



December 2011

FOUNDATION INVESTIGATION AND DESIGN REPORT

**New Inspection Building
Putnam South Commercial Vehicle Inspection Facility
GWP 4100-04-00**

Submitted to:

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REPORT



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FOUNDATION INVESTIGATION AND DESIGN REPORT NEW INSPECTION BUILDING, GWP 4100-04-00

LIST OF ABBREVIATIONS

LIST OF SYMBOLS

RECORD OF BOREHOLE SHEETS

FIGURE 1 - Key Plan

DRAWING 1 - Borehole Locations and Soil Strata

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APPENDIX A

Laboratory Test Data



PART A
FOUNDATION INVESTIGATION REPORT
NEW INSPECTION BUILDING
PUTNAM SOUTH CVIF
GWP 4100-04-00



1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Dillon Consulting Limited (Dillon) on behalf of Coco Paving Inc. to carry out foundation investigations as part of the design-build work for GWP 4100-04-00. The project consists of the detail design and construction of the new Commercial Vehicle Inspection Facilities at the Putnam north and south sites. This report addresses the new inspection building to be constructed at the Putnam south site. The location of the site is shown on the Key Plan, Figure 1.

The purpose of the foundation 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 Terms of Reference for the scope of work are outlined in Golder Associates' letter dated June 14, 2011.

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



2.0 SITE DESCRIPTION

The Putnam South CVIF is located immediately south of Highway 401 about 1.5 kilometres west of the Highway 401/Putnam Road interchange as shown on the Key Plan, Figure 1. Currently, a primary scale lane is oriented parallel to Highway 401 with the scale and existing inspection building located in the eastern portion of the site. South of the scale lane, a “race track” configured, asphalt surfaced parking/inspection area is present. A raised sewage disposal system is located immediately east of the inspection area.

The existing truck inspection station is located at the crest of a moraine in the generally rolling regional topography. The lands in existing truck inspection station have been constructed on variable thicknesses of fill materials to create a relatively level area. The station entrance ramp rises to the east and the exit ramp declines to the east similar to the adjacent Highway 401.

The topography in the area of the site ranges from about elevation 282 metres near the bullnose of the entrance ramp to about elevation 291 metres in the inspection area.

The adjacent land use is rural agricultural.

2.1 Site Geology

The site is located within the physiographic region of southwestern Ontario¹ known as the Stratford Till Plain which is a product of the Huron ice lobe. Throughout the area, the till is a fairly uniform, brown calcareous silty clay.

¹ Chapman and Putnam, 1985, The Physiography of Southern Ontario, 3rd Edition, Ontario Geological Series



3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on September 13 and 19, 2011 during which time two boreholes (boreholes 5 and 6) 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)
5	4,760,331	429,675	291.33	8.08
6	4,760,334	429,643	291.03	8.08

It should be noted that ten boreholes (numbered 1 to 10, inclusive) were drilled for the various CVIF components and the results are provided in the associated Foundation Investigation and Design Reports. Boreholes 5 and 6 are relevant to the new inspection building.

The investigation was carried out using an all terrain vehicle mounted CME 750 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 using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. The boreholes were terminated about 8.1 metres below the existing pavement or ground surface.

Groundwater conditions in the boreholes were observed throughout the drilling operations. Following completion of drilling and sampling, the boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 903 (as amended by Ontario Regulation 372).

The field work was monitored on a full-time basis by an experienced member of our engineering staff who located the boreholes in the field, monitored the drilling, sampling and in situ testing operations, logged the boreholes and surveyed their locations. The samples were identified in the field, placed in labelled 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 Record of Borehole sheets and in Appendix A.



4.0 SUBSURFACE CONDITIONS

4.1 General

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 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 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 the existing pavement structure or surficial topsoil and fill materials which were underlain by clayey silt and sandy silt glacial till.

4.2 Soil Conditions

4.2.1 Topsoil and Fill

A layer of topsoil about 0.1 metres thick was encountered at the ground surface in borehole 5.

The existing pavement structure, consisting of about 0.1 metres of asphalt and 0.3 metres of granular materials, was encountered at the pavement surface in borehole 6.

Beneath the topsoil and pavement structure, both of the boreholes encountered stiff to hard clayey silt fill materials. A trace of topsoil was present in the fill. The fill was about 1.7 and 2.1 metres thick in boreholes 5 and 6, respectively. The fill had N values, as determined in the standard penetration testing, of 14 to 20 blows per 0.3 metres with water contents of 13 to 25 per cent. The clayey silt fill had corresponding plastic and liquid limits of 17 and 33 per cent, respectively, based on a single Atterberg limits determination. The Atterberg limits data are shown on the Plasticity Chart, Figure A-4.

A grain size distribution curve for a sample of the clayey silt fill recovered from the standard penetration testing is provided on Figure A-1.

A layer of buried topsoil about 0.3 metres thick was encountered beneath the fill in borehole 5 at about elevation 289.5 metres. The buried topsoil had an N value of 30 blows per 0.3 metres for a test partially completed in the layer and a water content of about 20 per cent.



