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FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH MAST LIGHTS
FORMER HIGHWAY 403 (GARDEN AVENUE)/
HIGHWAY 403 INTERCHANGE
GWP 30-00-00, AGREEMENT NO. 3005-E-0017
MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION

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HIGH MAST LIGHTS
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1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Philips Engineering Ltd. (Philips) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detail design work for GWP 30-00-00. The project involves the detail design works along Garden Avenue, formerly Highway 403, from 0.6 km north to 0.9 km south of the Garden Avenue/Highway 403 Interchange in Brantford, Ontario. The proposed works within the project limits will consist of the following:

(a) Widening of Garden Avenue to accommodate auxilliary lanes.
(b) Signalization of the W-N/S and E-N/S ramp terminals.
(c) Widening of the W-N/S and E-N/S ramps to accommodate auxilliary lanes.
(d) Intersection improvements at the intersection of Garden Avenue and Sinclair Boulevard.
(e) Provision of a signalized intersection at Garden Avenue and the proposed Industrial Park Access Road.
(f) Provision for 350 metres of Industrial Park Access Road and a new commuter parking lot with access to the Industrial Park Access Road.
(g) Signalization at Henry Street.
(h) Signal interconnect to all signals within the project limits.
(i) High mast illumination and conventional illumination.
(j) Pavement rehabilitation/reconstruction of Garden Avenue.
(k) Pavement rehabilitation of the W-N/S and E-N/S ramps.

This report addresses the foundation investigation for thirteen high mast lights which will be installed in the Garden Avenue/Highway 403 Interchange area. Items (b), (e), (g) and (h) are addressed by others and the foundation aspects of the remaining items are addressed in various foundation investigation and design reports issued under separate cover.

The purpose of the foundation investigation is to determine the subsurface conditions at the locations of the proposed works by drilling a limited number of boreholes at selected locations and carrying out in situ testing and laboratory testing on selected samples. The terms of reference for the scope of work are outlined in the MTO's Request for Proposal and in Golder Associates' proposal P51-3083 dated August 2, 2005. The work was carried out in accordance with our Quality Control Plan for Foundations Engineering dated August 18, 2005. Philips provided Golder Associates with preliminary drawings in digital format which show the proposed high mast locations and topographic mapping for this project. Callon Dietz Inc. provided Golder Associates with survey information for the proposed high mast lights and as drilled borehole locations.

2.0 SITE DESCRIPTION

2.1 General

GWP 30-00-00 comprises the design of the widening and improvements of Garden Avenue from Lynden Road, 0.6 kilometres north of the Garden Avenue/Highway 403 Interchange, to Henry Street, 0.9 kilometres south of the interchange in the City of Brantford, Ontario. The location of the project is shown on the Key Plan, Figure 1.

Highway 403 in the vicinity of the Garden Avenue interchange is currently a four lane divided highway. Garden Avenue is a four lane divided road within the interchange area.

The land bordering the project limits is mainly agricultural and consists of vacant fields with shrubs or small woodlots. Some industrial development is situated between Sinclair Boulevard and the interchange, and off Henry Street and Garden Avenue, and a commercial development is located at the northwest quadrant of the interchange area. Immediately west and south of the interchange, a tributary to the Fairchild Creek flows southeastwards and skirts the south side of the W-N/S ramp. At normal stage, the creek water level is approximately at elevation 205 metres in the vicinity of the W-N/S ramp.

2.2 Site Geology

This project lies within the physiographic region of southwestern Ontario known as the Norfolk Sand Plain[1]. Near the area of the site, the Horseshoe Moraines intersect the sand plain. In the area of the site, a discontinuous veneer of surficial sandy soil deposited in glacial Lakes Whittlesey and Warren overlies extensive deposits of stratified clays and silts associated with the Haldimand Clay Plain.

Based on the Ontario Department of Mines and Northern Affairs Map 2241 entitled “Granular Deposits of the Brantford Area” dated 1972, the soils at the site consist of glaciolacustrine deep water sediments, mainly Lake Warren and younger. These are predominantly stratified to varved silts and clays with minor sand and are locally overlain by a veneer of sand.

Bedrock in the area of the site is considered to consist of shale and dolomite belonging to the Salina Formation of Upper Silurian Age. Bedrock surface topographical mapping and information from the MTO Geocres system indicates that the bedrock surface in the area of the site is at about elevation 184 metres or some 25 metres below the existing ground surface.

[1] L.J. Chapman and D.F. Putnam: The Physiography of Southern Ontario, Third Edition. Ontario Geological Survey, Special Volume 2, 1984.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on December 20, 21 and 22, 2005 and January 9 and 10, 2006. A total of seven boreholes was drilled to depths 10.4 to 11.1 metres at the locations shown on Drawing 1. Consistent with the Terms of Reference, boreholes were advanced at half of the proposed high mast light locations.

The table below summarizes the borehole locations, ground surface elevations and depths.

BOREHOLE	LOCATION (m) Northing	LOCATION (m) Easting	GROUND SURFACE ELEVATION (m)	BOREHOLE DEPTH (m)
1	4781031.7	245915.5	217.16	10.36
2	4781044.9	246331.5	215.52	10.36
3	4781227.4	246825.7	217.05	10.36
4	4781139.1	246990.7	214.30	11.13
5	4781129.5	246706.4	211.60	10.36
6	4781052.4	246884.5	214.67	10.36
7	4781144.4	247308.7	208.87	10.36

The boreholes were drilled using an all-terrain CME750 power auger supplied and operated by Lantech Drilling Services Inc., a specialist drilling contractor. In the boreholes, samples of the overburden were obtained at suitable intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. In addition, in situ vane shear strength testing was carried out in the softer cohesive strata, where feasible. The boreholes were terminated at depths of 10.4 to 11.1 metres below the existing ground surface. Groundwater conditions in the boreholes were observed throughout the drilling operations. Piezometers were installed in boreholes 1 and 3 as indicated on the corresponding Record of Borehole sheets. Groundwater observations are indicated on the Record of Borehole sheets and summarized in Section 4. All boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 128/03.

The field work was supervised on a full-time basis by experienced members of our engineering staff who obtained service locates at the borehole locations, directed the drilling, sampling and in situ testing operations and logged the boreholes. The samples were identified in the field, placed in labeled containers and transported to our London laboratory for further examination and testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg limits determinations were carried out on selected samples. The results of the testing are shown on the Records of Boreholes and on Figures A-1 to A-4, inclusive, in Appendix A.

The borehole locations and ground surface elevations at the borehole locations were provided by Callon Dietz Inc. It is understood that the elevations are referenced to a geodetic datum. The locations of the boreholes are shown on the Record of Borehole sheets and on Drawing 1.

4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the in situ testing and the laboratory testing carried out on selected samples, are given on the attached Record of Borehole sheets following the text of this report, in Appendix A. The stratigraphic boundaries are inferred from non-continuous samples and observations of drilling resistance and, therefore, may represent transitions between soil types rather than exact planes of geological change. Further, the subsurface conditions will vary between and beyond the borehole locations.

The soil conditions as found in the boreholes were variable but generally consisted of surficial layers of topsoil and fill underlain by extensive deposits of silty clay or clayey silt interlayered with silt. A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and is summarized in the following sections.

4.1.1 Topsoil

Topsoil, 80 to 180 millimetres in depth, was noted at the ground surface of boreholes 1 to 5 and 7. A 210 millimetre thick layer of buried topsoil was encountered beneath the fill in borehole 6 at elevation 213.3 metres.

4.1.2 Fill

The topsoil at boreholes 3 and 4 was underlain by fill from elevations 217.0 and 214.2 metres, respectively. Fill was also encountered at the ground surface of borehole 6. The fill layers were generally 1.4 metres thick and consisted of clayey silt with trace amounts of sand and gravel.

The fill had standard penetration test N values of 8 to 20 blows per 0.3 metres and water contents of 18 to 27 per cent.

