REPORT

October 6, 2014

FOUNDATION INVESTIGATION REPORT

SAND/SALT STORAGE STRUCTURE
GRAVENHURST PATROL YARD
HIGHWAY 11, TOWNSHIP OF MUSKOKA
ASSIGNMENT NO. 3, AGREEMENT NO. 5013-E-0034
MINISTRY OF TRANSPORTATION, ONTARIO
W.O. 2014-11033

Submitted to:
Ministry of Transportation, Ontario
Pavements and Foundations Section
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1 Copy - Golder Associates Ltd., Sudbury, Ontario

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PART A

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Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by The Ministry of Transportation, Ontario (MTO), Northeastern Region to provide foundation engineering services for a proposed structure at the existing Gravenhurst Patrol Yard, located approximately 500 m south of Muskoka Road 169 (Bethune Drive) on Highway 11 in the Geographic Township of Muskoka. This work has been carried out under the Retainer Assignment under Agreement #5013-E-0034.

The purpose of this investigation is to establish the subsurface conditions at the proposed Patrol Yard sand/salt storage structure by methods of borehole drilling, in situ testing and laboratory testing on selected samples. The location of the structure was determined in the field by Golder based on the Patrol Facility Site Plan drawing (Plan H-395-11-1, dated 2013 02), which was included in the Terms of Reference for this work. The approximate location of the proposed structure within the existing Patrol Yard facility is shown in plan on Drawing 1.

2.0 SITE DESCRIPTION

The proposed sand/salt storage structure will be 15.2 m by 24.4 m in plan dimensions and will be built within a cleared area in the existing patrol yard facility.

In general, the topography in the vicinity of the proposed structure is flat and the ground surface at the structure location varies between about Elevation 256 m and 257 m. Various materials storage piles mounds (asphalt, sand, etc.) are present in the general area of the proposed sand/salt storage facility. A detailed description of the subsurface conditions at the structure location is presented in Section 4.0.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The investigation for the storage structure was carried out between September 2 and 5, 2014, during which time a total of four boreholes were advanced within the footprint of the proposed structure. The locations of the boreholes are shown on Drawing 1 and the coordinates are provided on the Record of Borehole sheets in Appendix A.

The field investigation was carried out using a track-mounted D55 Turbo drill rig supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced through the overburden using 108 mm inner diameter hollow-stem augers. In general, soil samples were obtained at depth intervals of 0.75 m and 1.5 m, using a 50 mm O.D. split-spoon sampler driven by an automatic hammer and carried out in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586, Standard Test Method for Standard Penetration Test). All boreholes were backfilled with bentonite and cuttings upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The boreholes were advanced to depths ranging between 11.3 m and 12.8 m below existing ground surface.

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets provided in Appendix A.

The fieldwork was observed by a member of our engineering and technical staff, who located the boreholes, arranged for the clearance of underground services using Ontario One Call and a private locator, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury Geotechnical Laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, grain size distribution and Atterberg limits) was carried out on selected samples. The results of the laboratory testing on samples from the boreholes are presented on the Record of Borehole sheets and are included in Appendix B.

The location of the structure was provided by the MTO on the Patrol Facility Site Plan drawing (Plan H-395-11-1, dated 2013 02). Our staff determined the structure location in the field by referencing the plan and measuring distances from easily identifiable known points. The boreholes were located in the field as close to the four corners of the structure footprint as practical based on existing site access conditions. The UTM coordinates of the as-drilled borehole locations were recorded with a handheld GPS (accuracy to ± 3 m) using NAD 83 datum. The borehole coordinates were subsequently converted into MTM NAD 83 in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevation at an existing benchmark (GBM 271-67) located on an existing concrete garage within the facility. The borehole locations given in the Record of Borehole sheets and shown on Drawing 1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and drilled depths are as follows:

Borehole	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting		
BH-YARD1	4 973 399.2	315 563.8	256.4	11.3
BH-YARD2	4 973 379.0	315 663.4	256.4	11.3
BH-YARD3	4 973 372.9	315 656.4	256.6	12.8
BH-YARD4	4 973 390.3	315 642.6	256.8	12.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on published geologic information, made publically available from the Ontario Ministry for Northern Development and Mines[1] through “OGS Earth”, the surficial soils in the vicinity of the patrol yard generally consist of coarse-textured glaciolacustrine deposits of gravel and sand with minor amounts of silt and clay. Based on available information, the patrol yard may have been used as a sand and/or gravel pit. Published information from the Ontario Ministry for Northern Development and Mines[2] through “OGS Earth” indicates that the patrol yard is located in the Central Gneiss Belt of the Grenville Province, which contains rocks from 1.0 Ga to 1.6 Ga in age, consisting primarily of zones of mafic, igneous, migmatitic and metasedimentary rocks.

[1] Ontario Geologic Survey. 2003. Surficial Geology of Southern Ontario. Ontario Ministry of Northern Development and Mines.

[2] Ontario Geologic Survey. 2000. Bedrock Geology, Seamless Coverage of the Province of Ontario. Ontario Ministry of Northern Development and Mines.

