



**April 2012**

## **PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT**

**Bowmanville Commercial Vehicle Inspection Facility  
Work Order Project No. 10-20010  
Purchase Order Number: 2009-E-0046  
Ministry of Transportation, Ontario - Central Region**

**Submitted to:**

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**REPORT**



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**PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT  
BOWMANVILLE CVIF - WP 10-20010**

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**PART A**

**PRELIMINARY FOUNDATION INVESTIGATION REPORT**

**BOWMANVILLE COMMERCIAL VEHICLE INSPECTION FACILITY**  
**WP 10-20010, PURCHASE ORDER No. 2009-E-0046**  
**MINISTRY OF TRANSPORTATION, ONTARIO - CENTRAL REGION**



## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) Central Region to carry out a preliminary foundation investigation as part of the Total Project Management (TPM) assignment for the design of the westbound Bowmanville Commercial Vehicle Inspection Facility (CVIF). The location of the site is shown on the Key Plan, Figure 1.

The purpose of the investigation was to determine the subsurface conditions at the location of the new inspection building by drilling boreholes and carrying out in situ testing and laboratory testing on selected samples. The Scope of Work was outlined in Golder's proposal dated May 6, 2011. A draft Technical Memorandum providing our overview of the preliminary foundation constraints for three potential sites was provided on October 26, 2011.



## **2.0 SITE DESCRIPTION**

### **2.1 General**

The new westbound (north) CVIF is to be located to the north of Highway 401 between Morrish Church Road and East Townline Road as shown on the Key Plan, Figure 1.

Based on the information provided, the ground surface elevation at the site ranges from about 167 to 170 metres.

The site is generally grass and light bush covered with a wet area to the east. The adjacent land use is generally agricultural.

Site photographs are provided in Appendix B.

### **2.2 Site Geology**

The site is located in the physiographic region of Ontario known as the Lake Iroquois Plain<sup>1</sup> which is in an area of low relief covered by the waters of Lake Iroquois during the Pleistocene age. Surficial deposits of the silts and sands generally overly the glacial till.

The glacial till surface is irregular and drumlinized with the till coming to surface in many areas.

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<sup>1</sup> 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 February 2 and 3, 2012 during which time four boreholes (boreholes 1 to 4, inclusive) were drilled at the approximate locations shown on Drawing 1. The table below provides the borehole locations, ground surface elevations at the borehole locations and the depths of the boreholes.

Borehole	Location (m)		Ground Surface Elevation	Borehole Depth
	Northing	Easting	(m)	(m)
1	4 867 863.0	390 891.6	166.89	9.22
2	4 867 844.8	390 818.1	168.67	9.27
3	4 867 814.5	390 808.4	169.22	9.25
4	4 867 794.5	390 780.5	169.89	9.25

The investigation was carried out using a track mounted power auger supplied and operated by a specialist drilling contractor. In each borehole, samples of the overburden were obtained at 0.75 metre intervals of depth to 4.6 metres and at 1.52 metre intervals to the termination of each borehole using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. The boreholes were terminated about 9.2 metres below the ground surface.

Groundwater conditions in the boreholes were observed throughout the drilling operations and a perforated standpipe was installed in borehole 3. Following completion of drilling and sampling, the boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 903, as amended.

The field work was monitored on a full-time basis by an experienced member of our geotechnical engineering staff who located the boreholes in the field, monitored the drilling, sampling and in situ testing operations and logged the boreholes. The samples were identified in the field, placed in labelled containers and transported to our Whitby laboratory for further examination and testing. Index and classification tests, consisting of water content determinations and grain size distribution analyses, were carried out on selected samples. The results of the testing are shown on the Record of Borehole sheets and in Appendix A.



## **4.0 SUBSURFACE CONDITIONS**

### **4.1 Site Stratigraphy**

The detailed subsurface soil and groundwater conditions encountered in 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. The stratigraphic boundaries shown on the Record of Borehole sheets 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.