4.2.2 Clayey Silt Till

Beneath the fill and buried topsoil, boreholes 5 and 6 encountered a stratum of very stiff to hard clayey silt till between about elevation 288.5 and 289.2 metres. Borehole 5 was terminated in the clayey silt till after exploring it for about 6 metres. In borehole 6, the clayey silt till was about 4.2 metres thick. The clayey silt till had N values of 24 to 55 blows per 0.3 metres with natural water contents of 16 to 19 per cent. The clayey silt till had average plastic and liquid limits of about 17 and 32 per cent, respectively, based on three Atterberg limits determinations. The Atterberg limits data are shown on Figure A-4.

Grain size distribution curves for samples of the clayey silt till recovered from the standard penetration testing are provided on Figure A-2. Although not specifically encountered in the boreholes, cobbles and boulders should be expected in the clayey silt till.

4.2.3 Silty Clay

A layer of hard silty clay was encountered beneath the clayey silt till in borehole 6 at about elevation 284.3 metres. The silty clay was about 0.8 metres thick and had an N value of 30 blows per 0.3 metres with a natural water content of about 22 per cent.

4.2.4 Sandy Silt Till

Beneath the silty clay, borehole 6 encountered a stratum of dense sandy silt till at about elevation 283.6 metres. The sandy silt till was explored for about 0.6 metres prior to terminating the borehole. The sandy silt till had an N value of 38 blows per 0.3 metres and a natural water content of about 9 per cent. The sandy silt till had corresponding plastic and liquid limits of about 12 and 16 per cent, respectively, based on a single Atterberg limits determination. The Atterberg limits data are shown on Figure A-4.

A grain size distribution curve for a sample of the sandy silt till recovered from the standard penetration testing is provided on Figure A-3. Although not specifically encountered in the boreholes, cobbles and boulders should be expected in the sandy silt till.

4.3 Groundwater Conditions

Boreholes 5 and 6 remained dry during drilling on September 13 and 19, 2011, respectively.

The inferred long term groundwater level is at about elevation 285 metres. Groundwater levels should be expected to fluctuate seasonally and in response to significant precipitation events.



5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Lantech Drilling Services Inc., an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Dan Babcock, P.Eng. under the direction of Mr. Michael E. Beadle, P.Eng.. 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 Mr. Michael E. Beadle, 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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**FOUNDATION INVESTIGATION AND DESIGN REPORT
NEW INSPECTION BUILDING, GWP 4100-04-00**

PART B
FOUNDATION DESIGN REPORT
NEW INSPECTION BUILDING
PUTNAM SOUTH CVIF
GWP 4100-04-00



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

Based on the results of the investigation, the existing fill and buried topsoil are not considered suitable for foundation support. The proposed new building can be founded on conventional spread and/or strip footing bearing on the native clayey silt till at least 0.3 metres below the surface of the till typically at or below elevation 288.8 to 288.3 metres. While foundations constructed in this manner may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 500 kilopascals and a geotechnical resistance at Serviceability Limit States (SLS) of 350 kilopascals, it is anticipated that the factored ULS geotechnical resistance of 400 kPa and a SLS geotechnical resistance of 250 kPa would be adequate for building founding design. The SLS criterion is for 25 millimetres of total settlement based on a minimum 0.5 metre 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 geotechnical engineer. At least 1.2 metres of soil cover or thermal equivalent should be provided over the footings.

The soils at the site are not considered to be aggressive to concrete. Therefore, normal GU (formerly Type 10) cement may be used.

For seismic site response, Site Class C is appropriate.

6.2.1 Engineered Fill

Alternatively, the foundations could be founded on a minimum 1.0 metre thick engineered fill constructed on the clayey silt till typically at or below elevation 288.8 to 288.3 metres following removal of all fill and topsoil. The engineered fill could be constructed using compacted Granular A placed in maximum 300 millimetre thick loose



lifts. The engineered fill should extend beyond the footprint of the new building by 1.0 metre plus the thickness of the fill required beneath the footings. Full time geotechnical inspections and materials testing will be required during construction of any engineered fill.

Foundations constructed on Granular A engineered fill may be designed using a factored geotechnical resistance at ULS of 400 kilopascals and a geotechnical resistance at SLS of 250 kilopascals.

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 the Ontario Building Code. Assuming that the founding soils are not softened/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>$\tan \delta$</u>
Footings on clayey silt till	30	0.58
Footings on Granular A engineered fill	32	0.62

6.4 Lateral Earth 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 backfill, 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 Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type III should be used as backfill. Longitudinal drains should be installed to provide positive drainage of the granular backfill.
- A compaction surcharge equal to 12 kPa 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 III</u>
Soil unit weight:	22 kN/m ³	21 kN/m ³
Coefficients of lateral earth pressure:		
Active, K_a	0.27	0.31
At rest, K_0	0.43	0.47
Passive, K_p	3.7	3.3

- 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.

