FOUNDATION INVESTIGATION AND DESIGN REPORT
OVERHEAD SIGNS
HIGHWAY 403 BRIDGE REHABILITATIONS
FROM HIGHWAY 6 WESTERLY TO ABERDEEN AVENUE
CITY OF HAMILTON, ONTARIO
GWP 2172-06-00, AGREEMENT NO. 2006-E-0081
MINISTRY OF TRANSPORTATION - CENTRAL REGION

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TABLE OF CONTENTS

SECTION PAGE

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PART A – FOUNDATION INVESTIGATION REPORT

OVERHEAD SIGNS
HIGHWAY 403 BRIDGE REHABILITATIONS
FROM HIGHWAY 6 WESTERLY TO ABERDEEN AVENUE
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Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Morrison Hershfield Limited (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detail design work for GWP 2172-06-00.

This report was prepared for the design of two overhead signs. A new cantilevered overhead sign will be installed on the Highway 403/Highway 6 E-E/W ramp to Main Street West (Highways 2 and 8) at Highway 403 Station 12+470 and an existing sign at Station 12+875 will be replaced. The purpose of the foundation investigation was to determine the subsurface conditions at the locations of the proposed overhead signs by drilling boreholes 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 Golder Associates' proposal P71-3148 dated August 21, 2008. The work was carried out in accordance with our Project Specific Supplementary Specialty Plan for Foundations Engineering Specialty dated January 28, 2008.

MH provided Golder Associates with preliminary drawings for this project in digital format.

2.0 SITE DESCRIPTION

The project limits for GWP 2172-06-00 extend from the Highway 6 (North) Interchange westerly to approximately 1 kilometre west of the Aberdeen Avenue Interchange in Hamilton, Ontario. The area of the overhead signs is shown on the Key Plan, Figure 1.

Highway 403 is co-signed with Highway 6 for much of its length within the project limits. Highway 403 within the project limits was constructed in an area with irregular topography with elevations varying from 88 to 91 metres. In the vicinity of the Longwoods Road South Underpass, Highway 403 is a divided highway with three lanes in each direction. The lands on the south side of Highway 403 are mainly industrial. North of Highway 403, usage is mixed with greenspace and institutional, residential and commercial properties. An open channel is present at the toe of the steep slope below the sign location at Station 12+875.

2.1 Site Geology

The project area is situated in the physiographic region of southern Ontario known as the Iroquois Plain[1]. In the Lake Ontario lakehead region, the Iroquois sand plan exists as a narrow plain between Lake Ontario and the Niagara escarpment or locally known in Hamilton as the "mountain". The Iroquois Plain represents the lake bottom of former Lake Iroquois.

The surficial soils are primarily composed of lacustrine and outwash sands.[2] The surface of the bedrock is reported to be between elevations 30 and 91 metres.[3] The bedrock is reported to be red shale and mudstone with minor interbeds of silty limestone and dolomite of the Queenston Formation.[4] The Queenston Formation is a marine deposit of relatively uniform composition. The Queenston shale is irregularly interlayered with occasional beds or pockets of olive green calcareous siltstone. A 1960 study conducted by the Department of Highways found the top 3.0

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

[2] Karrow, P.F., 1987: Quaternary Geology of the Hamilton Area, Southern Ontario, Ontario Geological Survey Map 2509 (Revised). Scale 1:50,000.

[3] Karrow, P.F, 1958: Bedrock Topography of the Hamilton Area, Southern Ontario, Ontario Geological Survey Map 2034. Scale 1:63,360.

[4] Karrow, P.F., 1958. Bedrock Geology, Toronto-Windsor Area. 1969. Geological Survey of Canada Map 1263 A. Scale 1:250,000.

to 4.0 metres is weathered.[5] It is highly fissile, susceptible to weathering under certain conditions and breaks easily parallel to the bedding plane.

[5] Geocres Report No. 30M5-95 by Department of Highways, Ontario entitled “Engineering Study, Properties of Queenston Shale, Proposed Chedoke Expressway, Hamilton Area, Ontario” dated August 19, 1960.

3.0 INVESTIGATION PROCEDURES

The field investigation was conducted on September 7, 2008. Two boreholes, boreholes 101 and 102, were drilled to depths of 6.6 and 7.2 metres, respectively, at the locations shown on Drawing 1.

The boreholes were advanced using a truck mounted CME 45 power auger supplied and operated by a specialist drilling contractor. Samples of the overburden were obtained at 0.75 to 1.5 metre intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures.

Groundwater conditions in the boreholes were observed during drilling and these observations are provided on the corresponding Record of Borehole sheets. All of the boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 372/07.

The field work was supervised on a full-time basis by an experienced member of our engineering staff who arranged for utility locates, directed the drilling, sampling and in-situ testing operations, logged the boreholes, cared for the samples obtained and surveyed the borehole elevations. The borehole elevations are referenced to benchmarks provided by MH. It is understood that these elevations are referenced to geodetic datum.