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are presented on the attached Record of Borehole sheets in Appendix A and the soil laboratory test sheets provided in Appendix B. The results of the in situ field tests (i.e., SPT 'N'-values) as presented on the Record of Borehole sheets and in this section are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions encountered at the site consist of compact to very dense sandy gravel to sand fill at the ground surface underlain by a non-cohesive deposit of compact to dense sand in turn underlain by a deposit of loose to compact sandy silt to silt and sand with occasional layers of clayey silt and silt. All boreholes were terminated within the sandy silt to silt and sand deposit. Detailed descriptions of the subsurface conditions are provided in the following sections of this report.

4.2.1 Fill

Fill comprised of brown to black sandy gravel, sand and gravel and/or sand was encountered at the ground surface in all boreholes. The fill deposit was encountered between Elevation 256.8 m and Elevation 256.4 m and is between 3.6 m and 3.7 m thick. The fill material in Boreholes BH-YARD2 to BH-YARD4 contained gravel sized pieces of asphalt in the upper 0.6 m to 1.5 m.

SPT 'N'-values measured within the fill range from 10 blows to 87 blows per 0.3 m of penetration indicating a compact to very dense relative density.

The natural water content measured on thirteen samples of the sandy gravel to sand fill stratum ranges from about 2 per cent to 12 per cent.

The results of grain size distribution tests completed on seven samples of the fill are shown on Figure B1 in Appendix B.

4.2.2 Sand

A non-cohesive deposit consisting of brown sand, trace silt was encountered underlying the fill in all boreholes. The surface of the deposit was encountered between Elevation 253.1 m and Elevation 252.7 m and the thickness of the stratum ranges from 5.0 m to 5.1 m.

SPT 'N'-values measured within the sand stratum range from 24 blows to 46 blows per 0.3 m of penetration indicating a compact to dense relative density.

The natural water content measured on nine samples of the sand stratum ranges from about 18 per cent to 23 per cent.

The results of grain size distribution tests completed on four samples of the sand stratum are shown on Figure B2 in Appendix B.

4.2.3 Sandy Silt to Silt and Sand

A deposit of brown to grey wet sandy silt to silt and sand, trace clay was encountered underlying the sand stratum in all boreholes. Silt and clayey silt to silt layers were noted within the silt and sand portion of the deposit in Boreholes BH-YARD3 and BH-YARD4. The surface of the deposit was encountered between Elevation 248.1 m and Elevation 247.7 and was not fully penetrated beyond a thickness of 2.6 m to 4.1 m.

SPT 'N'-values measured within the deposit range from 5 blows to 26 blows per 0.3 m of penetration indicating a loose to compact relative density.

The natural water content measured on seven samples of this deposit ranges from about 19 per cent to 25 per cent.

The results of grain size distribution tests completed on four samples of this deposit, including the silt layer, are shown on Figure B3 in Appendix B.

Cohesive material encountered at a depth of about 10.7 m below ground surface (Elevation 246.1 m to Elevation 245.9 m). Atterberg limits tests were carried out on the two samples of the layer in Boreholes BH-YARD3 and BH-YARD4 and measured liquid limits of about 20 per cent and 23 per cent, plastic limits of about 16 per cent to 18 per cent and plasticity indices of about 3 per cent and 7 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B4 in Appendix B and indicate the material in this zone is classified as a silt of slight plasticity and clayey silt of low plasticity in the respective boreholes.

4.3 Groundwater Conditions

Groundwater levels were measured in the open boreholes during and upon completion of drilling at depths ranging from 3.8 m to 4.3 m below ground surface or between Elevation 252.8 m and Elevation 252.3 m, which roughly corresponds to the depth where the field moisture condition of the material changed from moist to wet.

Groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary depending on seasonal fluctuations, precipitation and local soil permeability.

5.0 CLOSURE

The drilling program was supervised by Mr. David Marmor, EIT. This report was prepared by Mr. David Marmor and reviewed by Ms. Sarah E. M. Poot, P.Eng., a senior geotechnical engineer and Associate with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for Foundations for this assignment and Principal with Golder, conducted an independent quality control review of the report.