6.5 Slab-on-Grade

It is understood that the new building finished floor elevation will be about 292 metres. Based on the results of the investigation, the existing fill and topsoil materials are not considered suitable for the support of a slab-on-grade. As a result, it is recommended that the existing fill and topsoil materials be removed and the floor slab supported on engineered fill constructed using Granular B Type III or sand placed in 0.3 metres thick lifts. The upper 200 millimetres of granular material beneath the slab should consist 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. For the design of the slab-on-grade, a modulus of subgrade reaction of 60 megapascals per metres (mPa/m) may be used.

6.6 Excavations

Excavations for the foundations will encounter the surficial topsoil and existing pavement structure, clayey silt fill and clayey silt till. Cobbles and boulders should be expected in the till strata.

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 fill would be classified as a Type 3 soil and the clayey silt till would be classified as a Type 2 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 maintained outside of the actual footing limits.

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



7.0 MISCELLANEOUS

This report was prepared by Mr. Michael E. Beadle, 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.)

(b) Cohesive Soils

Consistency

	c_u, s_u	
	kPa	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

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

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

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

LIST OF SYMBOLS

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

I. General

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal 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 $= \sigma'_p / \sigma'_{vo}$

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

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

PROJECT 11-1132-0082
W.P. 4100-04-00 LOCATION N 4760330.7 ; E 429674.5 ORIGINATED BY DB
DIST HWY 401 BOREHOLE TYPE POWER AUGER, HOLLOW STEM COMPILED BY WDF/LMK
DATUM GEODETIC DATE September 13, 2011 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						× LAB VANE		
291.33	GROUND SURFACE						20	40	60	80	100						GR	SA	SI	CL
0.08	TOPSOIL, silty Black FILL, clayey silt, trace to some sand, trace gravel Very stiff to hard Brown		1	SS	20															
289.53			2	SS	30															
1.80	TOPSOIL, silty Compact Black																			
289.20																				
2.13	CLAYEY SILT TILL, trace sand, trace gravel Very stiff to hard Brown becoming grey at about elev. 284.6m becoming brown at about elev. 283.4m		3	SS	25															
			4	SS	43															
			5	SS	46															
			6	SS	37															
			7	SS	45															
			8	SS	33															
			9	SS	24															
			10	SS	28															
283.25	END OF BOREHOLE																			
8.08	Borehole dry during drilling on September 13, 2011.																			