The soil samples were identified in the field, placed in labelled containers and transported to Golder Associates' London laboratory for further examination and testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg limits testing were carried out on selected samples. The results of the field and laboratory testing are given on the Record of Borehole sheets and the figures in Appendix A.

The table below summarizes the locations, ground surface elevations and depths of the current boreholes:

BOREHOLE	LOCATION (m)			GROUND SURFACE ELEVATION (m)	DEPTH (m)
	Northing	Easting	Chainage		
101	4 790 865	271 952	12+470 Lt	85.86	6.55
102	4 791 032	272 321	12+875 Lt	84.40	7.16

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 and laboratory testing carried out on selected samples, are given on the attached Record of Borehole sheets following the text of this report and in Appendix A. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and observations of drilling resistance and represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

The locations of the boreholes are shown on the attached Drawing 1. 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 Pavement Structure

A 270 millimetre thick layer of asphalt was found at the ground surface in borehole 102.

4.1.2 Fill

Layers of fill 0.4 and 5.7 metres thick were found at the ground surface in borehole 101 and beneath the asphalt in borehole 102. The upper 0.1 metres of fill in borehole 101 consisted of topsoil fill. Sand and gravel fill materials were encountered beneath the topsoil fill in borehole 101 and below the asphalt in borehole 102 from elevations 85.8 metres and 84.1 metres, respectively. The silty sand and gravel fill in borehole 102 had an N value of 29 blows per 0.3 metres and a water content of 4 per cent.

In borehole 102, the sand and gravel materials were underlain by mixed fill materials from elevation 83.0 metres. The mixed fill layer was about 4.6 metres thick and consisted of layers of silty sand and gravel, clayey silt and sandy silt. Beneath the compact silty sand and gravel fill, borehole 112 encountered clayey silt fill containing varying amounts of topsoil, cinders and wood. The clayey silt fill was very stiff with N values of 18 to 31 blows per 0.3 metres. The water content of the clayey silt fill ranged from 12 to 15 per cent. The clayey silt fill was of low plasticity with plastic and liquid limits of 18 and 29 per cent, respectively, and a plasticity index of 11 per cent. The results of a grain size analysis conducted on a sample of clayey silt fill are presented on Figure A-1 of Appendix A. The results of Atterberg limits testing are shown on Figure A-3.

The clayey silt fill in borehole 102 was underlain by sandy silt fill from elevation 80.0 metres. The sandy silt fill contained fence wire, topsoil and wood. The sandy silt fill had an N value of 75 blows per 0.3 metres and a water content of 12 per cent.

4.1.3 Clayey Silt

Boreholes 101 and 102 were terminated in layers of clayey silt after exploring them for some 6.2 and 1.2 metres, respectively. The clayey silt was encountered beneath the fill layers from elevation 85.5 metres in borehole 101 and elevation 78.5 metres in borehole 102.

The clayey silt is firm to stiff based on N values of 5 to 12 blows per 0.3 metres and in situ vane shear strengths of 43 to 57 kilopascals. The in situ shear strength was measured using a shear vane in the softer zones. Water contents of the clayey silt samples varied from 15 to 28 per cent. Based on the results of testing of three samples, the clayey silt is of low plasticity with average plastic and liquid limits of 16 and 29 per cent, respectively, and an average plasticity index of 13 per cent.

The results of grain size analyses carried out on three samples of clayey silt are presented on Figure A-2 in Appendix A. The results of the Atterberg limits testing are shown on Figure A-3.

4.2 Groundwater Conditions

Both boreholes were dry during and upon completion of drilling. Grey soils were encountered in borehole 101 only from approximately elevation 83.7 metres. Based on the change in soil colour, and the variation of water content with depth, the groundwater level has been inferred to be at or above elevation 84 metres.

5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Aardvark Drilling Inc., an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by 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.

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PART B – FOUNDATION DESIGN REPORT

OVERHEAD SIGNS
HIGHWAY 403 BRIDGE REHABILITATIONS
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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 overhead signs to be constructed as part of GWP 2172-06-00. The recommendations are 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 methods and scheduling.

Based on the information provided, the boreholes were located at the approximate sign locations as follows:

LOCATION (Highway 403 Chainage)	DIRECTION	BOREHOLE
12+470	E-E/W ramp to Main Street West (Westbound)	101
12+875	Westbound	102

6.2 Caisson Foundations for Overhead Signs

Caisson foundations for overhead sign supports should be designed in accordance with the requirements in MTO's *Sign Support Manual*. The *Sign Support Manual* includes a standard caisson foundation design (Section 4 and Standard Drawings SS118-3, SS118-4 and SS118-5) in which the caissons are extended 5 metres below the design frost depth (i.e. a total length of 6.2 metres below grade for this project), except where bedrock is encountered within this depth. The standard design is based on the following minimum soil conditions:

- **Case 1 (Cohesionless Soils)**: Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower third of the portion of the caisson below the design frost depth.

