPa nat.V.- + O.- ● rem.V.- ● U.- ○	WATER CONTENT, PERCENT wp w wl 10 20 30 40			
0	POWER AUGER BORING 110 mm DIA. SOLID STEM AUGERS	GROUND SURFACE	115.63								
		TOPSOIL	115.48								
1		Stiff reddish brown CLAYEY SILT to SILTY CLAY, trace sand, trace rootlets, some sand lenses. (TILL)		1	50 DO	9					
2		Reddish brown completely to highly weathered SHALE, thinly bedded, fine grained, interbedded with occ. greyish green calcareous siltstone layers. (QUEENSTON SHALE)	113.95 1.68	2	50 DO	79					
3				3	50 DO	100 / .2				OPEN HOLE DRY ON COMPLETION OF DRILLING	
4	END OF HOLE	112.43 3.20	4	50 DO	100 / .1						
5											
6											
7											
8											
9											
10											

OPEN HOLE DRY
ON COMPLETION
OF DRILLING

0
10 15 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1: 50

LOGGED RF

CHECKED PC

Golder Associates

RECORD OF BOREHOLE C1

SHEET 1 OF 1

LOCATION: SEE FIGURE 2

BORING DATE: JAN. 8, 1988

DATUM: GEODETIC

SAMPLER: HAMMER, 83.6kg, DROP, 760mm

PENETRATION TEST: HAMMER, 83.6kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (M)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa nat.V. - + Q. - ● rem.V. - ● U. - ○	WATER CONTENT, PERCENT			
0	POWER AUGER BORING 110 mm DIA. SOLID STEM AUGERS	GROUND SURFACE	118.06								
		TOPSOIL	0.16								
1		Hard reddish brown CLAYEY SILT, trace sand, trace fine gravel, frequent grey silt layers. (TILL)	118.69	1	50 DO	37					
2		Reddish brown completely to highly weathered SHALE, thinly bedded, fine grained, interbedded with occ. greyish green calcareous siltstone layers. (QUEENSTON SHALE)	116.69 1.37	2	50 DO	130					
3			114.86	4	50 DO	100 V.1					
4		END OF HOLE	3.20								
5											
6											
7											
8											
9											
10											

OPEN HOLE DRY
ON COMPLETION
OF DRILLING.

0
16 ± 5 PERCENT AXIAL STRAIN AT FAILURE
10

DEPTH SCALE

1 : 50

Golder Associates

LOGGED RF

CHECKED PC

SHEET 1 OF 1

BORING DATE JAN. 6, 1988

DATUM: GEODETIC

PENETRATION TEST HAMMER, 83.5kg, DROP, 760mm



LOCATION SEE FIGURE 2

AMPLER HAMMER, 63.5kg, DROP, 760mm

[illegible]

DEPTH SCALE

1 : 50

Golder Associates

LOGGED RF

CHECKED PC

RECORD OF BOREHOLE E1

SHEET 1 OF 1

LOCATION SEE FIGURE 2

BORING DATE JAN. 6, 1988

DATUM GEODETTIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 83.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (M)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa nat.V.- + Q.- ● rem.V.- ● U.- ○	WATER CONTENT, PERCENT				
0	POWER AUGER BORING 110 mm DIA. SOLID STEM AUGER	GROUND SURFACE	118.88									
		TOPSOIL	0.15	1	50 DO	23						
1		Very stiff to hard reddish brown CLAYEY SILT, trace sand, trace fine gravel, trace rootlets, occ. grey brown silt lenses. (TILL)		2	50 DO	43						
			117.49									
2			1.37	3	50 DO	55						
				4	50 DO	100 / .1						
3		Reddish brown completely to highly weathered SHALE, thinly bedded, fine grained; interbedded with frequent greyish green calcareous siltstone layers between 1.5 and 2.5 m depths. (QUEENSTON SHALE)		5	50 DO	100 / .2						
4				6	50 DO	100 / .1						
6		REFUSAL TO AUGER END OF HOLE	114.29 4.67									
6												
7												
8												
9												
10												

OPEN HOLE DRY
ON COMPLETION
OF DRILLING.