In general, the boreholes encountered topsoil over surficial layers of sandy silt and clayey silt which are underlain by a stratum of dense to very dense silty sand till.

### **4.2 Soil Conditions**

#### **4.2.1 Topsoil**

Topsoil ranging in thickness from 200 to 250 millimetres was encountered at ground surface in all of the boreholes.

#### **4.2.2 Sandy Silt**

Beneath the topsoil, all of the boreholes encountered a sandy silt layer between elevation 166.7 and 169.7 metres. The sandy silt layer ranged in thickness from about 0.4 to 1.2 metres.

The sandy silt had N values, as determined in the standard penetration test, from 5 to 11 blows per 0.3 metres.

#### **4.2.3 Clayey Silt**

Beneath the sandy silt, a 0.7 metre thick layer of clayey silt was encountered in borehole 2 at elevation 168.0 metres. The clayey silt had an N value of 24 blows per 0.3 metres.





#### **4.2.4 Silty Sand Till**

Beneath the surficial deposits, all of the boreholes encountered a stratum of dense to very dense silty sand till at elevations ranging from 166.3 to 168.5 metres. All of the boreholes were terminated in the silty sand till at a depth of about 9.2 metres below ground surface.

The silty sand till had N values ranging from 41 blows per 0.3 metres to 50 blows per 75 millimetres. The silty sand till had water contents ranging from 6 to 10 per cent with an average water content of about 8 per cent.

The results of the grain size analyses carried out on eight (8) standard penetration test samples of the silty sand till are shown on Figures A-1 and A-2.

Cobbles and boulders were encountered in boreholes 1, 3 and 4 in the silty sand till.

### **4.3 Groundwater Conditions**

All of the boreholes remained dry during drilling. A standpipe was installed in borehole 3 as shown on the Record of Borehole sheet.

The standpipe in borehole 3 was dry to elevation 160.1 metres on March 8, 2012. Groundwater levels should be expected to fluctuate seasonally and in response to significant weather events.



## **5.0 MISCELLANEOUS**

This investigation was carried out using equipment supplied and operated by R.C. Drilling Ltd., an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Robin Nowensky under the direction of Dr. Michael Maher, P.Eng. The laboratory testing was carried out at Golder's Whitby laboratory under the direction of Mr. John Watkins. 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 Mr. Tyson Pitt, P.Eng. under the direction of the Team Leader, 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**

**PRELIMINARY FOUNDATION DESIGN REPORT**

**BOWMANVILLE COMMERCIAL VEHICLE INSPECTION FACILITY  
WP 10-20010, PURCHASE ORDER No. 2009-E-0046  
MINISTRY OF TRANSPORTATION, ONTARIO - CENTRAL REGION**



## **6.0 ENGINEERING RECOMMENDATIONS**

### **6.1 General**

This section of the report provides recommendations based on our interpretation of the factual information obtained during the investigation and is intended for the guidance of 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.

### **6.2 Foundations**

In the area of the proposed foundation, the founding grade is to be at approximately elevation 167 metres.

Based on the results of the investigation, the proposed new building canopy and scales can be founded on conventional spread and/or strip footings bearing on the native silty sand till typically at or below elevation 165.6 metres. For preliminary design, foundations constructed on the till may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 450 kilopascals and a geotechnical resistance at Serviceability Limit States (SLS) of 300 kilopascals. The SLS criterion is for 25 millimetres of total settlement based on a minimum 0.5 metre footing width. Alternatively, for preliminary design, foundations construction on the till may be designed with a bearing resistance at ULS of 300 kilopascals and a factored geotechnical resistance at SLS of 200 kilopascals for 10 millimetres of settlement based on a minimum 0.5 metres footing width.

All exposed founding surfaces should be inspected by the geotechnical engineer prior to pouring concrete. It is preferable that the final 0.5 metres of excavation be carried out while the geotechnical engineer is on site.

If the footings cannot be poured the same day as the excavation, a 75 millimetre thick lean concrete working slab should be provided in the base of the excavation immediately following inspection by the Quality Verification Engineer, in accordance with OPSS 902.07.05.02 "Excavation for Foundations".