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

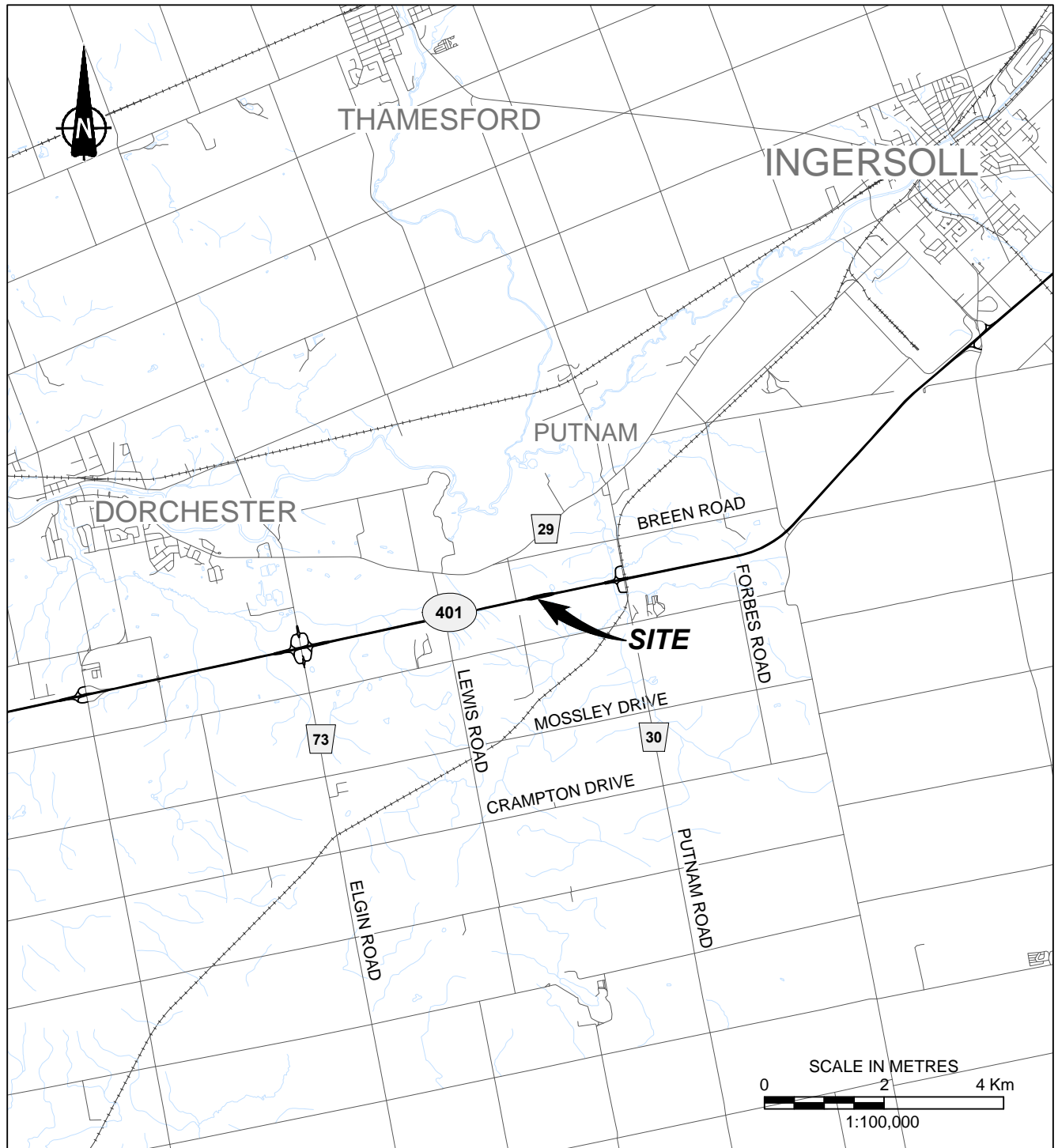
RECORD OF BOREHOLE No 6

1 OF 1

METRIC

PROJECT 11-1132-0082
W.P. 4100-04-00 LOCATION N 4760334.2 ; E 429643.4 ORIGINATED BY DB
DIST HWY 401 BOREHOLE TYPE POWER AUGER, SOLID STEM COMPILED BY WDF/LMK
DATUM GEODETIC DATE September 19, 2011 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
								○ UNCONFINED	+	FIELD VANE							
								● QUICK TRIAXIAL	×	LAB VANE							
								WATER CONTENT (%)									
								20	40	60	80	100		10	20	30	
291.03	GROUND SURFACE						291										
	ASPHALT																
0.18	FILL, crushed granular base Brown																
0.40	FILL, sand and gravel, with cobbles Brown																
	FILL, clayey silt, some sand, trace gravel, trace topsoil Stiff to very stiff Brown		1	SS	14		290								○		
			2	SS	16		289								○	—	2 12 48 38
288.53			3	SS	23		288								○		
2.50	CLAYEY SILT TILL, trace sand, trace gravel Very stiff to hard Brown becoming grey at about elev. 285.1m		4	SS	45		287								○		
			5	SS	55		286								○		
			6	SS	53		285								○		
			7	SS	50		284								○		
			8	SS	40		283								○		
284.33																	
6.70	SILTY CLAY, trace sand Hard Grey		9	SS	30												
283.56																	
7.47	SANDY SILT TILL, trace clay, some gravel Dense Brown		10	SS	38												
282.95																	
8.08	END OF BOREHOLE																
	Borehole dry during drilling on September 19, 2011.																



REFERENCE

DRAWING BASED ON CANMAP STREETFILES V2008.4.