- **Case 2 (Cohesive Soils)**: Soft clay with an undrained shear strength of 25 kilopascals (kPa) surrounding the upper two-thirds of the portion of caisson foundation below the frost depth, and "soft" clay with an undrained shear strength of 50 kPa surrounding the lower third of the portion of the caisson below the design frost depth.

Based on the review of the subsurface information, Case 2 applies for the new sign at Station 12+470 only. At this location, the subsurface soils have undrained shear strengths that exceed the input parameters used in the modeling of the standard caisson foundations and, therefore, the standard caisson foundation design is suitable for this site.

The sign location at Station 12+875 requires a site-specific design as much of the foundation length will be in fill materials. The following unfactored parameters may be used for detailed analyses of the caisson foundations:

SOIL TYPE	ϕ (°)	c_u (kPa)	γ (kN/m^3)	K_p	α
Granular Fill	25	-	19	2.5	-
Cohesive Fill	25	100	19	2.5	0.4
Clayey Silt (Borehole 101 only)					
- above elevation 83 metres	28	100	20	2.8	0.5
- below elevation 83 metres	28	50	20	2.8	0.7
Clayey Silt (Borehole 102 only)					
- below elevation 78.5 metres	28	100	20	2.8	0.5

where:

ϕ	-	angle of friction
c_u	-	cohesion
γ	-	total unit weight
K_p	-	coefficient of passive earth pressure
α	-	shaft resistance factor

6.2.1 Vertical Loads

Based on the subsurface conditions encountered in the boreholes, the unfactored unit shaft resistance 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 and 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. While any portion of the caisson within fill materials would normally be neglected, the overhead sign foundation at Station 12+875 will be founded almost wholly within the existing fill materials, therefore, at this location, it will be necessary to utilize the fill to resist the applied loadings with the parameters for the fill materials as given in the table in Section 6.2 above.

The unfactored component of vertical load carrying capacity that may be derived from end bearing for the standard 1.0 to 1.2 metre diameter caissons in the cohesive soils may be calculated using the following equation:

$$Q_b = 9 c_u A_b$$

where c_u is the undrained shear strength of the cohesive founding layer and A_b is 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). The axial resistance at serviceability limit states (SLS) is greater than at ULS and ULS values will govern design.

6.2.2 Lateral Loads

The lateral loads exerted by the caissons will be primarily resisted by cohesive soils. 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.

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.

Where an undrained shear strength, c_u, is provided, the undrained capacity of the caisson should be checked to determine whether the drained or undrained case will govern. In this case, the lateral resistance for the length of the caisson within cohesive soil should be calculated assuming an unfactored passive lateral pressure distribution varying linearly from 2 c_u at the surface to 9 c_u at a depth of three pile diameters and beyond acting over the actual width of the caisson.

For non-cohesive fills, the unfactored lateral passive resistance may be estimated by calculating the passive earth pressure over an equivalent wall area having a depth below the ground surface equivalent to six times the pile diameter and a width of three times the pile diameter. The equivalent unfactored passive lateral earth pressure may be calculated using the following equation:

$$P_p = K_p \gamma d$$

where
- K_p - passive earth pressure coefficient;
- γ - bulk unit weight (kN/m^3);
- d - depth below the ground surface (m)

A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtain the factored lateral geotechnical resistance.

In general, any portion of the caisson within fill and/or organic materials would normally be neglected; however, as indicated above, the overhead sign at Station 12+875 will be primarily founded within the existing fill materials, therefore, at this location, it will be necessary to utilize the fill to resist the applied loadings utilizing the parameters for the fill given in the table in Section 6.2, above.

6.2.3 Construction Considerations

A temporary liner will be required to support the sides of the excavation and permit cleaning and inspection of the base. 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 run off should be directed away from the excavation. The caissons should be constructed and inspected in accordance with SP903S01.

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
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
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
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)

(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)

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 101

1 OF 1

METRIC

PROJECT 08-1132-013-0 | G.W.P. 2172-06-00 | DIST | HWY 403 | DATUM GEODETIC

LOCATION N 4790865.4 ;E 271951.9 | BOREHOLE TYPE POWER AUGER/SOLID STEM AUGERS | DATE September 7, 2008

ORIGINATED BY DJM | COMPILED BY LMK | CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	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
85.86	GROUND SURFACE									
0.09	FILL, topsoil, silty sand and gravel									
85.46	FILL, sand and gravel, crushed									
0.40	Grey									
	CLAYEY SILT, trace sand Stiff Brown to grey at about elev. 83.7m		1	SS	12		85			
			2	SS	12		84			0 9 52 39
			3	SS	11					
82.96							83			
2.90	CLAYEY SILT, trace sand Firm to stiff Grey		4	SS	5					
							82	+2.0 +1.8		
			5	SS	6		81			0 3 50 47
								+2.2		
			6	SS	7		80			
79.31										
6.55	END OF BOREHOLE Borehole dry during drilling on September 7, 2008.									