At least 1.4 metres of soil cover or thermal equivalent should be provided over the footings and finished site grading should promote drainage away from the structures.



## 6.3 Resistance to Lateral Loads

Resistance to lateral forces/sliding resistance between the concrete spread footings and the subsoil should be calculated in accordance with Section 6.7.5 of the Canadian Highway Bridge Design Code (CHBDC). Assuming that the founding soils are not loosened/disturbed during excavation and footing construction, the following unfactored angle of friction between the concrete and the founding soils, and corresponding unfactored coefficient of friction,  $\tan \delta$ , may be used:

	<u>Angle of Friction</u> (degrees)	<u><math>\tan \delta</math></u>
Footings on silty sand till	35	0.70

## 6.4 Lateral Pressures

The unbalanced lateral pressures acting on the foundation walls will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the wall, on the freedom of lateral movement of the walls and on the drainage conditions behind the walls. The following recommendations are made concerning the design of the foundation walls:

- Select, compacted, free-draining granular fill meeting the specifications of OPSS Granular A or Granular B Type I should be used as backfill. Drains should be installed to provide positive drainage of the granular backfill.
- A compaction surcharge equal to 12 kilopascals should be included in the lateral earth pressures for the structural design of the walls. Compaction equipment should be used in accordance with SP 105S10 and OPSS 501.06.
- The granular fill should be placed within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical extending up and back from the rear face of the footing.
- The lateral earth pressures are based on the granular fill and the following parameters (unfactored) may be assumed:

	<u>GRANULAR A</u>	<u>GRANULAR B</u> <u>Type I</u>
Soil unit weight:	22 kN/m <sup>3</sup>	21 kN/m <sup>3</sup>
Coefficients of lateral earth pressure:		
Active, $K_a$	0.27	0.27
At rest, $K_o$	0.43	0.43
Passive, $K_p$	3.7	3.7



- If the wall support and superstructure allow lateral yielding of the stem, active earth pressures may be used in the geotechnical design of the structure. If the wall support does not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design.

It should be noted that the above design parameters assume level backfill and ground surface behind the wall. For sloping backfill/ground surface, these parameters should be adjusted accordingly.

Based on the subsurface conditions encountered in the boreholes and our experience in the area of the site, classification for Seismic Response C is considered appropriate.

## **6.5 Slab-on-Grade**

The slab-on-grade for the building should be supported by 200 millimetres of compacted Granular A. Unless uncontrolled migration of water vapour through the slab is acceptable, a robust polyethylene vapour barrier should be provided between the Granular A and the concrete.

## **6.6 Excavations**

Excavations for the foundations will encounter the surficial topsoil and sandy silt, clayey silt and silty sand till. Cobbles and boulders should be expected in the excavations in the silty sand till.

Conventional open cut excavations can be used for this component of the work. The excavation side slopes should not exceed an inclination of 1 horizontal to 1 vertical. Based on the current Occupational Health and Safety Act, the sandy silt would be classified as a Type 2 soil and the silty sand till would be classified as a Type 1 soil.

## **6.7 Groundwater Control**

It is anticipated that groundwater control, when required, can be adequately handled using appropriately sized and filtered sumps in the base of the excavation. Sumps should be located outside of the actual footing limits.

Surface water should be directed away from the open cut excavations.



## **6.8 Cuts**

Based on the information provided, the site of the proposed CVIF will be cut by up to about 3 metres from the existing high elevation of approximately 170 to about elevation 167 metres. The cut will encounter topsoil, loose to compact sandy silt and very stiff clayey silt over dense to very dense silty sand till. The 3 metre cut will encounter cobbles and boulders in the silty sand till.

The cut slope should be graded to an inclination of 2 horizontal to 1 vertical or flatter. Surface water should be directed away from the cut slopes by appropriate ditching at the top and toe of the slopes. The slopes should be provided with a minimum of 200 millimetres of topsoil and appropriate vegetation.