NOTES

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

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

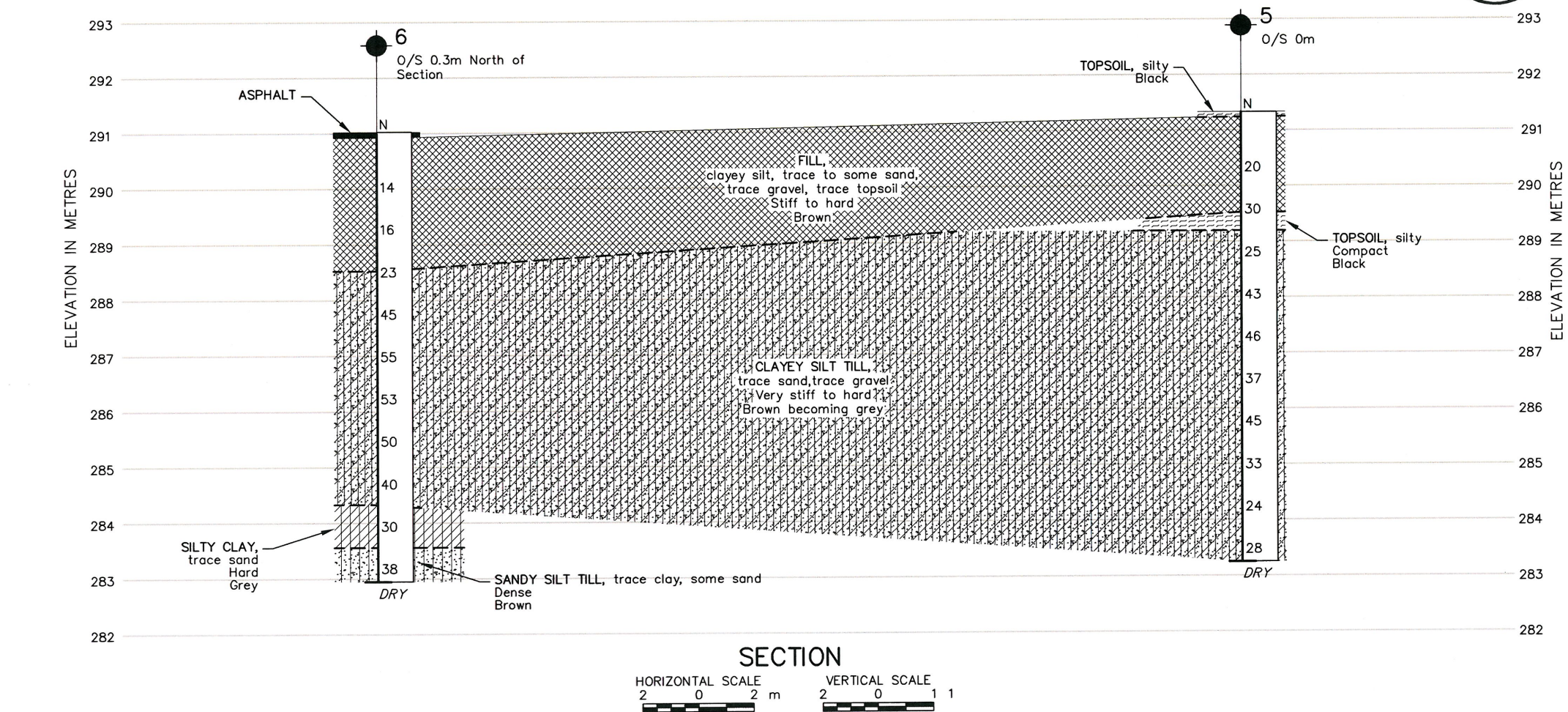
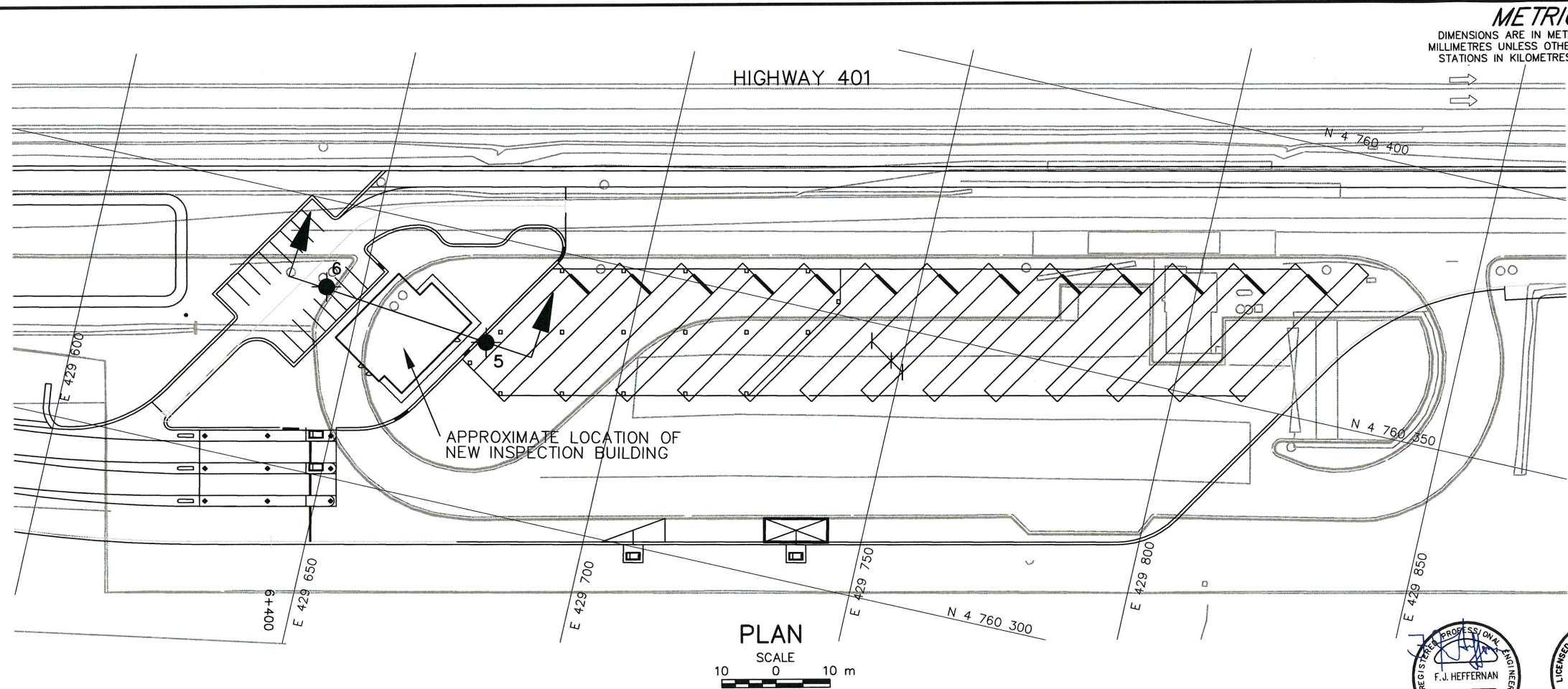
FOUNDATION INVESTIGATION
NEW INSPECTION BUILDING
PUTNAM SOUTH CVIF, GWP 4100-04-00