0
15-10 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1: 60

Golder Associates

LOGGED SB

CHECKED PC

RECORD OF BOREHOLE F1

SHEET 1 OF 1

LOCATION SEE FIGURE 2

BORING DATE JAN. 7, 1988

DATUM GEODETIC

SAMPLER HAMMER, 83.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 83.5kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		STRATA PLOT	ELEV. DEPTH (M)	SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, CM/SEC	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION				NUMBER	TYPE				
0	POWER AUGER BORING 110mm DIA. SOLID STEM AUGERS	GROUND SURFACE			118.63						
		TOPSOIL			0.15						
1		Hard reddish brown CLAYEY SILT, trace sand, trace to occ. gravel, occ. gray fine sand and silt lenses, occ. rootlets at about 1m depth. (TILL)		1	50 DO	31					
2				2	50 DO	47					
3				3	50 DO	76					
4				4	50 DO	86					
	Reddish brown highly weathered SHALE, completely weathered between 3 and 3.5m depth, thinly bedded, fine grained, with grayish green calcareous siltstone layers at about 2.5m depth. (QUEENSTON SHALE)		5	50 DO	100						
4	END OF HOLE				114.68						
5					4.06						
6											
7											
8											
9											
10											

OPEN HOLE DRY
ON COMPLETION
OF DRILLING.

0
15 10 5 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1: 60

Golder Associates

LOGGED SB

CHECKED PC

RECORD OF BOREHOLE G1

SHEET 1 OF 1

DATUM GEODETIC

LOCATION SEE FIGURE 2

BORING DATE JAN. 7, 1988

SAMPLER HAMMER, 83.6kg, DROP, 760mm

PENETRATION TEST HAMMER, 83.6kg, DROP, 760mm



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, CM/SEC		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (M)	NUMBER	TYPE	BLOWS/0.3M	SHEAR STRENGTH Cu, kPa	nat.V.- + Q.- ● rem.V.- ● U.- ○	WATER CONTENT, PERCENT		
0	POWER AUGER BORING 110 mm DIA. SOLID STEM AUGERS	GROUND SURFACE	118.24								
		TOPSOIL	118.09								
			0.15								
1		Very stiff to hard reddish brown CLAYEY SILT, trace sand, trace to occ. fine gravel, occ. fine sand and silt lenses. (TILL)		1	50 DO	25					
2		Reddish brown completely to highly weathered SHALE, thinly bedded fine grained occ. greyish green calcareous siltstone layers. (QUEENSTON SHALE)	118.11	2	50 DO	59					
		2.13	3	50 100 DO / .2							
3		115.04	4	50 100 DO / .2							
		3.20									
4		END OF HOLE									
6											
8											
10											

0

10

10

PERCENT AXIAL STRAIN AT FAILURE

10

20

30

40

OPEN HOLE DRY ON COMPLETION OF DRILLING.

OPEN HOLE DRY ON COMPLETION OF DRILLING.

0
15-10 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1: 60

Golder Associates

LOGGED SB

CHECKED PC

RECORD OF BOREHOLE H1

SHEET 1 OF 1

LOCATION SEE FIGURE 2

DRILLING DATE JAN 11 1988

DATUM GEODETIC

INCLINATION -90

AZIMUTH

DRILL RIG MOBILE B-57

DRILLING CONTRACTOR MASTER SOILS



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN		
								SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY		
								40	SLICKENSIDED	PL-PLANAR	C-CURVED		
								RECOVERY	R.Q.D.	FRAC.	DISCONTINUITY DATA		
								TOTAL CORE %	SOLID CORE %	INDEX PER 100M	TYPE AND SURFACE DESCRIPTION		
								000000	000000	000000	000000		
0		GROUND SURFACE		117.67									
		TOPSOIL		117.42									
				0.16									
1	Power Auger Boring	Hard reddish brown CLAYEY SILT, trace sand, trace to some fine gravel, frequent gray fine sand and silt lenses. (TILL)			1	50	38						
						DO							
2	110mm DIA. SOLID STEM AUGERS	Reddish brown completely to highly weathered SHALE, thinly bedded, fine grained, interbedded with greyish green calcareous siltstone layers. (QUEENSTON SHALE)		115.28	2	50	52						
				2.29		DO							
3				114.67	3	50	100						
				2.90		DO	.1						
4	BO CORE	Reddish brown moderately to slightly weathered SHALE, thinly bedded, fine grained, interbedded with greyish green calcareous siltstone layers, occ. clay seams; soft zones between depths 2.9-3.5m, 4.0-4.3m, and 5.3-7.1m. (QUEENSTON SHALE)			4	.08	60%						
5	Wash Boring	SILTSTONE LAYERS			5	.08	60-80%						
		DEPTH(m) THICKNESS(mm)											
6		3.18 25		111.63									
		3.35 25		5.94									
7		3.78 127											
		4.01 25											
		4.11 25											
		4.27 25											
		4.66 13											
		4.80 89											
		5.32 64											
		5.72 50											
8		END OF HOLE											
9		CLAY SEAMS											
10													