4.1.3 Upper Silty Clay

An upper silty clay stratum was found near approximate elevation 215.7 metres beneath the clayey silt in borehole 1, the topsoil in borehole 2, and the fill in borehole 3. The upper silty clay was also encountered below the buried topsoil in borehole 6 at elevation 213.1 metres. The upper silty clay layers were 2.8 to 4.9 metres thick and contained silt layers and seams. The results of grain size analyses conducted on samples of upper silty clay material are presented on Figure A-1 in Appendix A.

Standard penetration test values of 9 to 24 blows per 0.3 metres were measured. The upper silty clay is stiff to very stiff based on the N values and a single undrained in situ vane shear strength measurement of greater than 144 kilopascals.

Water contents of the upper silty clay varied between 21 and 29 per cent with an average of 25 per cent. The upper silty clay is typically of intermediate plasticity based on average plastic and liquid limits of 17 and 39 per cent, respectively, and an average plasticity index of 22 per cent. The results of the Atterberg Limits testing of samples of the upper silty clay stratum are presented on Figure A-4.

4.1.4 Silt

Layers of silt with clayey seams were encountered in the boreholes beneath the upper silty clay in boreholes 1 to 3 and 6 at elevations 200.3 to 211.4 metres, the clayey silt in borehole 4 at elevation 212.2 metres, the topsoil in borehole 5 at elevation 211.4 metres and the lower silty clay layers in boreholes 4 and 7 at elevations 201.7 to 210.6 metres. Grain size distribution curves for silt samples are shown on Figure A-2.

The silt had measured N values of 7 to 24 blows per 0.3 metres and water contents between 19 and 30 per cent.

4.1.5 Lower Silty Clay

Deposits of lower silty clay were at elevations 200.3 to 211.4 metres beneath the silt layers in boreholes 3, 4 and 7, and beneath the clayey silt in borehole 6. Boreholes 3, 4, 6 and 7 were terminated in the lower silty clay layers. The results of the grain size analyses on the silty clay are presented on Figure A-1.

Standard penetration test values of 4 to 21 blows per 0.3 metres were measured in the lower silty clay deposits. The silty clay is firm to very stiff but generally stiff based on undrained in situ vane shear strengths of 109 to greater than 144 kilopascals. A single vane sensitivity of 3.2 was measured.

Water contents of the silty clay strata varied between 21 and 33 per cent with an average of 27 per cent. The lower silty clay is an inorganic clay of low plasticity based on a single sample with plastic and liquid limits of 19 and 33 per cent and a plasticity index of 14 per cent. The results of the Atterberg Limits testing of the lower silty clay are presented on Figure A-4.

4.1.6 Clayey Silt

Clayey silt was encountered beneath the silt layers in boreholes 1, 2, 5 and 6 at elevation 209.5 metres to about 210.4 metres and below the fill in borehole 4 at elevation 212.8 metres. Where fully penetrated, the clayey silt layers are 0.6 to 4.3 metres thick. Boreholes 1, 2 and 5 were terminated in the clayey silt. Grain size distribution curves for four samples of clayey silt are presented on Figure A-3.

The clayey silt had N values ranging from 4 to 21 blows per 0.3 metres. The clayey silt is very stiff based on undrained in situ vane shear strengths of 126 to greater than 144 kilopascals. The average vane sensitivity was 2.4.

The water content of samples of the clayey silt varied between 18 and 34 per cent with an average of 26 per cent. The results of the Atterberg limits testing are shown on the Plasticity Chart on Figure A-4 indicate a low plasticity clay.

4.1.7 Bedrock

Borehole information from a previous investigation conducted by the MTO for the Garden Avenue Interchange Underpass indicated that bedrock was proved at approximate elevation 185.2 metres after penetrating 30 metres of stratified silty clay overburden.[2] The bedrock was described as moderately fractured dolomite bedrock of the Salina Formation.

4.2 Groundwater Conditions

Groundwater conditions in the boreholes were observed during and on completion of drilling and sampling. Piezometers were installed in boreholes 1 and 3 prior to backfilling. Details of the groundwater conditions encountered in the boreholes, piezometer installations, and measured groundwater levels are provided below and on the Record of Borehole sheets.

[2] Ontario Ministry of Transportation 1979. Foundation Investigation for Garden Avenue Interchange Underpass, G.W.P. No. 66-67-07. Geocres No. 40P01-79.

Groundwater was encountered in all boreholes during the investigation. Groundwater was encountered between elevations 201.7 and 213.5 metres or at depths of 1.4 to 7.2 metres below the existing ground surface.

The most recent measurements in the piezometers were obtained on January 10, 2006. The groundwater levels were found to be 2.7 and 3.8 metres below the existing ground surface or at elevations 214.4 metres and 213.2 metres at boreholes 1 and 3, respectively.

The following table provides a summary of the groundwater levels.

SUMMARY OF GROUNDWATER LEVELS

BOREHOLE	GROUND SURFACE ELEVATION (m)	ENCOUNTERED GROUNDWATER LEVEL		MEASURED GROUNDWATER LEVEL January 10, 2006	
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
1	217.16	3.66	213.50	2.74	214.42
2	215.52	3.66	211.86	-	-
3	217.05	6.71	210.34	3.81	213.24
4	214.30	2.44	211.86	-	-
5	211.60	1.40	210.20	-	-
6	214.67	4.57	210.10	-	-
7	208.87	7.16	201.71	-	-

The water level in the tributary creek to the Fairchild Creek adjacent to the W-N/S ramp was at approximate elevation 205 metres at the time of the field work. The groundwater levels are expected to fluctuate seasonally and are likely to be higher during periods of sustained precipitation and/or spring melt.

5.0 MISCELLANEOUS

The investigation was carried out using power equipment owned and operated by Lantech Drilling Services Ltd., an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Lubo Kosc under the direction of Mr. David J. Mitchell. The laboratory testing was carried out at Golder Associates' London laboratory under the direction of Mr. Chris M. Sewell. The laboratory is an accredited participant in the MTO Soil and Aggregate Proficiency Program and is certified by the Canadian Council of Independent Laboratories for testing Types C and D aggregates. This report was prepared by Ms. Dirka U. Prout, P. Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P. Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

GOLDER ASSOCIATES LTD.

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PART B – FOUNDATION DESIGN REPORT

HIGH MAST LIGHTS
FORMER HIGHWAY 403 (GARDEN AVENUE)/
HIGHWAY 403 INTERCHANGE
GWP 30-00-00, AGREEMENT NO. 3005-E-0017
MINISTRY OF TRANSPORTATION – SOUTHWESTERN REGION

March 2006 05-1130-139-0

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides our recommendations on the foundation aspects of the design of the proposed high mast lights (HML) to be constructed as part of GWP 30-00-00. The recommendations are based on our interpretation of the factual information obtained from a limited number of boreholes drilled during the investigation and on the available background information collected by others. 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 methods and scheduling.

Based on the information provided, thirteen (13) HML are to be constructed. The proposed locations of the high mast lights (HML) are detailed below:

HML	LOCATION		
DESIGNATION	NORTHING	EASTING	ELEVATION (m)
1	4781034	245916	216.96
2	4781115	246128	217.17
3	4781045	246332	215.52
4	4781138	246487	214.30
5	4781039	246623	211.96
6	4781243	246711	214.93
7	4781129	246706	211.60
8	4780937	246813	215.45
9	4781227	246826	217.05
10	4781052	246885	214.67
11	4781139	246991	214.30
12	4781052	247127	215.72
13	4781144	247309	208.87

Based on the proposed HML locations, the site topography and the results of the boreholes, the subsurface conditions at each of the HML locations may be based on the relevant borehole(s) as outlined below:

BOREHOLE	HML
1	1 and 2
2	3 and 4
3	6 and 9
4	11
5	5 and 7
6	8, 10 and 12
7	13

6.2 Foundation Design Parameters

6.2.1 Vertical Loads

It is assumed that the foundations will consist of drilled, cast-in-place, concrete caissons. The design frost depth for this site is 1.2 metres. Any portion of the caisson within fill, topsoil and/or organic materials should be neglected.

The following unfactored parameters may be used for the design of the HML foundations.