TITLE

LOCATION PLAN



PROJECT No. 11-1132-0082			FILE No. 1111320082-2000-F01001	
CADD	DCH	Nov. 3/11	SCALE	AS SHOWN
CHECK			REV.	
			FIGURE 1	

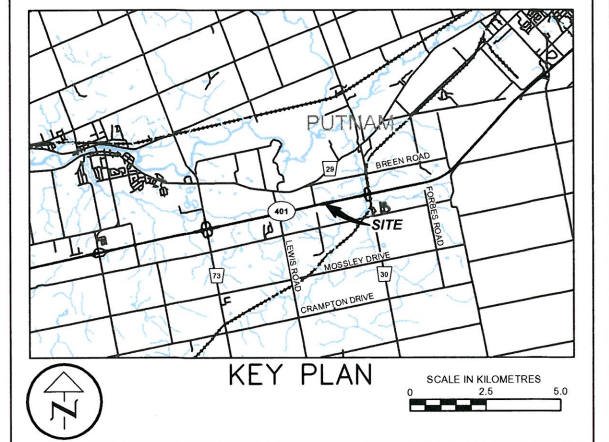


CONT No.
WP No. 4100-04-00

NEW INSPECTION BUILDING
HIGHWAY 401/PUTNAM SOUTH CVF
BOREHOLE LOCATIONS AND SOIL STRATA



Golder Associates Ltd.
LONDON, ONTARIO, CANADA



LEGEND

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- DRY Borehole dry during drilling
- WL encountered during drilling

No.	ELEVATION	CO-ORDINATES MTM ZONE 10	
		NORTHING	EASTING
5	291.33	4 760 330.7	429 674.5
6	291.03	4 760 334.2	429 643.4

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

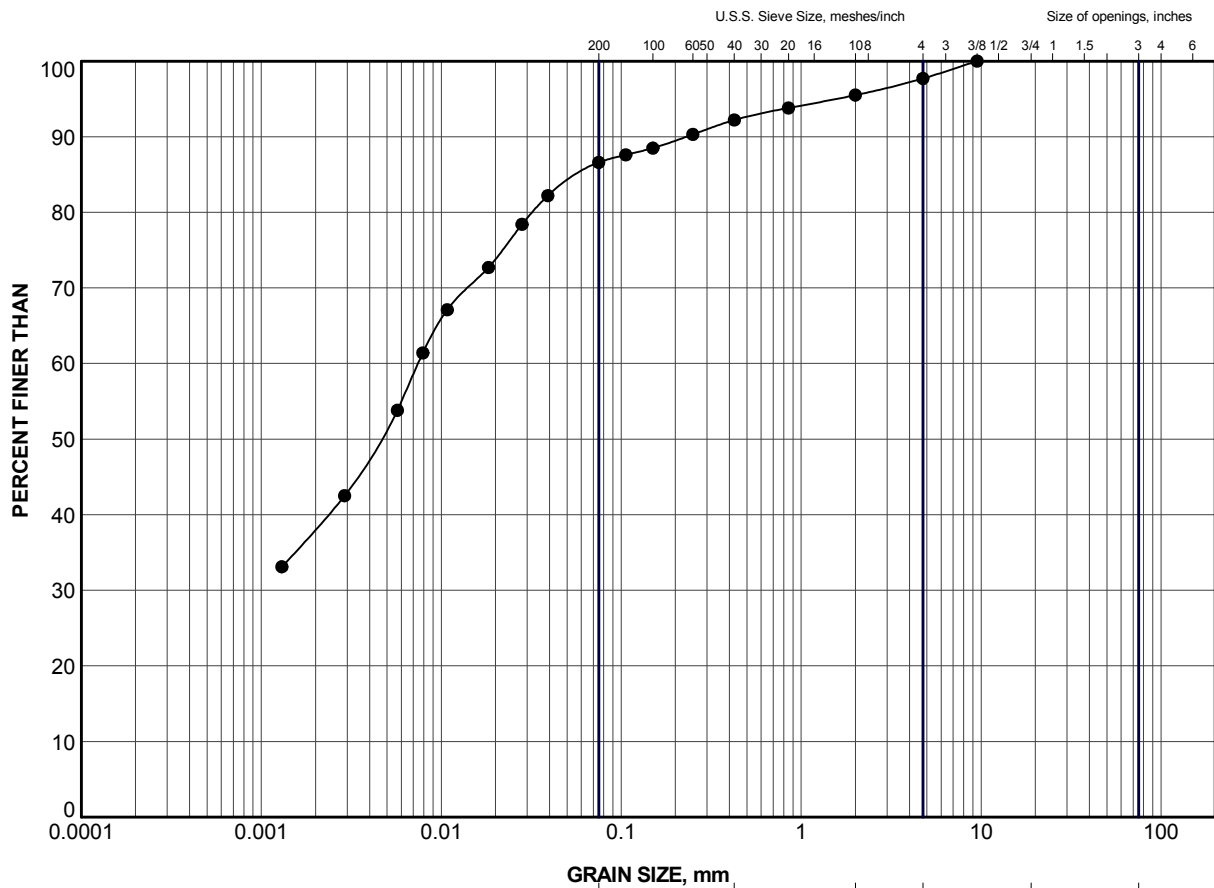
Base plans provided in digital format by Dillon Consulting