Report Signature Page

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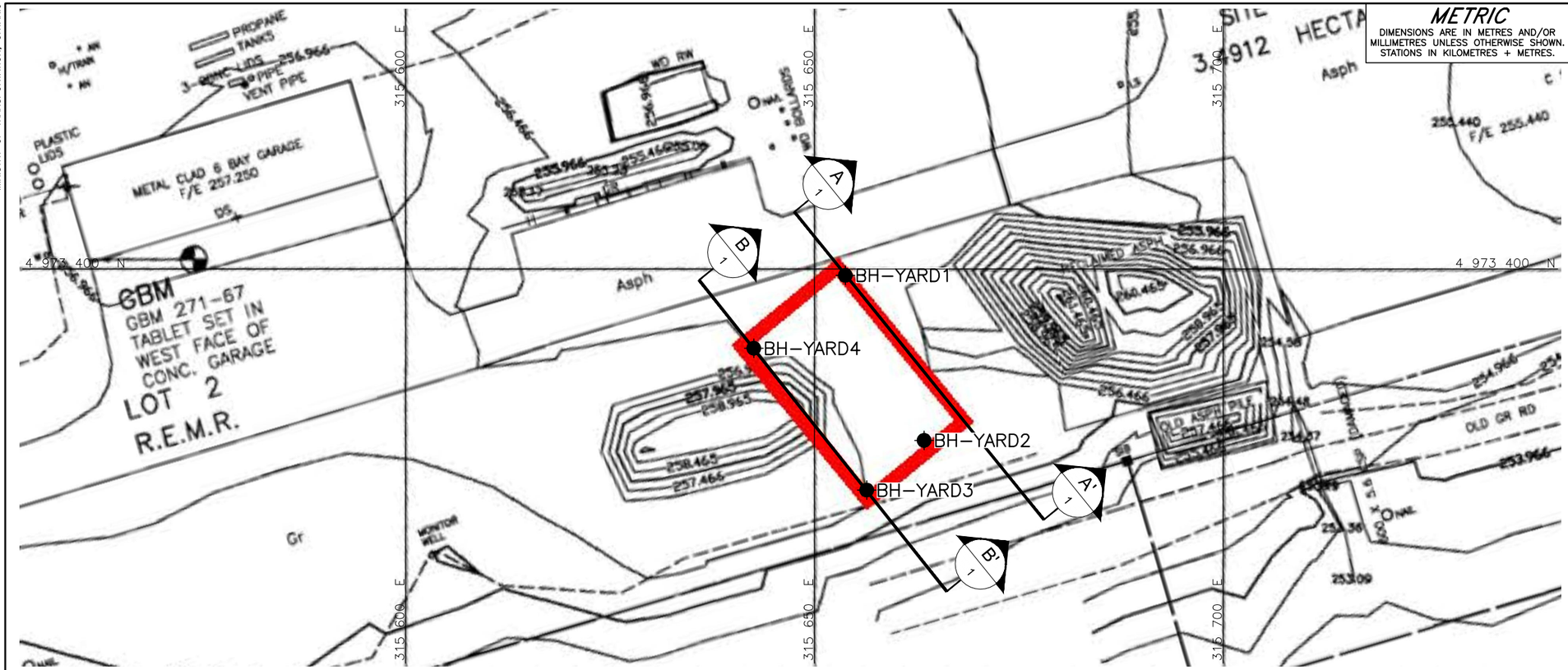
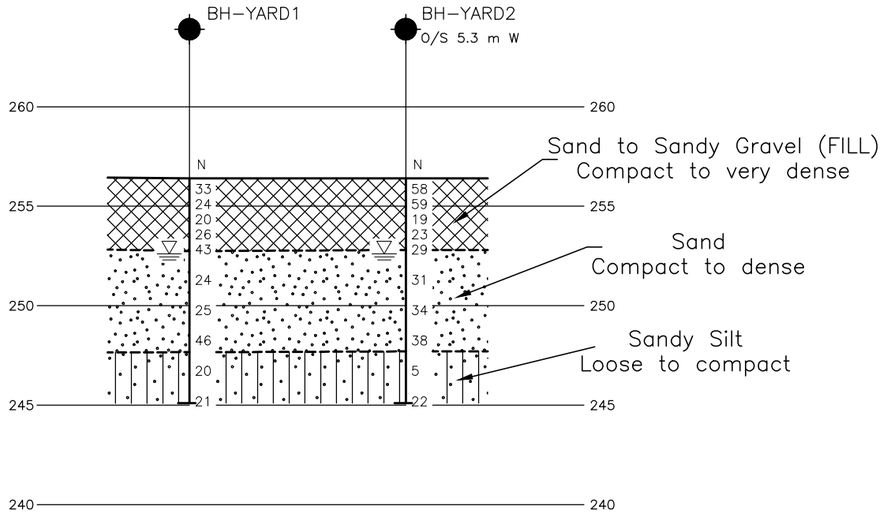
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE

6 0 6 12 m



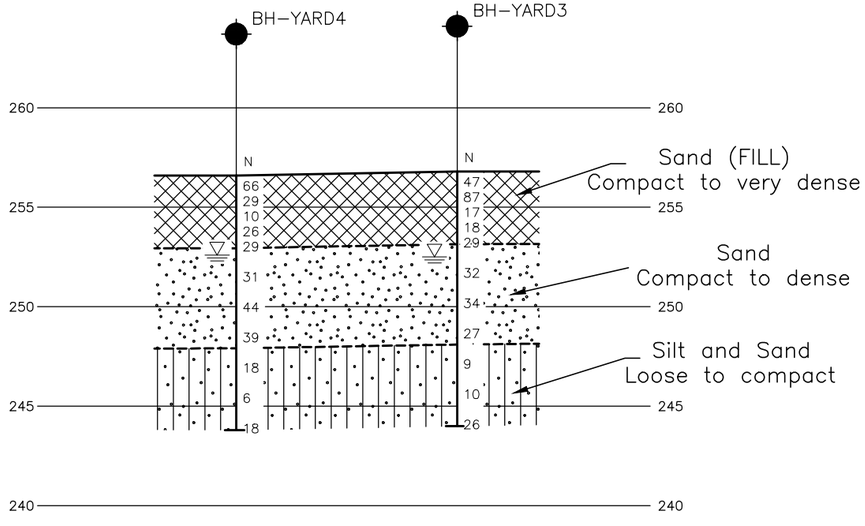
A-A'
1
SECTION

HORIZONTAL SCALE

6 0 6 12 m

3 0 3 6 m

VERTICAL SCALE



B-B'
1
SECTION

HORIZONTAL SCALE

6 0 6 12 m

3 0 3 6 m

VERTICAL SCALE

METRIC

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

CONT No.

WO No. 2014-11033

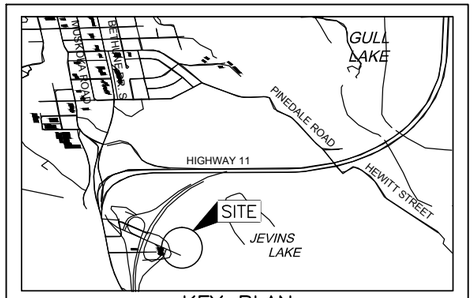
SHEET

SAND/SALT STORAGE STRUCTURE

GRAVENHURST PATROL YARD

BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates



KEY PLAN

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH-YARD1	256.4	4973399.2	315653.8
BH-YARD2	256.4	4973379.0	315663.4
BH-YARD3	256.6	4973372.9	315656.4
BH-YARD4	256.8	4973390.3	315642.6

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The complete Foundation Investigation for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Patrol Facility Site Plan (Plan H-395-11-1) provided in digital format, drawing file no. Gravenhurst Patrol Yard PLAN.pdf, dated DEC 2012, received SEP 22, 2014.

LICENSED PROFESSIONAL ENGINEER S.E.M. POOT 90471921 OCT 03, 2014 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA OCT 03, 2014 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 31D-581

HWY. 11	PROJECT NO. 14-1181-0014		DIST.
SUBM'D. DM	CHKD.	DATE: 10/6/2014	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. 1

PLOT DATE: October 6, 2014
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2014\14-1181-0014 Gravenhurst Patrol Yard\CIVIL 3D\141181014 A001.dwg

APPENDIX A

Record of Boreholes

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
FoS	factor of safety

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
υ	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

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

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	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_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
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 = $\tan\delta$
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

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
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
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.) drive open 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) Non-Cohesive (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.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel / Silty Clay with sand / Clayey Silt with sand

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RECORD OF BOREHOLE No BH-YARD1

1 OF 1 **METRIC**

PROJECT 14-1181-0014 | W.O. 2014-11033 | LOCATION N 4973399.2; E 315653.8 | ORIGINATED BY DM
DIST _____ HWY 11 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY MT
DATUM GEODETIC | DATE September 3, 2014 | CHECKED BY SEMP

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 + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.4	GROUND SURFACE										
0.0	Sand to Sand and gravel, trace silt (FILL) Compact to dense Brown Moist		1	SS	33		256		○		32 61 (7)
			2	SS	24						
			3	SS	20		255		○		0 96 (4)
			4	SS	26		254				
252.8			5	SS	43		253		○		
3.6	SAND, trace silt Compact to dense Grey Moist to wet					▽	252				
			6	SS	24				○		0 96 4 0
	Sand heaving inside augers at 6.1 m depth.		7	SS	25		250		○		
			8	SS	46		249		○		
247.7							248				
8.7	Sandy SILT, trace clay Compact Brown Wet		9	SS	20		247				
			10	SS	21		246		○		0 28 68 4
245.1											
11.3	END OF BOREHOLE Notes: 1. Water level at a depth of 3.8 m below ground surface (Elev. 252.6 m) upon completion of drilling.										

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

SUD-MTO 001 14-1181-0014.GPJ GAL-MISS.GDT 29/09/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No BH-YARD2

1 OF 1 **METRIC**

PROJECT 14-1181-0014
W.O. 2014-11033
DIST _____ HWY 11
DATUM GEODETIC
LOCATION N 4973379.0; E 315663.4
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
DATE September 3, 2014
ORIGINATED BY DM
COMPILED BY MT
CHECKED BY SEMP

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 ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.4	GROUND SURFACE										
0.0	Sand to Sandy gravel, trace silt (FILL) Compact to very dense Brown Moist Recycled asphalt noted in Samples 1 and 2.		1	SS	58		256				
			2	SS	59		255		○		71 27 (2)
			3	SS	19		254		○		
			4	SS	23		253		○		0 97 (3)
252.7			5	SS	29						
3.7	SAND, trace silt Compact to dense Brown Moist to wet					▽	252				
			6	SS	31		251		○		0 99 (1)
			7	SS	34		250		○		
			8	SS	38		249				
247.7							248				
8.7	Sandy SILT, trace clay Loose to compact Grey Wet		9	SS	5		247		○		
			10	SS	22		246		○		0 26 70 4
245.1											
11.3	END OF BOREHOLE Notes: 1. Water level at a depth of 3.8 m below ground surface (Elev. 252.6 m) upon completion of drilling.										