## **7.0 MISCELLANEOUS**

This report was prepared by Mr. Tyson Pitt, P.Eng. under the direction of the Team Leader, 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

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

#### Consistency

	<u>kPa</u>	<u>psf</u>
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

#### (b) Cohesive Soils

#### 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 cm<sup>2</sup> 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 <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
$D_R$	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)
$\gamma$	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

$\pi$	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

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\epsilon$	linear strain
$\epsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	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
$\gamma'$	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
$\sigma'_p$	pre-consolidation pressure
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

#### (d) Shear Strength

$\tau_p, \tau_r$	peak and residual shear strength
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	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
  - \* density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density x acceleration due to gravity)

**RECORD OF BOREHOLE No 1**

1 OF 1

**METRIC**

PROJECT 10-1132-0152  
W.P. 10-20010 LOCATION N 4867863.0 ; E 390891.6 ORIGINATED BY RMN  
DIST HWY BOREHOLE TYPE POWER AUGER COMPILED BY LMK  
DATUM GEODETIC DATE February 02, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE   LIQUID LIMIT LIMIT   CONTENT   LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20	40	60	80	100			20	40	60	80
166.89	GROUND SURFACE																	
0.00	TOPSOIL, silty Black																	
0.20	SANDY SILT, trace gravel		1	SS	7													
166.28	Loose Brown																	
0.61	SILTY SAND TILL, trace to some gravel, trace clay, with cobbles and boulders Dense to very dense Brown		2	SS	41													
			3	SS	43								○					8 57 28 7
			4	SS	76								○					
			5	SS	50/ 125mm								○					
			6	SS	50/ 150mm								○					4 52 35 9
			7	SS	50/ 100mm								○					
			8	SS	50/ 75mm													
			9	SS	50/ 75mm													
157.67	END OF BOREHOLE		10	SS	50/ 75mm													
9.22	Borehole dry during drilling.																	

LDN\_MTO\_01 10-1132-0152.GPJ LDN\_MTO.GDT 12/03/12

**RECORD OF BOREHOLE No 2**

1 OF 1

**METRIC**

PROJECT 10-1132-0152  
W.P. 10-20010 LOCATION N 4867844.8 ; E 390818.1 ORIGINATED BY RMN  
DIST HWY BOREHOLE TYPE POWER AUGER COMPILED BY LMK  
DATUM GEODETIC DATE February 02, 2012 CHECKED BY

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W <sub>P</sub>	W	W <sub>L</sub>					
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)							
168.67	GROUND SURFACE						20	40	60	80	100						GR	SA	SI	CL
0.00	TOPSOIL, silty Black																			
0.23	SANDY SILT, trace clay		1	SS	5															
167.98	Loose Brown																			
0.69	CLAYEY SILT, some sand		2	SS	24															
167.30	Very stiff Brown																			
1.37	SILTY SAND TILL, trace to some gravel, trace to some clay		3	SS	54															
	Very dense Brown		4	SS	50/ 100mm															
			5	SS	50/ 125mm															
			6	SS	50/ 100mm															
			7	SS	50/ 125mm															
			8	SS	50/ 125mm															
			9	SS	50/ 125mm															
			10	SS	50/ 125mm															
159.40	END OF BOREHOLE																			
9.27	Borehole dry during drilling on February 2, 2012.																			

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

**RECORD OF BOREHOLE No 3**

1 OF 1

**METRIC**

PROJECT 10-1132-0152  
W.P. 10-20010 LOCATION N 4867814.5 ; E 390808.4 ORIGINATED BY RMN  
DIST HWY BOREHOLE TYPE POWER AUGER COMPILED BY LMK  
DATUM GEODETIC DATE February 02, 2012 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
169.22	GROUND SURFACE							20 40 60 80 100						
0.00	TOPSOIL, silty Black							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
0.25	SANDY SILT, trace clay Loose to compact Brown		1	SS	10			20 40 60 80 100						
			2	SS	10									
167.85														
1.37	SILTY SAND TILL, some gravel, trace to some clay, with cobbles and boulders Dense to very dense Brown		3	SS	44									9 50 31 10
			4	SS	69									
			5	SS	70									
			6	SS	72									12 44 32 12
			7	SS	50/ 175mm									
			8	SS	50/ 100mm									
			9	SS	50/ 125mm									
159.97			10	SS	50/ 100mm									
9.25	END OF BOREHOLE  Borehole dry during drilling on February 2, 2012.													