WATER CONTENT = 11%

Backfill
Bentonite Seal
Backfill

Bentonite Seal
Caved

Granular Filter

WATER LEVEL IN
PIEZOMETER AT
ELEV. 113.28m
ON JAN. 27, 1988.

DEPTH SCALE

1: 50

Golder Associates

LOGGED R.J.W.

DATE FEB 5, 1988

CHECKED P.C.C.

RECORD OF BOREHOLE X1

SHEET 1 OF 1

LOCATION SEE FIGURE 3

DRILLING DATE JAN 12 1988

DATUM GEODETIC

INCLINATION -90

AZIMUTH

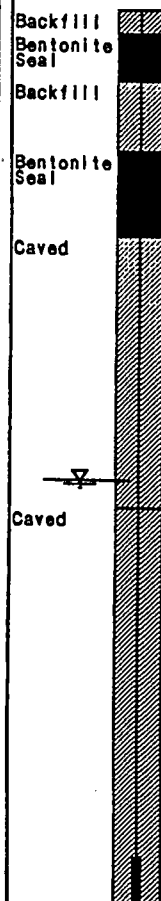
DRILL RIG MOBILE B-57

DRILLING CONTRACTOR MASTER SOILS



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/MIN)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED				SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED				DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 100M	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY L/CM/SEC																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
								TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION	TYPE AND SURFACE DESCRIPTION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
0	Power Auger Boring 110mm DIA. SOLID STEM AUGER	GROUND SURFACE		113.96																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														

WATER CONTENT = 11%



WATER LEVEL IN
PIEZOMETER AT
ELEV. 110.94m
ON JAN. 27, 1988.

END OF HOLE

CLAY SEAMS

DEPTH SCALE

1: 50

Golder Associates

LOGGED R.J.W.

DATE FEB 6, 1988

CHECKED P.C.C.

RECORD OF BOREHOLE X2

SHEET 1 OF 1

DATUM GEODETIC

LOCATION SEE FIGURE 3

DRILLING DATE DEC. 22, 1987

INCLINATION -90 AZIMUTH

DRILL RIG MOBL B-57

DRILLING CONTRACTOR MASTER SOILS



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	RECOVERY	R.O.D. %	FRACT. INDEX PER CM	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY L/m/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
0		GROUND SURFACE		106.87										
		TOPSOIL		0.15	1	50	7							Bentonite Seal
		Stiff dark reddish brown CLAYEY SILT, some sand, trace fine gravel (TILL)												Backfill
1				105.50	2	50	13							
		Reddish brown completely to highly weathered SHALE; thinly bedded, fine grained (QUEENSTON SHALE)		1.37	3	50	76							
2				104.13										
		Reddish brown slightly weathered to fresh SHALE; thinly bedded, fine grained, interbedded with greyish green siltstones and clay seams. (QUEENSTON SHALE)		2.74	6	50	125							Bentonite Seal
3														
4														
5														
6														
7														
8														
9														
10														
		END OF HOLE		97.88										
				8.99										

WATER CONTENT = 20.7% (MH)