NO.	DATE	BY	REVISION
Geocres No. 40115-33			
HWY.	401	PROJECT NO.	11-1132-0082
SUBM'D.	MB	CHKD.	DATE: Nov. 2/11
DRAWN:	DCH	CHKD.	APPD.
DIST.			SITE:
DWG.			1



APPENDIX A

Laboratory Test Data



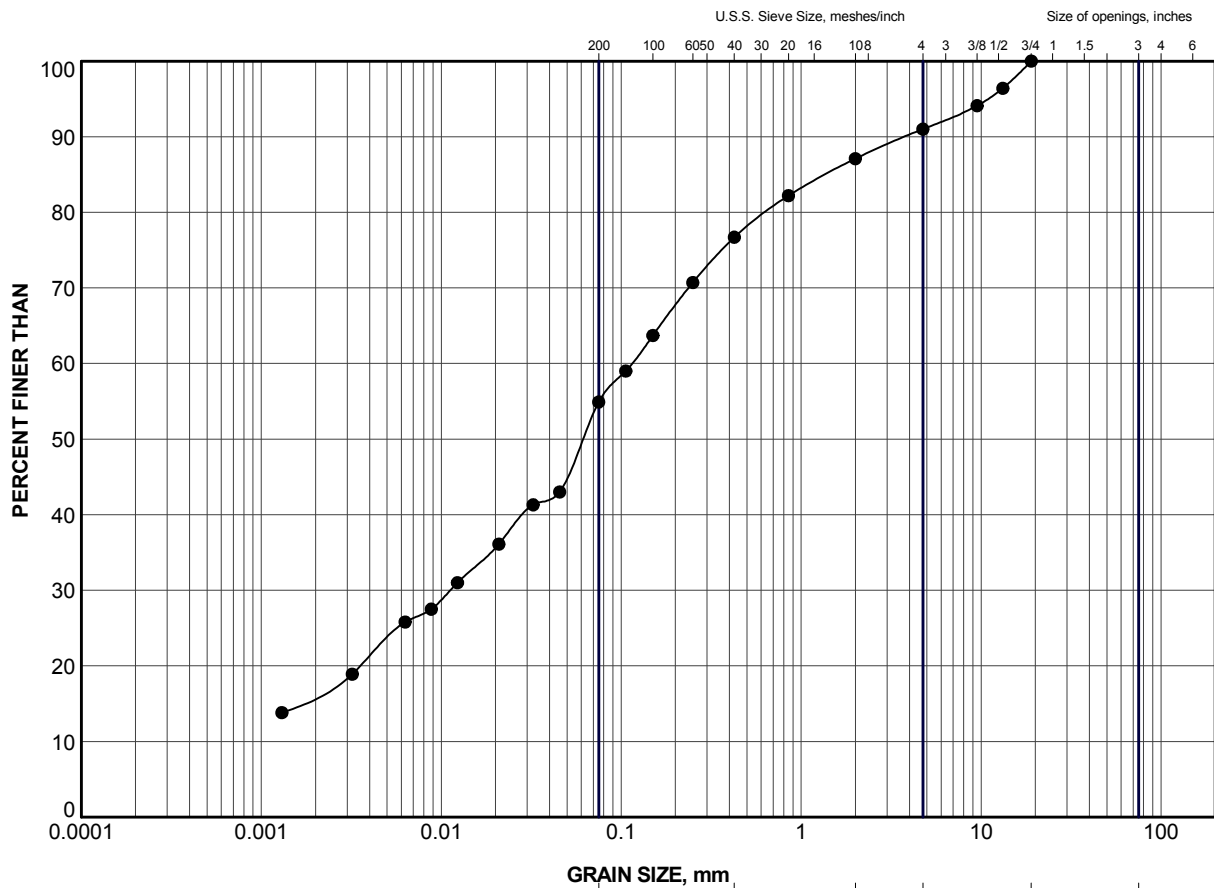
GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	6	2	289.3

PROJECT				FOUNDATION INVESTIGATION NEW INSPECTION BUILDING PUTNAM SOUTH CVIF GWP 4100-04-00			
TITLE				GRAIN SIZE DISTRIBUTION FILL			
PROJECT No.		11-1132-0082		FILE No		11320082-2000-F010A1	
DRAWN		DCH		Nov 10/11		SCALE N/A REV.	
CHECK						FIGURE A-1	