SOIL TYPE	ANGLE OF FRICTION ϕ (°)	COHESION c_u (kPa)	TOTAL UNIT WEIGHT γ (kN/m^3)	SHAFT RESISTANCE FACTOR (α)
Borehole 1				
Clayey Silt (above elevation 215.8)	28	150	19	0.3
Silty Clay	26	135	19	0.4
Silt	30	N/A	19	0.3
Clayey Silt (below elevation 210.5)	28	150	19	0.3
Borehole 2				
Silty Clay	30	200	19	0.4
Silt	30	N/A	19	0.3
Clayey Silt	28	150	19	0.4
Borehole 3				
Fill	N/A	N/A	N/A	N/A
Silty Clay (above elevation 210.8)	26	200	19	0.4
Silt	30	N/A	19	0.3
Silty Clay (below elevation 209.6)	26	150	19	0.4

SOIL TYPE	ANGLE OF FRICTION ϕ (°)	COHESION c_u (kPa)	TOTAL UNIT WEIGHT γ (kN/m^3)	SHAFT RESISTANCE FACTOR (α)
Borehole 4				
Fill	N/A	N/A	N/A	N/A
Clayey Silt	28	200	19	0.3
Silt	30	N/A	19	0.3
(above elevation 211.4)				
Silty Clay	26	200	19	0.4
(above elevation 210.6)				
Silt	30	N/A	19	0.3
(below elevation 210.6)				
Silty Clay	26	60	19	0.4
(below elevation 208.7)				
Borehole 5				
Silt	30	N/A	19	0.3
Clayey Silt	28	60	19	0.3
Borehole 6				
Fill	N/A	N/A	N/A	N/A
Topsoil	N/A	N/A	N/A	N/A
Silty Clay	26	200	19	0.4
(above elevation 200.3)				
Silt	30	N/A	19	0.3
Clayey Silt	28	150	19	0.3
Silty Clay	26	60	19	0.4
(below elevation 205.2)				
Borehole 7				
Silty Clay	26	200	19	0.4
(above elevation 206.1)			19	
Silt	30	N/A		0.3
(above elevation 205.2)			19	
Silty Clay	26	150		0.4
(from elevation 205.2 to 201.7)			19	
Silt	30	N/A	19	0.3
Silty Clay	26	60	19	0.4
(below elevation 200.3)				

Based on the subsurface conditions encountered in the boreholes, the unit shaft resistance, F_s, that may be used in the assessment of the vertical load carrying capacity of the caissons may be calculated using the following equation:

$$F_s = \alpha \, c_u \, d \, C$$

where α is a shaft resistance factor, d is the depth along the caisson, C is the circumference of the caisson, and c_u is the average undrained shear strength of each layer.

The upper 1.2 metres below the ground surface should be neglected to account for frost action. Any portion of the caisson within fill materials should also be neglected.

The component of the vertical load carrying capacity that may be derived from end bearing in the cohesive soils may be calculated using the following equation:

$$Q_b=9c_u A_b$$

where c_u is the undrained shear strength of the cohesive founding layer and A_b in the cross-sectional area of the caisson.

A resistance factor of 0.4 should be applied to obtain the factored axial resistance at ultimate limit states (ULS).

For analytical purposes, the relatively thin (typically less than 1 metre thick) silt layers in boreholes 1, 2, 3, 4, 6 and 7 may be assumed to have the properties of the cohesive soil strata. However, for the thicker layers in boreholes 4, 5 and 7, the following parameters should be used:

LOCATION	SOIL TYPE	ELEVATION (m)	TOTAL UNIT WEIGHT, γ (kN/m³)	BEARING CAPACITY FACTOR, N_t	SHAFT RESISTANCE FACTOR, β
Borehole 4	Silt	210.6 to 208.7	19	30	0.3
Borehole 5	Silt	211.4 to 209.5	19	30	0.3
Borehole 7	Silt	201.7 to 200.3	19	30	0.3

In these silt layers, the unfactored axial resistance of the caisson may be calculated by:

$$R = \Sigma (Cq_S\Delta z) + A_t q_b$$

where

R	=	unfactored axial capacity of the caisson (kN)
C	=	circumference of the (m) caisson
Δz	=	elemental layer thickness (m)
A_t	=	cross sectional area of the caisson (m^2)
q_S	=	shear stress along the shaft = $\beta\sigma_v'$
β	=	shaft resistance factor
q_b	=	bearing capacity of the caisson base = $N_t\sigma_b'$
N_t	=	bearing capacity factor

The shear stress may be calculated using the vertical effective stress, in kilopascals, adjacent to the caisson. The bearing capacity at the base of the caisson may be calculated using the vertical effective stress at the caisson base in kilopascals. A groundwater level at the ground surface should be assumed for design.

6.2.2 Resistance to Lateral Loads

The lateral loads exerted by the caissons will be resisted primarily by cohesive soils. The passive resistance in front of the caisson within the upper 1.2 metres below the ground surface should be neglected in the design of the foundation to account for frost action.

The lateral resistance of the cohesive soils along the shaft is represented by a constant distribution with depth and given by $9c_u$ B, where c_u is the undrained shear strength in kilopascals and B is the shaft diameter in metres. The unfactored lateral force resisted by a shaft of length L (in metres) is given by:

$$P = 9\ c_u\ B\ (L - 1.5B)$$

The above equation is based on the assumption that the lateral geotechnical resistance acts over a width equal to 3 times the shaft diameter. Also, large deformations (lateral movement) would be required to fully mobilize lateral shaft resistance. A resistance factor of 0.5 should be applied to obtain the factored lateral resistance at ULS.

For the significant silt layers in boreholes 4, 5 and 7, the unfactored passive lateral earth pressure, P_p, distributed along the length of the caisson foundation may be calculated using the following equations:

$$P_p = K_p\, \gamma\, d \qquad \text{above the groundwater level, and}$$
$$P_p = K_p\, \gamma\, d_w + K_p\, \gamma'\, (d - d_w) \qquad \text{below the groundwater level,}$$

where K_p is the passive earth pressure coefficient;
γ is the total unit weight (kN/m³);
γ' is the effective unit weight of soil below the groundwater level (kN/m³);
d is the depth below the ground surface (m); and
d_w is the depth to the groundwater level (m).

The lateral earth pressures may be assumed to act over an equivalent width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtain the factored lateral geotechnical resistance.

The stratigraphy and design parameters for the significant silt strata encountered in the boreholes at the HML pole locations are given below:

LOCATION	SOIL TYPE	ELEVATION	DESIGN PARAMETERS ϕ'	γ	γ'	K_p
Borehole 4	Silt	210.6 to 208.7	30	19	9	3.0
Borehole 5	Silt	211.4 to 209.5	30	19	9	3.0
Borehole 7	Silt	201.7 to 200.3	30	19	9	3.0

where ϕ' = effective friction angle (degrees);
γ = total unit weight of soil (kN/m^3);
γ' = effective unit weight of soil below the groundwater level (kN/m^3); and
K_p = passive earth pressure coefficient.

The upper 1.2 metres below ground surface should be neglected to account for frost action. Also, any portion of the caisson in fill materials should be neglected.

6.3 Construction Considerations

A temporary liner will be required to support the sides of the excavation and permit cleaning and inspection of the base. Alternatively, mud drilling techniques could be considered. Careful cleaning of the base of the caisson should be carried out prior to placement of concrete to remove all loosened or disturbed materials. Surface water runoff should be directed away from the excavation.

7.0 MISCELLANEOUS

This report was prepared by Ms. Dirka U. Prout, P.Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

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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

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.) split spoon sampler for a distance of 300 mm (12 in.)

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, 60º 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 cm^2 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.