WATER LEVEL IN
PIEZOMETER AT
ELEV. 104.4 m
ON JAN. 27, 1988

DEPTH SCALE

1: 50

LOGGED RF

DATE JAN 13, 1988

CHECKED PC

Golder Associates

RECORD OF BOREHOLE X3

SHEET 1 OF 1

LOCATION SEE FIGURE 3

DRILLING DATE DEC. 22, 1987

DATUM GEODETIC

INCLINATION -90

AZIMUTH

DRILL RIG MOBL B-57

DRILLING CONTRACTOR MASTER SOILS



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/HR)	FLUSH % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEN	F-FAULT J-JOINT P-POLISHED S-SLICKERSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION						
														RECOVERY		R.O.D. %	FRAC. INDEX PER CUM	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY mD/ft
														TOTAL CORE %	SOL CORE %				
0		GROUND SURFACE		105.59															
		TOPSOIL		0.15	1	50 DO	7												
1		Loose to compact dark brown silt, trace to some sand, trace clay, trace organics and rootlets, occ. pieces of wood and asphalt. (FILL)			2	50 DO	26												
2					3	50 DO	13												
				103.09	4	50 DO	133												
3		Reddish brown completely to highly weathered SHALE, thinly bedded, fined grained (QUEENSTON SHALE)		2.50															
				102.24	5	50 DO	85												
				3.36															
4	NORC	reddish brown slightly weathered to fresh SHALE, thinly bedded, fine grained, interbedded with greyish green fine grained siltstones and clay seams. (QUEENSTON SHALE)			6		60%												
6	NORC				7		50%												
7	NORC	SILTSTONE LAYERS			8		90-100%												
		DEPTH(m) THICKNESS(mm)																	
		3.49 38																	
		3.76 25																	
		4.03 38																	
		4.57 38																	
		5.67 50																	
		5.99 13																	
		6.40 89																	
		6.53 127																	
		6.74 38																	
		7.47 50																	
		8.13 50																	
8		8.20 50																	
		8.25 13																	
		8.59 166																	
9	NORC				9		100%												
				96.33															
				9.26															
		END OF HOLE																	

DEPTH SCALE

1: 50

Golder Associates

LOGGED RF

DATE JAN 13, 1988

CHECKED PC

WATER LEVEL IN
PIEZOMETER AT
ELEV. 103.2m
ON JAN 27, 1988

RECORD OF BOREHOLE X4

SHEET 1 OF 1

DATUM GEODETIC

LOCATION SEE FIGURE 3

DRILLING DATE JAN 14, 1988

DRILL RIG MOBILE B-57

DRILLING CONTRACTOR MASTER SOILS

INCLINATION -90

AZIMUTH



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (M)	RUN No.	PENETRATION RATE (M/HR)	FLUSH % RETURN COLOUR	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	HYDRAULIC CONDUCTIVITY L/M/SEC	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
0		GROUND SURFACE		105.60										
		TOPSOIL		105.35										
				0.15										Backfill
1		Very stiff to stiff reddish brown CLAYEY SILT, trace sand, trace fine gravel, frequent grey silt lenses, occ. clay seams, mixed with grey silty clay, fine sand, shale fragments and trace rootlets between 2.3 and 2.7m depths. (PROBABLY FILL)			1	50 DO	25							Bentonite Seal
2					2	50 DO	16							Backfill
3		Reddish brown completely to highly weathered SHALE, thinly bedded, fine grained. (QUEENSTON SHALE)		102.60	3	50 DO	10							Bentonite Seal
				2.90	4	50 DO	7.1							Caved
4		Reddish brown moderately to slightly weathered SHALE, thinly bedded, fine grained, interbedded with greyish green fine grained calcareous siltstone layers, frequent clay seams and soft zones between depths of 3.7-4.3m, 4.6-5.2m, 6.1-7.3m, and 7.6-7.9m. (QUEENSTON SHALE)		101.84	5	50	100%							
5	BQ RC			3.66	6	50	100%							
6	BQ RC	SILTSTONE LAYERS			7	50	25%							
7	BQ RC	DEPTH(m) THICKNESS(mm)			8	50	25%							
8	BQ RC	4.34 50			9	50	25%							
9	BQ RC	5.37 25			10	50	25%							
		6.89 50			11	50	25%							
		6.25 127			12	50	25%							
		6.45 75			13	50	25%							
		6.60 50			14	50	25%							
		7.24 25			15	50	25%							
		7.33 100			16	50	25%							
		7.95 25			17	50	25%							
		8.36 75			18	50	25%							
		8.69 50			19	50	25%							
9		CLAY SEAMS		96.36	20	50	25%							
		END OF HOLE		9.14	21	50	25%							
10														

WATER LEVEL IN
PIEZOMETER AT
ELEV. 101.13m
ON JAN. 27, 1988.

DEPTH SCALE

1 : 60

Golder Associates

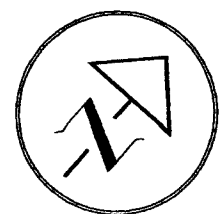
LOGGED R.J.W.

DATE FEB 5, 1988

CHECKED P.C.C.