**RECORD OF BOREHOLE No 4**

1 OF 1

**METRIC**

PROJECT 10-1132-0152

W.P. 10-20010

LOCATION N 4867794.5 ; E 390780.5

ORIGINATED BY RMN

DIST \_\_\_\_\_ HWY \_\_\_\_\_

BOREHOLE TYPE POWER AUGER

COMPILED BY LMK

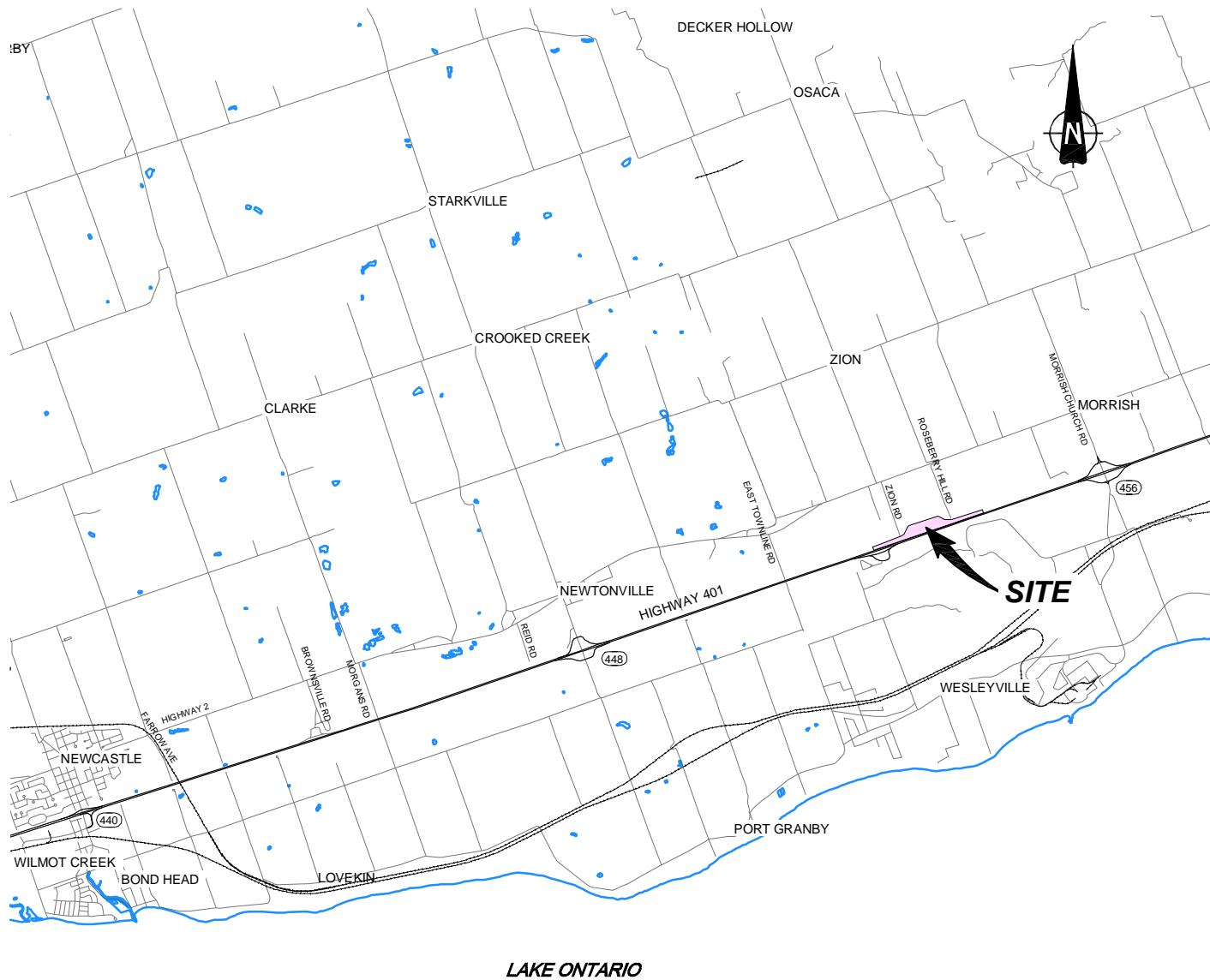
DATUM GEODETIC

DATE February 03, 2012

CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ  kN/m <sup>3</sup>	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	× LAB VANE	20						40	60	80
169.89	GROUND SURFACE																			
0.00	TOPSOIL, silty Black																			
0.20	SANDY SILT, trace clay, trace gravel Loose to compact Brown		1	SS	10															
			2	SS	11															
168.52							169													
1.37	SILTY SAND TILL, some gravel, trace to some clay, with cobbles and boulders Very dense Brown		3	SS	70								○							
			4	SS	62								○							
			5	SS	76								○				10 49 30 11			
			6	SS	50/ 100mm								○							
			7	SS	50/ 125mm								○				7 46 35 12			
							165													
			8	SS	50/ 125mm															
							164													
							163													
			9	SS	50/ 100mm															
							162													
							161													