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

(b) Cohesive Soils

Consistency	c_u, s_u kPa	c_u, s_u psf
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

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
in 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
v	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 stress (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

(a) Index Properties (continued)

w	water content
w_l	liquid limit
w_p	plastic limit
l_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)

(b) 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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_a	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	over-consolidation ratio = σ'_p/σ'_{vo}

(d) 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 δ
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

* density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

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London, Ontario

RECORD OF BOREHOLE No 1

METRIC

PROJECT 05-1130-139-0

G.W.P. 30-00-00 LOCATION N 4781031.7 ;E 245915.5 ORIGINATED BY LK

DIST ____ HWY 403 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY WDF

DATUM GEODETIC DATE December 20, 2005 CHECKED BY ____

ELEV / DEPTH	DESCRIPTION (SOIL PROFILE)	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.16	GROUND SURFACE				
0.00	TOPSOIL, silty Black				
0.18	CLAYEY SILT, trace sand, with silt layers Stiff Brown	1	SS	10	
215.79 1.37	SILTY CLAY, with silt layers Stiff to Very Stiff Brown to Grey at about elev. 214.2m	2	SS	21	0 1 53 46
		3	SS	19	
		4	SS	13	
		5	SS	9	
		6	SS	9	
211.37 5.79	SILT, trace sand, with clayey silt layers Compact Grey	7	SS	24	
210.46 6.70	CLAYEY SILT, trace to some sand, with silt layers Stiff to Very Stiff Grey	8	SS	9	
		9	SS	11	0 11 64 25
		10	SS	10	
206.80 10.36	END OF BOREHOLE Ground water encountered at elev. 213.50m during drillng Dec. 20, 2005. Water level measured at elev. 214.36m Dec. 22, 2005. Water level measured at elev. 214.42m Jan. 10, 2006.				

Column headings: SOIL PROFILE (ELEV DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE (217, 216, 215, 214, 213, 212, 211, 210, 209, 208, 207); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (10 20 30); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL.

Shear strength (field vane): (>144kPa) at about elev. 211.7; 126.4 (sensitivity 2.4) and 132.1 (sensitivity 2.3) at about elev. 209.6–209.3.

$+^3, \times^3$: Numbers refer to Sensitivity ○ $^{3\%}$ STRAIN AT FAILURE

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RECORD OF BOREHOLE No 2

METRIC

PROJECT 05-1130-139-0

G.W.P. 30-00-00

LOCATION N 4781044.9 ;E 246331.5

ORIGINATED BY LK / DJM

DIST HWY 403

BOREHOLE TYPE POWER AUGER / HOLLOW STEM

COMPILED BY WDF

DATUM GEODETIC

DATE December 20, 2005 - December 21, 2005

CHECKED BY

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.52	GROUND SURFACE					
0.06	TOPSOIL, silty Black					
	SILTY CLAY, trace sand, with silt layers and seams Stiff to Very Stiff Brown to Grey at about elev. 214.4m	1	SS	20		
		2	SS	21		
		3	SS	15		0 1 66 33
		4	SS	16	∇ (elev. 211.86m)	
		5	SS	14		
211.10 4.42	SILT, some clay, with clayey silt layers Compact Grey	6	SS	13		0 0 88 22
210.34 5.18	CLAYEY SILT, trace sand, with silt layers Stiff to Very Stiff Grey	7	SS	14		
		8	SS	9		
		9	SS	11		
		10	SS	10		
	(>144kPa) at elev. 207					
		11	SS	12		
		12	SS	10		
205.16 10.36	END OF BOREHOLE Ground water encountered at elev. 211.86m during drillng Dec. 20, 2005.					

Plot columns: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20, 40, 60, 80, 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (10, 20, 30); UNIT WEIGHT γ kN/m³; ELEVATION SCALE 215 to 206.

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

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RECORD OF BOREHOLE No 3

METRIC

PROJECT 05-1130-139-0
G.W.P. 30-00-00
LOCATION N 4781227.4 ;E 246825.7
ORIGINATED BY DJM
DIST ___ HWY 403
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
COMPILED BY WDF
DATUM GEODETIC
DATE December 21, 2005
CHECKED BY ___

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	GR SA SI CL
217.05	GROUND SURFACE						
0.06	TOPSOIL, silty, Dark Brown						
	FILL, clayey silt, trace sand, trace gravel, Very Stiff, Brown	1	SS	20	216		
215.68 / 1.37	SILTY CLAY, with silt layers, Stiff to Very Stiff, Brown to Grey at about elev. 213.0m	2	SS	14	215	w_L = 44	
		3	SS	17	214	w_L = 45	0 1 46 53
		4	SS	16			
		5	SS	12	213		
		6	SS	16	212		
		7	SS	10	211		
210.80 / 6.25	SILT, trace clay, with clayey silt layers, Compact, Grey	8	SS	15	210		0 0 96 4
209.58 / 7.47	SILTY CLAY, with silt layers, Stiff, Grey	9	SS	10	209, 208		
		10	SS	9	207		
206.69 / 10.36	END OF BOREHOLE						

Ground water encountered at elev. 210.34m during drillng Dec. 21, 2005.

Water level measured at elev. 213.45m Dec. 22, 2005.

Water level measured at elev. 213.24m Jan. 10, 2006.

Legend: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%).

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

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RECORD OF BOREHOLE No 4

METRIC

PROJECT 05-1130-139-0
G.W.P. 30-00-00
DIST ____ HWY 403
DATUM GEODETIC

LOCATION N 4781139.1 ;E 246990.7
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE December 21, 2005

ORIGINATED BY LK / DJM
COMPILED BY WDF
CHECKED BY ____

ELEV / DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%)	GR	SA	SI	CL
214.30	GROUND SURFACE									
0.09	TOPSOIL, silty, Dark Brown									
	FILL, clayey silt, trace sand, with silt layers, Stiff, Brown and Grey	1	SS	8		○				
212.78 / 1.52	CLAYEY SILT, with silt layers, Very Stiff, Brown	2	SS	21		○				
212.17 / 2.13	SILT, trace clay, with clayey silt layers, Compact, Brown and Grey	3	SS	14	∇ (211.86)	○				
211.41 / 2.89	SILTY CLAY, with silt layers, Stiff, Grey	4	SS	12		○				
210.64 / 3.66	SILT, trace clay, with clayey silt layers, Loose to Compact, Grey	5	SS	15		○	0	0	83	17
		6	SS	7		○				
208.74 / 5.56	SILTY CLAY, with silt layers, Firm to Stiff, Grey	7	SS	8		○				
		8	SS	9		○				
		9	SS	6		○				
		10	SS	4		○				
203.17 / 11.13	END OF BOREHOLE									

Ground water encountered at elev. 211.86m during drillng Dec. 21, 2005.

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; ELEVATION SCALE (214 to 204); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (10, 20, 30); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

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RECORD OF BOREHOLE No 5

METRIC

PROJECT 05-1130-139-0

G.W.P. 30-00-00

LOCATION N 4781129.5 ;E 246706.4

ORIGINATED BY LK / DJM

DIST ___ HWY 403

BOREHOLE TYPE POWER AUGER / HOLLOW STEM

COMPILED BY WDF

DATUM GEODETIC

DATE December 22, 2005

CHECKED BY ___

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
211.60	GROUND SURFACE									
0.00	TOPSOIL, clayey Black					211				
0.18	SILT, trace clay, with clayey silt layers Loose to Compact Brown	1	SS	9	∇					
		2	SS	14		210				
209.47 2.13	CLAYEY SILT, trace sand, with silt layers Firm to Stiff Brown to Grey at about elev. 208.6m	3	SS	12		209	0	1	65	34
		4	SS	4		208				
		5	SS	6			0	0	62	38
		6	SS	6		207				
		7	SS	6		206				
		8	SS	5		205, 204				
		9	SS	5		203				
		10	SS	7		202				
201.24 10.36	END OF BOREHOLE Ground water encountered at elev. 210.20m during drillng Dec. 22, 2005.									