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

DIST. HWY. QEW
CONT No.
WP No. 180-00-00

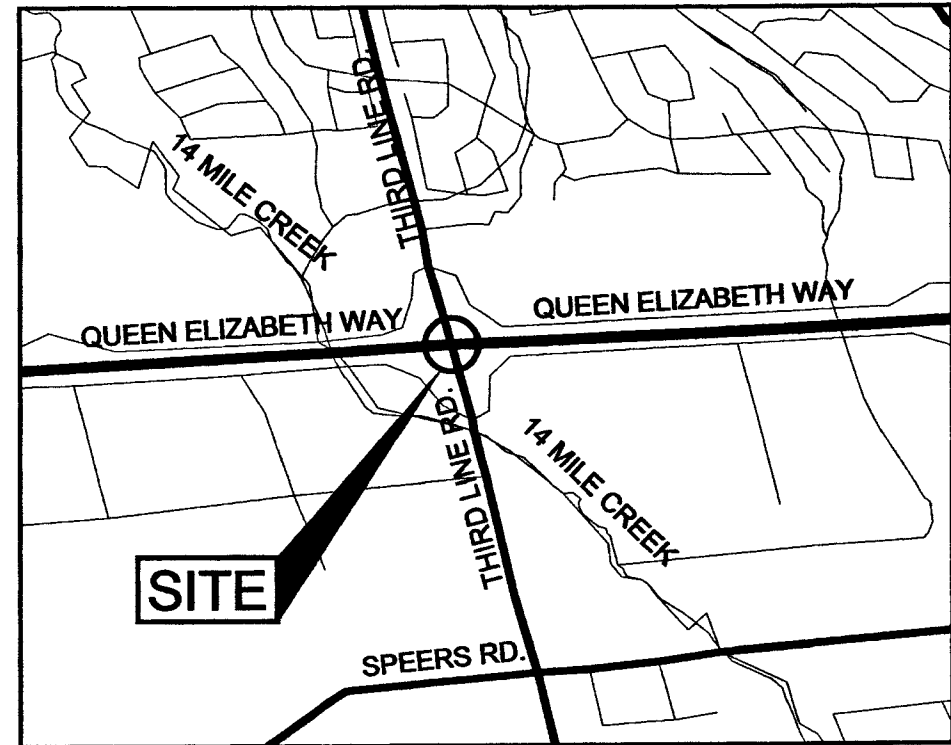


QEW / THIRD LINE
INTERCHANGE
BOREHOLE LOCATION PLAN

SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

2000 Investigation Borehole

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
1	108.9	4809395	286523
1B	108.9	4809382	286521
1D	109.1	4809409	286512
2B	108.7	4809401	286536
3B	108.0	4809319	286576
4B	108.1	4809334	286588
5	107.9	4809316	286600
201	105.9	4809210	286636
202	106.5	4809180	286596
203	107.2	4809168	286548
300	107.0	4809275	286609
301	106.1	4809228	286617
401	107.3	4809297	286653
804	109.6	4809436	286493
805	107.4	4809291	286632
806	107.4	4809260	286671
HML6	107.4	4809291	286566
HML 9	109.0	4809357	286472
HML 10	109.8	4809483	286565
HML 11	108.0	4809376	286647
HML 12	106.4	4809548	286745
HML 13	108.2	4809770	286909
QEW1	108.5	4809362	286557
QEW2	108.4	4809347	286544

REFERENCE

Drawing provided in digital form from Morrison Hershfield. File names
"4173-03.DWG, ALIGN.DWG AND QEWBASE.DWG"
in March, 2001.

LEGEND

1988 Investigation Borehole

No.	ELEVATION	LOCATION (APPROX.)	
		STATION	OFFSET
A1	117.7	13+210	70m LT OF
B1	115.6	13+260	70m LT OF
C1	118.1	13+310	70m LT OF
D1	118.7	13+360	70m LT OF
E1	118.9	13+410	70m LT OF
F1	118.6	13+460	70m LT OF
G1	118.2	13+510	70m LT OF
H1	117.6	13+560	70m LT OF
X1	114.0	13+645	50m LT OF
X2	106.9	13+845	50m LT OF
X3	105.6	13+830	55m RT OF
X4	105.5	-----	-----

REFERENCE

1988 Boreholes are from Golder Associates Report No. 871-1526 entitled
"Geotechnical Investigation, Proposed Mid-Halton Pollution Control Plant,
Oakville, Ontario" dated April, 1988.

PLAN