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

PROJECT 08-1132-013-0 | G.W.P. 2172-06-00 | DIST | HWY 403 | DATUM GEODETIC

LOCATION N 4791031.6 ;E 272320.5 | BOREHOLE TYPE POWER AUGER/SOLID STEM AUGERS | DATE September 7, 2008

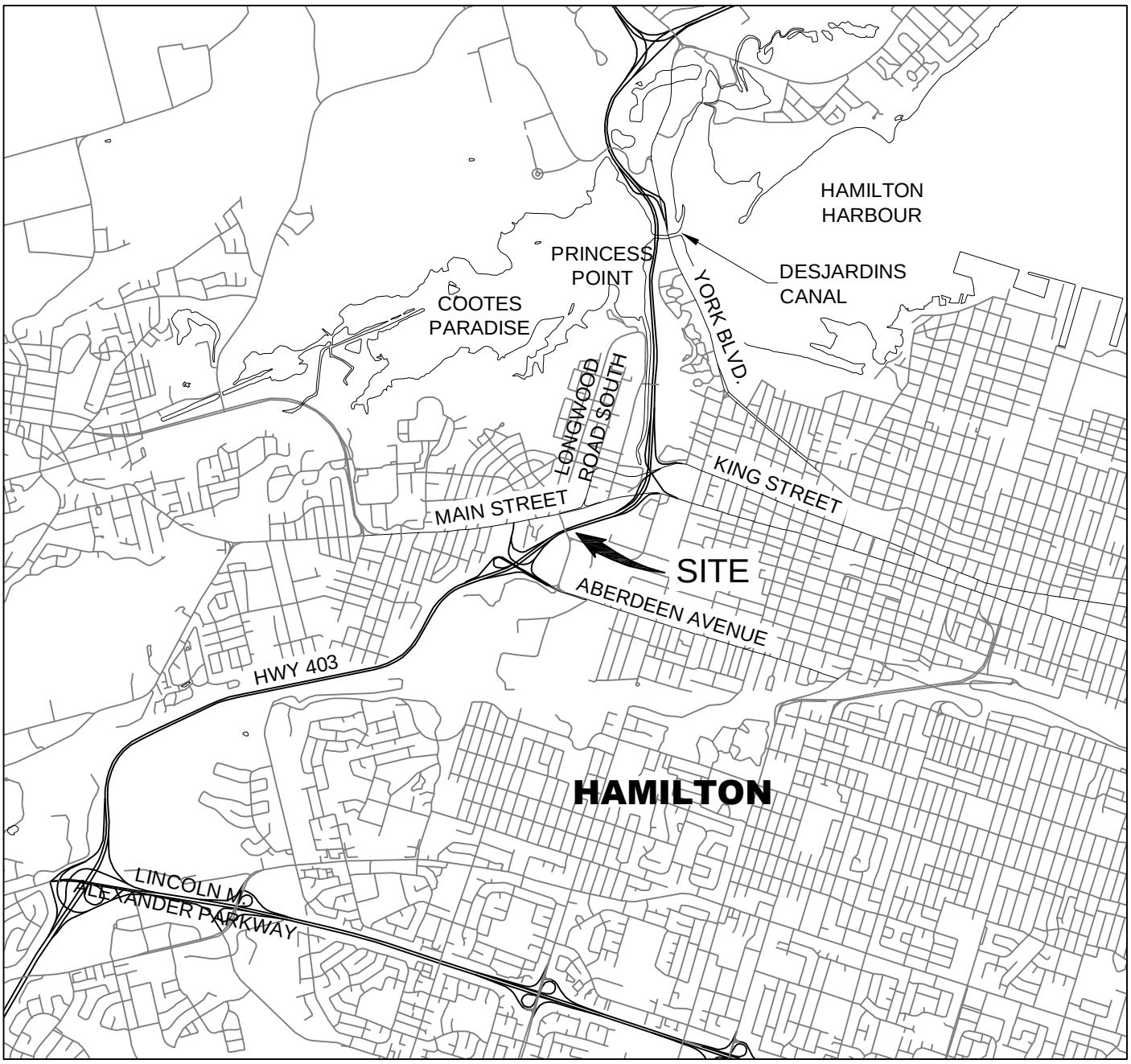
ORIGINATED BY DJM | COMPILED BY LMK | CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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
84.40	PAVEMENT SURFACE										
0.00	ASPHALT										
0.27	FILL, sand and gravel, crushed Brown						84				
0.53	FILL, silty sand and gravel, crushed Compact Brown		1	SS	29				○		
83.03							83				
1.37	FILL, clayey silt, trace sand, gravel, topsoil, cinders Very stiff Brown		2	SS	18				○		
82.27							82				
2.13	FILL, clayey silt, some sand, trace gravel, topsoil, cinder, wood Very stiff Brown and black		3	SS	31				○ — ●		0 30 47 23
			4	SS	22		81		○		
			5	SS	27				○		
79.98							80				
4.42	FILL, sandy silt, trace gravel, fence wire, topsoil, wood Very dense Brown and black		6	SS	75				○		
78.46							79				
5.94	CLAYEY SILT, some sand, roots Stiff Brown		7	SS	10		78		○ — ●		0 22 57 21
77.24			8	SS	11				○		
7.16	END OF BOREHOLE Borehole dry during drilling on September 7, 2008										