Dynamic Cone Penetration Resistance Plot: 20, 40, 60, 80, 100

Shear Strength kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20, 40, 60, 80, 100

Plastic Limit w_P — Natural Moisture Content w — Liquid Limit w_L; Water Content (%): 10, 20, 30

Unit Weight γ kN/m³

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 6

METRIC

PROJECT 05-1130-139-0
G.W.P. 30-00-00
LOCATION N 4781052.4 ;E 246884.5
ORIGINATED BY DJM
DIST HWY 403
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
COMPILED BY WDF
DATUM GEODETIC
DATE January 9, 2006
CHECKED BY

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.67	GROUND SURFACE					
0.00	FILL, clayey silt, trace sand, Siff, Brown	1	SS	14		
213.30 / 1.37	TOPSOIL, clayey, Black					
1.58	SILTY CLAY, trace sand, with silt layers and seams, Stiff to Very Stiff, Brown	2	SS	12		
		3	SS	24		
		4	SS	14		
		5	SS	12		0 5 49 46
210.25 / 4.42	SILT, trace clay, with silty clay layers, Compact, Brown	6	SS	14	▽	
209.49 / 5.18	CLAYEY SILT, with silt layers and seams, Stiff to Very Stiff, Grey	7	SS	9		
	(field vane >144kPa)					
		8	SS	9		0 0 61 39
		9	SS	8		
	(field vane >144kPa)					
205.22 / 9.45	SILTY CLAY, trace sand, with silt layers and seams, Firm, Grey	10	SS	7		
204.31 / 10.36	END OF BOREHOLE					

Ground water encountered at elev. 210.10m during drillng Jan. 9, 2006.

Chart columns: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20, 40, 60, 80, 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (10, 20, 30); UNIT WEIGHT γ kN/m³; ELEVATION SCALE 214–205.

Plot annotations: (>144kPa) at elev. ~208.4 and ~205.4; liquid limit 42 at sample 5.

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

ON_MTO 051130139HML.GPJ ON_MOT.GDT 3/14/06

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London, Ontario

RECORD OF BOREHOLE No 7

METRIC

PROJECT	05-1130-139-0		
G.W.P.	30-00-00	LOCATION	N 4781144.4 ;E 247308.7
DIST		HWY	403
BOREHOLE TYPE	POWER AUGER / HOLLOW STEM		
DATUM	GEODETIC	DATE	January 10, 2006
ORIGINATED BY	DJM	COMPILED BY	WDF
CHECKED BY			

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
208.87	GROUND SURFACE
0.09	TOPSOIL, clayey Black
	SILTY CLAY, trace sand, with silt layers and seams Stiff to Very Stiff Brown
206.13 / 2.74	SILT, some clay, with silty clay layers Compact Grey
205.21 / 3.66	SILTY CLAY, with silt layers and seams Firm to Very Stiff Grey
201.71 / 7.16	SILT, some clay, with silty clay layers Compact Grey
200.34 / 8.53	SILTY CLAY, with silt layers and seams Firm to Stiff Grey
198.51 / 10.36	END OF BOREHOLE Ground water encountered at elev. 201.71m during drillng Jan. 10, 2006.

SAMPLES

NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	21	
2	SS	8	
3	SS	15	
4	SS	6	
5	SS	6	0 0 50 50
6	SS	6	
7	SS	14	
8	SS	7	
9	SS	11	

Elevation scale: 208, 207, 206, 205, 204, 203, 202, 201, 200, 199

Dynamic cone penetration resistance plot: 20, 40, 60, 80, 100

SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100)

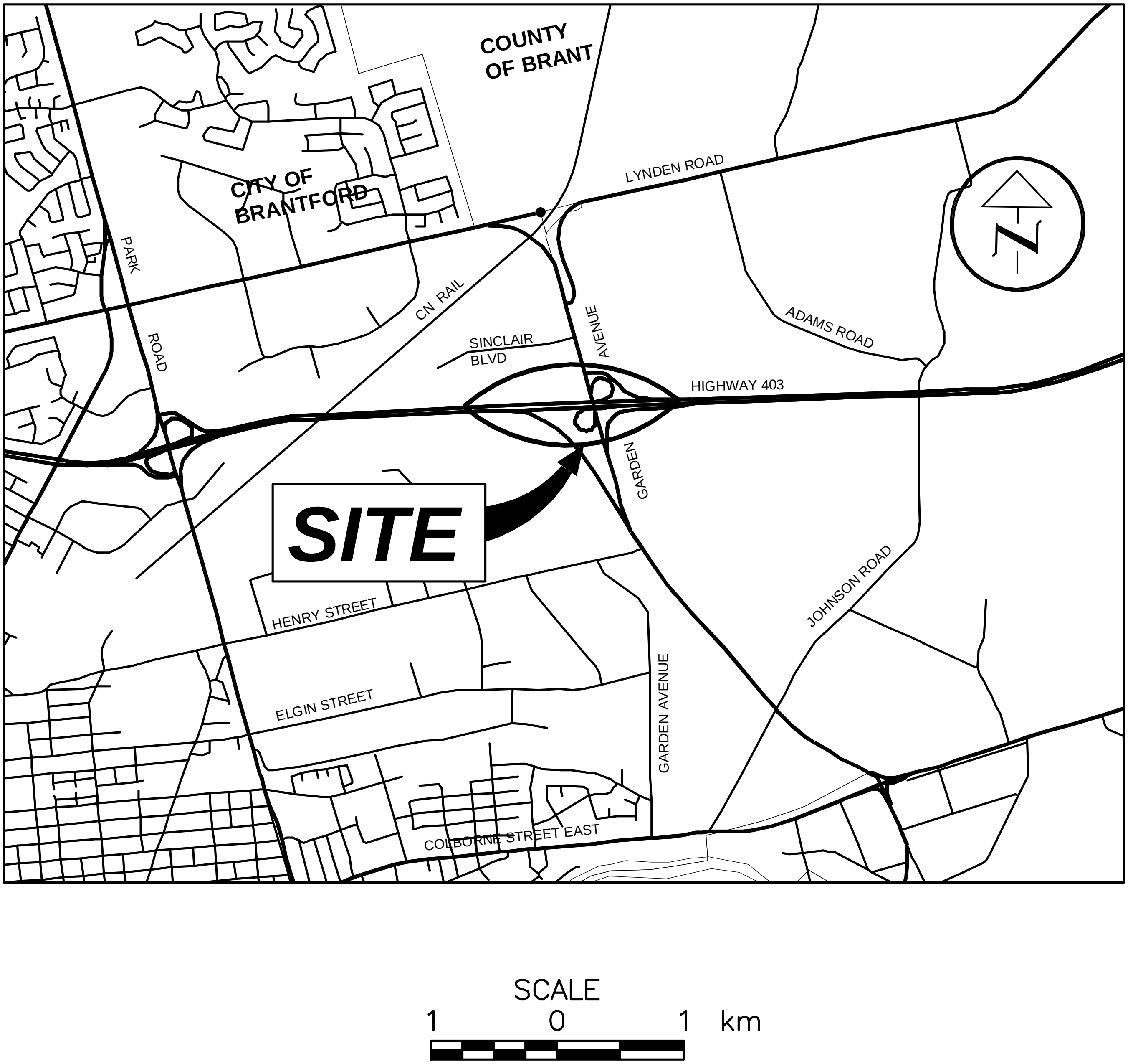
Field vane results: (>144kPa) at approx. elev. 206.4; (>144kPa) at approx. elev. 203.4; + 3.2 at approx. elev. 202.6; (>144kPa) at approx. elev. 201.6

PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10, 20, 30

UNIT WEIGHT γ kN/m³

Ground water conditions: ∇ at elev. 201.71

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



DRAWING FILE: 051130139-0F001.DWG Plot Date: Mar 14, 2006 - 9:53am

PROJECT	HIGH MAST LIGHTS GARDEN AVENUE / HIGHWAY 403 WP 30-00-00
TITLE	**KEY PLAN**

Golder Associates
LONDON, ONTARIO

PROJECT No.	05-1130-139-0		FILE No.	051130139-0F001
			SCALE AS SHOWN	REV. 0
CADD	WDF	JAN. 12/06	**FIGURE 1**	
CHECK				

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

DIST 1 HWY. 403
CONT. No.
WP No. 30-00-00

SHEET

HIGH MAST LIGHTS GARDEN AVENUE / HIGHWAY 403

BOREHOLE LOCATIONS & SOIL STRATA

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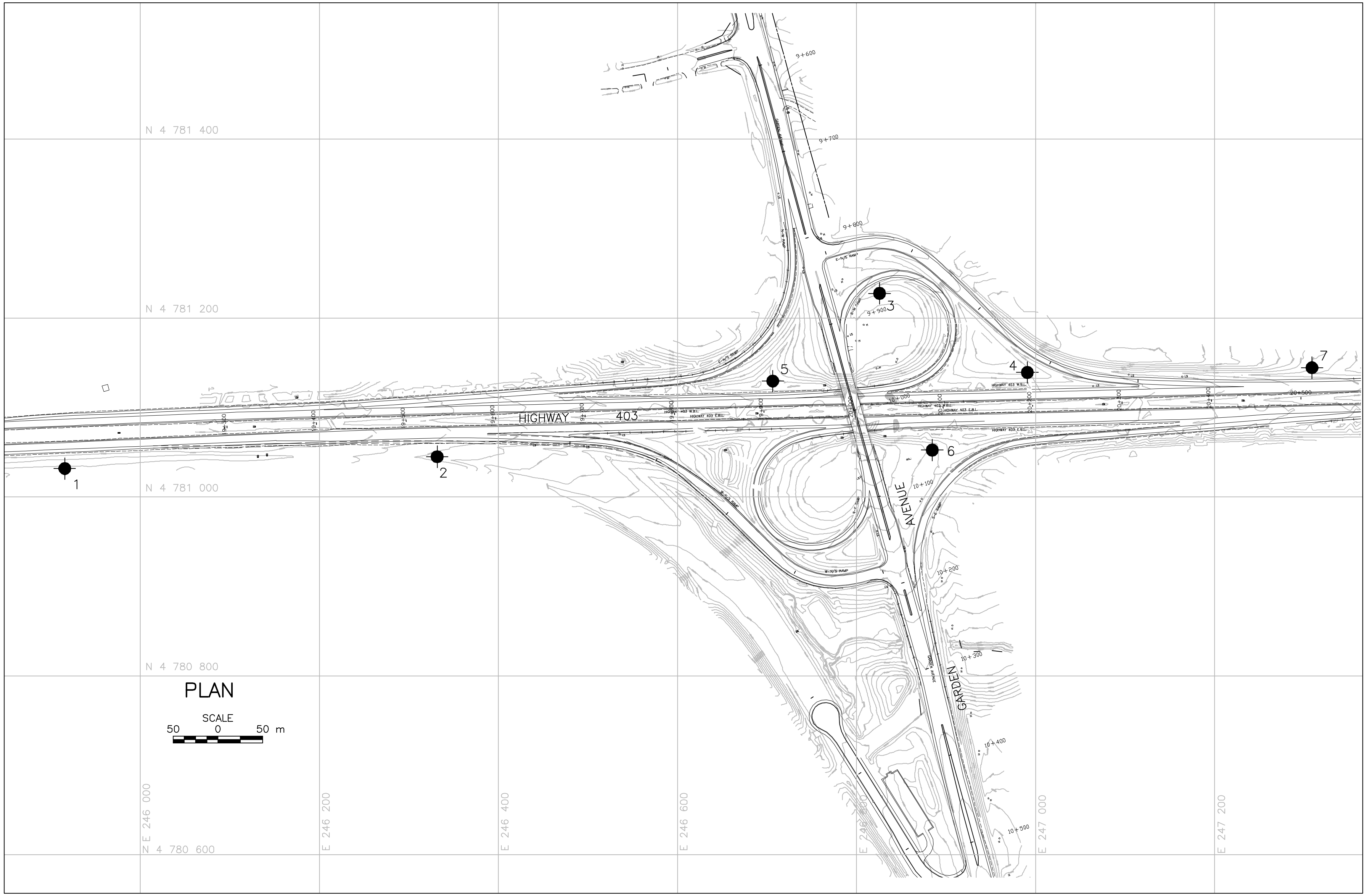
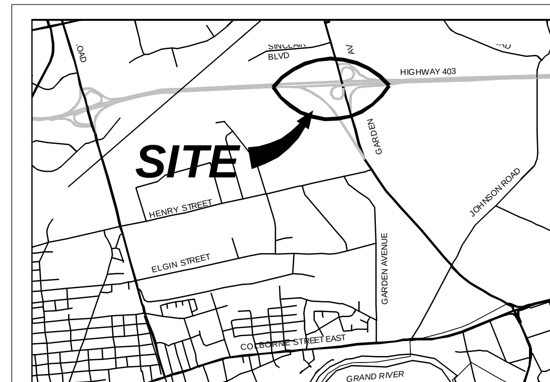
LONDON, ONTARIO, CANADA



PLAN

SCALE 50 0 50 m



KEY PLAN

SCALE 1 0 1 km

LEGEND

● Borehole

No.	ELEVATION (metres)	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	217.16	4 781 031.7	245 915.5
2	215.52	4 781 044.9	246 331.5
3	217.05	4 781 227.4	246 825.7
4	214.30	4 781 139.1	246 990.7
5	211.60	4 781 129.5	246 706.4
6	214.67	4 781 052.4	246 884.5
7	208.87	4 781 144.4	247 308.7

NOTES

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

This drawing is for subsurface information only.

REFERENCE

DRAWING SUPPLIED BY PHILIPS ENGINEERING LTD. ENTITLED HIGHWAY 403 AND GARDEN AVENUE INTERCHANGE, BRANTFORD HIGH MAST LIGHTING LAYOUT AND EXISTING GRADING & DRAINAGE CONDITIONS