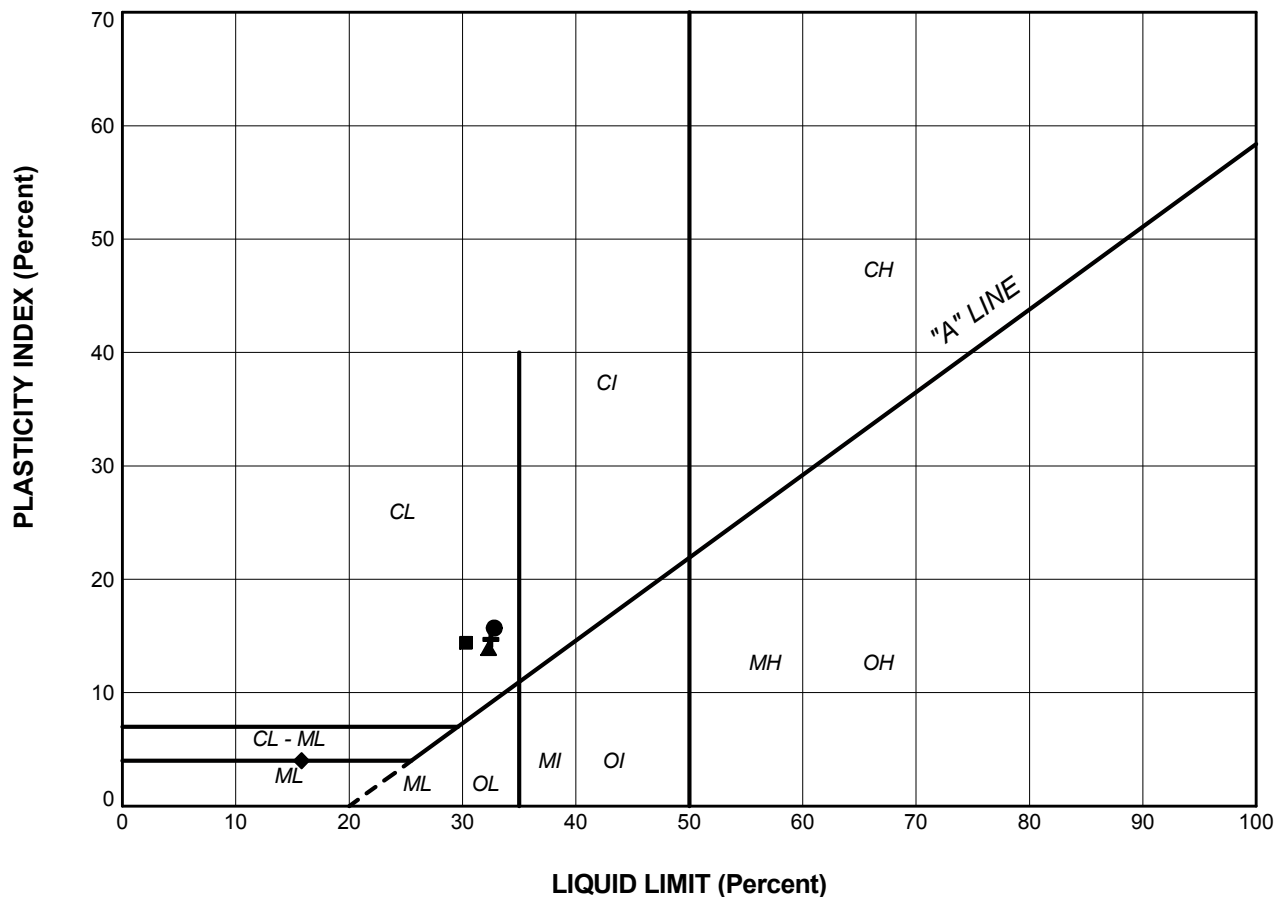


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	6	10	283.2

PROJECT	FOUNDATION INVESTIGATION NEW INSPECTION BUILDING PUTNAM SOUTH CVIF GWP 4100-04-00		
TITLE	GRAIN SIZE DISTRIBUTION SANDY SILT TILL		
<div> <div>Golder Associates</div> <div>LONDON, ONTARIO</div> </div>	PROJECT No.	11-1132-0082	FILE No. 1111320082-2000-F010A3
	DRAWN	DCH	Oct 21/11
	CHECK		
	SCALE	N/A	REV.
	FIGURE A-3		




SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	FILL				
●	6	2	32.8	17.1	15.7
■	CLAYEY SILT TILL				
■	5	3	30.3	15.9	14.4
▲	5	7	32.3	18.4	13.9
+	6	5	32.5	17.8	14.7
◆	SANDY SILT TILL				
◆	6	10	15.8	11.8	4.0

PROJECT		FOUNDATION INVESTIGATION NEW INSPECTION BUILDING PUTNAM SOUTH CVIF GWP 4100-04-00			
TITLE		PLASTICITY CHART			
 Golder Associates LONDON, ONTARIO	PROJECT No.	11-1132-0082	FILE No.	1111320082-2000-F010A4	
	DRAWN	LMK/AMG	NOV. 15/11	SCALE	N/A
	CHECK			REV.	
			FIGURE A-4		

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