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

LDN_MTO_01 08-1132-013-0.GPJ LDN_MTO.GDT 2/6/09



SCALE IN METERS

0 1000 2000

1:50000

PROJECT

OVERHEAD SIGNS
HIGHWAY 403 BRIDGE REHABILITATIONS
GWP 2172-06-00

TITLE

KEY PLAN

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-013-0		FILE No.	0811320130-F02001
			SCALE	AS SHOWN
CADD	LMK	Sept. 30/08	REV.	0
CHECK				

FIGURE 1

DRAWING FILE: 0811320130-F02001.DWG Plot Date: Feb 11, 2009 - 11:01am

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 2172-06-00

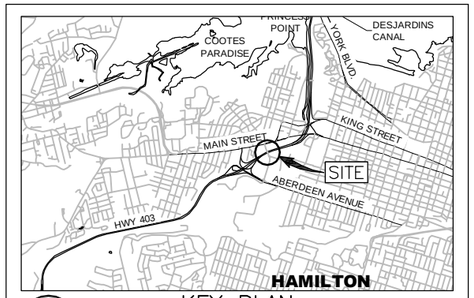
SHEET

OVERHEAD SIGNS

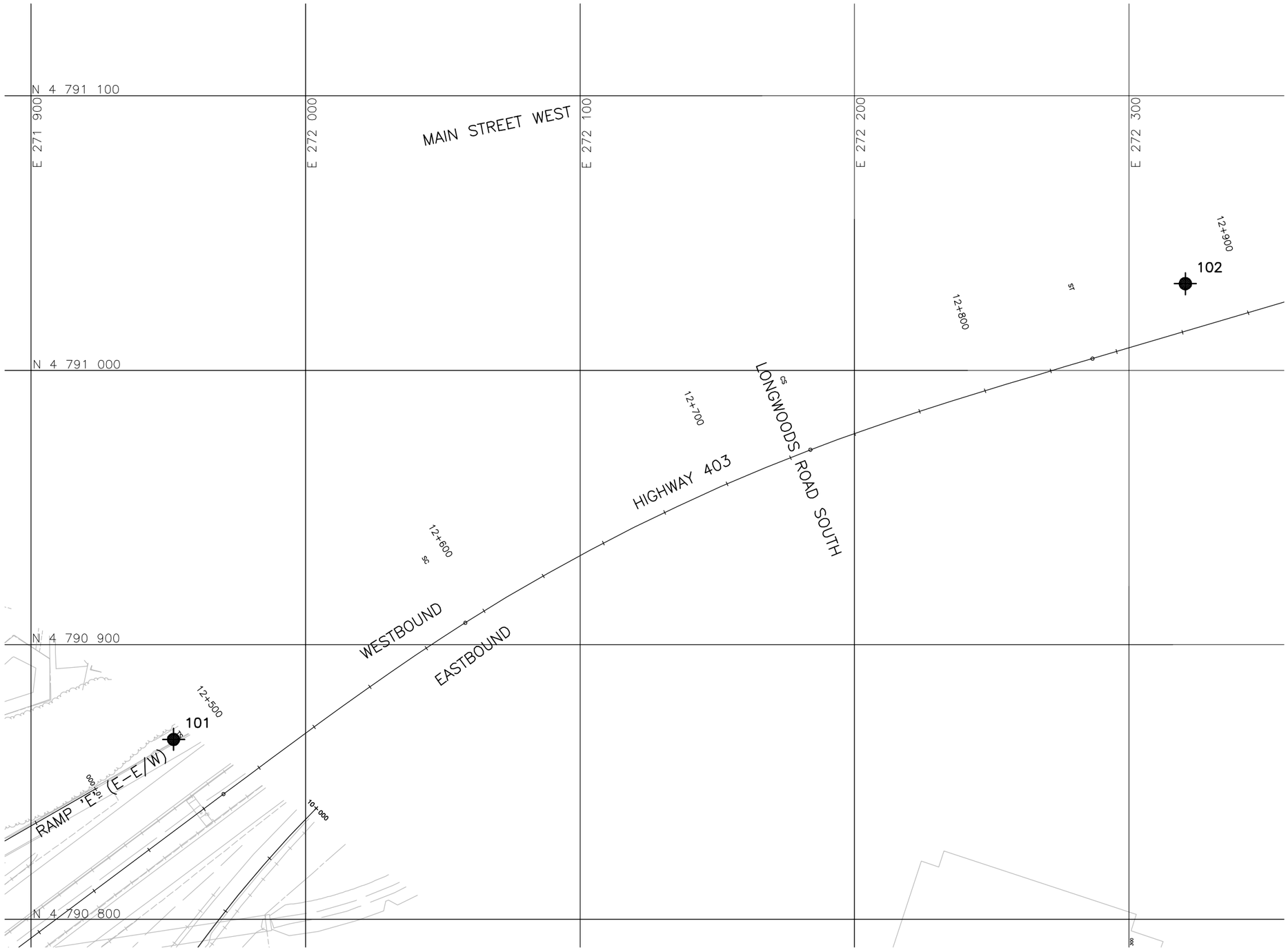
HIGHWAY 403 BRIDGE REHABILITATIONS
BOREHOLE LOCATIONS

Golder Associates

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN
SCALE IN KILOMETRES 0 1 2



PLAN
SCALE
15 0 15 m

LEGEND

Borehole – Current Investigation

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
101	85.86	4 790 865.4	271 951.9
102	84.40	4 791 031.6	272 320.5

NOTES

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

REFERENCE

Base plans provided in digital format by Morrison Hershfield.

NO.	DATE	BY	REVISION

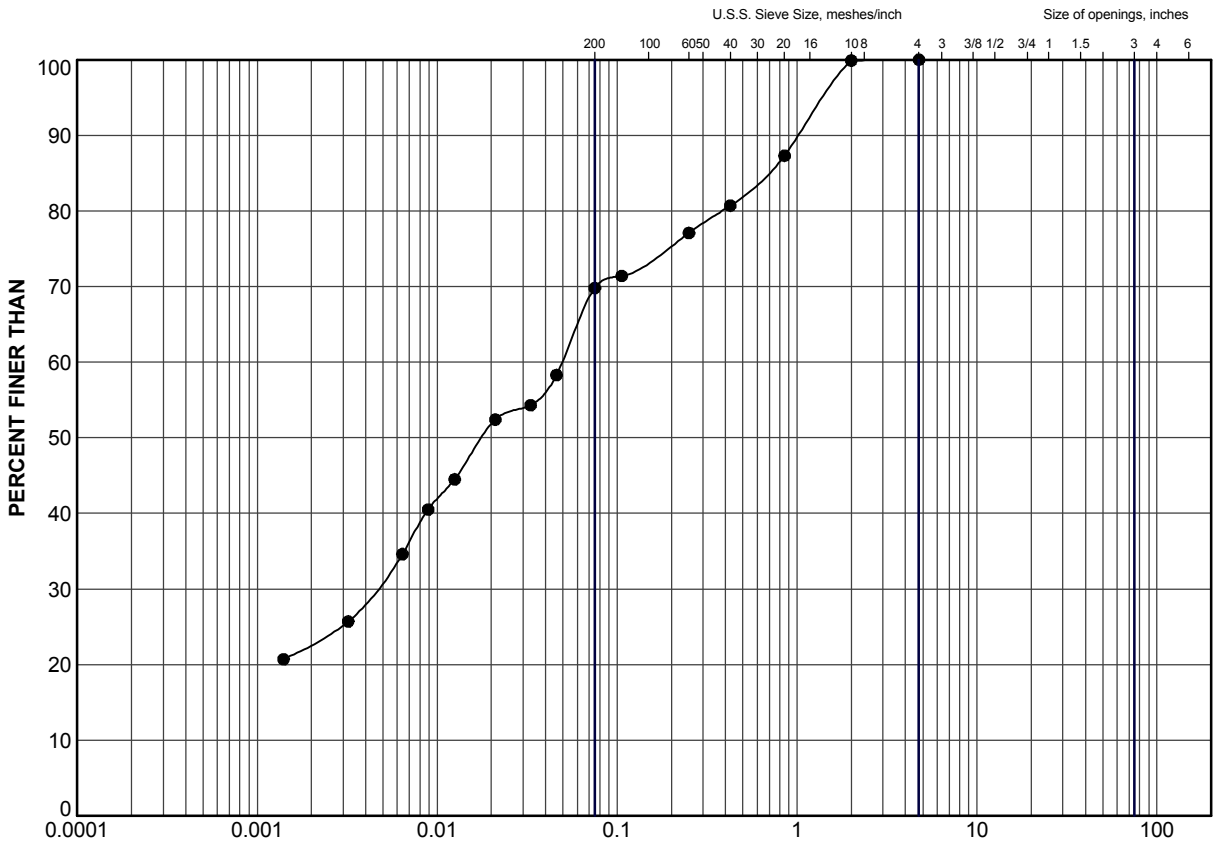
Geocres No. 30M5-267

HWY. 403	PROJECT NO. 08-1132-013-0		DIST.
SUBM'D. DUP	CHKD.	DATE: SEP 30/08	SITE:
DRAWN: LMK	CHKD.	APPD.	DWG. 1

PLOT DATE: February 11, 2009
FILENAME: N:\active\2008\1132 - Geotechnical\1132-000-01\08-1132-013-0 MH - GWP 2172-06-00 - FDNS - HWY 403 - 6\Drafting\AutoCAD files\08113201\30-002002.dwg