NO.	DATE	BY	REVISION

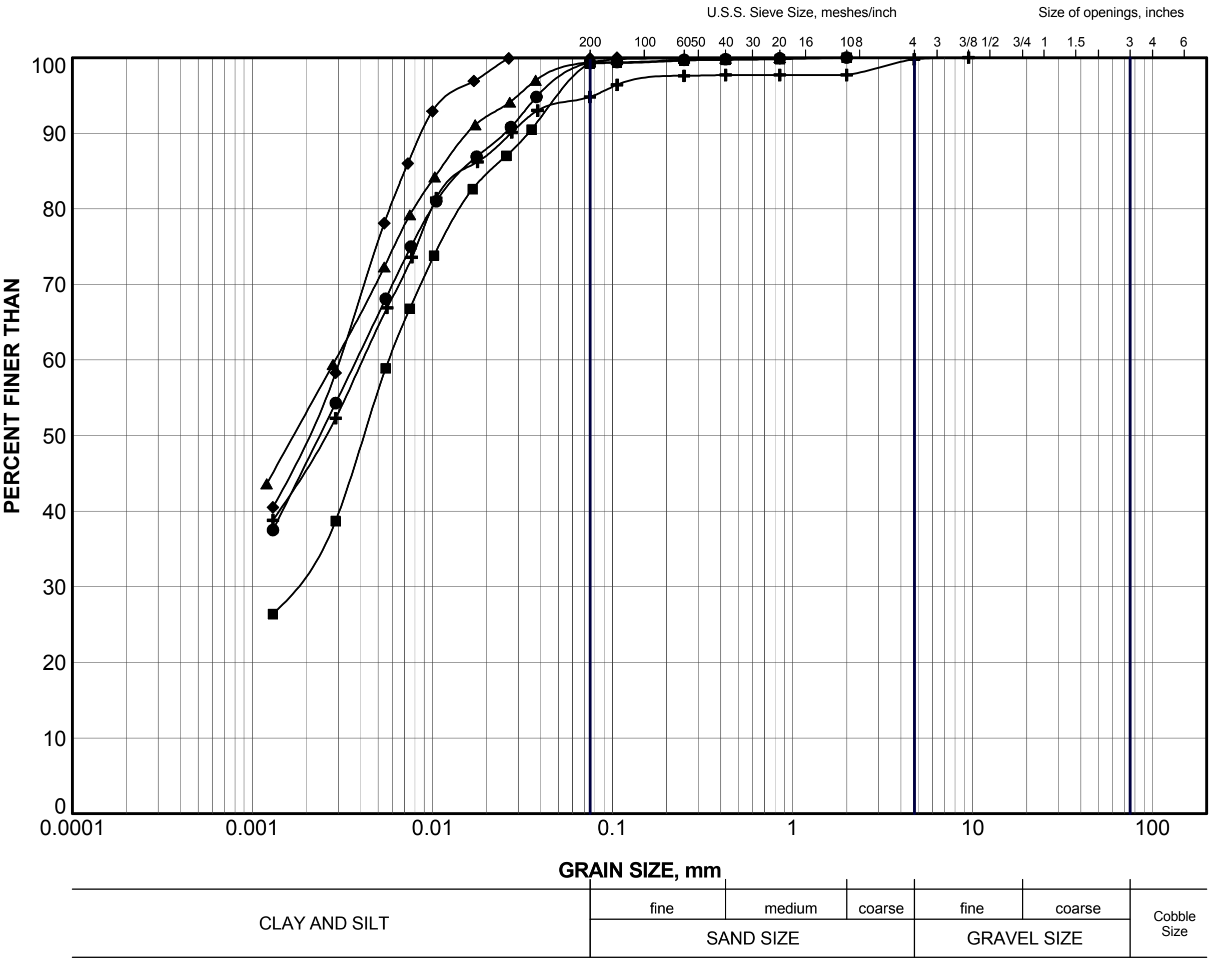
Geocres No. 40P1-93

HWY. No. 403		PROJECT NO.: 05-1130-139-0	
SUBM'D. DUP	CHKD: DUP	DATE: JAN 12/06	
DRAWN: WDF	CHKD. DUP	APPD.	DWG. 1

PLOT DATE: March 14, 2006
FILENAME: N:\Active\2005\1130 - Geotechnical\1130-100\05-1130-139 PHILIPS - GARDEN AVE FDNS - HWY 403\Drafting\Drafting - HML 05-1130-139-0\051130139-0001.dwg

APPENDIX A

LABORATORY TEST DATA



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	1	2	215.4
■	2	3	213.0
▲	3	3	214.5
✚	6	5	210.6
◆	7	5	204.1

PROJECT

HIGH MAST LIGHTS
GARDEN AVENUE AT HIGHWAY 403
GWP 30-00-00

TITLE

GRAIN SIZE DISTRIBUTION

SILTY CLAY

PROJECT No.	05-1130-139-0	FILE No.	051130139HML.GPJ
		SCALE N/A	REV.
DRAWN WDF	Jan 12/06	**FIGURE A-1**	
CHECK			

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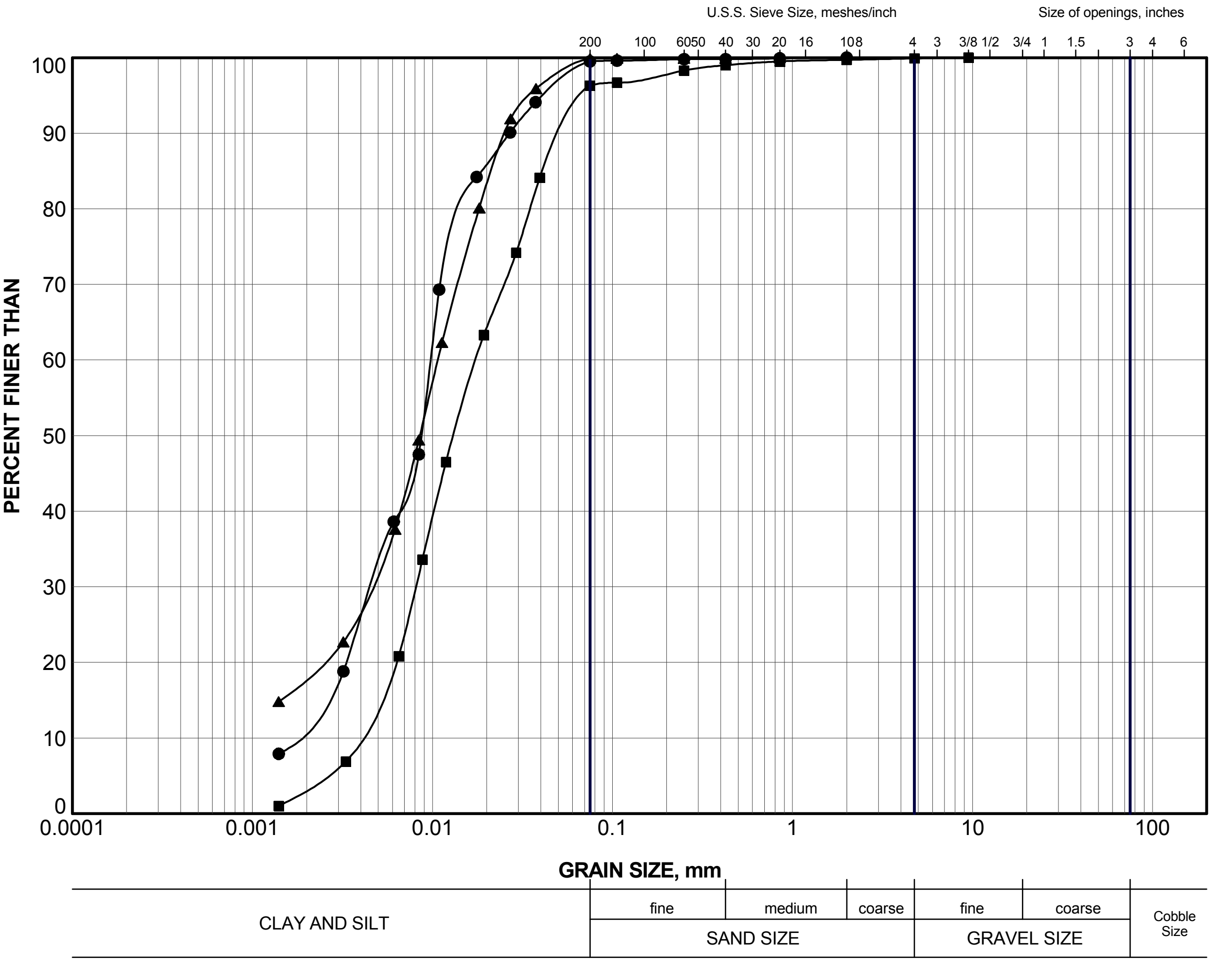
LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	2	6	210.7
■	3	8	210.0
▲	4	5	210.3