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

SUD-MTO 001 14-1181-0014.GPJ GAL-MISS.GDT 29/09/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No BH-YARD3

1 OF 1 **METRIC**

PROJECT 14-1181-0014 | W.O. 2014-11033 | LOCATION N 4973372.9; E 315656.4 | ORIGINATED BY DM
DIST _____ HWY 11 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY MT
DATUM GEODETIC | DATE September 4, 2014 | CHECKED BY SEMP

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 + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.6	GROUND SURFACE										
0.0	Sand, trace to some gravel and silt (FILL) Compact to very dense Brown to black Moist Recycled asphalt noted in Samples 1 and 2.		1	SS	47		256				
			2	SS	87				○		
			3	SS	17		255		○		10 90 (10)
			4	SS	18		254		○		
252.9			5	SS	29				○		
3.7	SAND, trace silt Compact to dense Brown Moist to wet					▽	253				
			6	SS	32		252				
							251				
			7	SS	34		250		○		0 93 (7)
			8	SS	27		249		○		
247.9							248				
8.7	SILT and SAND, trace clay Loose to compact Grey Wet		9	SS	9		247				
	Layer of SILT of slight plasticity at 10.7 m depth.		10	SS	10		246		○		0 34 55 11
							245				
243.8			11	SS	26		244				
12.8	END OF BOREHOLE Notes: 1. Water level at a depth of 4.3 m below ground surface (Elev. 252.3 m) upon completion of drilling.										

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

SUD-MTO 001 14-1181-0014.GPJ GAL-MISS.GDT 29/09/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No BH-YARD4

1 OF 1 **METRIC**

PROJECT 14-1181-0014 | W.O. 2014-11033 | LOCATION N 4973390.3; E 315642.6 | ORIGINATED BY DM
DIST ____ HWY 11 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY MT
DATUM GEODETIC | DATE September 5, 2014 | CHECKED BY SEMP

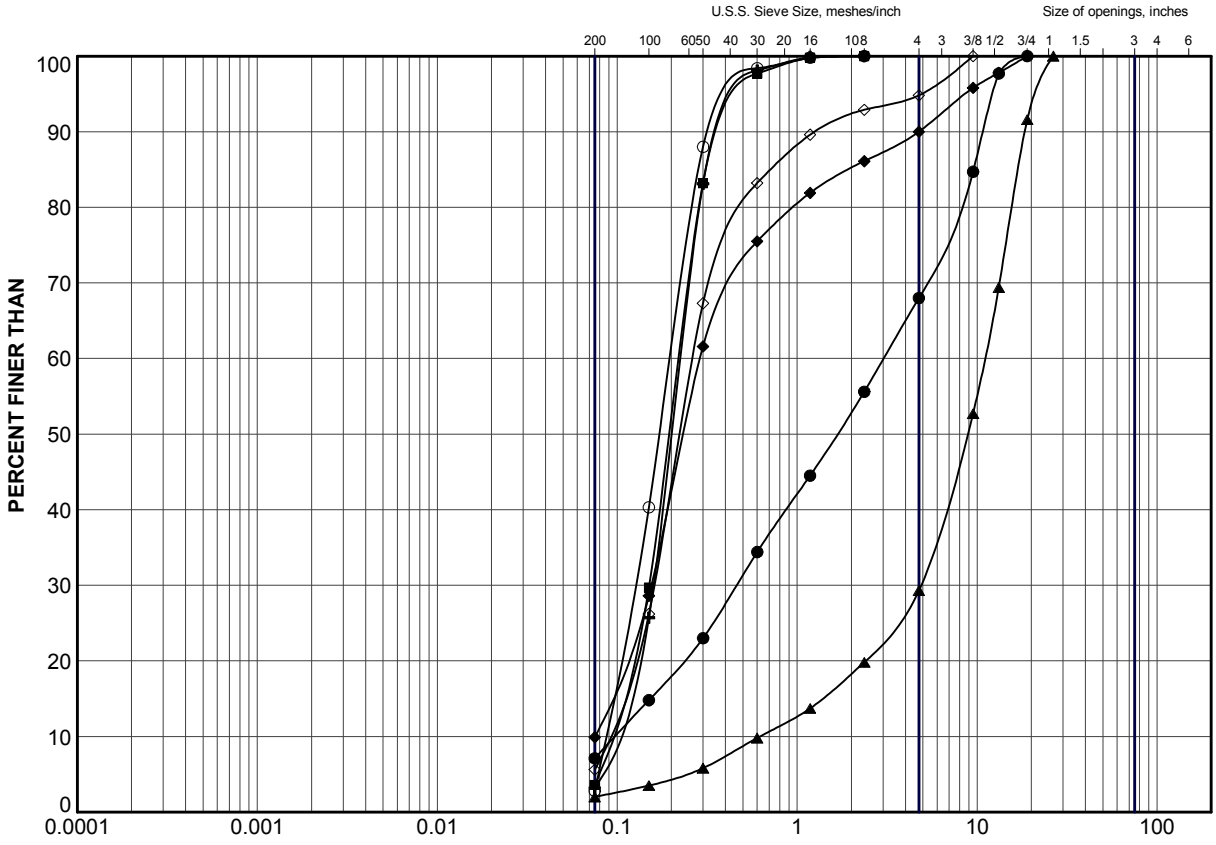
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
256.8	GROUND SURFACE										
0.0	Sand, trace silt, trace gravel (FILL) Compact Brown Moist Recycled asphalt noted in Sample 1.		1	SS	66		256				
			2	SS	29				○		5 90 (5)
			3	SS	10		255				
			4	SS	26				○		0 97 (3)
253.1			5	SS	29		254		○		
3.7	SAND, trace silt Dense Grey to brown Wet					▽	253				
			6	SS	31		252		○		
			7	SS	44		251		○		0 93 (7)
			8	SS	39		250				
248.1							249				
8.7	SILT and SAND, trace clay Loose to compact Grey Wet		9	SS	18		248		○		0 51 45 4
	Zone of CLAYEY SILT to SILT at 10.7 m depth.		10	SS	6		247		⊣○		
			11	SS	18		246		○		
244.0							245				
12.8	END OF BOREHOLE Notes: 1. Water level at a depth of 4.0 m below ground surface (Elev. 252.8 m) upon completion of drilling.						244				