APPENDIX A

LABORATORY TEST DATA



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	102	3	81.9

PROJECT

OVERHEAD SIGNS
HIGHWAY 403 BRIDGE REHABILITATIONS
GWP 2172-06-00

TITLE

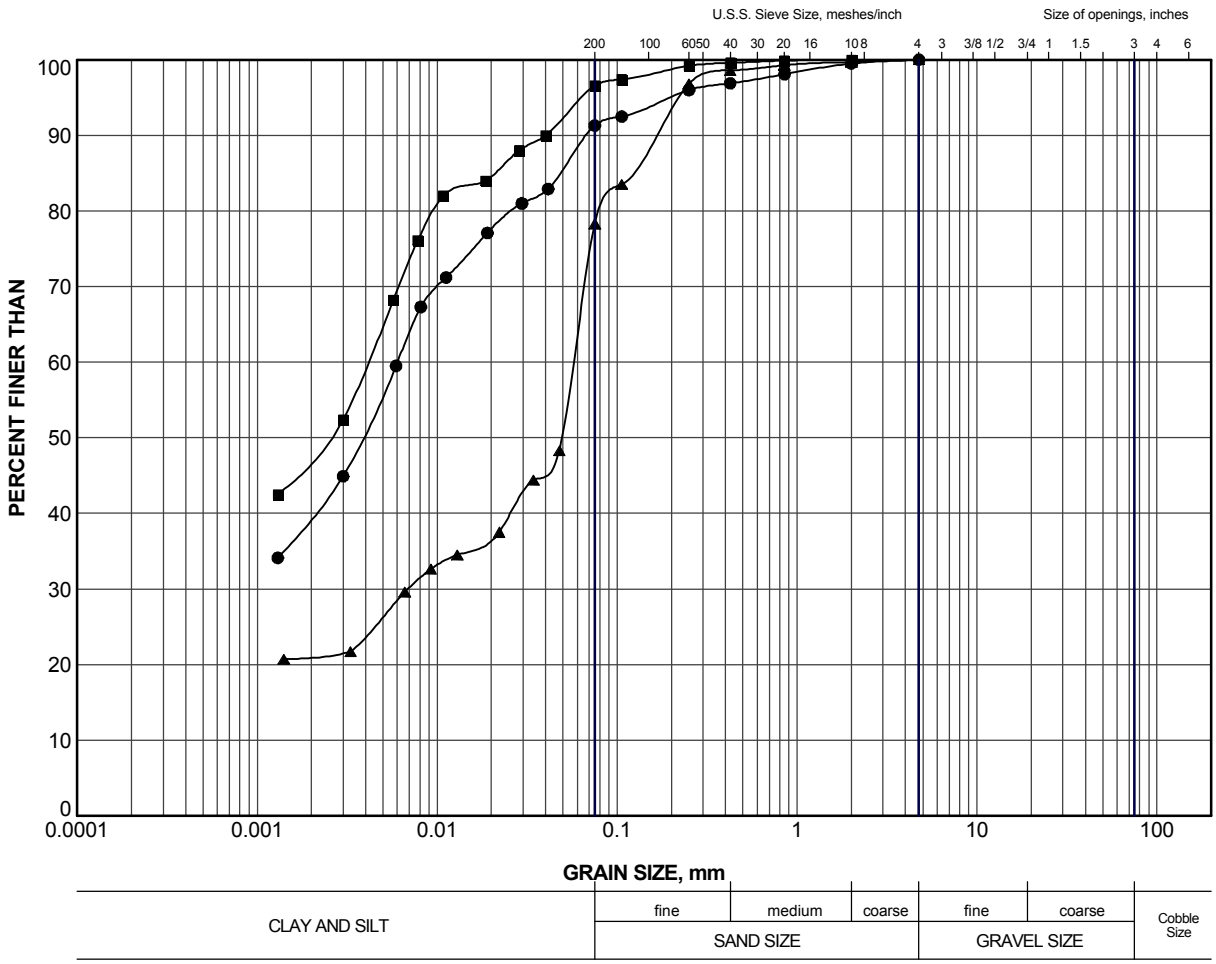
GRAIN SIZE DISTRIBUTION

FILL, Clayey Silt

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-013-0		FILE No.	0811320130-R020A1	
			SCALE	N/A	REV.
DRAWN	LMK	Sep 30/08			
CHECK			**FIGURE A-1**		

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	101	2	84.1
■	101	5	81.1
▲	102	7	78.1