160.64	END OF BOREHOLE		10	SS	50/ 100mm															
9.25	Borehole dry during drilling on February 3, 2012.																			

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



## REFERENCE

DRAWING BASED ON CLIENT SUPPLIED DATA AND  
CANMAP STREET FILES V2008.4

## NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH  
ACCOMPANYING TEXT.

PROJECT

BOWMANVILLE CVIF  
HIGHWAY 401  
WP 10-20010

TITLE

## KEY PLAN



PROJECT No.			FILE No.		
10-1132-0152			1011320152-F01001		
CADD	WDF	Mar. 6/12	SCALE	AS SHOWN	REV. 0
CHECK			<b>FIGURE 1</b>		

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

CONT No.  
WP No. 10-20010



BOWMANVILLE CVIF  
HIGHWAY 401  
BOREHOLE LOCATIONS

SHEET



**Golder Associates Ltd.**  
LONDON, ONTARIO, CANADA



KEY PLAN

SCALE IN KILOMETRES  
0 1 2

LEGEND

● Borehole - Current Investigation

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
1	166.89	4 867 863.0	390 891.6
2	168.67	4 867 844.8	390 818.1
3	169.22	4 867 814.5	390 808.4
4	169.89	4 867 794.5	390 780.5

NOTES

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

REFERENCE

Base plans provided in digital format by Dillon Consulting Limited.