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

SUD-MTO 001 14-1181-0014.GPJ GAL-MISS.GDT 29/09/14 DATA INPUT:

APPENDIX B

Laboratory Tests Results



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-YARD1	1	256.1
■	BH-YARD1	3	254.6
▲	BH-YARD2	2	255.3
✚	BH-YARD2	4	253.8
◆	BH-YARD3	3	254.8
◇	BH-YARD4	2	255.7
○	BH-YARD4	4	254.2

PROJECT

HIGHWAY 11
SAND/SALT STORAGE STRUCTURE
GRAVENHURST PATROL YARD

TITLE

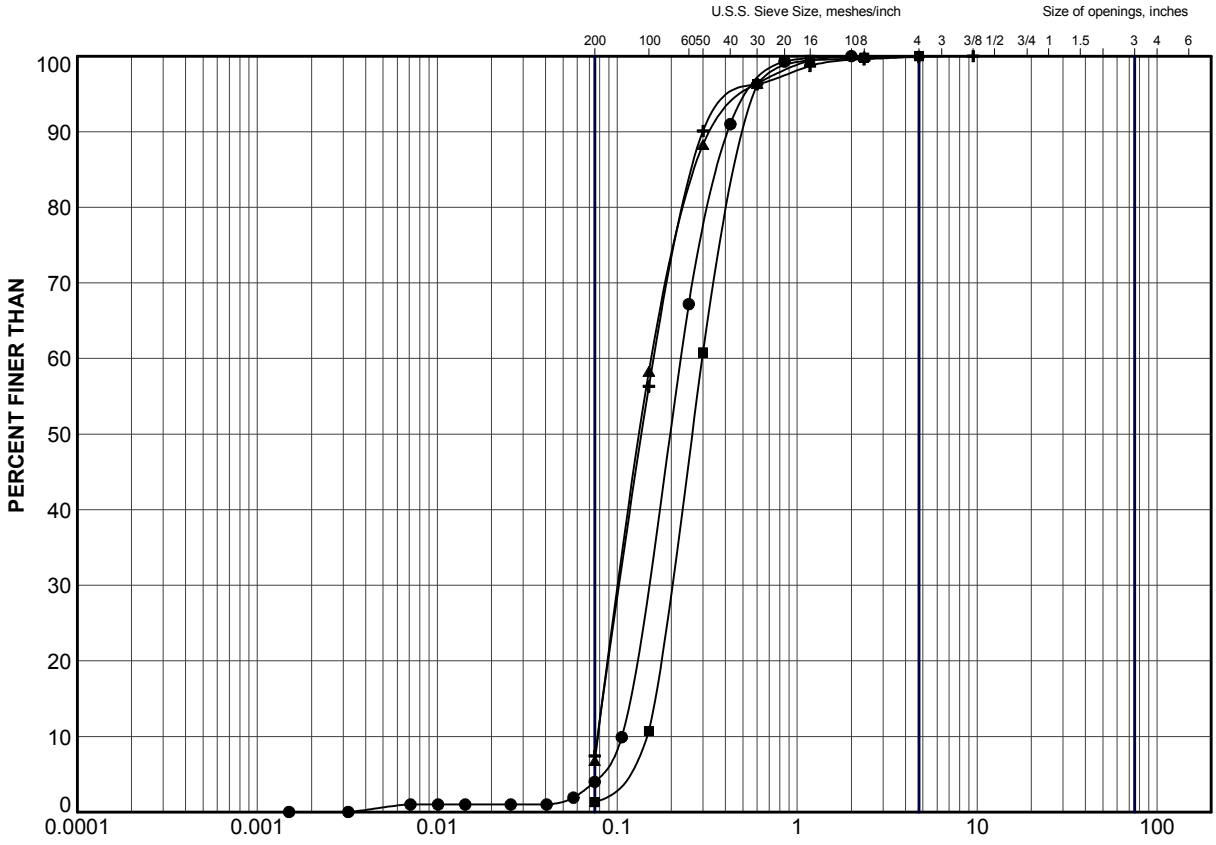
GRAIN SIZE DISTRIBUTION

SAND to SANDY GRAVEL (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	14-1181-0014		FILE No.	14-1181-0014.GPJ
DRAWN	TB	Sep 2014	SCALE N/A	REV.