PROJECT

OVERHEAD SIGNS
HIGHWAY 403 BRIDGE REHABILITATIONS
GWP 2172-06-00

TITLE

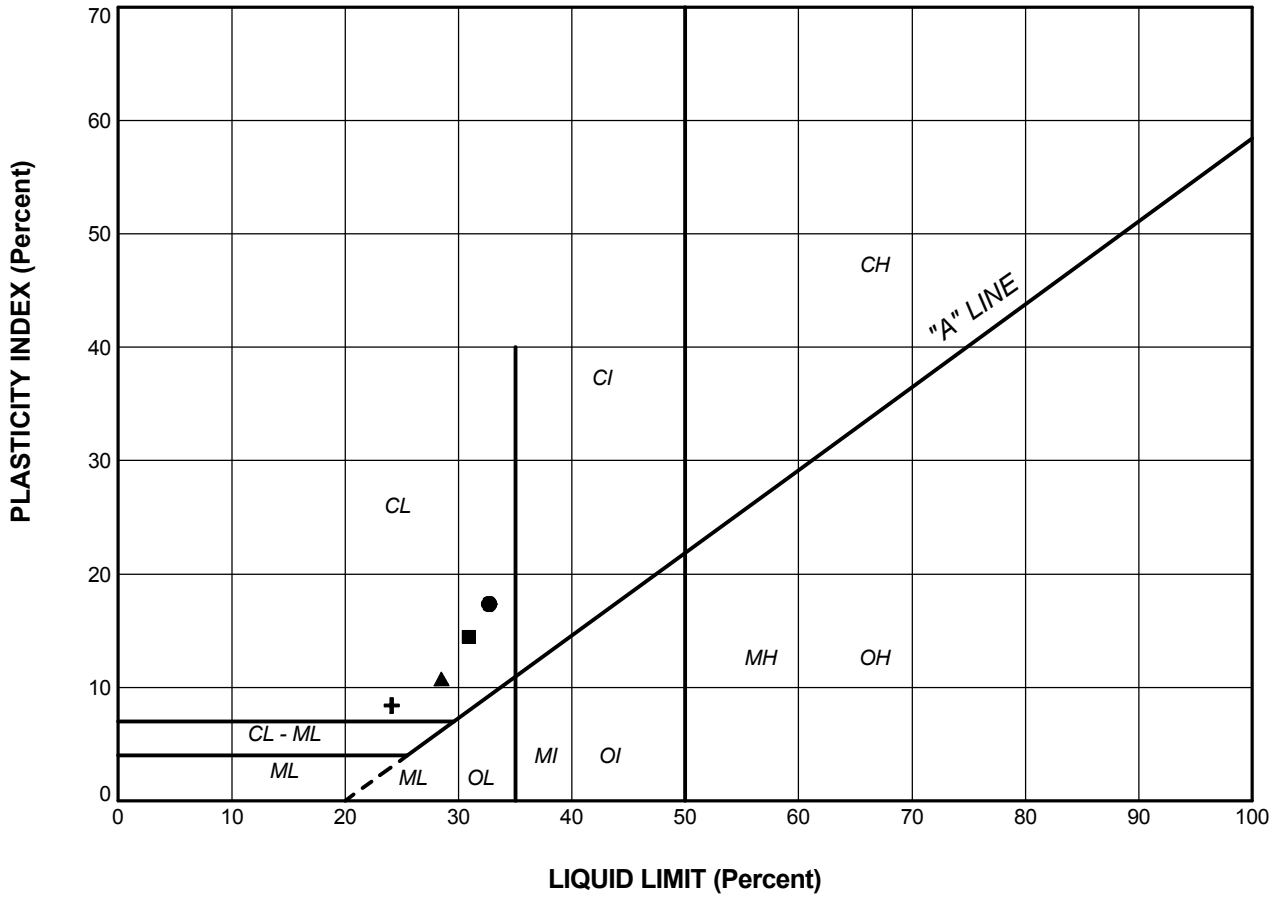
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-013-0		FILE No.	0811320130-R020A2	
			SCALE	N/A	REV.
DRAWN	LMK	Sep 30/08			
CHECK			**FIGURE A-2**		

LDN_MTO_NEW GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
FILL, Clayey Silt					
▲	102	3	28.5	17.8	10.8
CLAYEY SILT					
●	101	2	32.7	15.4	17.4
■	101	5	30.9	16.5	14.5
✚	102	7	24.1	15.7	8.4

PROJECT

OVERHEAD SIGNS
HIGHWAY 403 BRIDGE REHABILITATIONS
GWP 2172-06-00

TITLE

PLASTICITY CHART

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-013-0	FILE No.	0811320130-R020A3	
			SCALE	N/A	REV.
DRAWN	LMK	Sep 28/08			
CHECK			**FIGURE**	**A-3**	

MTO_PI GLDR_LDN.GDT