PROJECT

HIGH MAST LIGHTS
GARDEN AVENUE AT HIGHWAY 403
GWP 30-00-00

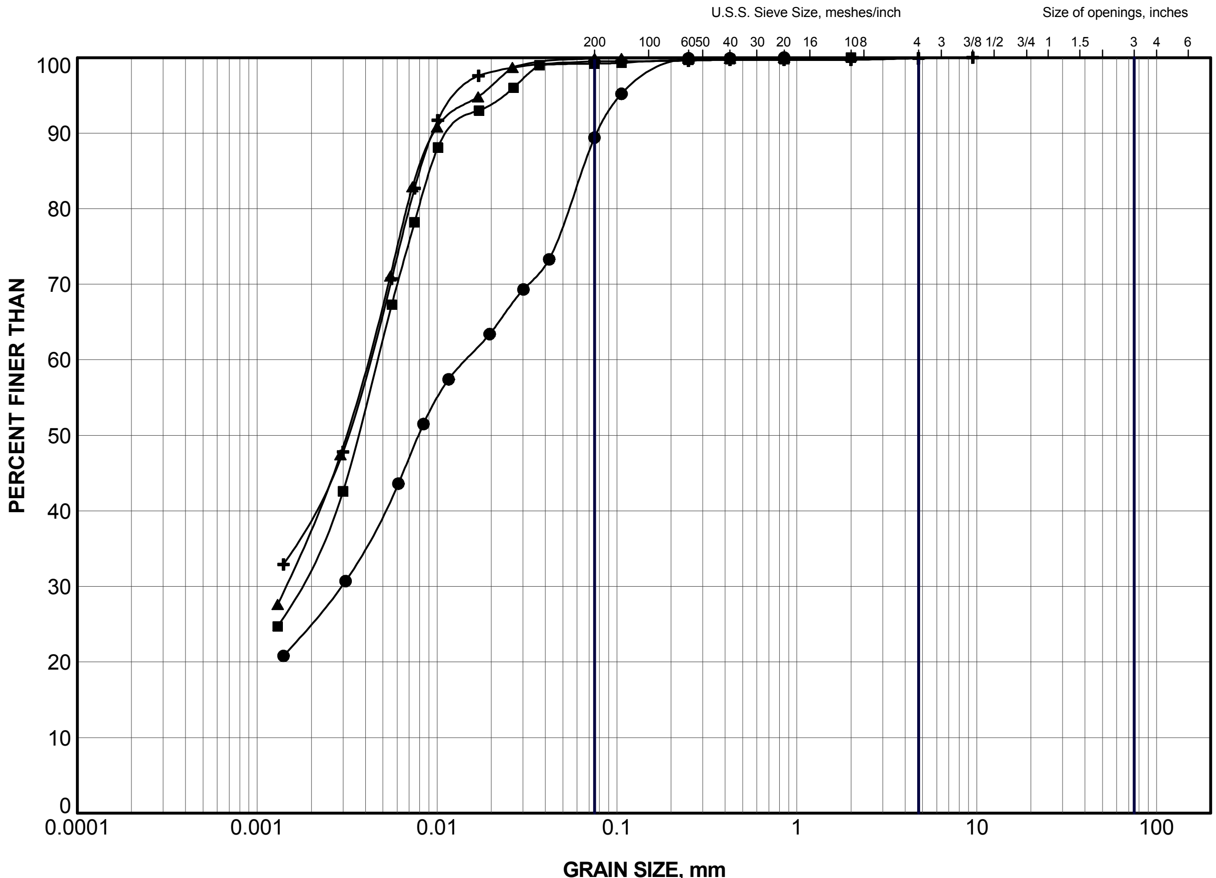
TITLE

GRAIN SIZE DISTRIBUTION

SILT (with clayey seams)

Golder Associates LONDON, ONTARIO	PROJECT No. 05-1130-139-0	FILE No. 051130139HML.GPJ	
		SCALE N/A	REV.
	DRAWN WDF Jan 12/06	FIGURE A-2	
	CHECK		

LDN_MTO_NEW GLDR_LDN.GDT



CLAY AND SILT	SAND SIZE			GRAVEL SIZE		Cobble Size
	fine	medium	coarse	fine	coarse	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	1	9	207.8
■	5	3	209.1
▲	5	5	207.6
✚	6	8	207.6

PROJECT

HIGH MAST LIGHTS
GARDEN AVENUE AT HIGHWAY 403
GWP 30-00-00

TITLE

GRAIN SIZE DISTRIBUTION

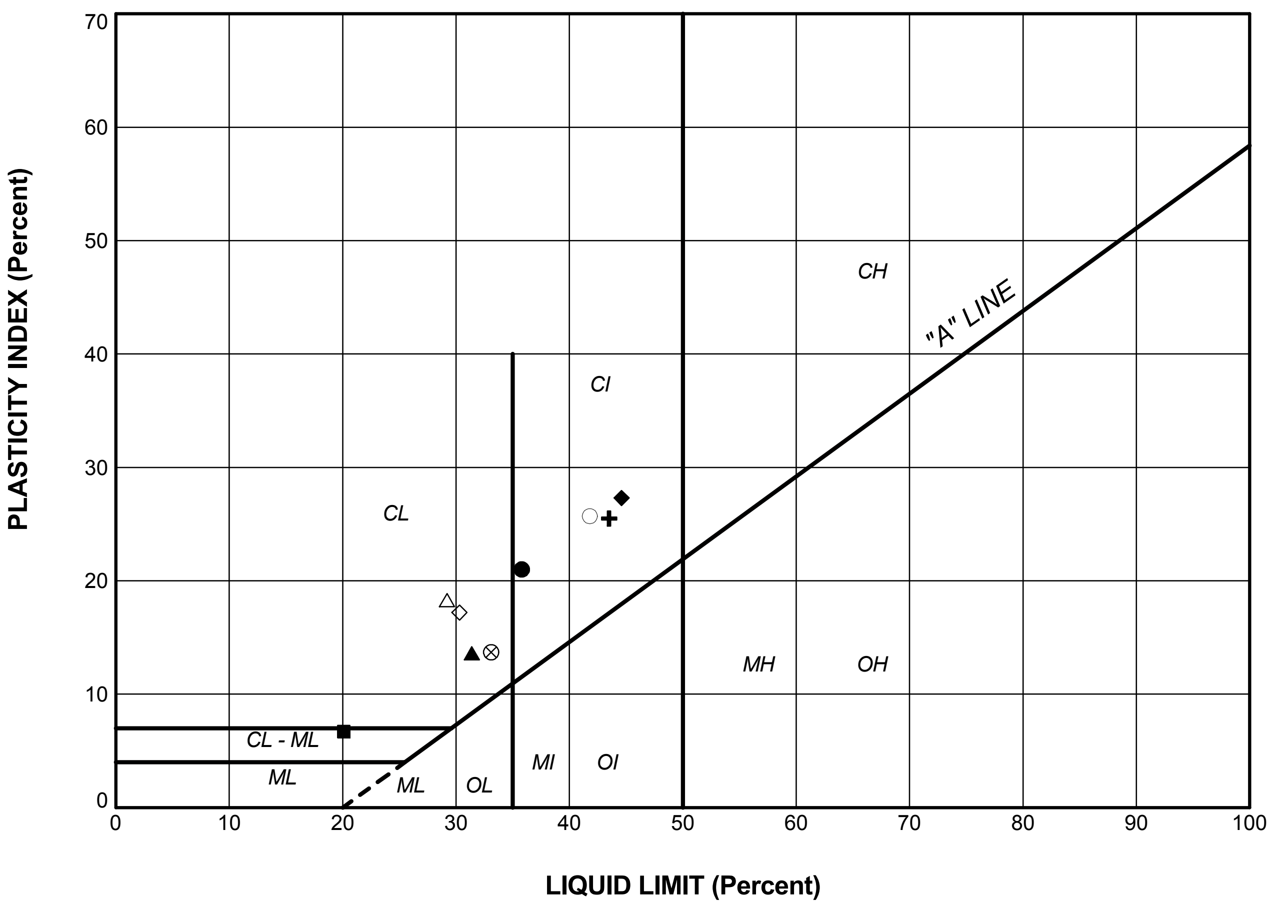
CLAYEY SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.	05-1130-139-0	FILE No.	051130139HML.GPJ
DRAWN	WDF	Jan 12/06	SCALE N/A
CHECK			REV.

FIGURE A-3

LDN_MTO_NEW GLDR_LDN.GDT



SOIL TYPE	PLASTICITY
C = Clay	L = Low
M = Silt	I = Intermediate
O = Organic	H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
SILTY CLAY					
●	1	2	35.8	14.8	21.0
▲	2	3	31.4	17.8	13.6
✚	3	2	43.5	18.0	25.5
◆	3	3	44.6	17.3	27.3
○	6	5	41.8	16.1	25.7
⊗	7	5	33.1	19.4	13.7
CLAYEY SILT					
■	1	9	20.1	13.4	6.7
◇	5	5	30.3	13.1	17.2
△	6	8	29.2	10.9	18.3

PROJECT

HIGH MAST LIGHTS
GARDEN AVENUE AT HIGHWAY 403
GWP 30-00-00

TITLE

PLASTICITY CHART

Golder Associates
LONDON, ONTARIO

PROJECT No.	05-1130-139-0	FILE No.	051130139HML.GPJ	
		SCALE	N/A	REV.
DRAWN	WDF	Jan 13/06	FIGURE A-4	
CHECK				

MTO_PI GLDR_LDN.GDT