CHECK	SEMP	Sep 2014		
APPR	JMAC	Sep 2014	**FIGURE B1**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-YARD1	6	251.5
■	BH-YARD2	6	251.5
▲	BH-YARD3	7	250.2
✚	BH-YARD4	7	250.4

PROJECT

HIGHWAY 11
SAND/SALT STORAGE STRUCTURE
GRAVENHURST PATROL YARD

TITLE

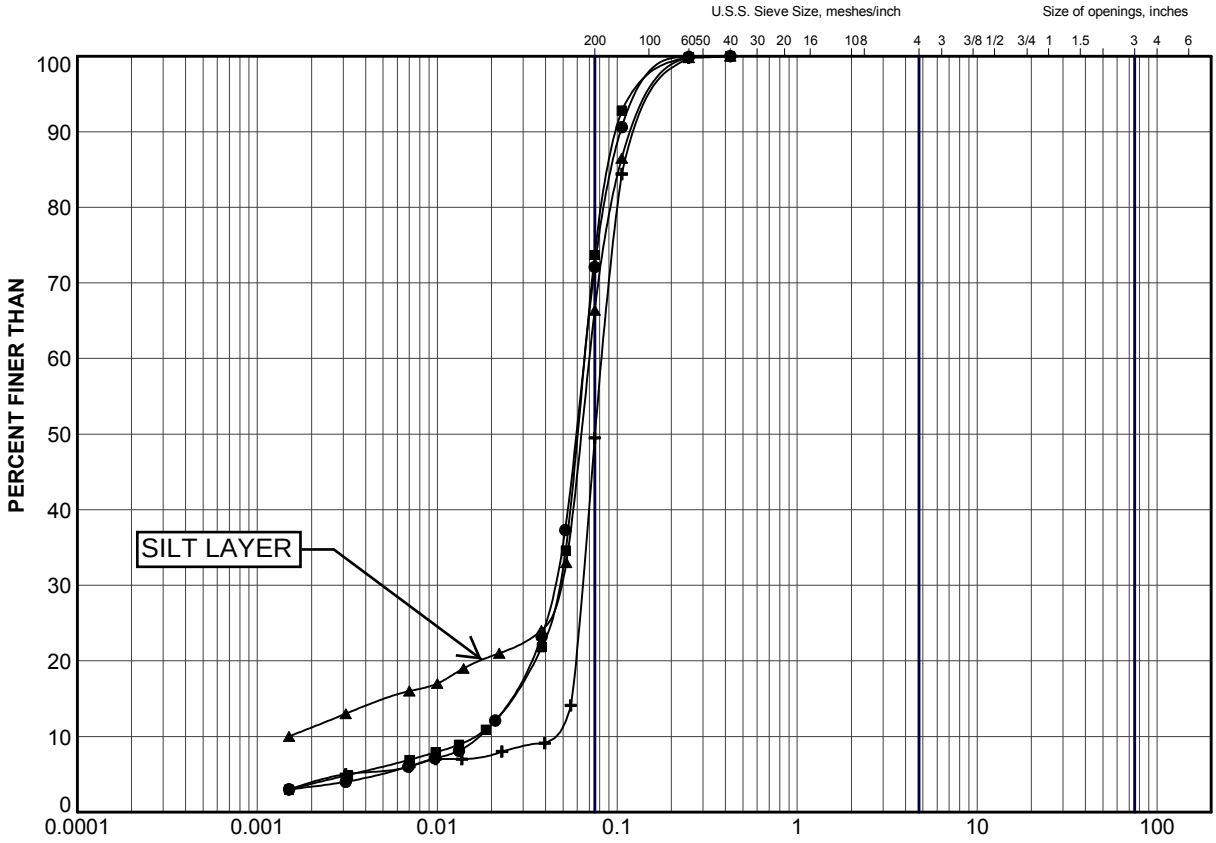
GRAIN SIZE DISTRIBUTION

SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	14-1181-0014		FILE No.	14-1181-0014.GPJ
DRAWN	TB	Sep 2014	SCALE	N/A
CHECK	SEMP	Sep 2014	REV.	
APPR	JMAC	Sep 2014	**FIGURE B2**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BH-YARD1	10	245.4
■	BH-YARD2	10	245.4
▲	BH-YARD3	10	245.6
✚	BH-YARD4	9	247.4