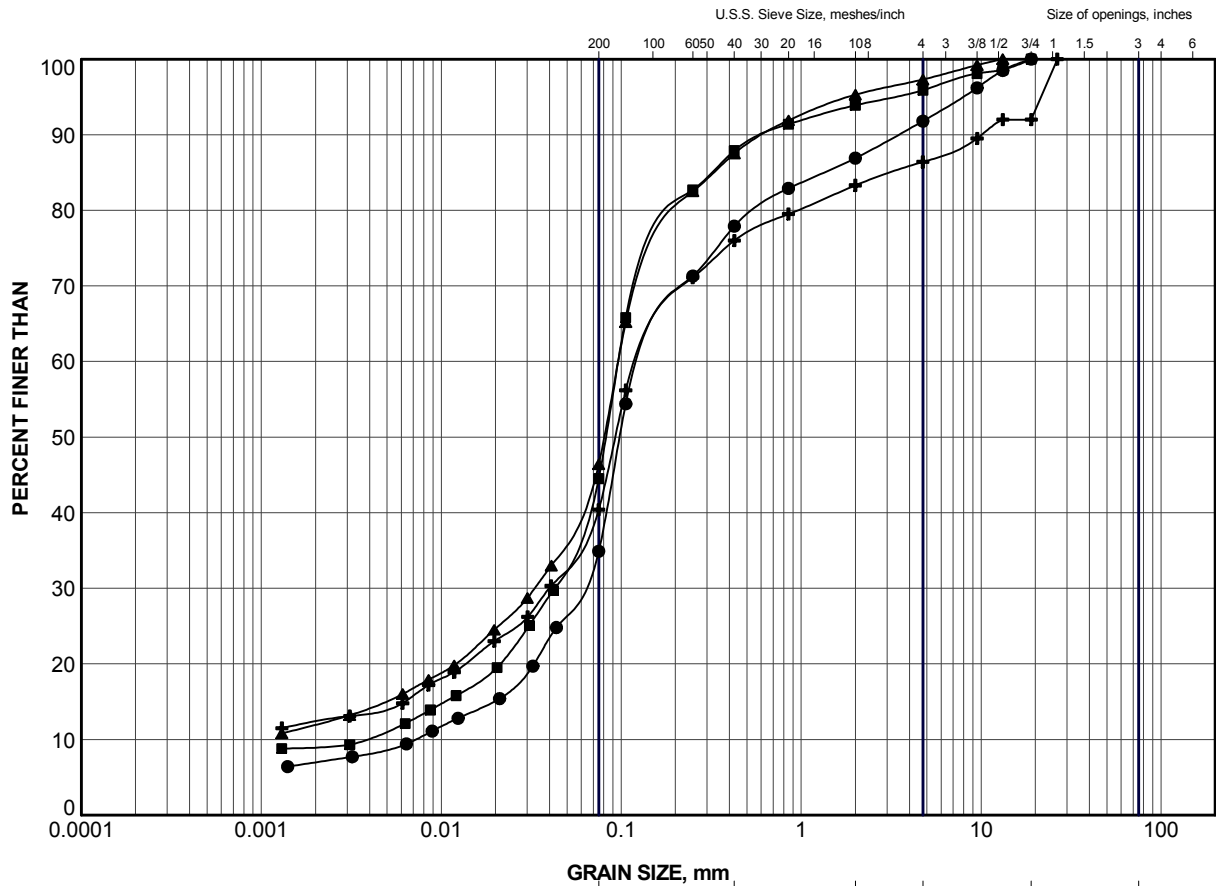
NO.	DATE	BY	REVISION
Geocres No.	30M15-115		
HWY.	401	PROJECT NO.	10-1132-0152
SUBM'D.	DJM	CHKD.	DATE: Apr. 26/12
DRAWN:	LMK	CHKD.	APPD.
			DWG. 1