PROJECT

HIGHWAY 11
SAND/SALT STORAGE STRUCTURE
GRAVENHURST PATROL YARD

TITLE

GRAIN SIZE DISTRIBUTION

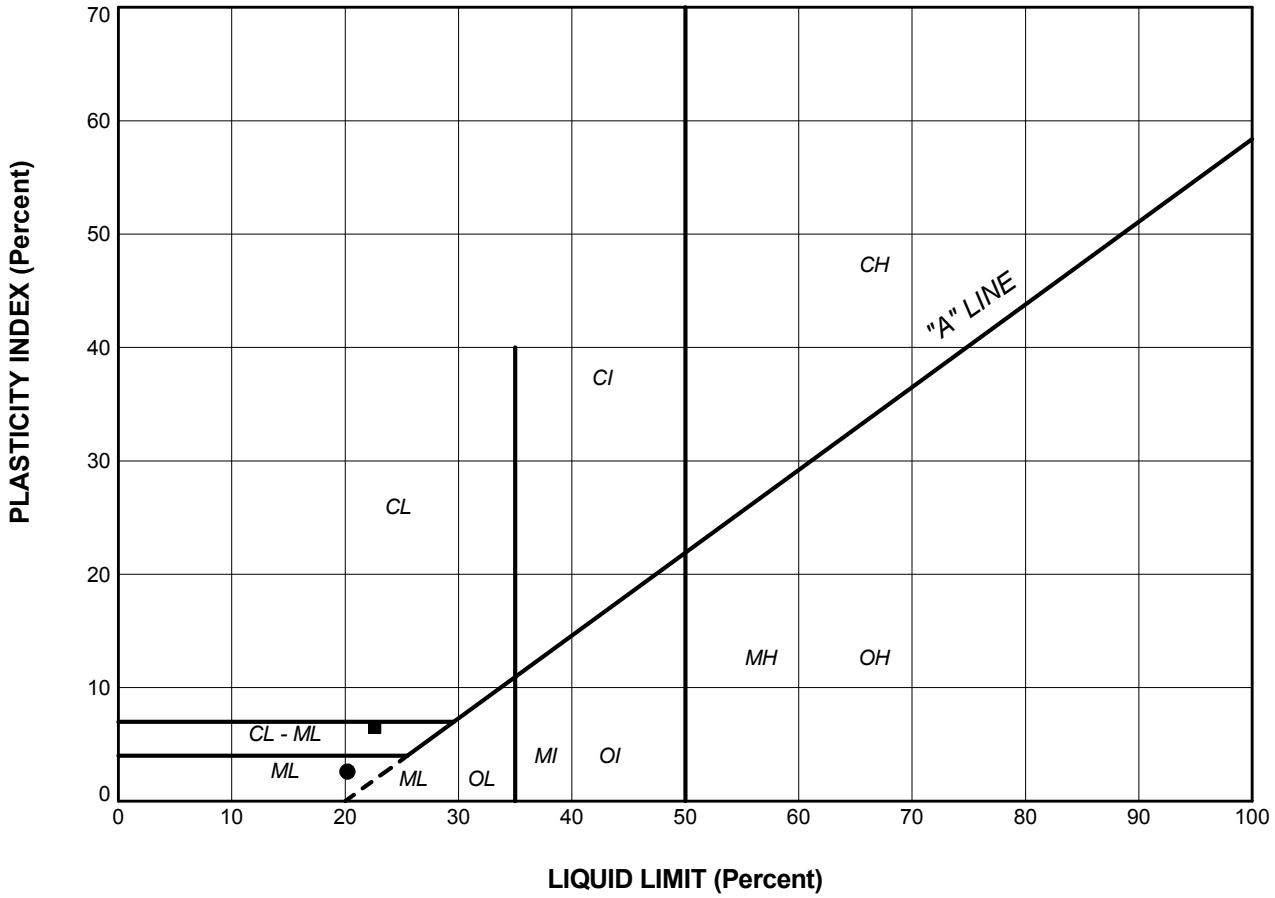
SANDY SILT to SILT and SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	14-1181-0014		FILE No.	14-1181-0014.GPJ
DRAWN	TB	Sep 2014	SCALE	N/A
CHECK	SEMP	Sep 2014	REV.	
APPR	JMAC	Sep 2014		

FIGURE B3

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LIQUID LIMIT (Percent)

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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BH-YARD3	10	20.2	17.6	2.6
■	BH-YARD4	10	22.6	16.1	6.5

PROJECT

HIGHWAY 11
SAND/SALT STORAGE STRUCTURE
GRAVENHURST PATROL YARD

TITLE

PLASTICITY CHART

CLAYEY SILT and SILT (LAYERS)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	14-1181-0014		FILE No.	14-1181-0014.GPJ
DRAWN	TB	Sep 2014	SCALE N/A	REV.
CHECK	SEMP	Sep 2014		
APPR	JMAC	Sep 2014	**FIGURE B4**	

SUD-MTO PL (NEW) GLDR_LDN.GDT

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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