# APPENDIX A


## Laboratory Test Data

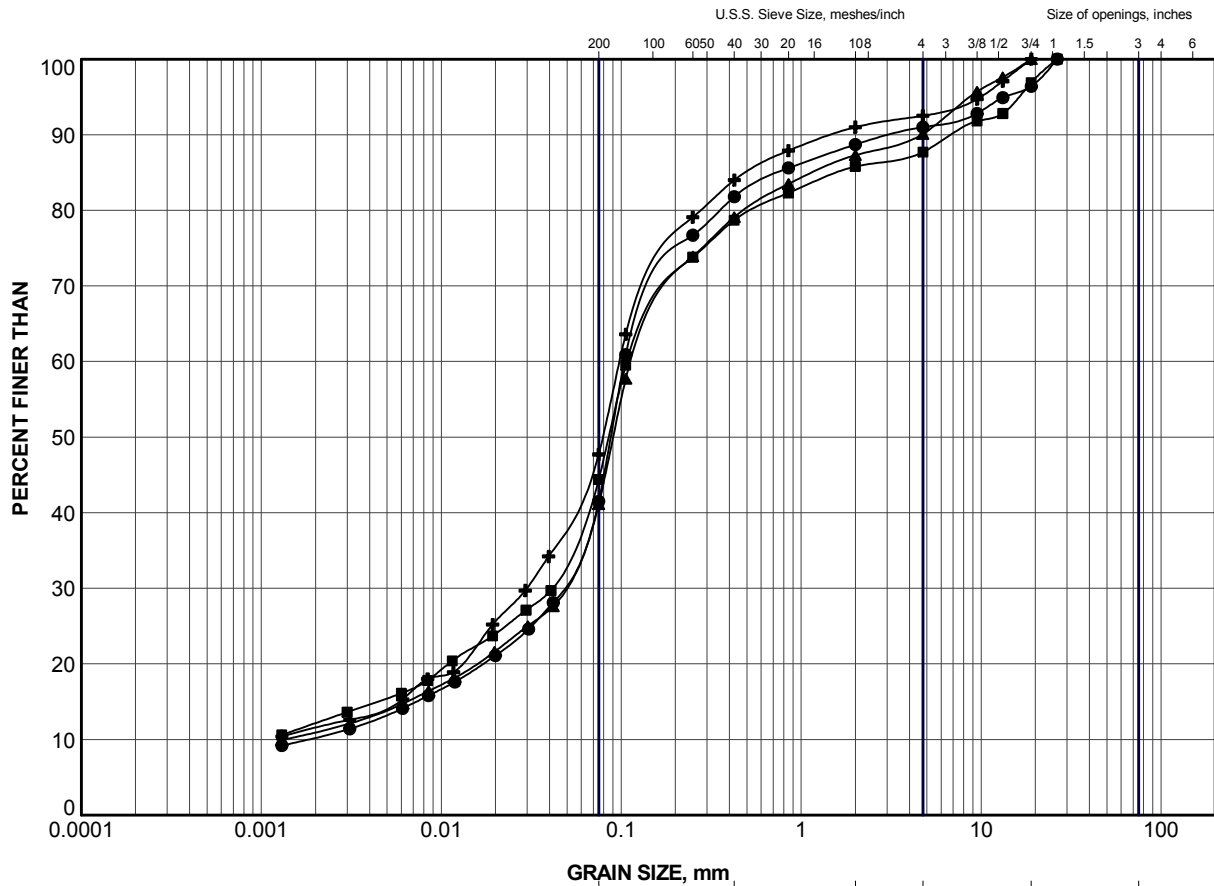


CLAY AND SILT	SAND SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	1	3	165.1
■	1	6	162.9
▲	2	3	166.9
+	2	5	165.5


PROJECT				BOWMANVILLE CVIF HIGHWAY 401 WP 10-20010			
TITLE				GRAIN SIZE DISTRIBUTION SILTY SAND TILL			
PROJECT No.		10-1132-0152		FILE No.		1011320152-F010A1	
DRAWN		LMK		SCALE		N/A	
CHECK		Mar 07/12		REV.			
 <b>Golder Associates</b> LONDON, ONTARIO				<b>FIGURE A-1</b>			



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

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	3	3	167.5
■	3	6	165.2
▲	4	5	166.6
+	4	7	165.2

PROJECT		BOWMANVILLE CVIF HIGHWAY 401 WP 10-20010			
TITLE		GRAIN SIZE DISTRIBUTION SILTY SAND TILL			
 <b>Golder Associates</b> LONDON, ONTARIO	PROJECT No.	10-1132-0152	FILE No.	1011320152-F010A2	
	DRAWN	LMK	Mar 07/12	SCALE	N/A
	CHECK			REV.	
	<b>FIGURE A-2</b>				



# **APPENDIX B**

## **Site Photographs**



## APPENDIX B SITE PHOTOGRAPHS



Photograph 1: Looking east in vicinity of inspection station.





## APPENDIX B SITE PHOTOGRAPHS



Photograph 2: Looking east from top of cut into fill area and future off ramp.

n:\active\2010\1132 - geotechnical\1132-0100\10-1132-0152 dillon-bowmanville tis-2009-e-0046\prime-fdns\rpts\r01\1011320152-r01 apr 26 12-app b.docx

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